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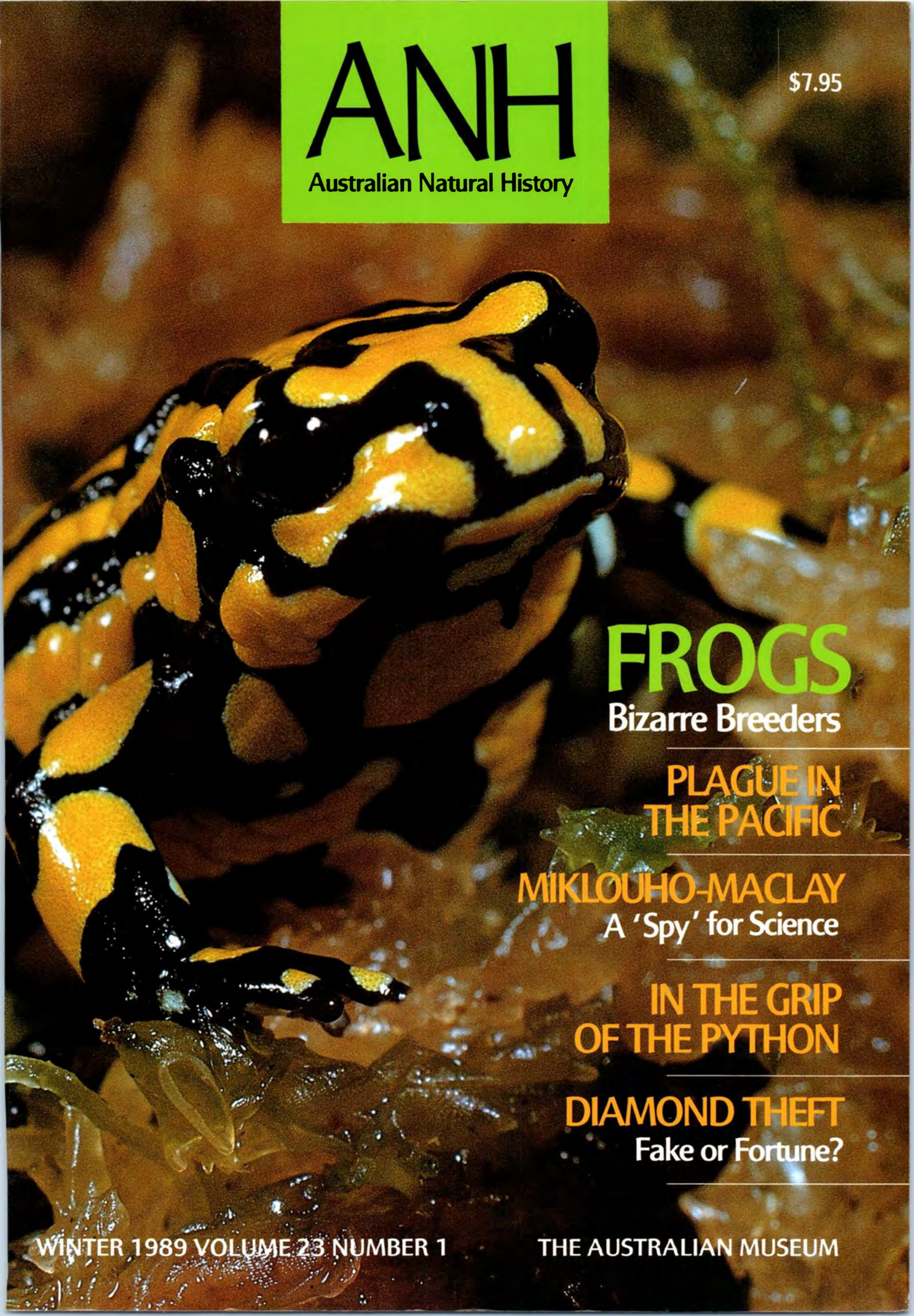

FROGS
Bizarre Breeders

PLAGUE IN THE PACIFIC

MIKLOUHO-MACLAY
A 'Spy' for Science

IN THE GRIP OF THE PYTHON

DIAMOND THEFT
Fake or Fortune?

WINTER 1989 VOLUME 23 NUMBER 1 THE AUSTRALIAN MUSEUM

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EDITOR
Fiona Doig
SCIENTIFIC EDITOR
Georgina Hickey, B.Sc.
CIRCULATION
Cathy McGahey
ART DIRECTION
Watch This! Design
PRODUCTION ASSISTANT
Jennifer Saunders
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Lisa Rawlinson
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Front Cover
Females of the brightly coloured Corroboree Frog conceal their eggs from predators by laying them in chambers beneath rocks, vegetation or soil. Other frogs have evolved some quite bizarre methods of caring for their young.
Photo: Anthony Healy.

E D I T O R I A L

ACCOUNT OVERDRAWN

BY FIONA DOIG
EDITOR

I READ SOMEWHERE RECENTLY THAT THE CSIRO was doing very important research into new sewage treatment systems that could not only save our oceans from the onslaught of raw sewage but also had viable, financially rewarding export prospects. This section of the CSIRO exists on grants totalling about $250,000. It's an appalling amount to combat a major environmental problem (particularly one created in such copious quantities); when compared to the millions the Water Board is spending on advertising to tell us everything is OK when it isn't, the funding gap is ludicrous.

The lack of priority given to science funding worries me. We are taking away from the environment more than we are putting back. Our future will not much longer be available from our physical resources, like minerals and soil. It is reaping without sowing. But it's just not going to keep working because we have overdrawn our environmental credit limit. (Mother Nature is a harsh repossessor with high interest rates.) It will happen quickly and then we'll wonder where it went.

Our future lies in efficient management, new techniques and proper utilisation of our resources, not just the physical products we create from them. All of which requires a lot of thought energy. Research is vital if we are to control and improve our resources. So is education.

Brainpower is the resource for the future. It is available in large quantities. It can be tapped *now*. Benefits from training undertaken now will be available in just a few years.

We're all a little short-sighted in our thinking, in particular, politicians whose visions for the future are myopic in the extreme. I see the effects of this every day. I see struggling graduate students without secure jobs waiting in long queues for grants and with very poor prospects for working in their chosen field. What happens now that students have to pay for their degrees? Is this another torture test for their stretched commitments?

Ask yourself what part you play. In your business or home, what products and resources do you rely upon? Will they dwindle? Are you creating enough for the future? What will you do when they run out?

Solving our ecological crises isn't as simple as planting trees to replace what has been cut down. It requires looking at the situation afresh. I don't have the answers. But there are people who have the capacity to find them. Solutions to our problems require fresh, alert minds that aren't stuck in the thick of the problem. People who can take a problem and turn it around.

In our throw-away society so much potential energy is not utilised. Our waste is buried, not recycled. But why say it is a problem? Look at its uses and turn the problem into a resource. All it takes is a marvellous piece of biological equipment, specially made for such tasks: our brains. Take the sewage problem—it is being pumped out into our oceans and causing alarming problems. Yet it can be used as a resource. Research into this *is* being done. In this country. Now. By one of those struggling graduate students. But she cannot spend a lot of time on it. She works in a restaurant and sells advertising space. In order to support herself. I know—she works for this magazine.

Just think what difference her research could make if the work involved actually financially supported her. Then add to that the countless other science graduates working outside their field, wasting their talent. That's the kind of waste we should feel guilty about. That kind of waste we need to stop. Now.

Let's invest in the greatest renewable resource we have: our minds. ■

BERNARD GIANI/AUSTRALIAN PICTURE LIBRARY

IN THIS ISSUE

FASCINATING AS HISTORICAL ARTICLES MAY BE, THE JOB OF illustrating them can be extremely difficult. Being faced with a selection of fading, ancient, black and white photos that aren't going to print well creates an artistic challenge. Fortunately some of the collections of this fascinating Russian scientist of last century are kept in the Macleay Museum. It took about a week to select, pack up, transport, unpack and set up, and return the specimens (borrowed from the Macleay Museum) for the studio shots in the article on Miklouho-Maclay (page 30). The real human skulls created the most interest among those involved in the photo shoot, with one museum person so concerned with 'voodooism' that he would not enter the studio.

Tim Flannery's idea behind the Plague in the Pacific article on page 20 came to him while at the Extinctions Conference at Sydney University in 1988. "I came out thinking about how the modern world works—the ecological crises we are experiencing now—and kept seeing analogies when looking at it through a prehistoric perspective. The plague was one of these."

The story about the great fake diamond robbery came up at a Christmas party at the Museum. Oliver Chalmers, an Australian Museum veteran, now retired, of 60 years standing in office, regales us with the tale on page 14.

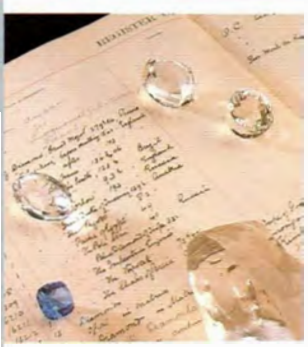
Regular contributor Tim Low's gripping tale about pythons came about when he spent a couple of months as lodge naturalist at the Cape York Wilderness Lodge. The wet season didn't dampen his enthusiasm, as is evident by reading pages 58–65.

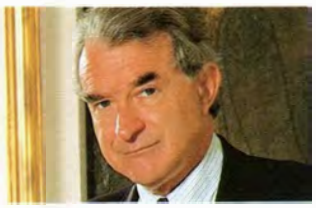
Roger de Keyzer's interest in bioluminescent insects (see page 50) was spurred on during long travels in South-East Asia. He was amazed at the size of some larvae—up to ten centimetres in length.

Regular sections abound with interesting facts and tales and the poster for this issue features two of the first fishes described in Australia.

Articles

Regular Features





Columns

LETTERS

Comments, criticisms and congratulations from concerned correspondents. Readers are invited to air their views.

Surveyors of Yore

I must shower praise with unequivocal abandon upon all those responsible for contributing to this magazine. There are no other magazines that can compare with the diversity of material included in ANH and I say this having particular regard for the high quality of production and photography. My wife, father and children find many articles most intriguing and I am bringing the magazine to the attention of others to whom I feel the same interest may be aroused.

It is indeed gratifying to read about the most valuable scientific specimens collected by surveyors past, particularly Sir Thomas Mitchell ("Stuffed and Pickled", ANH vol. 22, no. 10, 1988) and Sir Augustus Gregory ("Boabs", ANH vol. 22, no. 9, 1988). It is truly regrettable that the current batch of surveyors in 'leadership' positions have little to compare with the contributions of these great men, with the notable exceptions of the Surveyors-General of both New South Wales and South Australia.

If at times in the near future I can persuade each branch of the Institution of Surveyors to improve the wretched quality of their journals, I may seek your permission to reproduce some of the articles in your magazine that include allusions to surveyors. I believe such articles should improve the surveyors own opinions of their careers and themselves.

—John F. Brock
Smithfield, NSW

Bombing at Middleton

I have just finished reading the article "A Voyage to Elizabeth & Middleton Reefs" (ANH vol. 22, no. 11, 1988) and was interested in finding out that these reefs are slow in recovering from a possible Crown of Thorns infestation.

During the Second World War years, I was attached to 12 Squadron RAAF and in late 1944, while training at Tocumwal, New South Wales, we constantly used Middleton Reef as a bombing site. We were only using 25lb training bombs, which were dropped at random, but this could have had some effect in damaging the reef. I feel certain that our squadron was not the only outfit to use this region.

As a keen conservationist for the protection of the environment, I feel guilty in a little way, but then it was wartime and things were desperate. No excuse however.

—Jim Bigelow
Cooparoo, Qld

What impact have bombs had on our reefs?

No More Religion!

As a subscriber to your magazine, I view with alarm the appearance of a forum for sniping between atheists and creationists ("Views from the Fourth Dimension" by Michael Archer). There appears to be an inertia that leads one to believe this immaturity is condoned by the editors.

I cannot see the relevance of theological argument in a magazine of this type and would hope that the new format will eliminate such uninformed back-biting between extremists of both philosophies. Your magazine is but one of many catering for those interested in the natural sciences. If it is to survive amongst its well-presented competitors, I suggest that it should put its house in order.

—L. Johnston
Coal Point, NSW

Another Algal Blue

Ken McNamara seems to be confused as to the name of the group to which the causative agents of stromatolites belong. In his review of Jan Taylor's book, *Evolution in the Outback* (ANH vol. 22, no. 10, 1988) he accuses the author of perpetuating a number of myths, one of which is that stromatolites are made by blue-green algae, whereas, he says they are made by "organisms in a completely different kingdom, the cyanobacteria". Yet later in the same issue in his article on stromatolites he says "cyanobacteria (formerly known as blue-green algae)".

His second statement is the correct one. The blue-green algae were called Myxophyceae, Cyanophyceae or Cyanophyta, depending on how far back you go for your source. In the 1940s, studies with the newly developed electron microscope showed that their internal structure was similar to that of bacteria and not to that of other algae. Consequently the name cyanobacteria was suggested for them. Although a more logical name, and one that is gaining more acceptance in recent years, the use of this name is not universal, so the blue-green algae are variously termed Cyanophyta or Cyanobacteria, depending upon the views of the author, but both names refer to the same group of organisms.

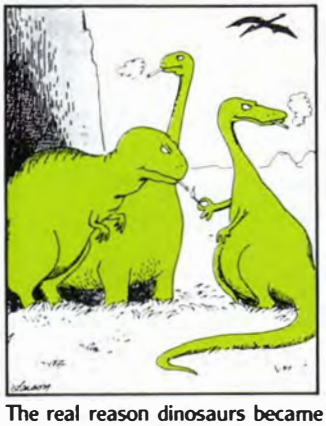
Incidentally I found this year that the stromatolites at Hamelin Pool, which I had visited and studied with no problems in 1979, now appear to be closed to the public. A much less spectacular series of stromatolites is sign-posted on the road further north, but there is no explanation as to what they are. Tourists attracted to the site by the notice are at a loss as to what to look for, as I soon discovered when I visited the site.

—F.J. Taylor
University of Auckland, NZ

The Other Dinosaur Theory

I refer to ANH vol. 22 no. 11, page 523, 'Metamorphosis' ad. I enclose authoritative pictorial documentation to answer your first question, "Why did the dinosaurs die?"

—Dr A.C. Behrndt
Tanunda, S.A.



The real reason dinosaurs became extinct, according to cartoonist Gary Larson.

What Next?

At the conclusion of the article "The Nature of Australia" by Robyn Williams (ANH vol. 22, no. 11, 1988–89) he asks "What next?" in reference to the documentary and any future steps towards the recognition of our heritage.

The 'What next' happened to be the presentation of the Australian Bicentennial Heritage Award to John Vandenbeld on 30 November 1988. The award was presented by the Australian Council of National Trusts together with national sponsors

AUSTRALIAN BICENTENNIAL HERITAGE AWARD

John Vandenbeld accepting the Australian Bicentennial Heritage Award for *The Nature of Australia.*

Jones Lang Wootton and FAI Insurance Group. In presenting the special award we recognised that the ABC Natural History Unit had skilfully and effectively used the film-makers' craft to bring to a world audience a picture of the unique natural treasures of Australia. An extremely successful and important step towards the understanding of our natural heritage.

We continue to recognise outstanding contributions to the preservation and promotion of Australia's heritage in our Australian Heritage Award, which is presented in April each year during Heritage Week.

—Fiona Peechey
Australian Heritage Award Secretariat

Hunting Showdown

What a bland and apparently dispassionate apologia for shooting ("Hunting", ANH vol. 22, no. 11, 1988)! With such commendations (could Dr Cowling possibly be a shooter?), I'm surprised that hunting is not compulsory for everyone.

"For centuries, hunting has been an acceptable form of recreation... so too was bear baiting and cock fighting.

"It was once the province of the rich...now anyone may, if they choose, hunt..." So too with warfare—and the similarity of course does not end there.

"Decisions on whether a species is hunted should primarily depend on technical conservation criteria". What presumption, and what a limited and restricted view of wildlife!

The argument based on a human instinct to hunt assumes that there *is* such an instinct (as opposed merely to eat), and that instincts *should* still be satisfied (what about 'instincts', for example, for forceable sexual conquest?). Of course "recreational hunting can provide useful products"; so does pillage in wartime—and again the similarity does not end there, as the hunter *removes* from others *their* opportunity to observe and enjoy in their way the hunted animal.

"From a conservation viewpoint, hunting has had benefits". So too has tourism, photography—and the resource is not thereby reduced or limited.

"At any time the environment can support a certain population, and often the mortality caused by hunting would be replaced by other less 'humane' kinds of mortality if hunting did not occur." How many ducks are 'humanely wounded' instead of killed outright? If kangaroos overpopulate national parks and require culling, it should be done by professionals and not by those to whom killing is a sport. (And 'sport' is of course the critical difference between professional slaughter for food or culling, and 'acceptable recreation').

How many hunters *are* 'responsible', 'humane', and *do* discriminate between legitimate 'target' and 'nontarget' species?

"Fees for hunting licences and registration...contribute at least $5 million annually...a proportion of these funds are dedicated to wildlife conservation". The tobacco lobby makes a similar argument apropos of taxation—which funds health service costs relating to tobacco-induced illness. How much of that $5 million simply goes in an attempt to *regulate hunting*?

Dr Cowling's article is an exercise of monumental and blatant hypocrisy, and should mislead few readers of *Australian Natural History.*

—Dr John Bradshaw
Belgrave South, Vic.

QUIPS, QUOTES & CURIOS

COMPILED BY GEORGINA HICKEY
SCIENTIFIC EDITOR

Throwing up a Grubby Defence

If humans have been ingenious at devising defensive strategies, insects haven't been slouches either, and they've been at it a lot longer. Stings, slime and stinks have been special favourites, but caterpillars have mastered, more than any other group, the art of 'defensive regurgitation' to help them survive. As if chundering on your attacker is not bad enough, some caterpillars have found all manner of chemical cocktails to make the message stick. Carnivorous ones may throw up defensive chemicals collected from their prey (a lot of good it did them!), while herbivorous ones that eat the leaves of coca plants reportedly produce a cocaine-laced vomit.

Ecologist Steven Peterson and colleagues at the State University of New York at Stony Brook recently uncovered another cunning example of chemical warfare in insects (*Ecology* 68: 1268–1272, 1987). North American Eastern Tent Caterpillars (*Malacosoma americanum*), when bothered by predatory ants, regurgitate a droplet of liquid that has a strong deterrent effect, but only when the caterpillars have dined on young Black Cherry leaves (*Prunus serotina*). By comparison, when Peterson and his team fed the caterpillars crab-apple leaves, the ants were not put off by the vomit; and a diet of mature Black Cherry leaves only minimally repelled the ants. Closer examination showed that young Black Cherry leaves are rich in prunasin, a substance that breaks down during digestion to release hydrogen cyanide and benzaldehyde. And, much to the scientists' surprise, further tests revealed that it was only the benzaldehyde component of anide as would be expected, that repelled the ants. Just how the ants perceive the offending vomit is not known, but the tent caterpillars clearly take advantage of their potent diet—they carefully deposit pheromone trails leading to young leaves with the greatest amounts of prunasin.

—B.B.

Guaranteed to Make You Yawn

It seems that the most common things in life are often taken for granted. Such is the case with the yawn. Most of what we know about yawning has been built on popular wisdom. It is only recently that the yawn has come under the scientific spotlight.

A yawn is characterised by gaping of the mouth, accompanied by a long inspiration followed by a short expiration. It often occurs in conjunction with stretching of the limbs. Neurological evidence for this comes from the fact that hemiplegics, much to their amazement, may involuntarily stretch otherwise paralysed limbs during a yawn. A yawn is an all-or-none action (try stifling a yawn midstream!), and is usually associated with drowsiness or boredom. In fact yawning in public is taken as a clear but rude signal of these states.

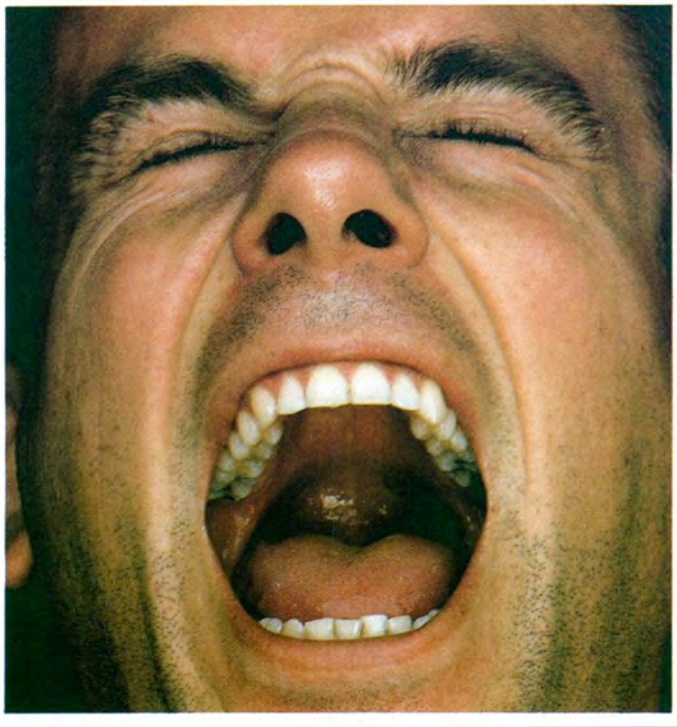
Robert Provine and colleagues from the University of Maryland experimentally confirmed the popular notion that yawning in humans is most prevalent in the morning after waking and just before retiring (*Ethology* 76: 152–160, 1987). The correlation between yawning and times of low arousal has led to the commonly held assumptions that the role of yawning is to clear the lungs of 'bad air' (carbon dioxide) that accumulates during shallow breathing and/or to raise the level of oxygen in the blood to increase alertness. However, Provine and colleagues have found no support for these respiratory hypotheses: yawning is not affected by breathing increased amounts of oxygen or carbon dioxide, or by vigorous exercise; infrequent yawners do not compensate with longer yawns or *vice versa*; and 'yawning through the nose' during clenched-teeth yawns or simple oral inhalation does not satisfy the urge to yawn (*Ethology* 72: 109–122, 1986).

The fact that it is nigh impossible to have a satisfactory yawn with clenched teeth suggests to Provine an important function of the gaping component of the yawn. Contraction of facial muscles during a yawn would force blood through the cerebral blood vessels to the brain which, presumably, would increase alertness. It also has the function of opening the eustachian tubes, balancing the atmospheric pressure between that of the middle ear and the environment.

Probably the most extraordinary aspect of yawning is its contagiousness. Witnessing yawns, reading about them, listening to them or even thinking about them stimulate yawning. (It is most likely that you have yawned while reading this!) Provine and colleagues suggest that the infectious nature of the yawn may have an important signalling function that synchronises the bedtime behaviour of a group of animals. The gaping component of the yawn might signal sleep and the stretching component (which Provine found to be significantly correlated with waking yawns but not those on retiring) a readiness for action. Several advantages would be incurred. Sleeping together helps keep animals warm and protects them from predators; being awake at the same time allows the animals to hunt together, thereby increasing their efficiency to obtain food.

If yawns are social signals that help animals communicate their states and intentions to one another, one wouldn't expect to observe yawning in non-communal animals. The Bearded Dragon, however, is one example of a non-communal yawner, and no doubt there are more. But then yawning in these animals may only superficially resemble human yawns and, until the physiology of the behaviour in other animals has been studied, it is thus dangerous (although tempting) to assume similar human functions.

—G.H.



ANTHONY FARR

Yawning is contagious.

Bob Beale, Sydney Morning Herald's science writer, is a regular contributor to QQC.

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Bats' spindly legs and their need to hang upside down are evolutionary trade-offs for flight.

Why Bats Hang Upside Down

When bats first took to the night skies more than 55 million years ago, they left behind many of the perks of quadrupedal life. The evolutionary trade-off for the large, magnificent wings, which enabled them to fully exploit the post-Cretaceous flush of night-flying insects, were spindly little legs that could not support their weight. Bats may have been free to colonise the four corners of the Earth but actual landings on terra firma became a little tricky.

Flight, it seems, called for some radical remodelling of the proto-bat body. In their biomechanical analysis of bat-being, US scientists D. Howell and J. Pylka speculated on how and why this remodelling took place (*J. Theor. Biol.* 69: 625–631, 1977). They suggested that the most obvious bat specialisations are responses to the need to lighten the bat frame to reduce flight loadings.

The solution adopted by bats appears to have been similar to that used by the extinct reptilian pterosaurs. In both groups, the developing flight apparatus—an elastic membranous layer of skin, muscle, nerves and blood vessels stretched over a bony frame—was inextricably tied to the forelimbs: so it was the hindquarters that were sacrificed. Birds, the only other vertebrates capable of sustained flight, retained powerful running hindlimbs, overcoming their weight problem by lightening the bones themselves, losing their teeth and developing primary feathers as their wing surface. In bats and pterosaurs, the pelvis and legs became extremely gracile. In at least bats, long legs were needed as struts for spread and control of the tail membrane and so couldn't be drastically shortened without effecting flight efficiency. But they could be much thinner.

And thinner they became. Too skinny to support a normal four-footed mammal of equal size and weight, and too skinny to bear the weight of the by-then very top-heavy, budding bat. Bats must have quickly found themselves on the other side of the branch, hanging upside down.

The inverted position had its advantages. The weight-bearing forces of suspension are very different from those of compression (as anyone with a bad back and a distorted clothes line will know). In bats, ligaments and tendons in the foot and leg share the load, making hanging a relatively passive process. As Howell and Pylka point out, a dead bat can be hung up by its hind claws.

FORD KRISTO

Despite bats' inability to stand on their own two feet, they are adept at scurrying along the ground. Shown here is *Tadarida australis*.

Despite their inability to stand on their own two feet, bats are by no means helpless on the ground. The amazing ability of a grounded bat to rapidly scuttle backwards across a flat surface or straight up a wall has inspired some unforgettable scenes in Dracula movies. In bats, the upper leg bone (femur) is rotated 180° beyond the normal mammalian position so that the knees actually bend backward. 'Spider-like' is a word often used to describe the posture of a bat's hindlimb at rest on a flat surface. This posture is geared to reducing compression forces on the legs by cradling or suspending the body when the bat moves along the ground, the backwards motion actually pulling the weight rather than pushing or carrying it.

Early roosting habits probably helped shape the bat body. If, as is often suggested, early bats hid during the day in crevices between rocks or under bark, a flat bat may have been a happy bat. A roost located between a rock and a hard place perhaps encouraged lateral extension of the legs with an attendant rotation of the femur and supination of the hind foot. Toes may have rapidly transformed to act as a single hook for suspending the body from cave walls or other rough surfaces such as bark. And so it came to pass that orthodox bat behaviour was born.

But somehow the rules of bat-being did not reach all players. The three vampire bat species of central and South America (see ANH vol. 21, no. 7, 1984–85) remain truly quadrupedal, tiptoeing up to their sleeping prey with head and body raised and stout legs angled in 'proper' mammalian fashion. Having reversed the trend for skinnier legs, the vampires make good use of them, commonly jumping metres—laterally—out of the way of a kick or swipe from a less than delighted dinner 'host', before dancing back for dessert.

Bats may be bizarre in their wings and their ways but we should not forget that they comprise almost one quarter of all living mammals. More mammals hang upside down than have hooves. The topsy-turvy world of the bat is no fly-by-night practice—it is. for a mammal, the only way to fly.

—Sue Hand
University of NSW

IRENE PEPPERBERG

Alex, the conversational African Grey Parrot.

Polly Want Some Alphabet Soup?

What's the best way to train a parrot to speak? Australians, blessed as we are with a multitude of talking birds like corellas and cockatoos, have more than a passing interest in the subject. Irene Pepperberg, a visiting assistant professor in the Anthropology Department of Chicago's Northwestern University, thinks she's hit the jackpot with an African Grey Parrot (*Psittacus erithacus*) named Alex (*Bird Talk* Sept./Oct. 1984: 16–19; *New Sci.* 30 July 1987: 28). Over the past decade Alex has learnt the correct English labels for more than 30 different objects, seven colours, five shapes and quantities up to six. He can combine individual words to describe about 80 different objects and can distinguish the quality that makes two objects different. He asks for specific items and even 'tickling', and learnt the word 'grey' by asking about the colour of his mirror image.

Alex became an intellectual conversationalist by dint of Pepperberg's training technique, which relies heavily on a human model or 'rival' to prompt Alex to outdo the rival to get the attention of the principal trainer. Equally important, says Pepperberg, is that other trainers have erred in using food rewards for birds that correctly name objects: she says the trick is to reward the bird with the object itself, which in Alex's case usually means an enjoyable session destroying the thing with his beak.

Pepperberg hopes that some day her 'model/rival' approach can be used to help autistic, withdrawn or non-communicative children, and those suffering from echolalia—a disorder characterised by the senseless repetition of words, which at one time was all that parrots were thought capable of.

—B.B.

Action Plan for Australian Marsupials

Nobody doubts that Australia's unique mammals have suffered greatly since European settlement of this continent. The greatest loss of species has occurred in the dry sclerophyll to woodland habitats—those suitable for farming or easy pastoral exploitation. The marsupials have been particularly hard hit in terms of diversity and, in recognition of the urgent need to coordinate overall conservation measures, a special project aimed at developing an 'Action Plan for Australian Marsupials' has been set in motion.

The 'Species Conservation Program—1987/1990' of IUCN's Species Survival Commission (SSC) has, as one of its prime objectives, the development and publication of species 'Action Plans'. Action Plans are being developed by SSC Specialist Groups around the world, often with the financial support of the World Wildlife Fund (WWF) and the United Nations Environment Program (UNEP).

Action Plans document the current status of species, identify specific problems and make recommendations to correct these. They are distributed widely among government and United Nations agencies and non-government conservation organisations, and are valuable in influencing national policies and funding priorities.

In Australia, the SSC's Australasian Marsupial Specialist Group, with full financial support from WWF Australia, is embarking upon a one-year project to develop an 'Action Plan for Australian Marsupials'. It is hoped that, by involving Australia's leading scientists

A.G. WELLS/NPIAW

C.A. HENLEY/NPIAW

A.G. WELLS/NPIAW

These endangered marsupials are just some of the threatened species that may be covered by the Australian Marsupial Action Plan. Above: Bilby. Left: Northern Hairy-nosed Wombat. Right: Brush-tailed Bettong. Below: Numbat.

PROVISIONAL LIST OF 'THREATENED' MARSUPIALS SUBJECT TO ACTION PLAN

Common Name	Species	Status
Long-tailed Dunnart	*Sminthopsis longicaudata*	Insufficiently known
Sandhill Dunnart	*S. psammophila*	Insufficiently known
Julia Creek Dunnart	*S. douglasi*	Indeterminate
Dibbler	*Antechinus apicalis*	Indeterminate
Red-tailed Phascogale	*Phascogale calura*	Indeterminate
Numbat	*Myrmecobius fasciatus*	Endangered
Western Barred Bandicoot	*Perameles bougainville*	Rare
Bilby	*Macrotis lagotis*	Endangered
Leadbeater's Possum	*Gymnobelideus leadbeateri*	Vulnerable
Northern Hairy-nosed Wombat	*Lasiorhinus krefftii*	Endangered
Long-footed Potoroo	*Potorous longipes*	Indeterminate
Brush-tailed Bettong	*Bettongia penicillata*	Endangered
Burrowing Bettong	*B. lesueur*	Rare
Desert Rat-kangaroo	*Caloprymnus campestris*	Indeterminate
Rufous Hare-wallaby	*Lagorchestes hirsutus*	Rare
Banded Hare-wallaby	*Lagostrophus fasciatus*	Endangered
Bridled Nailtail Wallaby	*Onychogalea fraenata*	Rare
Proserpine Rock-wallaby	*Petrogale persephone*	Rare

The development of the Australian Marsupial Action Plan will be based primarily upon the IUCN's list of threatened mammals (that is, those denoted and defined by the Union as endangered, vulnerable, rare, indeterminate or insufficiently known), although the species covered by the plan will be reviewed as research progresses.

D. WHITFORD/NPIAW

and wildlife managers, the project will be able to identify the precise steps needed to be taken to ensure the long-term survival of all the marsupials under threat (as defined by the IUCN). In effect, an attempt will be made to detail management plan requirements for each species.

The WWF has established a Steering Committee to monitor the projects's implementation. The members of this committee are Professor Alistair Gilmour (Chair), Associate Professor Michael Archer, Ronald Strahan, Dr George Wilson, Dr Martin Denny (Marsupial Group Chair), Dr Ray Nias and myself. The individual members of the Marsupial Specialist Group will provide the base scientific expertise for the program, although information will be welcomed from all sources. If you have any comments pertinent to the program, particularly information relating to status and management requirements, please let us know.

—Michael Kennedy
Australian Marsupial Action Plan
PO Box 302, Avalon, NSW, 2107

The Fungus and the Fly

Flowering plants often use insects as pollinators but a role for insects in fertilisation outside the seed plants is not as well known. Thomas Bultman and James White, from the University of Texas at Austin, have recently discovered insect fertilisation of a fungus by the actions of a fly (*Oecologia* 75: 317–319, 1988). Like many fungi, this one, *Epichloe typhina*, is a 'parasite', spending much of its life inside the stems of forage grasses. When it is ready to reproduce it grows to the outer surface of the stem where it releases spores. When this happens, a particular fly, *Phorbia phrenione*, licks the fungus and lays its eggs on top of it. The fly moves from fungus to fungus, repeating the action. In the process, it carries male and female spores to other spores, so that fertilisation can take place. In return for these favours, the fly larvae consume the fungus. Although the association between the fly and the fungus has been known for some time, the fly was thought only to be a parasite on the fungus. It now seems that theirs is a mutual interaction, with both fly and fungus benefiting. **—B.B.**

Contemplation of the Navel

Why is it that men (and not women) collect blue fluff in their navels? Tim Albert, Editor of the *British Medical Association News Review*, published possible reasons for this everyday phenomenon (*BMA News Rev.* Aug. 1984, p. 17).

Firstly, the phenomenon is not strictly blue. It appears that the colour of the fluff is related to the colour of men's clothes. Blue hues are evidently preferred. There also seems to be a direct correlation with the depth and concavity of the belly button; the habit of wearing cotton as opposed to silk and nylon; and the degree of hirsuteness. With regard to the latter, abdominal body hair tends towards the navel, as do roads to Rome. Fluff particles caught in this bristly trap are directed to the navel whenever the body moves. This would explain why the phenomenon of belly button fluff is less common in women, and presumably, in men bereft of body hair. So now you know.

—G.H.

Like roads to Rome, abdominal body hair directs fluff into the navel. Glenn Hunt (Australian Museum), is the obliging owner of this impressive umbilicus.

ANTHONY FARR

CATHY McGAHEY

The Indian Ocean north-west of Australia showing the relative positions of Broken Ridge, Ninetyeast Ridge and the Exmouth Plateau.

Earth-moving Discoveries on the Ocean's Bottom

The mammoth international Ocean Drilling Program last year (1988) made some Earth-shattering finds in the Indian Ocean, west of Australia, including evidence that a huge sea-floor ridge there was once above sea level (*Nature* 335: 593–594, 1988). Broken Ridge lies directly west of Perth, running east–west between about 85° and 100° east. The drilling showed that it and another long narrow ridge—Ninetyeast Ridge—running north at right angles to Broken Ridge, were formed by volcanic activity at different times. Broken Ridge is the older of the two, being formed about 90 million years ago. The scientists found clear evidence that a rifting episode lasting around three to seven million years occurred in middle Eocene times (40–50 million years ago). The southern escarpment of the ridge rose more than two kilometres until it cleared the sea surface, before sinking again like the mythical Atlantis. Ninetyeast Ridge, on the other hand, was formed about 80–38 million years ago as the Indian Plate moved north over a 'hotspot', leaving a trail of lava 5,000 kilometres long and 200 kilometres wide.

On a later leg of the Program, a rich haul of sediments was recovered from Exmouth Plateau (*Science News* 134: 166, 1988). The sediments chronicle the break-up of the ancient supercontinent Pangaea, the waxing and waning of sea levels, the evolution of calcareous nanoplankton (tiny marine plants with a hard covering of calcium carbonate, which were, at various times in Earth's history, the dominant plankton), and the oldest section of sedimentary rock ever obtained during scientific ocean drilling. The rocks date back to late Triassic times, about 220 million years ago. The plateau sits on a sunken piece of Australia that was once attached to India, and the clay and silt that make up the Triassic rocks were formed at the bottom of shallow seas or river deltas along the former coast of Pangaea.

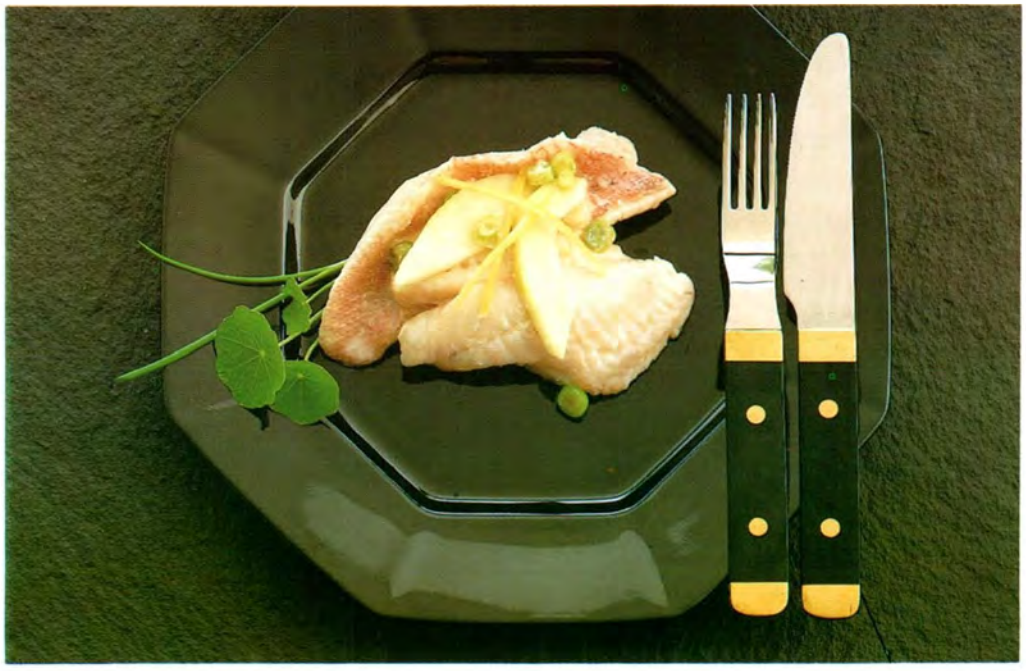
—B.B.

A Fish a Day . . .

. . . keeps the doctor away? It may not sound right, but our finny friends are rapidly assuming the status of apples in popularity for a healthy diet. Various studies have shown that communities with a high fish diet, such as Greenland Eskimos, suffer less cardiovascular disease than most meat-oriented societies. Medical researchers, in the search to uncover why fish diets might help ward off disease, have focused their attentions on omega-3 fatty acids, which are found in high concentrations in fish oils. Recently, Paul Fox and Paul DiCorleto, of the Cleveland Clinic Research Institute, have shown that omega-3 fatty acids inhibit the production of the 'growth factor' PDGFc—a protein that stimulates the growth of vascular smooth muscle cells, which normally line the outside of a blood vessel (*Science* 241: 453–456, 1988). Too much PDGFc can lead to a build-up of the smooth muscle cells, which then penetrate the wall of the blood vessel and, often in conjunction with cholesterol, constrict the flow of blood. That makes blood clots more likely to block the vessel and trigger a heart attack.

The protective effect gained by the ingestion of fish oils might also be due to other mechanisms. Omega-3 fatty acids apparently reduce platelet stickiness (and hence blood clotting) by about 30–40 per cent, and they may somehow stimulate the production of chemicals that reduce cholesterol levels in the blood. Whatever the method, before dredging up that dusty bottle of cod-liver oil, it is worth knowing that a higher concentration of omega-3 fatty acids occurs in the muscle of the fish. Fillets of fish, besides being better for you, are a lot more palatable!

—B.B.



We all know that fresh fish is good for you, but now we are closer to knowing why.

COURTESY NSW FISH MARKETING AUTHORITY

Eggs that Swim

Notheia anomala is an Australian brown algae that grows on, and in some degree parasitises, other brown algae, notably *Hormosira* plants—branched strings of round brown beads that adorn many Australian beaches. (Gary Gibson and Margaret Clayton have written about it in a recent issue of *Phycologia* 26: 363–73, 1987.) Although there are many cases of parasitism of red algae on other red algae, the phenomenon (called adelphophytism) is almost unknown among the brown algae (Phaeophyta).

Another unusual (although not unique) feature of *Notheia* is the motility of its egg cells (female gametes). Like the male gametes, they have a pair of flagella (lash-like appendages), with which they trundle around in the water. But unlike other kinds of egg cells when newly shed, such as those of most fishes, they seem in no hurry to be fertilised, and in nature they appear primarily interested in finding a place to settle—namely, a suitable site on a host plant that they can later draw on for nutrients. They presumably 'home in' on such sites by following chemosensory cues.

Only when they have settled down do these eggs attract spermatozoids (male gametes), perhaps by a chemical pheromone. The sequence of chemical influences is neat. One chemical substance, produced by the host plants, attracts the female gametes, and later another, produced by the settled eggs, attracts the sperm cells. One of these fertilises each egg. The resulting zygote then begins its life of parasitism, producing a plant that burrows into the host tissue, perhaps deriving some nourishment from the metabolites of its distant relative. However, like the mistletoes, *Notheia* plants are not completely dependent on parasitism, since they presumably have the same kinds of brown and green pigments as are found in other brown algae and can photosynthesise just as well as free-living seaweeds.

Notheia is of additional interest because of its phylogenetic order Fucales. Many European and American school children and college students learn that the brown seaweed *Fucus* is diploid like animals—that is, the cells have two similar sets of chromosomes, as opposed to the haploid condition found in many algae and other plants. Female *Fucus* organs (oogonia) produce, in neat packets of eight, relatively large and non-motile eggs that are immediately ready for fertilisation, which restores the diploid condition as it does in animals. And many students have to write essays comparing *Fucus* to animals and discussing how such all-diploid plants might have evolved. This sort of discussion has always involved a lot of guesswork. But now, perhaps, we have a partial answer: they may have come from some ancestor like *Notheia* with large motile female gametes, which in the course of evolution lost their flagella and became eggs like those of *Fucus*.

For botanists, as for zoologists, the Antipodes are full of surprises waiting to be discovered.

—Ralph A. Lewin
University of California

The brown algae *Hormosira banksii*, colloquially referred to as Neptune's Necklace, is often parasitised by another brown algae, *Notheia anomala*.

RALPH A. LEWIN

WHAT'S IN A NAME?

Why are Frenchmen Called Frogs?

It is not, as one might think, a derogatory expression based on their predilection for the back legs of the edible frog *Rana esculenta*. Frenchmen (actually Parisians) coined the term themselves from their ancient heraldic device of three erect, dancing frogs. As long ago as 1791, a common court phrase at Versailles was *"Qu'en disent les grenouilles?"* ("What do the frogs [people of Paris] say?").

But there is point in this good-humoured raillery. Paris was once a quagmire called Lutetia ('mud-land') and it is said that the people, like frogs, lived in the mud. Further point is given by the unique French cuisine, which to the English was distasteful.

—G.H.

A Frenchman by any other name?

JEAN-PAUL FERRERO/AUSCAPE

"The thief prised open the doors of the Florentine showcase and took the famous diamonds. No clues to his identity came to light."

THE GREAT (FAKE) DIAMOND ROBBERY

BY OLIVER CHALMERS
FORMER CURATOR OF MINERALS
AUSTRALIAN MUSEUM

AN INTERESTING STORY FROM THE Australian Museum archives concerns the theft of faceted gemstones and seven models of famous historical diamonds from a showcase in the Mineral Gallery in 1968. Although a serious matter at the time, there is a humorous side to the story.

The burglar managed to evade the patrolling attendants at closing time and thus had unimpeded access to the display collections. Needless to say, the Museum at that time had a very unsatisfactory security system.

The use of diamond models for display in mineral galleries is standard practice in all major natural history museums around the world. They are made from 'paste' or 'strass'—a glass containing a high content of lead oxide. The refractive index of the glass is increased resulting in brilliance comparable to that of diamonds. It also imparts a degree of colour dispersion comparable to diamonds. White light entering a transparent substance such as a faceted gemstone is separated into its component colours. The degree of dispersion is greater in diamonds faceted in the correct proportions than in all other gemstones. Thus in a well-cut diamond, we see flashes of violet, blue, green, yellow, orange and red (the colours of the spectrum) emerging from the top surface of the stone. This phenomenon is known as 'fire'. The imitations show a degree of fire comparable to that of diamonds. The disadvantage is that the lead glass is very soft and easily scratched and chipped. Had these paste imitations been the real thing, they would have been priceless.

These paste diamonds were originally acquired by the Australian Museum between 1901 and 1911. One of the models was of the Cullinan, the largest diamond known, found in the Premier Mine, Transvaal, South Africa in 1905. It is part of a crystal that weighed 3,106 carats (621.2 grams). Also cut from this crystal were a drop-shaped, faceted, 530.2-carat (106.04 grams) stone called the Great Star of Africa, which is now in the British Crown Jewels set in the top of the sceptre, and a large square brilliant of 317.40 carats (63.48 grams). Altogether nine major stones were cut and 96 small brilliants. Over 62 per cent by weight of the original rough Cullinan was lost in the cutting. All faceted Cullinan stones are now in the Crown Jewels displayed in the Tower of London, or in the personal possession of the British Royal Family.

The other six imitation models stolen were of diamonds originally mined in India. Unlike the Cullinan, most of them were found about 900 years ago and all passed into the hands of native Indian rulers. The Persian armies invaded India in 1739 and looted Delhi, taking all the priceless diamonds and the Peacock Throne (which was part of the regalia of Indian rulers such as Shah Jehan who built the Taj Mahal).

Two of the imitations were of the Koh-i-Nur ('Mountain of Light'): one as it was cut in Indian fashion after it was found and the other after being recut. The Indian Koh-i-Nur was a rectangular slab bearing no resemblance to the brilliant cut that evolved in the 17th century, supposedly in Venice. By some unknown means, the Koh-i-Nur arrived back in India in 1833 and eventually came into the possession of the East India Company, which presented it to Queen Victoria in 1850. The native-cut stone lacked lustre and fire so the Queen ordered it to be recut in brilliant form, which was done by a firm of cutters in Amsterdam who came to London and refashioned it in the premises of the British Crown Jewellers. However, because the original Koh-i-Nur was so badly cut, the resulting brilliant is too shallow and shows no brilliance or fire; a grave disappointment. It is in the British Crown Jewels.

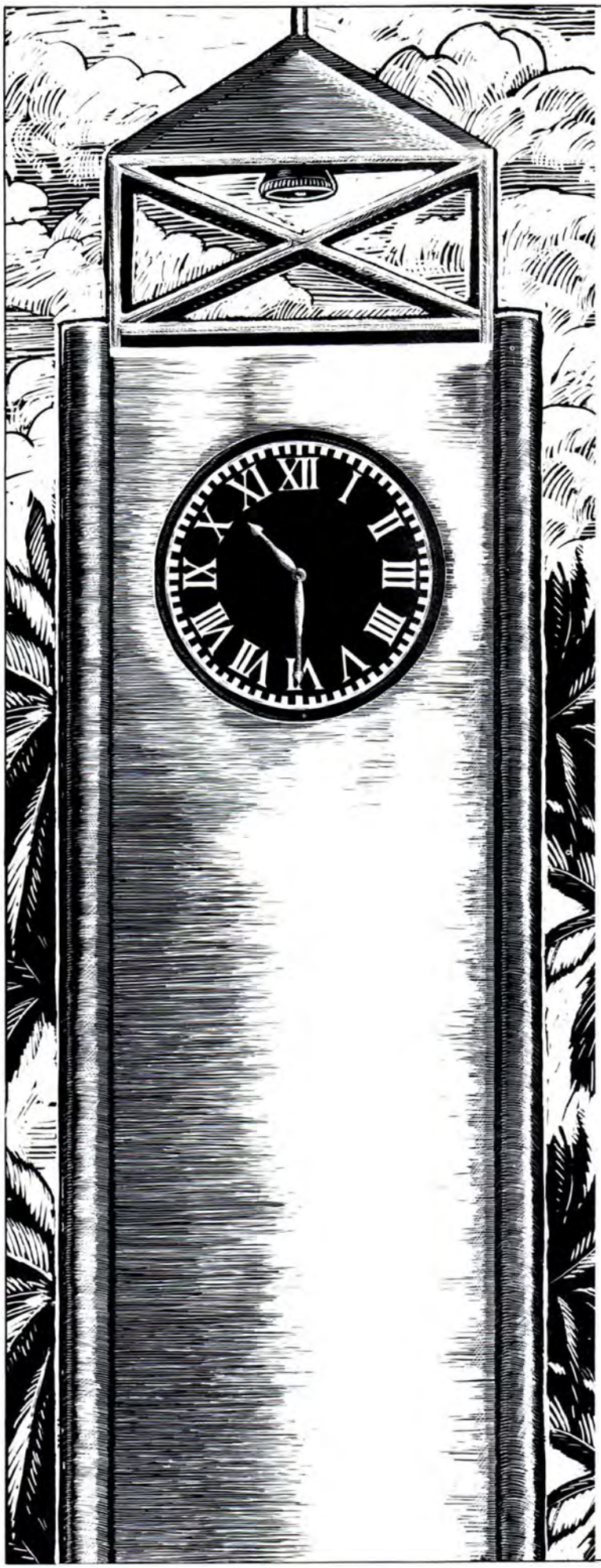
Some of the stolen gems. Clockwise, from top: the Koh-i-nur before recutting, the Orloff, the rough Cullinan, the Hope Blue and the recut Koh-i-nur, with the original ledger entries.

ANTHONY FARR

A model of the famous Hope Blue diamond was also stolen. As the name implies it is a deep blue. (Diamonds of practically any colour can be found. There is the 'Dresden Green' and the 'Tiffany Yellow' but most are colourless.) A blue diamond weighing 112 carats was bought in India in 1642 by the French traveller and gem merchant Tavernier. He brought it back to Europe where it was later acquired by the French Court. Its weight was reduced to 67.50 carats by recutting under the orders of Louis XIV. It was then stolen during the French Revolution and is thought to have been cut into three stones, one of which, weighing 44.5 carats, is thought to be the existing Hope Blue. This stone was sold three times (first to a wealthy banker named Hope, hence its name) and is reputed always to have brought bad luck to its owners. The third buyer was Harry Winston, a well-known New York diamond merchant. It was then acquired by the United States National Museum (Smithsonian Institution). It is displayed to the public in a safe on the back wall of a showcase, the front of which is extra-thick, burglar-proof glass. Two armed security guards stand on either side of the showcase.

To return to the Australian Museum burglary, the thief prised open the doors (not a difficult operation) of the Florentine showcase and took the glass imitations of the famous diamonds and some faceted stones, mainly quartz varieties. No clues as to his identity came to light and, as a security measure, all authentic gem material was removed from the gallery.

In about 1970, a scrappy parcel bearing the post mark of Vancouver reached the Museum. It contained all the specimens that had been stolen. They were so badly packed that the diamond models were severely scratched and chipped. A note enclosed read "Sorry gentleman [*sic*]. They are not real." We surmised that the burglar was a seaman of foreign origin who, on shore leave in Sydney, had his cupidity aroused on seeing what he thought were the original, priceless, historical diamonds displayed in a showcase that was obviously quite insecure and could easily be broken into. Since the robbery, security in the Museum has been tightened, with security guards patrolling the building 24 hours. ■



A clock so old, it began doing time before the convicts.

Two hundred and eighteen years ago, an English horologist named John Jullion built an exquisite clock in Stanwell Place, near Heathrow.

The year was 1770. The same year, of course, that Captain Cook first landed his ship, the Endeavour, at what was to become Kurnell.

This clock now resides in the Cronulla Street Plaza, and is credited with being the oldest on public display in Australia.

On Saturday morning, November 19th, 1988, the Caltex Refining Co. Pty Limited proudly presented it to the people of the Sutherland Shire.

THE CRONULLA PLAZA CLOCK TOWER, PROUDLY DONATED BY CALTEX.

"History speaks through living trees. The four examples presented here can inform us about our past, merely by their location."

SIGNPOSTING THE PAST

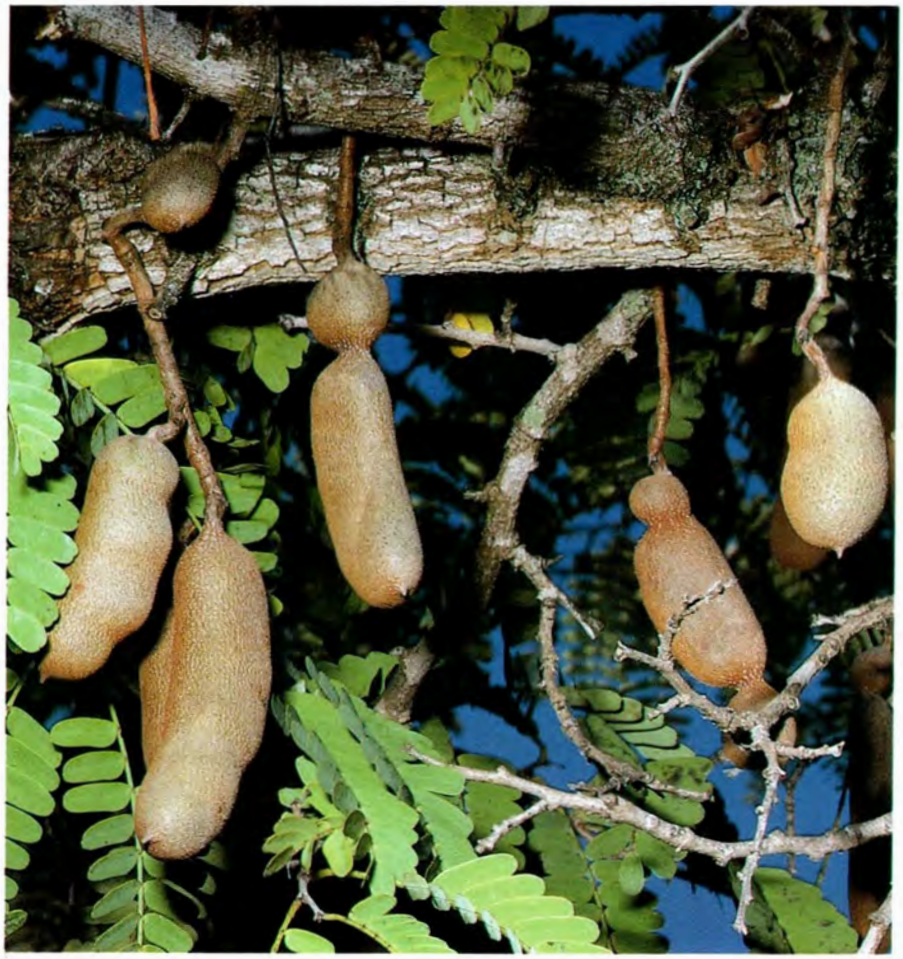
BY TIM LOW

THE LADY APPLE (*SYZYGIUM SUBORBICULARE*) of northern Australia, like Australia's other so-called native 'apples', is not related to the greengrocer's 'Delicious' and 'Granny Smith'. Indeed, it has only one unlikely close relation among Western foodplants—the Clove Tree (*S. aromaticum*).

A scrawny tree of coastal woodlands and dunes with big leathery leaves, the Lady Apple is useless as a spice. Rather, the striking red fruits, the size of small apples, are an important food of Aborigines. They are juicy sweet and refreshing in taste and contain a reasonable store of vitamin C.

Along the coasts of northern Queensland and the Northern Territory it is well known that Aborigines like to bring big hoards of Lady Apples to their campsites, and that great thickets of Lady Apple seedlings later sprout in the enriched soil around the camp.

Tamarind fruits are a good source of thiamine. The pods are borne on a large graceful tree with pinnate foliage and are often grown in the tropics as an ornamental.



Such campsites are often bounded by older thickets of Lady Apple trees, attesting to much earlier feasts.

The evidence suggests that Lady Apple trees can serve as valuable archaeological tools. Along the coasts of northern Australia there are many unusually dense thickets of these trees, often interspersed with other edible fruit trees such as Wongi (*Manilkara kauki*) and Finger Cherry (*Rhodomyrtus macrocarpa*). Even in the absence of stone tools or seashells it may be possible to identify such sites as old Aboriginal camps.

In the Northern Territory, on the more remote promontories and small offshore islands, the Tamarind tree (*Tamarindus indica*) is proving an excellent signpost for archaeologists. The sweet pods of this tree were brought in as food provisions centuries ago by Indonesian fishermen from the port of Macassar in Sulawesi (Celebes). The fishermen came seeking trepang (sea cucumber or beche-de-mer), which were boiled and smoked at elaborate camps on our northern shores for export from Macassar to China.

Leading archaeologist J.D. Mulvaney in the 1975 edition of his book *The Prehistory of Australia* has praised the significance of these trees: "Fortunately for archaeologists, the trepangers brought with them the astringent fruit of *Tamarindus indicus* which seeded prolifically in places. Tamarind trees serve as botanical markers for their camps, because their height and rich green foliage contrast with the flat seascape. Upon inspection, the area around tamarind trees is sometimes covered with a scatter of potsherds, bottle glass and stone hearths."

On Groote Eylandt in the Gulf of Carpentaria, Tamarinds have been around so long that local Aborigines know them as traditional food trees. They call them *angkayuwaya*. The brittle pods are cracked to extract the sticky brown pulp, which has a very sweet, very sour taste. It is a popular curry flavouring in Asia.

Other trees can be used as archaeological or historical signposts in different ways. The Indian Jujube or Chinee

The Lady Apple has white, spongy, watery pulp, with a sour, fragrant and refreshing taste. The apples are a food of fruit bats, which help disperse the large round seed.

PHOTOS: TIM LOW

African Boxthorn is a thorny shrub with attractive berries and clustered, elliptic to obovate leaves. Starlings and other birds spread the seeds, and the shrub has become a serious pest. It has been declared a noxious weed in most States.

Apple (*Zizyphus mauritiana*), a small Asian tree noted for its flavoursome fruits, now runs wild around many towns in northern Australia. It is a particular nuisance around Townsville, forming spiky thickets along roads and in cow paddocks. The reddish fruits often dry on the bush, becoming in taste and appearance much like the Chinese dates sold in health food stores, which is exactly what they are.

Chinee Apples were brought to Australia by early Chinese workers, and their presence on the edges of small country towns reminds us of the role played by the Chinese in Australian settlement. I have seen clumps of the trees around Springsure, Clermont and other quiet country towns where a Chinese presence is no longer obvious.

African Boxthorn (*Lycium ferocissimum*) is an intimidating spiky weed of black soil plains and coastal dunes in eastern and southern Australia. Few people realise that the small orange berries can be eaten, and they are widely believed to be poisonous. The sweet fruits often leave a bitter aftertaste, which may indicate traces of harmful alkaloids, although I have used the fruits successfully in jams and tarts.

African Boxthorn was introduced to Australia as a hedgeplant, not as a foodplant, and I doubt that it has been used here as food. However, it may serve as an archaeological marker in its own way. Boxthorn favours rich soils, and botanists have discovered that in southern Australia it thrives on top of Aboriginal middens, where charcoal and food remains have enhanced the soil. Here again, a wild plant is serving as a signal to the past.

The four examples presented here show how wild fruit trees, merely by their locations, can inform us about the past. Yet history speaks through living trees in other, different ways.

Throughout Australia there stand thousands of ancient eucalypt trees bearing long scars where bark was cut for canoes, shields or dishes. Towering Bunya Pines (*Araucaria bidwillii*) in the Bunya Mountains feature old footholds cut by Aborigines seeking the nuts. These old trees are remarkable relics of a largely forgotten past. Like the Lady Apple groves, Arnhem Land Tamarinds and Chinee Apple thickets, they stand in silent testimony to Australia's extraordinary history. ■

"Would it be too impertinent to ask why both names remain obscure to the majority of Australian households?"

THE HUNGER FOR SALT

BY ROBYN WILLIAMS
ABC RADIO SCIENCE SHOW

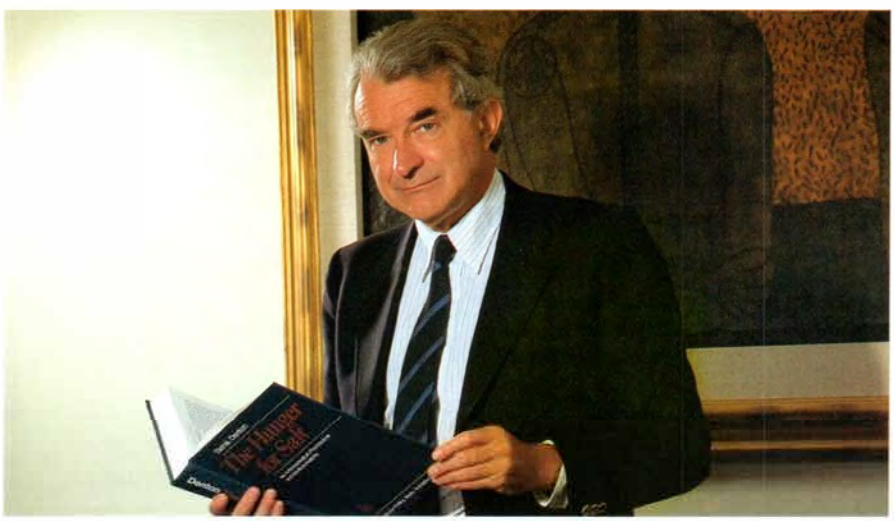
IN 1988 WE WERE ASKED TO CELEBRATE Australia's bicentenary by being offered a list, in November of that year, of 200 notable persons who had influenced this nation's progress. *The Sydney Morning Herald* then presented several of these names to 1,000 readers to test how well known they really are.

Henry Handel Richardson came last. An amazing 77 per cent had never heard of this famous (famous?) novelist, known as Ethel to her friends. Second last was Sir Macfarlane Burnet. Seventy-two per cent had never heard of him. And of the remainder a further nine per cent got him wrong! I worry about this.

Who then knows about Derek Denton, Dick to his mates, Founding Director of the Florey Institute in Melbourne? (Lord Florey was also on the Australian Bicentennial Association's list. Now Florey . . .) Consider Denton's credentials. He's Professor of Experimental Physiology and Medicine at the University of Melbourne and heads one of the best research outfits in the world. His book *The Hunger for Salt* is accepted as the seminal work in the field, covering not only physiology as applied to medicine, but zoology, anthropology and social history as well. Apart from that he's a director of the board of *The Age* newspaper, a founding director of the Australian Ballet, and he has one of the best collections of modern Mexican art in the Southern Hemisphere. Oh, and by the way, he's the first Australian to be asked by the OECD (Organisation of Economic Cooperation and Development) to examine another nation's science, that of Sweden.

Denton's field is the composition of the mammalian body's juices. Remember that the fundamental basis of life is homeostasis: maintaining a consistent internal chemistry. In our own cells there is a continuous flow of nutrients and electrolytes, especially of potassium and sodium. The passage of these ions is the basis of nervous transmission and much more. Little wonder that a regular supply is essential for mammalian life. A normal diet should provide enough, with excess being removed through the kidneys. But in some regions, such as those with very high rainfall which leaches the salts available, animals may have to go to extraordinary lengths to obtain salt.

Derek Denton.



SAM CRITCHLEY

At the Florey Institute, also known as the Sheep Hilton because of the five-star accommodation provided for dozens of those useful ungulates, they have perfected ingenious ways of raising or lowering the sodium in the vascular systems of the animals and then draining supplies of the result. Drooling to order. The result has been a revolution in the management of human patients whose salt balance has been severely disturbed. Hundreds of lives have been saved as a result.

It's the human side of the salt story that has also preoccupied Denton's writing and research. Salt has so dominated our existence that it has formed the basis of trade, war and wealth for centuries. The word salary comes from the same roots as the French *sel*, meaning salt—the wages of Romans were based on such a reward. Cannibalism too is thought to have been rooted in the hunger for salt: in regions where sodium is in short supply the tissues of people can help make up the difference!

But the full story can only be appreciated by reading Denton's grand opus *The Hunger for Salt*. No less an authority than Lewis Thomas, celebrated essayist and President of the Sloane Kettering Institute for Cancer Research in New York, praised the book effusively when I interviewed him about it.

Linked to the study of salt has been the research on the mammalian endocrine system. Control of sodium is managed by the adrenal and pituitary glands. Through an understanding of this hormonal interplay came a startling discovery. The Florey scientists found that the hormone relaxin (responsible for allowing the ligaments and other skeletal structures in the pelvis to stretch when a baby is about to be delivered) could be synthesised by means of genetically engineered bacteria. As an absence of this hormone may well be a major problem in the cause of cerebral palsy, because the head of the baby has insufficient space for delivery, the ample provision of relaxin could be a tremendous boon. Add to that the fact that arthritis is strangely absent during the pregnancies of women who otherwise suffer from this disease and one is tempted to foresee remarkable possibilities for relaxin.

All these productive and indeed useful ideas have come from a willingness to think with the same biological vision as Sir Macfarlane Burnet exemplified (see ANH vol. 21, no. 11, 1985–86). His was a wide-ranging view of science that could link evolutionary theory, immunology and physiology, but not only in an interdisciplinary way but one forming a philosophy of the subject and so taking it further.

Would I be too bold to suggest that Derek Denton's approach has been equally far-reaching? Would it be too impertinent to ask why both scientists' names remain obscure to the majority of Australian households? ■

BRINGING YOU THE BIRDS OF THE WORLD

BIRDS INTERNATIONAL is a new and exciting, full-colour quarterly magazine produced by "bird people" for "bird people". It is directed to the broad, cross-section of those interested in birds, and caters equally to the interests of the professional ornithologist, the dedicated aviculturist, and the weekend birdwatcher.

■ Whenever a publication like this is launched, the standard response is, "But what type of magazine is it, and how does it differ from other bird magazines?" We answer by pointing out that the emphasis on international coverage, in both authors and subject matter, is the feature that immediately sets apart BIRDS INTERNATIONAL. Quite simply, it is a quarterly journal devoted to the birds of the world.

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JOSEPH M. FORSHAW
Editor

GRANT YOUNG
Publisher

BIRDS
INTERNATIONAL

E X T I N C T I O N S

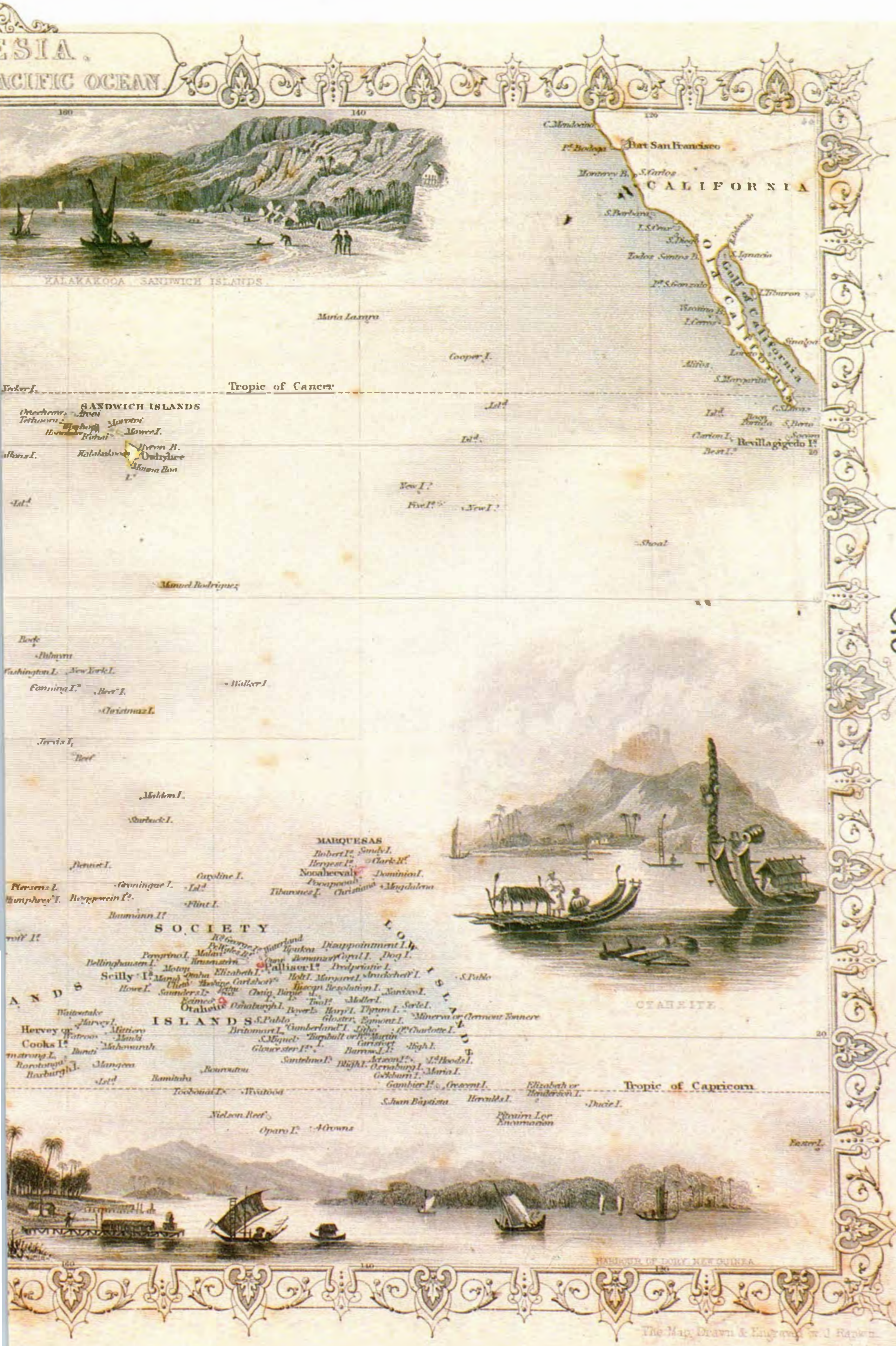
The presence and effect of humans in the Pacific over the last 40,000 years is analogous to the boom and bust cycle of the Plague.

PLAGUE IN THE PACIFIC

BY TIM FLANNERY
HEAD OF MAMMAL DEPARTMENT
AUSTRALIAN MUSEUM

THE PACIFIC OCEAN, DOTTED WITH A multitude of verdant jewel-like islands, with their attractive and diverse peoples, has from the days of Cook to those of Club Med exercised a romantic attraction to Europeans. Ironically these islands are among the most devastated ecosystems on Earth! Some are already damaged beyond repair; and all are sliding inexorably towards oblivion.

A 19th-century map of the Pacific.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MARQUESAS
Nooaheeval
SOCIETY
ISLANDS
Scilly I.s
Palliser I.s
Otaheite
Hervey or Cooks I.s
CYAHEITE
Tropic of Capricorn
HARBOUR OF DOREY NEW GUINEA
The Map Drawn & Engraved by J. Rapkin

HOWARD HUGHES

Tahitian girl from Darwin's *Journal of Researches*. The South Pacific was seen as a perfect idyll by 19th-century Europeans.

That we have failed to perceive this is due largely to the great remaining charms of the tropical islands. Even the acutely analytical and observant mind of Charles Darwin was distracted by the erotic rhythms of the hula during his stay in Tahiti—we barely find a jot on the biology of the islands in his works.

Our newly won realisation of the parlous state of Pacific Island ecology has come from two of science's Cinderella disciplines: archaeology and palaeontology, disciplines that the economic rationalists would seek to destroy through underfunding on the grounds that they contribute nothing to the economic life of the country. And yet, in this instance, they have provided an insight that may well be indispensible to future generations.

INVESTIGATION OF THE PREHISTORY OF the Pacific is far from complete. We know precious little of Melanesia, and nothing of large parts of Micronesia, but the emerging story shows that very similar events have occurred throughout the region. Perhaps it is best to start with the largest and best known of the Pacific Islands—Australia.

Scientists have long been aware that Australia once supported a diverse fauna of large animals. Rhinoceros-sized *Diprotodon* species, immense horned turtles and enormous flightless birds once crowded the landscape, but all of them vanished between 40,000 and 20,000 years ago, undoubtedly throwing Australia's fragile ecology into chaos. For

Approximately 60 of Australia's largest vertebrates became extinct 20–40,000 years ago. This *Diprotodon* skeleton had marks on some ribs suggestive of human interference.

all we know, these large animals may be the tip of the iceberg, with many thousands of dependent species (parasites, insects and plants) disappearing with them. Significantly, Australia then settled into a period of ecological quiescence, and it was not until after 1788 that the extinctions started again. This time, with European exploitation, a further 20 mammals and three birds (so far) have vanished, along with many plants and uncounted insects. In total, these two phases of extinction have accounted for approximately 25 per cent of our land mammal species (excluding bats and marine mammals), that is, approximately 70 out of 260 species. But what, you may ask, has this ancient history got to do with us? Later I will show that these are simply the first of two events in a cyclical and accelerating process of destruction. Furthermore, in geological terms, they are *not* ancient history but extremely recent events. The Australian ecosystem has not evolved a single replacement species to compensate for these losses and, indeed, is in many ways still reeling from the massive shock of the extinctions.

Throughout the smaller surrounding islands the story is the same. Just to the north of Australia, the Indonesian island of Flores once supported a unique fauna. Komodo Dragons preyed on two species of pigmy elephants, while six species of endemic rats (some enormous), and one tiny shrew, made up the total non-flying land mammal fauna. Today only a single rat and the shrew are left, 78 per cent of the original land mammal fauna now being extinct. The nearby island of Timor has a similar but more tragic story to tell, for it has lost all of a more diverse rodent fauna, its pigmy elephants and a relative of the Komodo Dragon; only a single species of shrew remains. It seems likely that, in both cases, the pigmy elephants became extinct before the rats, when people first reached the islands, and that the rats survived until a few thousand years ago, when a new kind of land use (animal husbandry) arrived.

Further to the east the bird faunas seem to have suffered. (Land-bound mammals had not reached further into the Pacific than the Solomon Islands before the arrival of people.) The best documented case of the destruction of an island ecosystem is that of New Zealand. Indeed, until recently, its disastrous history was thought to be unique but we now know that it is all too typical of the Pacific. Before the arrival of the Maoris, there were approximately 110 land and freshwater bird species in New Zealand, including a dozen or so gigantic moas. Prior to the arrival of Europeans, at least 34 of these had become extinct, and a further seven have followed in the 20th century. In all, New Zealand has already lost about 37 per cent of its land and freshwater bird species, and 33 per cent (one of three) of its bats. Insect and lizard species also appear to have fallen victim to the environmental catastrophe.

The Hawaiian islands have only recently been investigated, but preliminary studies indicate that 39 species of birds became extinct before European contact, and that a further 15 have followed since that time. Out of the original 75 species, 54 (72 per cent) have disappeared forever. Preliminary investigations of the Marquesas Islands, New Caledonia, Tonga and other island groups show a similar decline. Countless invertebrates, including many land snails and plants, have also disappeared. Of those that survive, many are only found on outliers or in tiny relict patches. The forests of Polynesia really are silent and dead. And yet what a riot of colour and sound there must have been a mere thousand years ago!

Extinct: the Norfolk Island Kaka (*Nestor productus*) at right. The New Zealand Kaka (*N. meridionalis*) is still extant. First reported by Captain James Cook in 1774, the last known individual died in captivity in London in 1851.

WILLIAM T. COOPER

WHAT HAS CAUSED THESE EXTINCtions, what implications have they for the future, and how can we cope with the ecological collapse that they imply? In the broadest sense, the cause is obvious. The various faunas of these areas were stable for hundreds of thousands—if not millions—of years before the arrival of humans, but when they arrived on any landmass the extinctions began. But why should these catastrophic, multiple extinctions occur in this area and not in Asia and Africa where humans and their ancestors have been present for over a million years? In order to answer this I have searched for analogies among other groups of organisms. The closest analogies are undoubtedly found among the plagues that have afflicted humans over recorded history. Indeed, the Black

The male (front) and female of the extraordinary New Zealand Huia (*Heterolochia acutirostris*) had different shaped bills and feeding strategies. The species has been extinct since around 1907.

PLATE 2

HUIA

Front: male. *Rear:* female. *Plant:* titoki (Alectryon excelsus).
[Three-fifths natural size]

WHITCOMBE & TOMBS

Plague itself provides the closest analogue.

It seems that for many thousands of years the bacterium (*Yersinia pestis*) that causes the Bubonic Plague was infecting burrowing rodents such as marmots in central Asia. Although still a serious disease to the rodents, it had achieved a balance with both its hosts and the environment. When people came into contact with the bacterium, perhaps through hunting its hosts, some bacteria were transferred to humans and the commensal rats that lived with them. The bacterium had broken into a new environment and begun exploiting new resources: it had become a plague species. As the disease spread rapidly throughout the Old World, the bacterium rapidly depleted the populations of rats and humans on which it depended for its existence. As densities of hosts diminished, so did the disease—until human and rat populations built up somewhere else again. Because of its terrible efficiency, the disease was destroying the very resources upon which it depended. Occasionally a mutation occurred (such as that which caused Pneumonic Plague) and this opened up fresh fields for the bacterium to exploit. Despite this, its very success ensured that even these newly available resources were rapidly destroyed. Eventually perhaps, if antibiotics had not intervened, the boom and bust (plague) cycles may have ended, and a much less virulent strain may have struck some balance with its new hosts, but with a much reduced resource base.

It is easy, when watching an organism that can reproduce every 20 minutes, to trace its evolutionary course over a few centuries. It is much harder to see the patterns and cycles within a species that takes over 20 years to reproduce itself. Nevertheless, the similarities between humans in the Pacific Islands and *Yersinia pestis* in the Old World are compelling. Some 50,000 years ago we too broke free from our ancestral homelands and left behind the delicate ecological responses that had held us in check there.

A human attempt to control another plague species: the rat incinerator, Sydney 1900.

Very soon, we were building up massive populations in lands unused to human exploitation, where food was plentiful and our old diseases left behind. Released into a new environment, we had begun our cycle of boom and bust. The resources of our new homelands, whether they were moas, *Diprotodon*, pigmy elephants or flightless geese, were depleted at a faster rate than they could be renewed, and the huge and rapidly built-up human populations must have passed a peak, declining with the ecological collapse that followed the initial mass extinctions. For a time, much smaller human populations existed in harmony with a much reduced resource base. In some places, however, 'mutations' occurred. New peoples or new technologies arrived, allowing yet another phase of overexploitation, followed by ecological collapse, resulting in the historic extinctions that characterise the European settlement of Australia, New Zealand and Hawaii. Today these 'mutations' continue to allow us to exploit previously unobtainable resources. During the '60s and '70s it was whales; now it

Rats, mostly *Rattus norvegicus* and *R. rattus* (but note the native Water Rat, *Hydromys chrysogaster*, which does not carry plague, at bottom right) killed to stop plague transmission in Sydney, 1900.

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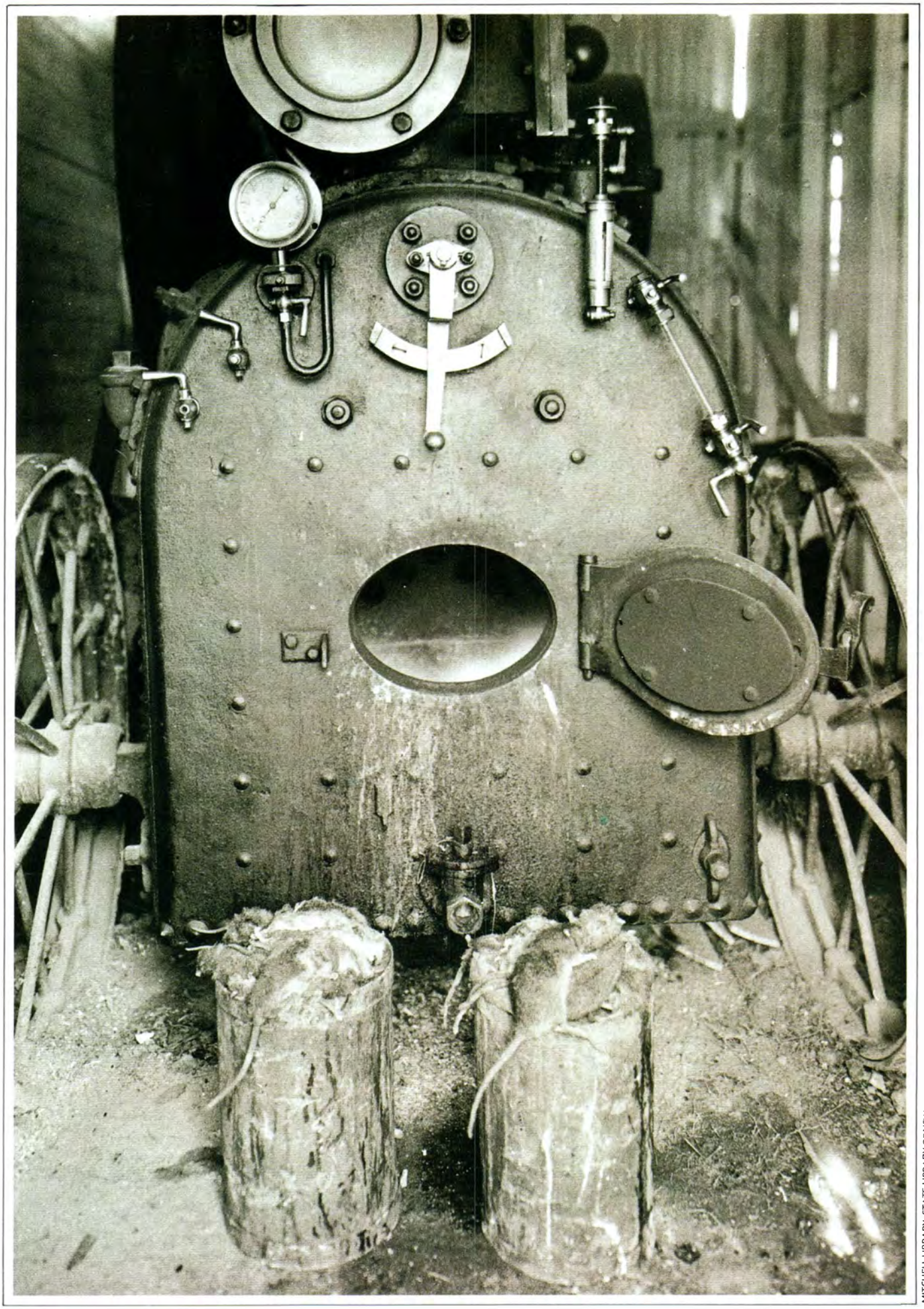

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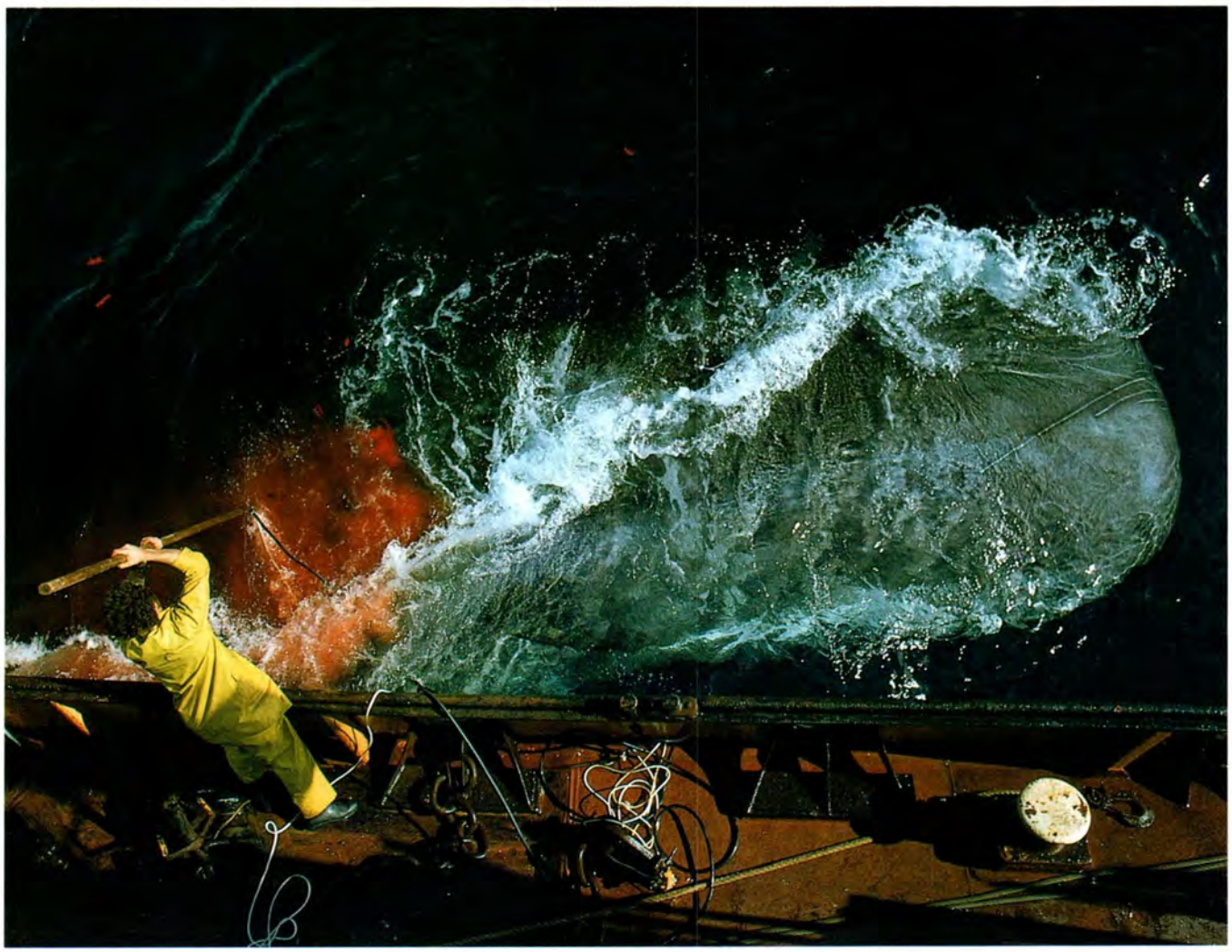


The last of the world's megafauna to be decimated by humans are the great whales. Thankfully, economies of scale and worldwide conservation action have so far prevented any species from becoming extinct.

is deep sea fish that take a decade to reproduce, and forests on the steepest of tropical mountains.

SO WHAT DOES THIS TRAGIC HISTORY tell us of our future? One thing is clear: as the waves of our new plague strategy surge over the landscape, much of the ecological diversity necessary to support us in the future is diminished. Perhaps the future of the Pacific is writ small in the history of Easter Island. Discovered about 1,000 years ago by Polynesian voyagers, Easter Island must have been like many other island paradises. Abundant endemic birds probably sang from groves of endemic palms and other plants, and these and marine resources supported a vigorous and spectacular culture. The Easter Islanders (or Rapanui) invented a sort of picture writing and erected massive stone busts—the crowning glory of Polynesian physical culture. Yet, when the Rapanui were encountered by European explorers in the 18th and 19th centuries, they had been reduced to dire straits. Their few pitiful canoes were made from scraps of driftwood and were barely capable of coastal travel.

Less than a millenium before they must have arrived in huge double-hulled ocean-going craft, but overexploitation by an ever growing human population led to the disappearance of every land bird and every usable stick of wood on the island. Vicious warfare had broken out for the few remaining resources and the losers, unable to leave the island, lived short and miserable lives in walled-up caves. It is clear that, had things gone on, the Easter Islanders would have had no future, for the island had been stripped bare by its human inhabitants and could no longer support a viable population. Luckily for the survivors, they became linked to South America by European trade. Their continued existence now depends, in part, upon overexploitation of some other part of the world. But for how long can this go on?

It is hard to believe that such a drastic end could be in store for our civilisation. But one thing is certain; we are still in the 'plague' phase of our species' existence. Even in Australia, our numbers are growing frighteningly. Between 1982 and 1986, by immigration and reproduction, we gained a further million mouths to feed. At present we are plaguing to the extent that even in the 'underpopulated' areas of Australia we are destroying the very soil that feeds us. The situation will deteriorate, and very quickly, if we continue as a plague species. The situation in other parts of the world is far worse, with truly horrifying rates of human population increase occurring in some regions. If we do not cease to grow, to reassess what it means to make a quick buck, our children will be locked in bloody war over the few natural resources that escape today's pillage.

It is a great tragedy that the examples we need to see ourselves in our true light have been with us for a very long time. Daniel Defoe, the documenter of the Great Plague of London, wrote in 1665 of those who had hoped to profit from the tragedy.

"One thing I cannot omit here, and indeed I thought it was extraordinary. . .the astrologers, fortune tellers. . .were gone and vanished, not one of them was to be found. I am verily persuaded that a great number of them fell in the heat of the calamity, having ventured to stay upon the prospect of getting great estates; and indeed their gain was indeed too great for a time, through the madness and folly of the people; but now they are silent, many of them went to their long home, not being able to foretell their own fate. . ." ■

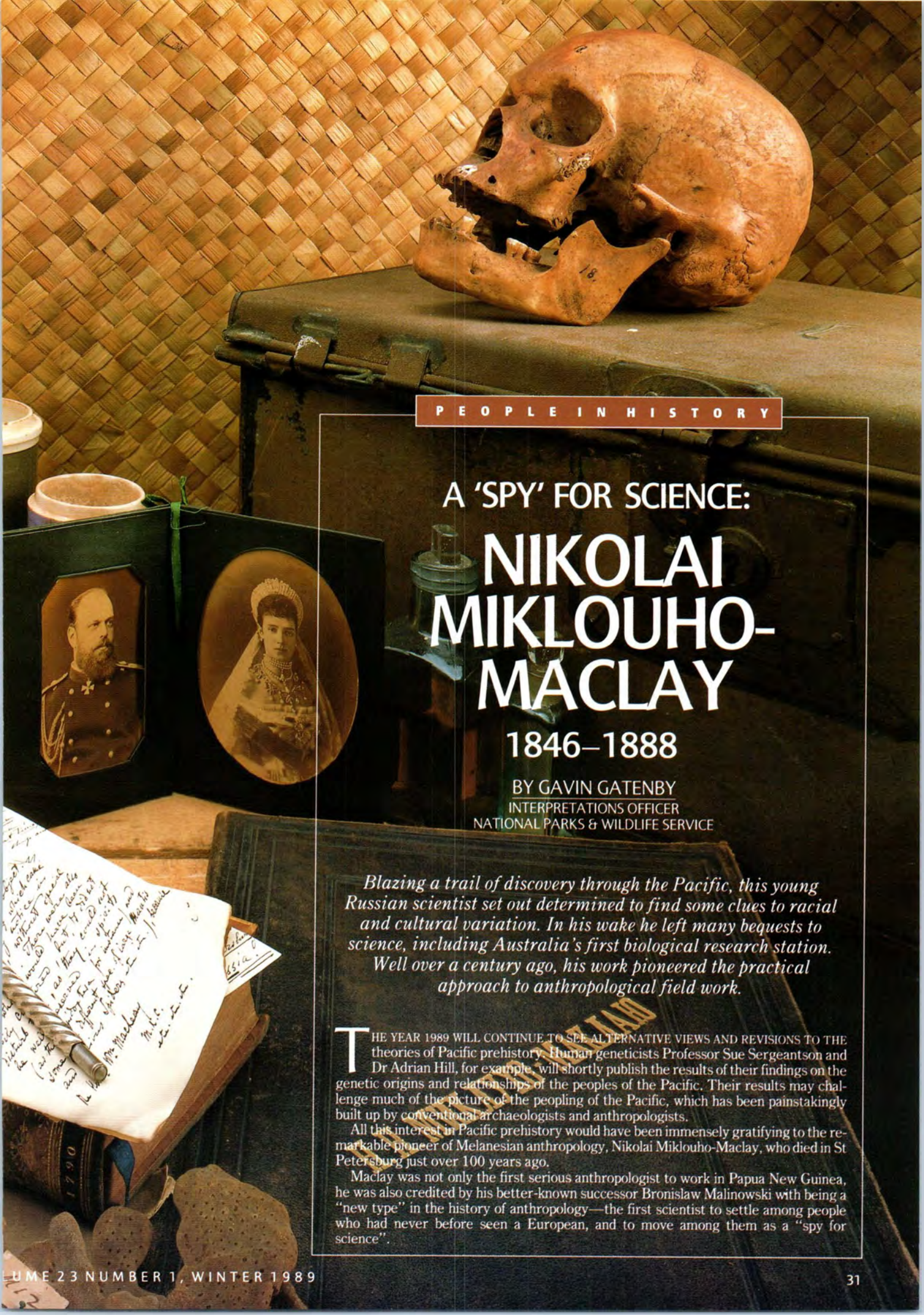
Easter Island: every stick of wood destroyed and every land bird gone.

MICHAEL JENSEN/AUSCAPE INTERNATIONAL

JEAN-PAUL FERRERO/AUSCAPE INTERNATIONAL

Miklouho-Maclay had wide-ranging interests within the sciences. Starting as a sponge biologist, his studies encompassed birds, fish (especially sharks) and, in particular, human anatomy and culture. Some of these specimens, now held in the Macleay Museum at Sydney University, were collected by him: the sponges, the jar of neurological bird collections, the skull and the shark's jaw. Many personal items pictured, including the tin trunk, cane field box, folder and photo frames with pictures of the Tzar and Tzarina, belonged to Miklouho-Maclay. It is not certain that he owned the puffer fish hat, which came from Kings Mill Island. Miklouho-Maclay corresponded regularly with William Macleay, a letter to him featuring prominently in the foreground.

ANTHONY FARR



PEOPLE IN HISTORY

A 'SPY' FOR SCIENCE: NIKOLAI MIKLOUHO-MACLAY 1846–1888

BY GAVIN GATENBY
INTERPRETATIONS OFFICER
NATIONAL PARKS & WILDLIFE SERVICE

Blazing a trail of discovery through the Pacific, this young Russian scientist set out determined to find some clues to racial and cultural variation. In his wake he left many bequests to science, including Australia's first biological research station. Well over a century ago, his work pioneered the practical approach to anthropological field work.

THE YEAR 1989 WILL CONTINUE TO SEE ALTERNATIVE VIEWS AND REVISIONS TO THE theories of Pacific prehistory. Human geneticists Professor Sue Sergeantson and Dr Adrian Hill, for example, will shortly publish the results of their findings on the genetic origins and relationships of the peoples of the Pacific. Their results may challenge much of the picture of the peopling of the Pacific, which has been painstakingly built up by conventional archaeologists and anthropologists.

All this interest in Pacific prehistory would have been immensely gratifying to the remarkable pioneer of Melanesian anthropology, Nikolai Miklouho-Maclay, who died in St Petersburg just over 100 years ago.

Maclay was not only the first serious anthropologist to work in Papua New Guinea, he was also credited by his better-known successor Bronislaw Malinowski with being a "new type" in the history of anthropology—the first scientist to settle among people who had never before seen a European, and to move among them as a "spy for science".

Nikolai Miklouho-Maclay at St Petersburg, Russia, circa 1887.

Maclay's life reads like a novel by Joseph Conrad. He was born Nikolai Nicolaevich Miklouho (Maclay was added later) in Novogorod, Russia, in 1846, to a family of the minor nobility. Young Miklouho attended St Petersburg University but was expelled in 1864, without right to enter any other Russian university. His expulsion may well have been linked to political activities, the schools and universities being then in a state of populist ferment following the publication of Tchernyshevsky's controversial novel *What is to be Done?* (1863). To complete his studies he travelled to Germany, enrolling at Heidelburg, Liepzig and finally Jena, moving in the process from humanities and medicine to natural sciences.

In Jena he fell under the influence of the pioneer Darwinian zoologists Carl Gegenbaur and Ernest Haekel (the latter invented the term 'ecology'). Haekel was so impressed with Miklouho that he asked him to accompany a small expedition to France, Spain and Portugal. Here he assisted Haekel to develop new theories on the evolutionary origins of sponges and swim bladders in fishes. He also took part in a dangerous excursion to the legendary Marrakech, in remote northern Africa, disguised as a Morrocan.

It was following this expedition that the young scientist decided to add Maclay (sometimes spelled Maklai) to his Cossack surname. Mystery surrounds this decision but there was, at the time, a fashion for things and connections Scottish and the Miklouho family numbered Scottish mercenaries in the service of Catherine the Great among their ancestors. Some years later, in Sydney, the addition was to prove most useful.

In 1869 Maclay undertook a private expedition to the Red Sea, believing that he might be the last zoologist to examine its fauna before the opening of the Suez Canal changed the ecology forever. He collected nine sponges unknown to science but the six-week trip was perhaps more important in setting his future style as a scientist. He travelled alone, his red hair shaved, beard cut short and dyed, arms darkened. To complete his Moslem disguise he dressed in Syrian robes. By the time of his return to Europe, Maclay had determined to embark on a lone expedition to the Pacific. He pursued this vision with reckless single-mindedness tempered by a degree of native Machiavellian cunning unusual in one so young.

In the course of his campaign to launch the expedition, he met and charmed characters as diverse as Thomas Henry Huxley, Alfred Russel Wallace, Sir Roderick Murchison (President of the Royal Geographical Society) and Prince Peter Kropotkin, then a young radical who was later to become the leader of the Russian anarchist movement. He astutely played the Royal Geographical Society off against the Russian Geographical Society. As he barnstormed the salons of Europe in search of funds, equipment and letters of introduction, he left a string of bad debts in his wake. Eventually, in 1871—bankrolled by his long-suffering mother, provided with a passage on the corvette *Vityaz* by the Imperial Russian Navy and fitted out with equipment and research topics from various European experts—he spent his last weeks in his homeland as a guest at Oranienbaum Palace on the shores of the Gulf of Finland.

To obtain the imprimatur of the Tsarist scientific establishment, young Maclay had led the Russian Geographical Society to believe that he would spend only a brief time in Papua New Guinea, mainly to study sponges, before making his way north through the Pacific to the Russian east coast over several years. But the anthropological investigations were already bulking much larger in his thinking than the passing mention he had made of them in his undertaking to the Geographical Society (to be investigated "with permission, according to opportunity"). In preparing for his odyssey Maclay had solicited, from authorities across the full range of natural sciences,

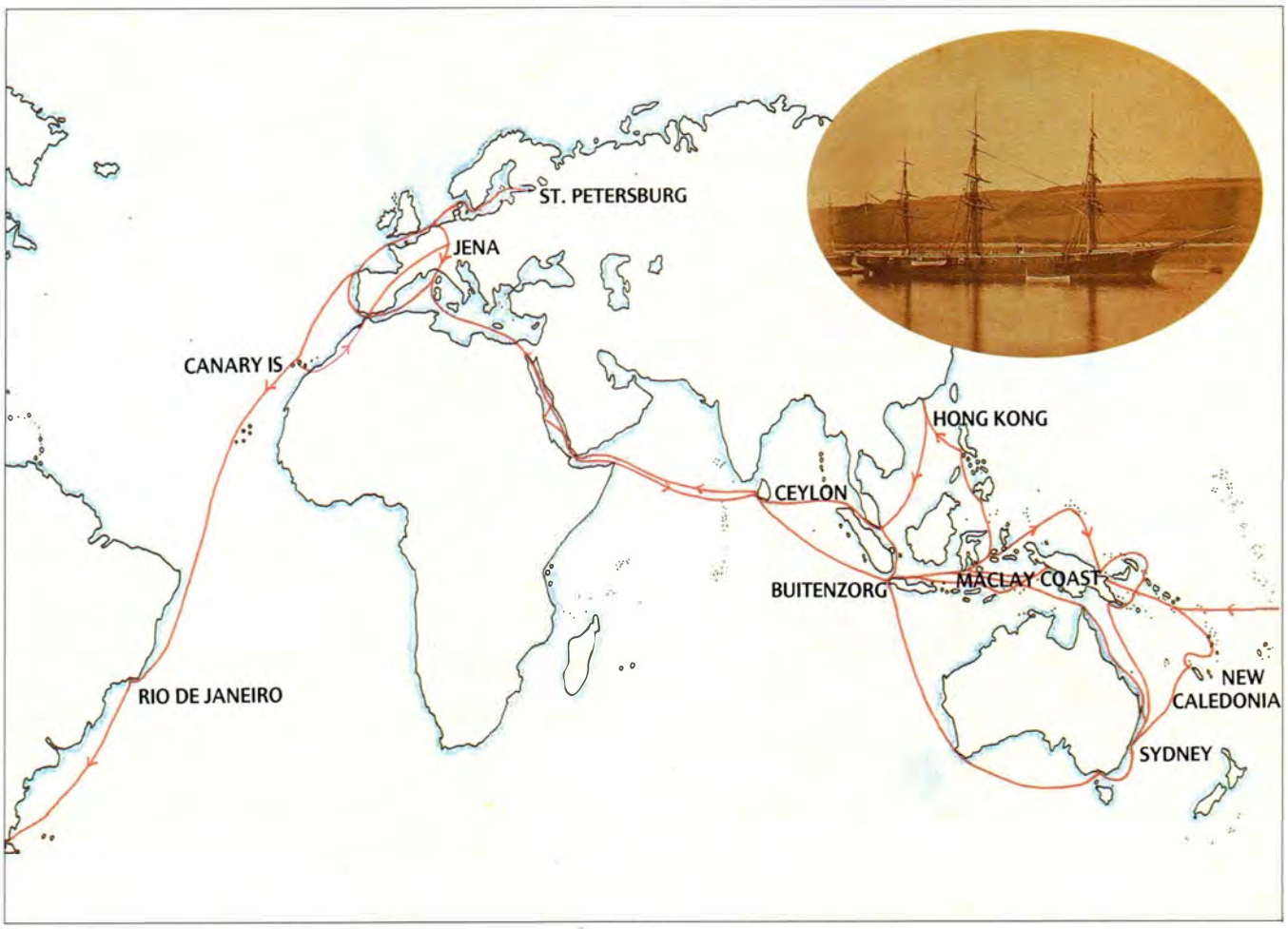
A GENERATION IN REVOLT

The expulsion of young Nikolai Miklouho from St Petersburg University in 1864 took place during an upsurge in populist dissent that followed the publication of Tchernyshevsky's *What is to be Done?* Tchernyshevksy was an economist and one of the great intellectual mentors of his day. His novel, published in 1863, set standards of self-denial, altruism and "service to the masses" for thousands of Russian students. Many among Nikolai Miklouho's generation refused to make their peace with the regime and became lifelong opponents of Tsarism. It is possible to see the genesis of Maclay's personal ethos in the rather elitist philanthropists at the core of the novel.

When thousands of students attempted to live out the example set by *What is to be Done?*, Tsarism responded with a wave of arrests and expulsions. Tchernyshevsky himself was pilloried and imprisoned for 20 years in 1864.

Young Miklouho's hero, Tchernyshevsky, leader of the Revolutionary Democratic Movement, was pilloried in 1864 and imprisoned for 20 years following the publication of his controversial novel *What is to be Done?*

MACLEAY MUSEUM



GEOGRAPHICAL SOCIETY USSR

CATHY McGAHEY

Miklouho-Maclay's voyages took him to New Guinea six times. He realised the value of studying a society that was little influenced by other cultures. His extended visit to Astrolabe Bay was the first made by a European in this region. Inset: the corvette *Vityaz*, which brought Miklouho-Maclay to Astrolabe Bay in 1871.

An anatomy class in Jena, Germany, 1866–68. Miklouho-Maclay is third from the right behind his teacher, Professor Carl Gegenbaur.

MACLEAY MUSEUM

questions on the Pacific requiring urgent answers. The result was a list of 130 questions that together constituted an encyclopaedia of the unknown. The big questions, it seemed to Maclay, were those concerned with human dispositions in the Pacific. These were the tasks he set for himself: "Firstly, to explain the anthropological relationship of the Papuans to other races . . .Secondly,. . .to determine, by personal observation, the dispersion of these races in comparison with the rest of the tribes of the Pacific Ocean."

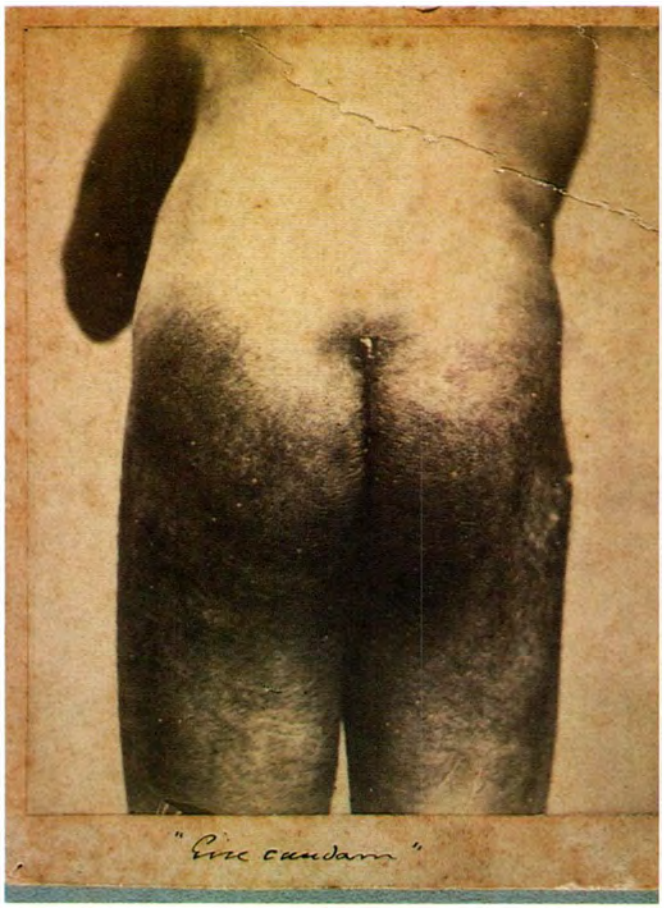
It was a heroic undertaking, greatly complicated by the prevailing level of scientific technique and incredibly limited body of evidence. A century would pass before the theory of plate tectonics explained the apparently anomalous distribution of the world's fauna. In the place of our present rich assemblage of data on hominid evolution there was only the inspired guess-work of Darwin and others. The gaps were filled by scientific speculation about an ancient continent, Lemuria, now sunk beneath the Indian Ocean, on which humans had evolved from anthropoid apes. Had they then migrated across this land bridge to Asia and Australia? Were there to be found, deep in the highlands of New Guinea, genetically primitive peoples who were the last link with our early origins?

In the company of these great problems, on 20 September 1871, Maclay landed in Astrolabe Bay on the north coast of New Guinea. The Russian corvette was the first European vessel that the local inhabitants had seen and it made a big impression on them.

So did Maclay. To the startled inhabitants he displayed the same reckless indifference to personal fate he had used when charming and wrangling his way through the scientific establishment of Europe! In one village, when confronted alone by armed and startled men, he calmly proceeded to appropriate a sleeping mat, remove his clothes and lie down in the shade to sleep. In another, he sauntered into a clearing, sat down and began to sketch his surroundings. Such displays of self-confidence confounded the villagers' natural urge to spear the miraculous apparition.

On a point on Constantine Harbour, Russian sailors erected a hut for Maclay and obligingly surrounded it with the latest in directional landmines. Here the Russian Navy left him and his two servants with an array of scientific equipment and a small horde of tinned and dried stores. During the next 15 months Maclay was to pioneer the field approach to anthropology that is now regarded as the basis of the science. It was also an approach with inbuilt pitfalls. He was quickly to find that his very presence became an important factor in the lives of the people whose society he had hoped to study, untainted by European influence.

To guarantee his personal security Maclay resorted to the sort of minor technological tricks used by all 19th-century travellers among pre-literate peoples. One night he fired off a naval flare and the local people, thinking he controlled the light from the moon, named him *Kaaram-tamo*, the Moon Man. When he set fire to water laced with alcohol a deputation from the local village begged him not to set fire to the ocean. Understandably the villagers of the coast and the nearby mountain came to regard Maclay as a supernatural being, an inevitability that he regarded with distaste.



It is ironic that Miklouho-Maclay had a tail: some scientists of his time were keenly interested in atavism and believed that he might actually find people with tails in New Guinea. This rare and previously unpublished photo was taken by Ramsay, then Curator of the Australian Museum, where Miklouho-Maclay was known as 'the little monkey man'.

He skilfully defused suggestions that he should lead 'his' coastal villagers in an attack on their old antagonists in the nearby foothills, and gained the confidence of the people with his attention to their medical problems.

The establishment of easy communication was essential to Maclay's work. Fortunately his facility with languages enabled him to acquire, in 15 months, some 350 words of the Bongu dialect. This was enough to gather basic information about the material culture of the people, but insufficient to deeply penetrate their belief systems and social structure.

Against immense difficulties he made progress unevenly, whenever opportunities presented themselves and often hampered by bouts of malaria, which left him barely able to rise from his bed. His Swedish servant, whose personality was ill-suited to this isolated life, was similarly afflicted and Boy, his young Samoan servant, died of peritonitis. (In a characteristic display of scientific sangfroid, Maclay removed his brain, larynx and tongue for science.) His hut was unequal to the ravages of the climate and food proved difficult to procure from the locals, who had little surplus.

He persevered, however, collecting artefacts and biological specimens, sketching the people and dwellings, compiling notes on their customs. He undertook risky coastal voyages to the island communities and ventured several kilometres inland to the people of the foothills.

On 19 December 1872, 15 months after his arrival at Astrolabe Bay, the Russian steam clipper *Izumrud* appeared at Port Constantine. The officers did not expect to find Maclay, their visit having been prompted by reports of his death from fever in Russian newspapers. But, in the best Mark Twain tradition, the reports were greatly exaggerated and, when they recognised their countryman on the platform of the canoe that paddled out to meet them, the Commander ordered the traditional naval three cheers and a flourish of caps.

There could be no doubt of his achievement. He had gained the respect and affection of the people among whom he had worked and he had survived where most would have perished. He had collected the first scientific account of the Papuans and their society, but he was far from establishing the dispersion of their race "in comparison with the rest of the tribes of the Pacific Ocean".

The *Izumrud* took him to Canton but, at a stopover in the northern islands of the Philippines, he found tribes that displayed racial characteristics he believed were similar to those of what he was now calling the Maclay Coast. Many men might have returned to fame and a relatively comfortable life in their homeland but the quest for knowledge and the lure of the tropics had got into Maclay's blood as firmly as the malaria, and he decided to travel south again to Djakarta to take part in a Dutch expedition to New Guinea. While in Hong Kong he

MACLEAY MUSEUM

A number of specimens collected or studied by Miklouho-Maclay from the Macleay Museum. His main interest was the human brain and he extracted several for racial comparison by cutting off the skull cap. In 1885, he described two species of Papuan forest wallaby including *Dorcopsulus macleayi* (originally named *Dorcopsis*) in the centre foreground with the original paper, and studied the unusual whorls of hair on two tree-kangaroos described by Ramsay. His collections also encompassed artefacts, including two of the clay pots (the small light-coloured pot is a modern one showing how similar they are today) and a club from New Guinea. The second skull from the top left, from his 1880 New Ireland collection, is remodelled with clay. A number of diprotodont teeth in the right foreground are just a small part of Miklouho-Maclay's Queensland collection.

ANTHONY FARR

MACLEAY MUSEUM

One of Miklouho-Maclay's drawings (1875) of typical "negritos", displaying what some scientists referred to as a "chimpanzee profile".

took part in an experiment in the physiological effects of opium, smoking 107 grains in two and three-quarter hours under the watchful gaze of a British doctor!

When he reached the Dutch East Indies he stayed for six months at the Buitenzorg residence of the Governor General, writing and recuperating from the ravages of tropical diseases. The Dutch expedition failed to materialise and he set off himself for the south-west coast of Dutch New Guinea, recruiting two men of Portuguese–Malay descent as guides. He had chosen this coast because, allegedly, it had been less subject to traders and raiders than the north-west. He could hardly have been more mistaken.

The land to which he came, Papua Koviai, proved to be a Conradian nightmare of detribalisation, slave raiding, arms and alcohol trading and untrustworthy petty rulers—a stark contrast to the relatively undisturbed societies he had encountered at Astrolabe Bay. In a landscape he judged to be the most poignantly beautiful he had yet encountered, he found murder, robbery and depopulation.

Returning from one outing he found that his base at Aiva had been raided. His equipment had been looted, captives had been taken from the little settlement that had accumulated around his outpost, and the headless body of the little daughter of one of his informants was left on his work table.

The raid, by mountain tribesmen, was understandable. The beheaded girl's father was a deposed frontier official who was much hated. In an atmosphere more and more lacking in ethical certainties, Maclay retreated from Papua Koviai, taking with him, as a captive, one of his retinue whom he arrested at gunpoint for failing to defend the settlement. Instead of being a 'spy for science', the realities of survival had forced him to behave in the style of the capricious and brutal slavers and traders he despised. It was an experience that was to shape much of the rest of his life.

Six months after his return to Buitenzorg, Maclay was off again. In 1875 he embarked on a long expedition into the Malay Peninsula mountains, in search of reported 'Negrito' or 'Papuan' tribes in the unexplored interior. Again he found racial characteristics that he believed were similar to those of the Maclay Coast.

IN 1878, MACLAY SHIFTED THE BASE of his operations to Australia and subsequently much of his saga unfolds here. In Sydney he found a scientific establishment, centred around the Macleay family with whom he fortuitously claimed an

THE FIRST BIOLOGICAL STATION

The most important visible legacy of Maclay's Australian years is a stone building that still stands at Laing's Point (Green Point) in Sydney Harbour. This building was opened in 1882 as Australia's first biological research station. The station was the fulfillment of a dream that had followed Maclay across half the world since he and Anton Dohrn had formulated the idea of a worldwide chain of marine research stations while working together in Sicily in the winter of 1868. Dohrn established his station at Naples in 1875 and Maclay purchased land near Singapore for the same purpose.

On his arrival in Sydney in 1878 Maclay threw himself energetically into a campaign for land and funding. He was supported by the Linnaean Society, William Macleay and Sir John Robertson—the veteran New South Wales parliamentarian whose daughter, Margaret, Maclay was later to marry. The building was eventually built by government-matched public subscription and completed in 1881. Unlike Dohrn's station, which had both public exhibitions and a laboratory, the Laing's Point facility was a monastery for biologists where Maclay, the first (and, as it turned out, the only) inhabitant, could work in the isolation and seclusion that he preferred.

The Biological Research Station was eventually resumed by the Army but the concept is again alive and well: Maclay would no doubt be surprised and intrigued by the volume and variety of research being carried out both at the Australian Museum and particularly at its Lizard Island Research Station on the Great Barrier Reef.

The biological field station as it was in the early 1880s and today.

MACLEAY MUSEUM

ancient common ancestry. His scientific achievements and adventurous life were well known to the educated public and he became known as 'Baron' Maclay, a title to which he had no claim but which suited his purposes well enough. He immediately threw himself with his usual vigour into a campaign for the establishment of a marine biological research station.

Early in 1879 he also began the political and humanitarian struggle that was to obsess him for the remaining decade of his life. It was nothing less than a single-handed struggle to defend the rights of Melanesians and to protect them from the alienation of their lands, from slavery and from the trade in arms and intoxicants. Maclay pushed himself forward as 'The White Papuan', *the* authority on Melanesia in general and the political representative of the 'Maclay Coast' in particular.

He saw that time was running out for 'his' people and 'his' coast—more ships were visiting Astrolabe Bay and the press ran many reports and rumours of colonisation schemes aimed at New Guinea and Melanesia. Uppermost in Maclay's mind must have been the horrors of unregulated exploitation that had accompanied European imperial expansion across the globe. He had himself become embroiled in them in Papua Koviai. Much of the intelligentsia of Europe was discussing and denouncing the effects of exploitation, from the polite salons to the socialist meeting rooms. Surely there must be a new path?

Maclay was a man of his times. His schemes for protecting New Guinea and easing its transition into the technological age, although not particularly striking in their originality, mostly envisaged a 'protectorate' by one or more of the great powers. Naturally the protectorate would have to have local 'autonomy' and the continuation of local customs and culture. He trusted nobody but feared German encroachment or an Australian 'settler state' most.

He waged a difficult, unequal struggle on behalf of people who were not even aware of his campaign. In the words of his most recent biographer, E.M. Webster: "Playing all sides to preserve Maclay Coast interests, he acted like any ruler of a small, weak state."

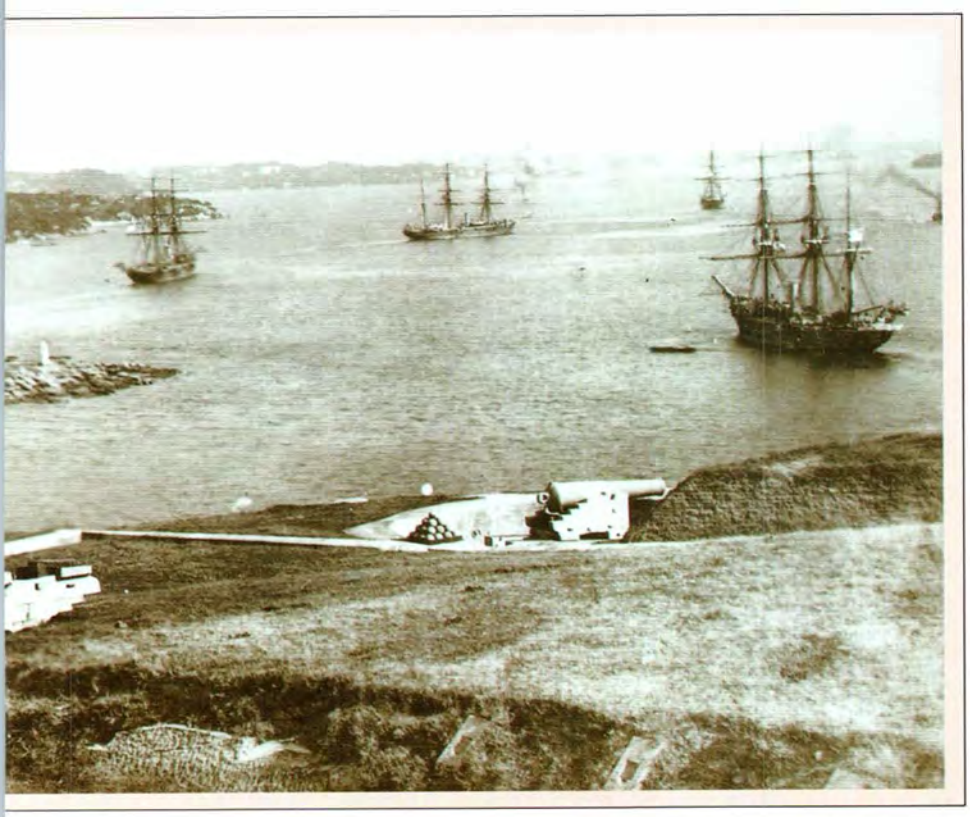
It was a game he played with considerable skill. He opened his campaign with a direct appeal to Sir Arthur Gordon, the British High Commissioner of the South Pacific and the first of many British officials he was to persistently lobby in the coming years. While he placed early faith in the British, he came to believe that they could not be relied upon. The Foreign Office was becoming reluctant either to annexe further territory or to control a rising Australian nationalism, which tended to push independently for European colonisation of New Guinea. He added a second string to his bow by appealing directly to the Tsar.

He made a triumphant return to Russia in 1882 and, after highly successful public lectures in St Petersburg, held a secret meeting with Alexander III and his Minister for the Navy at the Gatchina Palace. At this meeting he arranged to assist the Imperial Navy select a site for a naval station somewhere in Melanesia—naturally he favoured Astrolabe Bay. En-route to a secret rendezvous with a Russian warship, Maclay travelled to France, where he was feted by the liberal historian Gabriel Monod, and then on to England where, never one to let an opportunity slip, he campaigned among the humanitarian intelligentsia for a British protectorate!

He met the pre-arranged warship at Batavia and revisited the Maclay Coast in March 1883. It was a disappointing visit, for many of his old friends and informants there had died and, while the Russian Navy found that many of the harbours he showed them were excellent anchorages, they were also found to be unhealthy and the locals could not even supply sufficient food to individual ships, let alone fleets. Imperial Russia was mildy interested but politely declined to provide a protectorate.

As time passed Maclay's worst nightmare moved towards fruition. An obscure police magistrate from Queensland raised the British flag at Port Moresby and took possession of eastern New Guinea; shortly afterwards Germany laid claim to north-eastern New Guinea, including the Maclay Coast. Maclay continued to assert his scheme for independence for the Maclay Coast people and he increasingly placed his faith in the Russian empire guaranteeing local autonomy. In February 1886 he returned to Russia and manoeuvred frantically for official and public support for the establishment of a Russian colony of a new and benign type on the Maclay Coast.

In response to his public appeal for colon-



Jimmy Campbell.

During his years in Australia, Miklouho-Maclay continued his studies in brain anatomy. He came to believe that internal rather than external characteristics might hold the key to racial distinctiveness and these studies focused on the brain. For his comparative investigations he was given ready access to the bodies of executed criminals of various races. One of these, the body of an Aboriginal bushranger named Jimmy Campbell (pictured), he sent to Professor Rudolf Virchow in Berlin; it represented the first whole Aboriginal body to be sent overseas. Maclay had already examined the cerebral convolutions of the brain and pronounced that its owner had possessed considerable "intellectual capacity". Although such activities were quite the norm in the 1880s, today they are totally condemned. All major Australian museums have a policy of repatriation of Aboriginal skeletal remains for reburial by Aboriginal people.

COLLECTION: JOHN OXLEY LIBRARY, BRISBANE

UNION OF THE SOVIET FRIENDSHIP SOCIETY USSR

Crowds gather at Miklouho-Maclay's grave in Leningrad, 14 April 1988, for a commemorative ceremony marking the centenary of his death. Learned secretary of the Geographical Society of the USSR, V.Z. Rodinov, lays the wreath. Miklouho-Maclay is highly revered in the USSR.

ists he accumulated a small army of dreamers, adventurers and would-be philanthropists but little offical support. By now he was obsessed with his scheme. He returned briefly to Sydney in March 1887 and brought his family back with him to St Petersburg to continue his campaign but his health was rapidly declining. He died in April 1888, at the age of 42.

IN DEATH MACLAY BECAME MANY THINGS to many people. Although he was not a believer, Chekhov and Tolstoy saw him as driven by faith in "Christian civilization". Gabriel Monod, the liberal historian, saw the man as far more important than his work. He wrote of Maclay as a new type of scientific mystic whose "incredible ascendancy" taught the simple Papuans that they were dealing with "a being of superior race". Maclay's Russian admirers stressed his services to Russia, while Australian obituaries emphasised his services to science and the Australian phases of his career. His passing was regretted both by the Imperial Russian Navy and by the Peace Society!

While he remained largely forgotten in Australia for half a century, Maclay's fame spread in the Soviet Union. His life became the subject of offical Stalinist hagiography and was bleached of actions and attitudes of questionable ideological soundness. He became a model 'progressive', an opponent of slavery and imperialism; in 1971 the ethnological institute of the Soviet Academy of Sciences was named in his honour. His life and heritage, promoted by his Australian grandsons, became a significant point of cultural contact between the Soviet Union, Australia and New Guinea.

Maclay was never a scientist to indulge in large-scale theory-building or sweeping generalisations, preferring the adventure of fieldwork and the collection of observations and artefacts from which others could extrapolate. He did believe he had established that a Papuan genetic type remained scattered through the South-East Asian archipelago, a conclusion he based on the conventional study of skin colour, hair type and physiology. It will be fascinating to see how his observations stand up to the fast-developing field of human genetics. Just how the Maclay legend stands up to the litmus test of *Glasnost* will also be intriguing. ■

Suggested Reading

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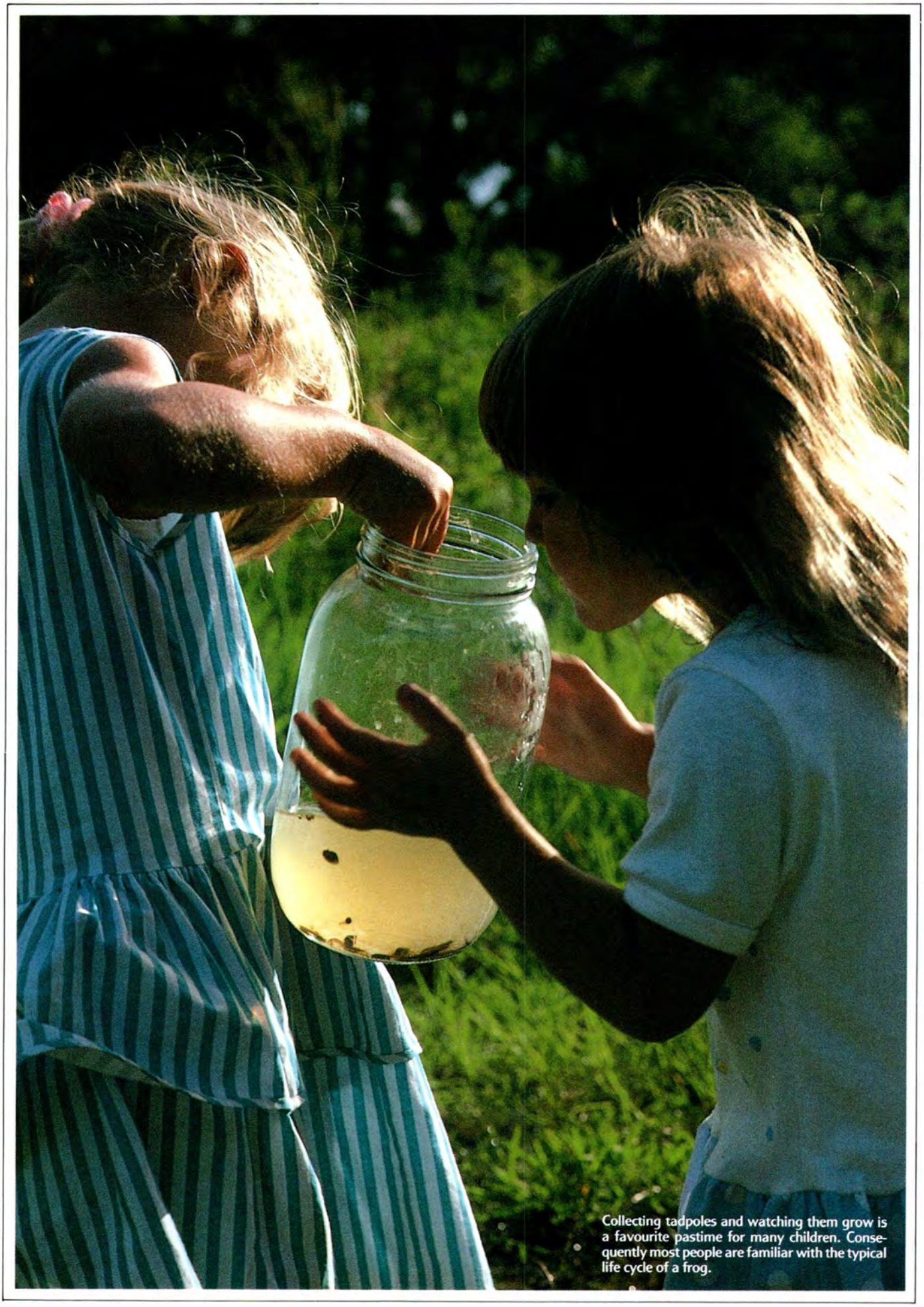


Collecting tadpoles and watching them grow is a favourite pastime for many children. Consequently most people are familiar with the typical life cycle of a frog.

HARRY EHMANN/APLAW

Imagine keeping your young in hip pockets, brooding them in your stomach or burying them in sand. Parental care has been taken to extremes in some species of Australian frogs.

MICHAEL MAHONY

Mixophyes shevilli **frogs mating (in the position known as amplexus). In this species the male clasps the female just behind the front legs.**

BIZARRE BREEDERS:

FROGS AS PARENTS AND PROVIDERS

BY MICHAEL MAHONY
EVOLUTIONARY BIOLOGY UNIT
SOUTH AUSTRALIAN MUSEUM

IMAGINE A FROG NO BIGGER THAN YOUR thumb nail that carries its young in hip-pockets; or, even more bizarre, two species that brood their young in their stomach. How did these Australian frogs evolve such amazing reproductive strategies to survive? This question is far from answered, but some clues to its resolution can be gained by examining the biology of these species along with several of their Australian relatives that have also modified the typical life-history pattern of frogs, but to a lesser extent.

A widespread experience of childhood is collecting and keeping tadpoles in a jar of water and watching them change into frogs. Because this is part of our first-hand experience it leaves a lasting impression so that many of us have a clear picture of the 'typical' life cycle of a frog. However, as we will see, some Australian frogs have made surprising departures from this pattern.

HARRY EHMANN/NPIAW

Near-term eggs and one tadpole of *Pseudophryne douglasi* under water. Whereas females of most *Pseudophryne* species lay eggs in chambers beneath rocks, vegetation or within soil, the eggs of *P. douglasi* are laid in water amongst rocks. The adherent silt provides camouflage.

HARRY EHMANN/NPIAW

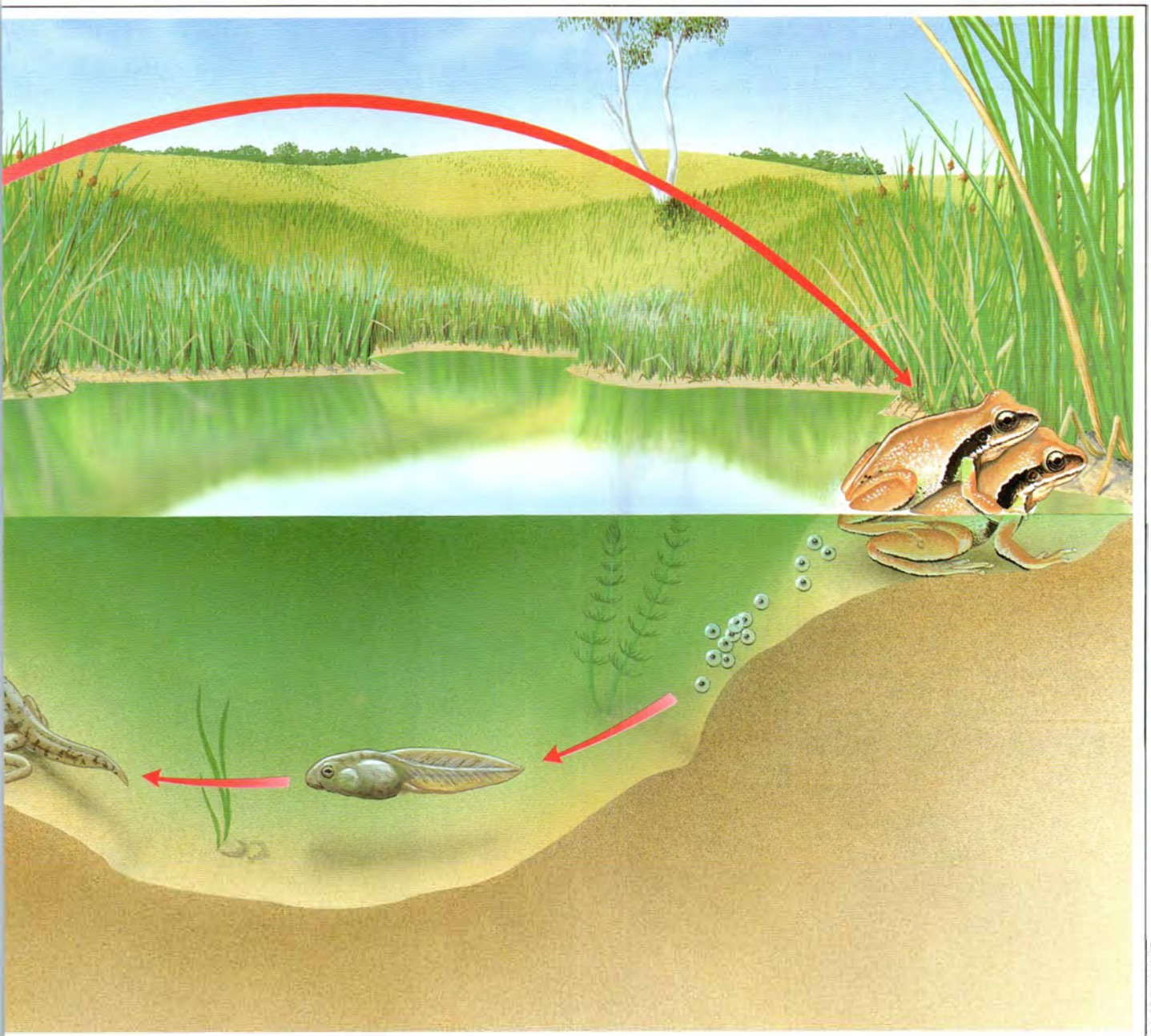
A male *Pseudophryne dendyi* with his eggs laid in a soil depression. The embryos develop to an advanced stage and remain in a resting state until it rains and pools are formed.

D. WHITFORD/ANT PHOTO LIBRARY

A gravid female *Pseudophryne* species. Note the eggs stretching her thin skin.

The typical life history of a frog involves the following steps. The male frog usually attracts a female with a mating call. When a female is attracted the male clasps the female around either the front or rear legs, a position known as amplexus. As the female lays her eggs, the male covers them with sperm and fertilisation ensues. At this point both the female and male usually take no further part in the development of their offspring, which are now at the mercy of their environment and a considerable array of predators. The embryos develop within the eggs and, after some time, the tadpoles hatch to begin life in the water. The tadpoles feed on available material such as algae, decaying vegetation and insects. When they reach a sufficient size they undergo a major modification of their body structure: the tail is absorbed, legs grow and gills are replaced by lungs. This process is known as metamorphosis.

Because larval life is a precarious time when predation is high, most frogs lay



DAVID KIRSHNER

Typical life-history cycle of a frog.

large clutches of eggs (between 500 and 1,500) so that a sufficient number of individuals survive to maturity to reproduce, thus ensuring the continuity of the species. This reproductive strategy has obviously been very successful because most frogs have this pattern. Furthermore, fossil studies show that frogs have existed with much the same basic morphology and presumably life-history pattern since well before the rise and decline of the dinosaurs.

ANTHONY HEALY

The brightly coloured Corroboree Frog (*Pseudophryne corroboree*). Females lay their eggs in chambers beneath rocks, vegetation or soil, concealed from predators.

So why is it that during evolution some frogs have modified the typical life-history pattern? Presumably such modifications enhance the number of offspring that reach maturity, by preventing predation or desiccation, or in other cases they have enabled frogs to take advantage of particular microhabitats. Until recently little has been known of the unusual reproductive modifications of some Australian frogs. It is a measure of the secrecy, rarity and specialised habitats of these Australian species that scientists are still trying to unravel the particulars of their strange life histories.

WITHIN AUSTRALIA THE MOST unusual life-history patterns are observed within one family, the so-called ground frogs (family Myobatrachidae). In this family it is possible to identify several of the steps in the evolutionary development of parental care.

The first step towards some form of parental care is the laying of eggs in situations where they are concealed and not simply placed in ponds or streams. A number of Australian frogs lay their eggs on land, either in well-constructed burrows (frogs of the genus *Heleioporus*) or in chambers beneath rocks, vegetation or within soil (*Pseudophryne* and some *Geocrinia* species). These sites are invariably close to ponds, lakes or streams, which will fill with water when it rains. The strategy of these species is apparently to have egg development proceed to the stage of hatching. The embryos remain in suspended animation until it rains and pools are formed, at which point the tadpoles hatch and take advantage of the water. Subsequent development and metamorphosis to adults follow the pattern that is typical for most frogs. These species occur in areas where rainfall is clearly seasonal. Hence the first hazardous stage of the life cycle has been removed from the pond or stream.

Although it is not known whether adults of these species protect their eggs from predation or desiccation prior to their hatching, adults are often found sitting within the egg chamber or on top of the eggs. It is among these species that we see clues to the possible origins of the more advanced forms of parental care.

The next step towards the development of parental care is to bypass the typical free-living and feeding tadpole stage of the life cycle. There are several Australian frogs that do not have a free-swimming tadpole stage. This does not mean that tadpoles do not occur in these species, but rather the tadpoles do not occur in pools or streams. They are usually found in nest chambers such as moist cavities in the soil, rocky crevices or mossy banks. The major evolutionary development at this step is the production of large yolked eggs that enable the young to reach metamorphosis without feeding. The length of larval life is reduced and the energy store of the egg is sufficient for metabolism of the young and the morphological changes of metamorphosis. Remarkably, however, the tadpole stage still occurs even though the young do not need to swim. During evolution this stage has been modified but not deleted. A consequence of this development is that fewer eggs can be produced by the female.

In some cases it is apparent that the absence of a swimming and feeding tadpole stage is due to the lack of pools or streams of water in some habitats. This is the case in the 'fossorial' (living mostly underground) sand-burrowing frogs of Western Australia: the Turtle Frog (*Myobatrachus gouldii*) and the Round Frog (*Arenophryne rotunda*). The habitat of these frogs consists of porous sandy soils, where surface water is present for only a short time. The climate is semi-arid with a distinct wet period during autumn, and any pools that may form after rain quickly evaporate or soak into the soil. These species lay large yolky eggs in nest chambers up to two metres below the surface in moist sandy soil. Their tadpoles are therefore restricted to this chamber until they metamorphose.

Lack of sufficient water can hardly be

The life cycle of the fossorial sand-burrowing Turtle Frog from Western Australia does not include a swimming and feeding tadpole stage. This is due to the lack of free water in its habitat. Its strong wide forearms and fingers assist its head-first entry into sand.

The fossorial Round Frog from Western Australia burrows into the sand head first, leaving only some faint tracks and a small mound.

HARRY EHMANN/NPIAW

HARRY FHMANN/NPIAW

It is the male Hip-pocket Frog that provides parental care. When the eggs fertilised by him are ready to hatch, he positions himself within the clump so that the tadpoles can enter the pouches, where subsequent development and metamorphosis occur.

the cause for terrestrial nest chambers in rainforest frogs, but members of the genus *Kyarranus* (Aboriginal for 'frog') live in montane rainforest habitats in north-eastern New South Wales and south-eastern Queensland and deposit their eggs in nest chambers in the soil. These chambers are usually spherical with a small opening at the top and are made in the loamy clay soils of the rainforest floor, generally beneath a layer of leaf litter or moss. The tadpoles swim in the small amount of water that collects in the chamber. During spring and summer the rainfall is sufficiently high to keep the soil moist, hence preventing desiccation of the eggs or tadpoles. The eggs of these frogs are large and yolky so the tadpoles have no need to feed prior to metamorphosis. It can only be assumed that this modification to the standard life cycle evolved either to prevent predation or to take advantage of the moist microhabitats of the rainforest, rather than to avoid desiccation.

The prerequisite for the development of parental care has been established: a small number of large yolky eggs that can bypass the typical aquatic larval stage.

Three species of Australian ground frog exhibit parental care: the appropriately named Hip-pocket Frog (sometimes called Pouched or Marsupial Frog, *Assa darlingtoni*) and the two gastric-brooding frogs *Rheobatrachus silus* and *R. vitellinus.*

Assa darlingtoni (the generic name is Latin for 'dry-nurse') is a tiny frog (adults are 15 to 20 millimetres long) found in the montane rainforests of south-eastern Queensland and north-eastern New South Wales. In this species the male carries the tadpoles in pouches situated along the sides of his body. The opening of the pouch forms a slit close to the hip on either side. Mating and egg-laying occurs on land, usually beneath the thick and moist leaf litter of the rainforest floor, not in a pond or stream. The eggs are large in comparison with those laid by most frogs that breed aquatically. The small number of eggs (16 or so) are closely joined by

Kyarranus loveridgei **live in montane rainforests. Eggs laid in this nest chamber were later puddled into the soil during heavy rain by this male.**

MARK EHMANN/NPAW

HARRY EHMANN/NPIAW

MICHAEL MAHONY

M.J. TYLER/ANT PHOTO LIBRARY

LEO MEIER/WELDON

Typical frog spawn is laid in free water by the female, fertilised by the male and then left to the mercy of the environment and predators.

their jelly coats. Following egg-laying the female appears to guard the eggs, having provided them with a rich supply of nutrients for their growth to froglets. The male watches over the developing eggs until the tadpoles are ready to hatch from their individual eggs; then the male settles himself within the clump and the tadpoles make their way along the side of his body and enter into the pouches. The remainder of the tadpoles' development, including metamorphosis, occurs in the pouches. Eventually, small froglets (four to five millimetres long) leave the pouch to fend for themselves. During their time in the pouch the tadpoles are nourished and grow from the nutrient remaining from the large yolk provided by their mother. There is no evidence that the male provides any nourishment for the young, but rather he provides protection from predators. The tadpoles' appearance is superficially similar to those that live in water, although they have an unusually long tail that has a clear network of blood vessels. This feature may aid in respiration. During the 45–70 days that the male carries his developing young, he feeds on small, passing insects. The largest number of young yet found being carried was 16, with a maximum of eight young in either pouch. During this time the male is certainly less mobile than when he is without young.

Even more astonishing is the life cycle of the gastric-brooding frogs of the genus *Rheobatrachus* (Latin for 'water-loving' frog), of the Conondale Ranges in south-eastern Queensland and the Clark Ranges of mid-coastal Queensland. Both species brood their tadpoles in their stomach and 'give birth' to young froglets via their mouth. No other vertebrate in the world is known to brood eggs or young in its stomach. It is only the females of these species that broods their young. The largest number of young known to have been brooded is 26. It is unknown for how long brooding occurs. However, the maximum length of time that a female collected from the wild has been in captivity before giving birth is 20 days. While brooding, the stomach of the female is modified structurally to act as a 'brood sac'. The walls become thinner and less muscular, and production of digestive juices ceases in response to an inhibitory chemical secreted by the young. As in *Assa darlingtoni* the tadpoles are similar to the structure typical of those species that live in water. The eggs of *Rheobatrachus* are large and yolky, indicating that the young probably develop from this energy source and are not provided with nutrition from the mother. There is still a great deal to be learnt about the reproductive, brooding and 'birth' behaviour of these species. The mating behaviour, egg-laying and ingestion of either the eggs or tadpoles have not been observed.

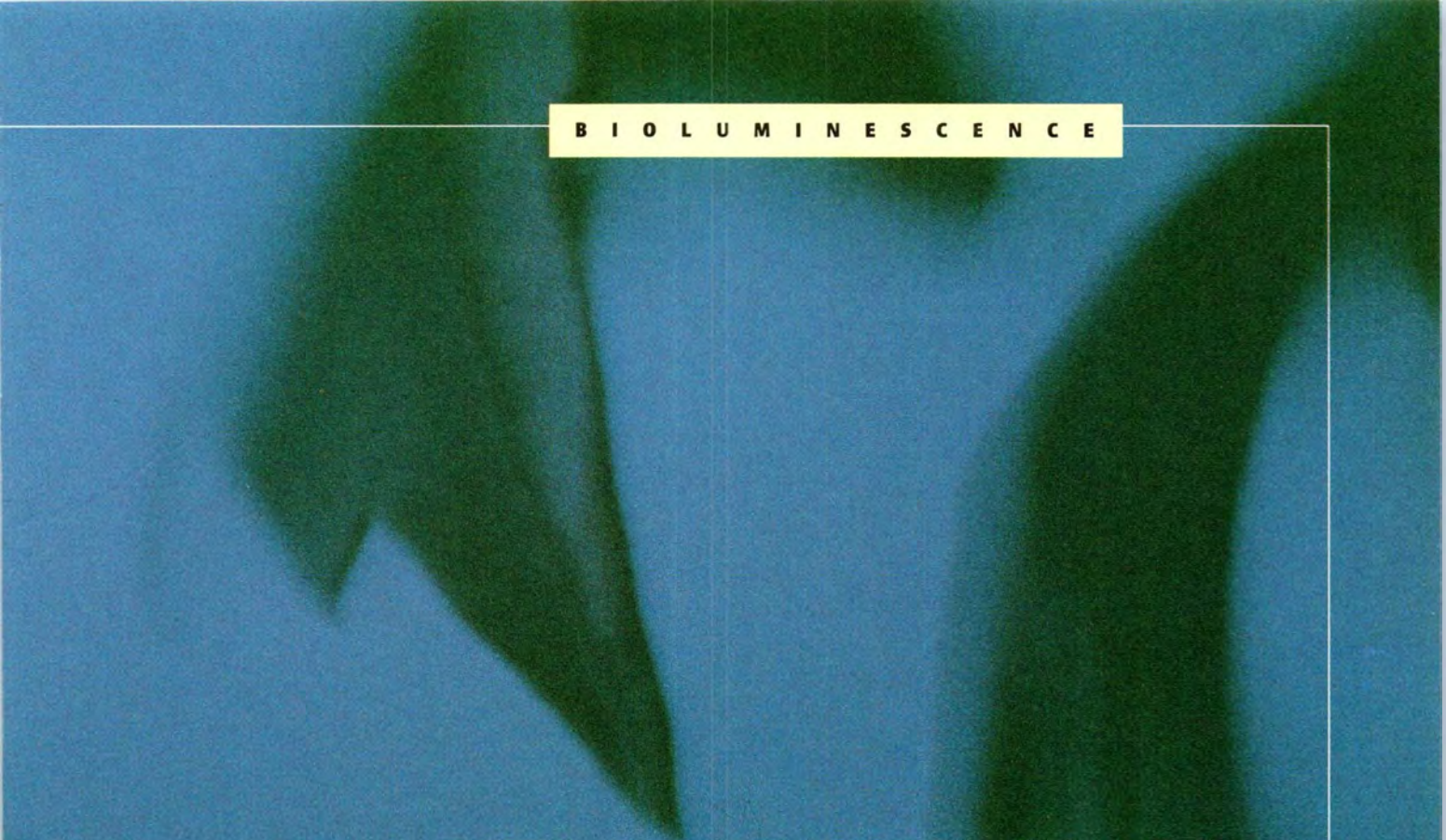
The female gastric brooding frog *Rheobatrachus silus* broods the tadpoles in her stomach and 'gives birth' to young froglets via her mouth.

Until more is known one can only surmise about the forces that may have led to the evolution of such a form of parental care. Perhaps parental care developed to overcome predation of the young. These species occur in montane rainforest, so prevention of desiccation is unlikely to be the factor leading to the development of parental care. Another possibility is to prevent them from being washed away in the strongly flowing rainforest streams. This conclusion receives further support from the fact that the gastric brooders are aquatic frogs. It is worth noting, however, that in the geological past these rainforests have not always been as moist as at the present, and desiccation may have been a problem during these times.

The Australian ground frogs have a long evolutionary relationship with the Australian continent and species occur in all the major habitats from sandy desert to alpine bogs. It is not surprising, therefore, that we should find specialisations of life-history patterns. The forces that have led to some of these derived patterns of life history and the steps involved will continue to puzzle the evolutionary biologist and keen naturalist. ■

IVAN POLUNIN/ANT PHOTO LIBRARY

Male firefly (*Pteroptyx malaccae*) displaying at night. This species is gregarious.



THE COLD LIGHT OF THE FIREFLY

Bright, bold and flashy! Not the latest sportscar advertisement, but an aid to capturing prey and attracting mates, bioluminescence has evolved in many insects; some of them bright enough to read by!

BY ROGER DE KEYZER
ENTOMOLOGY DIVISION
AUSTRALIAN MUSEUM

MANY PEOPLE ON DARK, STILL SUMmer nights in Australia would have noticed pale green or yellow flashing lights in moist gullies and rainforests but few would have understood the significance of what they had seen. Some would have said they were fireflies and left it at that, not knowing that fireflies are not flies but actually beetles of the family Lampyridae.

Very little work has been done on the biology of Australian species of Lampyridae and so most of our knowledge stems from research done on European, American and New Guinea species. Currently the Australian species are represented by two genera—*Luciola* and *Pteroptyx*. The majority of species are found in northern Australia but *Luciola* (*Atyphella*) *lychnus* can be found in the Blue Mountains in New South Wales.

The main function of bioluminescence in fireflies is for males to advertise themselves to females seeking a mate. Each species has its own male signal and female response, which can be identified by using the duration of the flash, the number of flashes in a signal pattern, the rate of flashes in the pattern and the rate of repetition of the pattern.

There is, however, a more sinister purpose for these flashing lights in the American lampyrid genus *Photuris*. Females of

Oscillogram of synchronised light flashes produced by male fireflies (*Pteroptyx malaccae*) from West Malaysia.

IVAN POLUNIN/ANT PHOTO LIBRARY

Synchronous flashing of male fireflies (*Pteroptyx malaccae*) in West Malaysia produces a Christmas tree effect.

GLOWING PAINS

To the layperson, bioluminescence, autofluoresence and phosphorescence can mean the same thing. They all result in the production of light—but by very different means.

Bioluminescence is the production of visible light by living organisms. Light is usually produced from definite organs or from bacteria and other symbionts that are either on or in tissues of the hosts' light-producing organs. This light is variable in wavelength (hence the different colours) and the substances employed in light production are highly specific and can only be used in cross-reactions between closely related organisms, for example in fireflies of different genera.

Autofluorescence is the property of an object to glow in the dark when illuminated with ultraviolet light. This is perhaps best known in some scorpions that appear bright blue–green under ultraviolet light. Recently fluorescent markings have also been found in some Australian butterflies. Phosphorescence is the property of a substance to emit light in the dark after previous exposure to light. Unlike bioluminescence and autofluorescence, phosphorescence is *not* a biological phenomenon.

this genus are the 'sirens' of the insect world, using their lights to mimic the flash patterns of females of other genera, particularly *Photinus*, and even of their own genus and species. Once the male is lured to where the female *Photuris* is resting, it is pounced upon and eaten. Some of these 'femme fatales' are only thought to be predatory once they have mated, possibly due to a substance in the male ejaculate that triggers signal mimicry. Once mated the female of *Photuris* rarely responds to her conspecific males' flash, so males of her own species are rarely eaten. This type of mimicry is known as aggressive or Peckhammian mimicry. Some *Photuris* females can mimic the flash patterns of five other firefly species from various genera. Some male *Photuris* species mimic flash patterns of males of other species, which may be the prey of their females. These males may then be able to inseminate the hunting females, perhaps at the risk of self-sacrifice in that they may unwittingly become a meal for an unreceptive female.

Most adult fireflies, however, do not feed; the larvae are carnivorous and feed mainly on snails and slugs and other small invertebrates. They inject a substance through their hollow, sharply pointed mandibles that both paralyses and liquefies the tissues of their prey. They then imbibe the fluid with the aid of their mouthparts.

Fireflies not only use their luminous organs for sexual communication, predation and deception but also for illumination in general, gregarious oviposition (that is, when different females lay their eggs together) and defence. The latter includes warning of noxious taste and inedibility, and in startle and repulsion of would-be predators. Juveniles probably use their lights for defence and perhaps for illumination and communication. One worker has found that ovipositing females of African species of *Luciola* avoid larval lights and migrate to other less crowded areas to lay their eggs. The eggs and pupae of fireflies are also luminescent.

Male lampyrids are usually caught by people as they are flying about at night flashing their lights. Females rarely fly and are mostly found on the ground or resting on vegetation. Some tropical species are known to synchronise their flashes so that a large number of individuals, within one area, emit light at the same time.

FIREFLIES ARE NOT THE ONLY INSECTS that are bioluminescent. Many insects are said to be luminescent but, in many cases, the continuous emission of light may

An SEM of the head of an Australian firefly (*Luciola* sp.). Adult fireflies do not usually feed, hence the greatly reduced mandibles (jaws).

GEOFF AVERN

be due to bacteria, symbionts or a recent meal of luminescent fungi. Self-luminescence is the issue here. Apart from lampyrids, self-luminescent insects include some springtails (Collembola), click beetles (Elateridae), glow-worm beetles (Phengodidae) and glow-worm flies (Mycetophilidae). (The term 'glow-worm' is used in Europe and North America to refer to luminous lampyrid larvae or to the larviform female of the European lampyrid *Lampyris noctiluca*. Here, the terms 'glow-worm beetle' and 'glow-worm fly' will only be used to refer to phengodids and mycetophilids respectively.) Some lantern flies (Fulgoridae), which are actually bugs, are also reported to be luminescent but there are many conflicting reports as to whether they actually *produce* light or not.

Springtails are small to minute, soft-bodied, primitive insects that are found worldwide in soil, especially in decaying vegetable matter and rotten logs. They are rare in arid areas but may be found in Subarctic and Antarctic regions. Some species are known to emit flashes (5–10 seconds duration) when they are mechanically stimulated, while others have a continuous emission of light. The flashes of light may have a defensive or warning function, or aid in species recognition, especially for mating purposes.

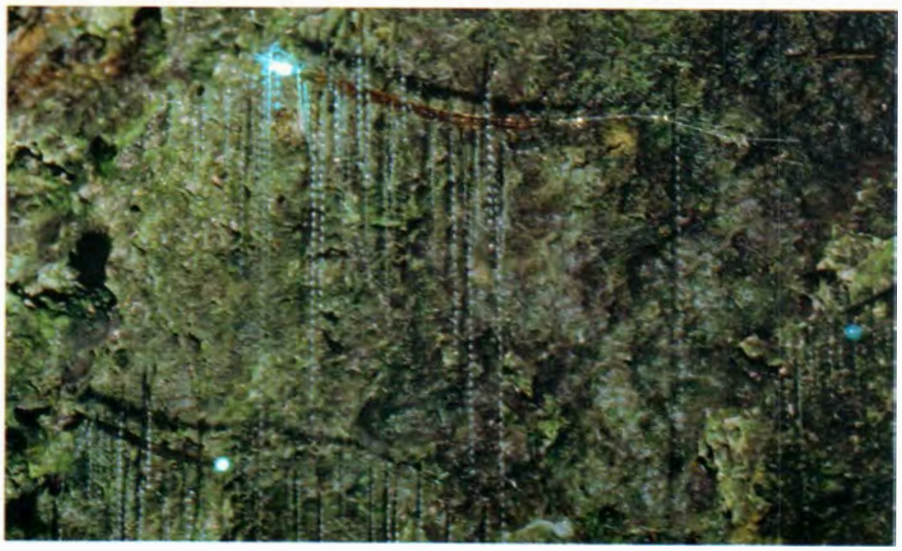
Click beetles are not known to be luminescent in Australia but in the New World tropics many species from the tribe Pyrophorini have light-producing organs. The larvae of one Brazilian species live in the tunnels of termite mounds and use their light to attract prey, primarily ant and termite alates (winged reproductives).

Glow-worm beetles, like the fireflies to which they are related, have luminescent larvae and adults. They are not known in Australia but are found in South-East Asia and the Americas. Females of known glow-worm beetles are luminescent and are larviform (wingless and of the appearance of the larva). Larviform females are also found in fireflies but no larviform female fireflies have been recorded from Australia. Usually larviform females can easily be distinguished from larvae by the greater number of antennal and tarsal segments and the presence of two tarsal claws. However, larviform female glow-worm beetles are an exception. The only feature that distinguishes them from the larvae is the presence of an oopore (opening for egg-laying) on the ventral side of the ninth abdominal segment. Unlike male fireflies, glow-worm beetle males are not known to fly about with their lights on in search of a mate but some flash brightly during mating, perhaps to hold the female's attention, or for defence or both. There is much variation in the arrangement of the light-producing organs in glow-worm beetles. The larviform females of the starworm *Diplocladon hasselti* from Malaysia, for example, is perhaps the most 'enlightened', with two to three light-producing organs on every segment of its body except the head.

Many people in Australia would have noticed green constantly glowing lights in caves and, on closer inspection, found larvae of glow-worm flies suspended from sticky threads. These glow-worm flies are also found in shaded areas along streams and in moist depressions of banks. Australia has two genera of glow-worm flies with luminous larvae (*Arachnocampa* and *Mallochinus*) but the best-known species is New Zealand's *Arachnocampa luminosa*—the species found in the famous Waitomo glow-worm cave. Larvae hang from the ceiling at night on specialised threads and feed mainly on ghost midges (Chironomidae), which they capture in sticky droplets on the dangling silk and mucous threads of their webs. The midges are presumably attracted to the larval glow. These glow-worms are cannibalistic and while glowing brightly may be fighting or eating their neighbours. There is also sexual communication in *A. luminosa*. When a male lands on a female pupa, she glows. Very often several males will be on the female pupa, waiting to mate with her once she has emerged. If there are no males present when the female emerges, she uses

A firefly larva foraging for prey in Sumatra, Indonesia. Larvae of this species can be as large as ten centimetres.

M.W.F. TWEEDIE/ANT PHOTO LIBRARY



OTTO ROGGE/ANT PHOTO LIBRARY

A larva of the New Zealand glow-worm fly *Arachnocampa luminosa* in Waitomo Caves. The posterior light of the larva is used to attract prey, such as ghost midges, which are ensnared in the sticky threads.

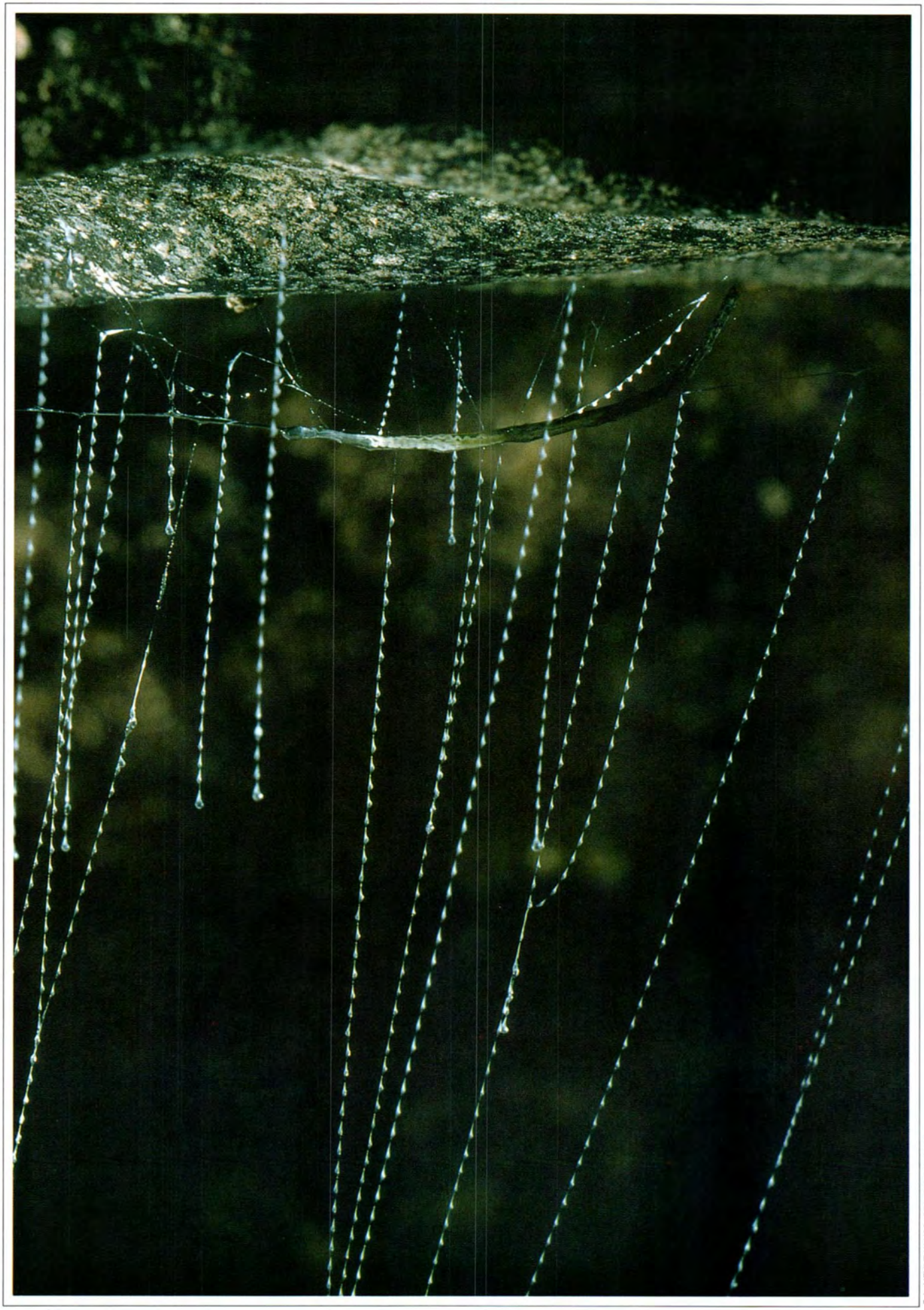
The larva of the glow-worm fly *Arachnocampa tasmaniensis* suspended from a cave roof (Mole Creek Caves, Tasmania). Silk threads with sticky droplets are used to capture prey.

Bright Lights for Laboratory Techniques

One of the latest applications of bioluminescence is in the laboratory detection of microorganisms. Rather than waiting days for cultures to develop on agar, this method may provide the results almost instantly. It involves placing a 'dipstick' into the prepared sample to be tested (be it from urine or suspected salmonella-infected food, for example) and then into a mixture containing compounds extracted from fireflies (luciferin and the enzyme luciferase). If the sample contains microorganisms, the mixture will light up.

How does it work? All living cells use ATP (adenosine triphosphate) to carry energy. If, as occurs naturally in fireflies, ATP is mixed with luciferin and luciferase, the energy is released as light. The sample being tested must first be mixed with a reagent to remove any non-microbial ATP, and then the remaining microbial ATP must be extracted. This is then mixed with the firefly extracts and the amount of light emitted measured with a luminometer. The more microbial material, the more ATP and the brighter the light. It may be possible to first treat the sample with antibiotics that kill particular bacterial strains and then test it for specific infections.

—Georgina Hickey
Scientific Editor



C.A. HENLEY/AUSCAPE INTERNATIONAL

light to attract them.

In insects there are four types of luminescence: the continuous glow, the intermittent glow, pulsation and the flash. The continuous glow may last day and night as in the case of the eggs and pupae of lampyrids and in adult female glow-worm beetles of the genus *Phengodes*. Larval glow-worm flies also emit a continuous glow but only at night. The intermittent glow is found in larval *Phengodes*, larval fireflies and click beetle adults. This may last for several seconds or even minutes, appearing slowly, reaching a maximum intensity and then slowly fading out. Pulsation luminescence is known in some species of adult fireflies where flashes are emitted one after the other before the light fades out from the previous flash. But flashing is by far the most common method employed by adult males of fireflies whereby short bursts of intense light are emitted in a fraction of a second.

Bioluminescence occurs in a variety of animals other than insects, especially in marine organisms such as deep sea fish, crustaceans (copepods, ostracods, prawns and shrimps), cnidarians (jellyfish, octocorals, gorgonians, seapens and siphonophores), comb jellyfish, tunicates (pyrosomas and salps), molluscs (squids, marine

A cross-section of part of a firefly's light-producing organ reveals three main layers: a transparent cuticle (blue), photocyte cells (green) arranged in cylinders and well supplied with trachea (shown) and nerves, and a reflective layer (pink), showing granular inclusions.

DAVID KIRSHNER

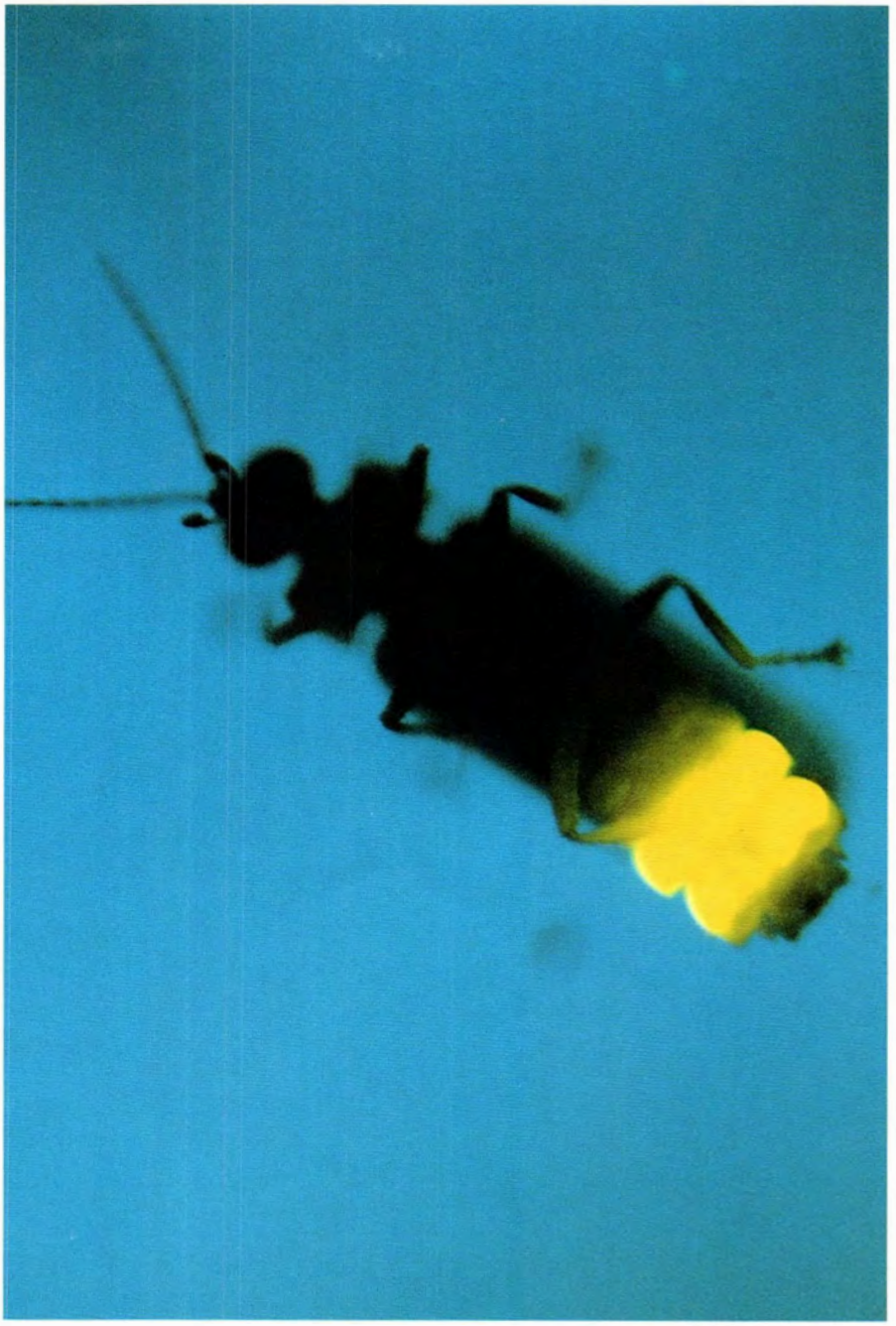
snails and slugs), polychaete worms and echinoderms (brittle stars, sea stars, sea cucumbers and sea lilies). Many bacteria (both marine and terrestrial), protozoans and terrestrial fungi are also bioluminescent. Just as with insects, luminescence in the sea has a variety of purposes: defence, deterring and startling would-be predators, camouflage, luring prey and attracting mates.

THE PHYSIOLOGICAL ASPECTS OF BIOLUMINescence have fascinated people for centuries. In fireflies (both adults and larvae) light-producing organs are found on the undersides of the last two segments in males and the third from the last segment in females. In click beetles and glow-worm beetles there may be prothoracic as well as abdominal light organs in both larvae and adults. Research on fireflies has shown that each light organ is composed of 7,000 to 8,000 large cells called photocytes, grouped together in cylindrical masses under a layer of transparent cuticle. The photocyte masses are well supplied with tracheae (air tubes) and nerves. Behind the layer of photocytes is a second layer of cells filled with tiny, granular urate crystals and it is this layer that acts as a reflector. The position of these light organs is usually different in male, female and larval forms of fireflies. The structure of the light organs in the New Zealand glow-worm fly *Arachnocampa luminosa* is quite different to fireflies and glow-worm beetles in that they are made up of the expanded distal portions of four Malphighian tubules (excretory organs) lying in the eighth abdominal segment; the photocytes are transparent; and the reflective layer lacks the granular inclusions.

In fireflies light is produced by the oxidation of a compound known as luciferin in the presence of an enzyme called luciferase. The complex process of producing light is believed to be triggered by the enzyme acetycholine released by an activated nerve ending. The whole process seems to be reversible in that the luciferin can be used over and over again. There is quite a long delay between nervous stimulation and light emission, which suggests acetycholine must diffuse into the photocytes or that the intermediate steps of this complex reaction occur quite slowly. The flash is quite short but, as each cylinder is uncoordinated with the others, the entire light organ produces a relatively long flash. In some species, temperature increases the frequency of flashing. The process of light production in other luminous organisms is presumed to vary around this general description.

The cold light of the firefly is very efficient in that only about ten per cent of the energy emitted is heat, compared to a standard light bulb that gives off 95 per cent of its energy as heat. There is no infra-red or ultraviolet light and all light emitted occurs within the visible spectrum. This light can also be switched on and off at will and, as the whole process is reversible, it has applications in similar light production systems designed by humans to reduce energy consumption.

The study of bioluminescence is also important for investigating the kinetics of enzymes and other reactions of biological importance. Bacterial luminescence has been used to observe the theory of absolute reaction rates: it has provided a rational basis for interpreting the effects of both temperature and hydrostatic pressure on chemical reaction rates in living cells. Such research has brought forth a well-known and specific assay method for the presence of ATP (adenosine triphosphate)—a chemical used in the transfer of energy within living cells and a required co-factor in the firefly luminescent system. This test may shed some light on the chemical mechanisms involved in other luminescent systems. ■



In male fireflies, the light-producing organs are located on the underside of the last two segments. This species is *Pteroptyx valida* from West Malaysia.

IVAN POLUNIN/ANT PHOTO LIBRARY

Suggested Reading

Buck, J.B., 1948. The anatomy and physiology of the light organ in fireflies. In *Bioluminescence*, ed. by E.N. Harvey *et al. Ann. N.Y. Acad. Sci.* 49: 397–482. (Buck includes a discussion on the four types of bioluminescence in insects—continuous glow, intermittent glow, pulsation and flashing.)

Herring, P.J., 1978. *Bioluminescence in Action.* New York Academic Press: New York. (This is an excellent coverage of luminescent animals in general; J.E. Lloyd deals with insect bioluminescence on pp. 241–272.)

Lloyd, J.E., 1971. Bioluminescent communication in insects. *Ann. Rev. Entomol.* 16: 97–122. (The physiology of the firefly luminescent system is discussed.)

Lloyd, J.E., 1983. Bioluminescence and communication in insects. *Ann. Rev. Entomol.* 28: 131–160. (Lloyd summarises in detail all known aspects of bioluminescence in insects.)

WADE HUGHES/LOCHMAN TRANSPARENCIES

In the struggle for life, the Northern Quoll is both predator and prey. Here it is shown eating a native rodent.

PYTHON ON THE PROWL

Meal time for an Amythestine Python is a sight to behold. Tim Low captures the dining etiquette of this snake on film.

WHEN I WORKED AS A NATURALIST at the Cape York Wilderness Lodge the staff had two main topics of dinner-table conversation—pythons and the weather. The talk of weather was unsurprising for I was there during the monsoon season and the Wet in northern Australia is a phenomenon to behold. The talk of pythons was also understandable, for we all agreed we had never been anywhere with so many snakes.

The main object of interest was a sleek three-metre Amythestine Python (*Morelia*

BY TIM LOW

The Amythestine Python's favourite perch was a low branch on a large shrub. By lying with its head broadly looped, the python had enough reach to strike animals on the ground.

TIM LOW

While climbing higher into the shrub the python gripped the quoll tightly in its tail.

The dead Northern Quoll had bulging eyes and a bleeding face from the pressure applied by the python's grip.

amethistina), which had lived around the lodge for some years. When I first arrived there, departing naturalist Klaus Ulhenhut showed me some of its haunts. During previous weeks it had been coiling by day behind a rubbish bin against a fence or on the posts of a nearby greenhouse, both within a few metres of the lodge kitchen and dining hall. Unfortunately it was no longer there.

But a few nights after Klaus left it appeared, draped across a very low branch on a large shrub behind the kitchen. This proved a favourite perch, and the python could be seen there every night lying as if in wait for prey. By day it coiled up in a shallow hollow at the base of the shrub. As lodge naturalist it was my job to show wildlife to the guests, and nothing was easier than showing them this magnificent iridescent snake. Being a python it was of course non-poisonous, and showed no inclination to strike or flee, even when closely approached.

The Cape York Wilderness Lodge is only 400 metres from the top of mainland Australia, and lies surrounded by monsoon rainforest and eucalypt woodland. These are infested by exotic weeds, feral cattle and pigs, but can still be counted among the best-preserved native habitats in Australia. The open forests, especially near rocky outcrops, are still home to the Northern Quoll (*Dasyurus hallucatus*), a beautifully patterned marsupial carnivore that has disappeared over much of its former range in northern Australia, probably from the impact of Cane Toads (*Bufo marinus*), foxes and feral cats.

Before coming to the lodge I had heard many tales of the semi-tame quolls that scampered about the open-plan dining hall at night, taking food from children's hands, even becoming entangled in the large toaster. So I was disappointed to arrive at the lodge and be told the quolls had gone. The staff blamed the python.

But after ten days at the lodge I realised there was still a quoll about. I saw it dart through grass near the machinery shed one night. And then a few nights later I was called over by one of the staff just before dinner to see it scampering along a path near the dining hall. It came up as if expecting a hand-out, but raced off before we could offer anything. I felt it was one of the most beautiful and engaging animals I had ever seen.

Fifteen minutes later I was dining with guests when Pete, the chef's apprentice, came to my ear whispering something about a quoll out behind the kitchen. I was pleased for I knew the guests would like to see a wild quoll. But then I read the worry on Pete's face and remembered the python. I rushed out the back and there was the quoll, blood smeared across its face, eyeballs bulging, in the tight grip of the snake's coils. The lodge staff gathered about excitedly, along with the braver guests, and someone said we should rescue the quoll, but it was clearly dead, and anyway we had no right to interfere in this natural process. I was shocked to think that the quoll, so alert and frisky not half an hour ago, could fall so easily to the python, which had never left its perch. I sprinted to get my camera, and returned to find the python had transferred the quoll to its tail, and was now climbing higher into the shrub to escape the commotion.

Five minutes later the python consumed its catch. Snakes can dislocate their lower jaw, and the skin between their scales is very elastic, so swallowing the quoll proved an easy feat. The lodge staff, who had made so much fuss over the quoll's death, were soon engrossed in the spectacle of its consumption.

Later that night I returned to the shrub and was shocked to find the python back on its perch, awaiting more prey. It lay in its usual position of readiness, with the neck broadly looped and head facing downwards, bringing the ground within striking reach.

This snake was never seen to capture prey again, but the very next night a small Amythestine Python, 1.3 metres long, at-

The python swallowed the quoll head-first, using its mid-body coils to hold the quoll in place.

TIM LOW

TIM LOW

The python had little difficulty swallowing an animal much thicker than itself, and showed scant regard for a crowd of onlookers viewing and photographing the spectacle.

tacked a Rainbow Lorikeet (*Trichoglossus haematodus*) in the staff village. The lorikeet was an injured bird kept as a pet in a hanging cage. It squawked loudly and was rescued unharmed by one of its keepers, who found it locked in the python's coils.

The big python stayed in the shrub another few days, slowly digesting the quoll. It then moved on, and was seen only intermittently in the following weeks: once early in the morning on the roof of a hut, and three times at night beside paths. The staff often told me of seeing big pythons at night around the lodge, but several snakes were coming and going and it was difficult to tell who was who.

TRAVELLING ON THE DIRT ROADS AT night I saw other pythons, often lying on the ground with necks broadly looped and heads facing the road. They were undoubtedly awaiting the passing parade of bandicoots (*Isoodon macrourus*), White-tailed Rats (*Uromys caudimaculatus*), Agile Wallabies (*Macropus agilis*), echidnas (*Tachyglossus aculeatus*) and Bush Thick-

The elastic skin of the Amythestine Python stretches to accomodate the quoll. Normally the scales overlap and the skin is not visible.

For six days and nights the injured python lay coiled on a bed of dead leaves between thick clumps of grass, only 20 metres from the hut where I lived.

TIM LOW

knees (*Burhinus magnirostris*), the main prey-sized animals I saw on the roads. Once I found a large Northern Children's Python (*Liasis maculosus*) gliding across the road at night, and staff members saw two Black-headed Pythons (*Aspidites melanocephalus*). Klaus said there were also Water Pythons (*Liasis fuscus*) and a few Carpet Pythons (*Morelia spilota*)—a remarkable tally of five python species in all. The Amythestine was by far the most common of these, and the largest; indeed it is Australia's longest snake, with a reported maximum length of 8.5 metres.

At Cape York the largest animals in the forest were—regrettably—feral cattle. Many of these were descended from a herd overlanded by Frank Jardine from Rockhampton in 1864, to set up for the now abandoned Somerset station, in what was one of Australia's most amazing feats of early settlement. These cattle are almost certainly damaging the forests around the lodge, compacting the soil with their hard hoofs, grazing the native plants, and aiding the spread of weeds. They damage the local termite mounds, and even overturned a small mound in which White-tailed Kingfishers (*Tanysiptera sylvia*) were nesting. The Department of Primary Industries considers them a serious brucellosis and screw-worm risk, and wants them removed.

When I first came to the lodge the feral cattle seemed shy, but as the Wet progressed herds of up to 17 could be seen grazing brazenly by the roads at night. (By contrast, the feral pigs in the rainforest were keenly hunted by islanders from nearby Bamaga, and they remained very wary.) Young bulls expelled from the herds formed small groups, and one took up residence around the lodge, grazing near the machinery shed late at night and sheltering in nearby rainforest.

I will never be sure what happened but I believe that one night this bull trampled the quoll-eating python. I found the snake out-

Northern Brown Bandicoots may also be victim to the Amythestine Python's unrelenting grip.

FRITHFOTO/ANT PHOTO LIBRARY

side the staff toilet block just 20 metres from my hut, looking pitifully emaciated, with four patches of damaged scales about the size of hoofs. At first I thought it dead but after prodding the snake it slithered weakly into nearby long grass. There it lay for six long days and nights, moving scarcely at all, ignoring the attacks of angry honeyeaters and the pounding falls of monsoon rain. It rested until 11 pm on the sixth night when with much relief I watched it glide away, looking thin but healthy, towards the distant dining hall. The next night it was seen lying by the dining room road, and the following night re-appeared on its perch on the shrub. Unfortunately it was scared by guests two nights later and was never seen again.

By this time my two-month stay at the lodge was over, and regretfully I packed my bags, said my goodbyes and left with friends for the islands of Torres Strait. Ten days later at Thursday Island I phoned the new lodge naturalist, Owen Foley, for news about the lodge wildlife. He told of the raucous Palm Cockatoos (*Probosciger aterrimus*) flying close to the lodge, of flocks of Rainbow Bee-eaters (*Merops ornatus*) migrating to New Guinea (I watched them pass over the islands), of Cooktown Orchids (*Dendrobium bigibbum*) in bloom, and then he mentioned an awful smell that had appeared out the back of the dining hall. A worker had been assigned to clean out a sewage pit, but the smell had persisted, and the worker had been criticised, until someone spotted the rotting carcass of a python at the base of the shrub.

So the snake had died after all. Pythons feed infrequently, and the quoll may well have been its last meal. There seemed a strange poignancy in the two deaths. But I knew that at least one animal had benefited—a bandicoot.

Each night in the dining hall two Northern Brown Bandicoots would come to feed upon bread scraps and biscuits profferred by the guests. One of these bandicoots wore a large scar across its back: Mark, the lodge manager, explained that it had been struck one night by the python in the middle of the dining hall, during dinner. The bandicoot had escaped, but minus the skin from its back. Now, at least until the next python takes up residence, this lucky survivor will be able to nibble its bread in peace. ■

KLAUS UHLENHUT/ANT PHOTO LIBRARY

Visitors to the Cape York Wilderness Lodge can witness life and death struggles between Amythestine Pythons and their prey.

The reburial of Aboriginal remains is a controversial and emotional issue. Most institutions have a policy regarding the return of collections to Aborigines. But with remains dating back thousands of generations, doubts still remain for some scientists.

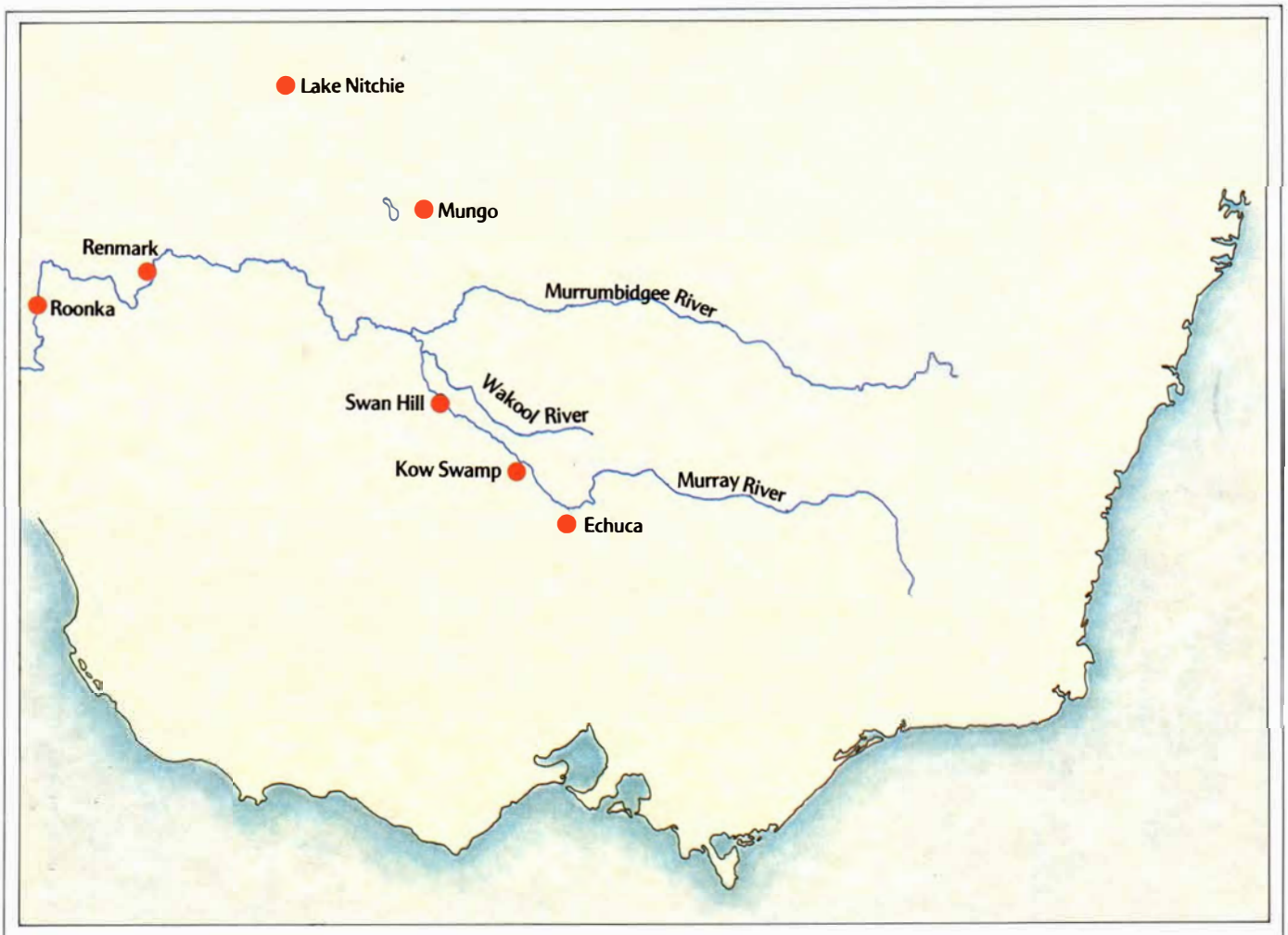
REFLECTIONS ON THE MURRAY BLACK COLLECTION

BY JOHN MULVANEY
FORMER CHAIR OF PREHISTORY
AUSTRALIAN NATIONAL UNIVERSITY

GEORGE MURRAY BLACK WAS A PASTORALIST at Tarwin Meadows, South Gippsland. From about 1929 to 1950 he passed winters in more congenial climates along the Murray River between Echuca and Renmark. His obsession was fossicking on dunes for eroded human burials or probing the sand for them. Encouraged by anatomists, Murray Black accumulated the bones of about 1,800 individual Murray 'blacks'. These he de-

ANTHONY FARR, AUSTRALIAN MUSEUM

Murray Black's Murray 'blacks'? Murray Black spent much of his time fossicking for eroded human burials along the Murray River. Their ages range from recent to about 14,000 years. This hand-coloured engraving comes from Angas, *South Australia Illustrated.*



CATHY McGAHEY

Murray Black collection sites.

posited in Canberra's Institute of Anatomy and later at the University of Melbourne. Their ages range from recent to possibly 14,000 years.

No archaeologist was ever associated with Black's activities. Justified at the time in the interests of science, his 'grave robbing' occurred at a period when no State provided legislative protection for Aboriginal remains or artefacts, and when ethical issues differed where Aborigines were involved.

Although the Melbourne collection was particularly well stored, the lack of archaeological participation meant that few burials were excavated systematically, recorded or photographed, so their stratigraphic situation is unknown, while any associated grave goods were seldom noted. Although the total number of individuals is large, many consist of fragmentary or incomplete skeletons. As the collection accumulated during those lacklustre years of depression, war and subsequent financial starvation, for decades the remains were virtually unstudied. Partly due to my prompting, a summary of 'knowledge' was published in the 1959 *Proceedings of the Royal Society of Victoria*. Even with illustrations, a mere four pages sufficed!

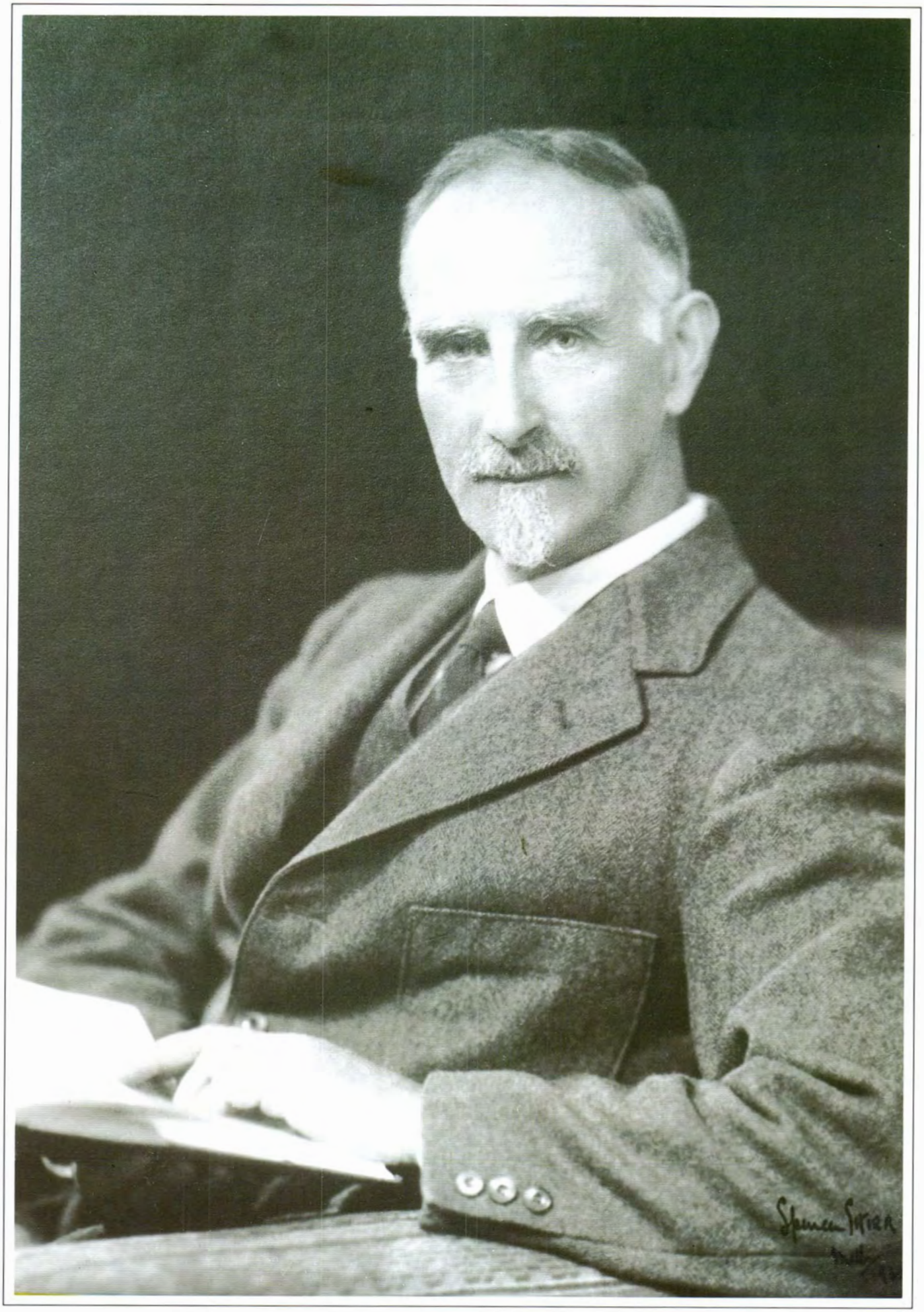
Understandably, many Aboriginal people feel outrage and revulsion for such plundering, which was neither scientific nor according to archaeological practice and which broke normal codes of ethical behaviour. It would be illegal today. If such gross violation is admitted—indeed, the Federal and Victorian Ministers for Aboriginal Affairs have agreed in principle to return the Murray Black material—why should Aboriginal people be asked to pause to reflect on the consequences of mass reburial?

As this emotional issue impinges upon spiritual beliefs and ritual life, any adverse comment may be labelled as opposing religious liberty, as racist or self-interested special pleading. Because I am retired and as I never practised human biology, I disclaim personal motives. Without any attempt to defend past wrongs, however, it is reasonable to isolate aspects of the issue of total reburial and to consider the consequences. This extends beyond the emotions felt by some present Aboriginal Australians, no matter how sincerely held. Also involved are the concerns of future Aboriginal generations, the preservation of other ancient human remains (whether discovered in the past or the future) and the status of the Aboriginal race assessed from the perspective of other races.

The Australian Archaeological Association some years ago accepted the validity of Aboriginal custodianship of sensitive skeletal remains. It met in Hobart in the debate over the control of bones of known historical identities. Like the Association, I am on public record supporting the return of the Crowther collection to Tasmanian Aborigines. These were individuals who died at Oyster Bay last century and were dug up later and removed from the cemetery by a medical doctor. I do not dispute that the remains of known individuals or those of recent ancestors should be reburied (or not excavated). This does not imply that such bones lack scientific value. It simply means that social and personal factors outweigh scientific considerations.

After four or five generations, however, historical identities become blurred. At the other extreme, the Lake Mungo burial discovered in 1969 involves the remoteness of perhaps 1,200 generations, an interval beyond comprehension. Even the Coobool Creek burials collected by Murray Black are over 400 generations removed. Put another way, those people were buried 5,000 years before Egyptians built the pyramids. To assert that their spiritual values and cultural life reflected those of contemporary traditional society is almost certainly wrong. At this degree of remoteness, such burials assume a world significance, meaningful to persons of any race. The

George Murray Black was a pastoralist in South Gippsland. His extracurricular passion was that of collecting human burial remains. Some would call it grave robbing; others see it in the interest of science.



ancestry of races forms part of global history. That Aboriginal custodianship of remains older than a few generations should not involve their total destruction through reburial is argued here.

OBJECTIVE STUDIES OF MURRAY BLACK burials belong essentially to recent years, because archaeological and biological anthropology disciplines developed late in Australia. Research awaited the emergence of qualified graduates during the '70s. Claims that 'scientists' had sufficient time to complete all conceivable research ignore that delay. This may not justify the collection's retention, but it does explain why its significance was so tardy in recognition.

Another relevant factor is the surge in quantifiable knowledge concerning the pre-European past, accompanying the growth of archaeological fieldwork from the '60s and the application of radiocarbon dating. By 1962 the certain ancestral Aboriginal presence exceeded 10,000 years. In 1965, that age became 20,000 years, 30,000 by 1970 and, in 1974, possibly 40,000 years. It may be older, but this is the present limit of reliable dating. No other society has had its chronology expanded so rapidly. It also established that all continental zones were colonised before 20,000 years ago, the period of massive global cooling and fall in sea level. Fresh discoveries and consequential interpretive revisions continue; the latest establishes Tasmania's occupation by 30,000 years ago.

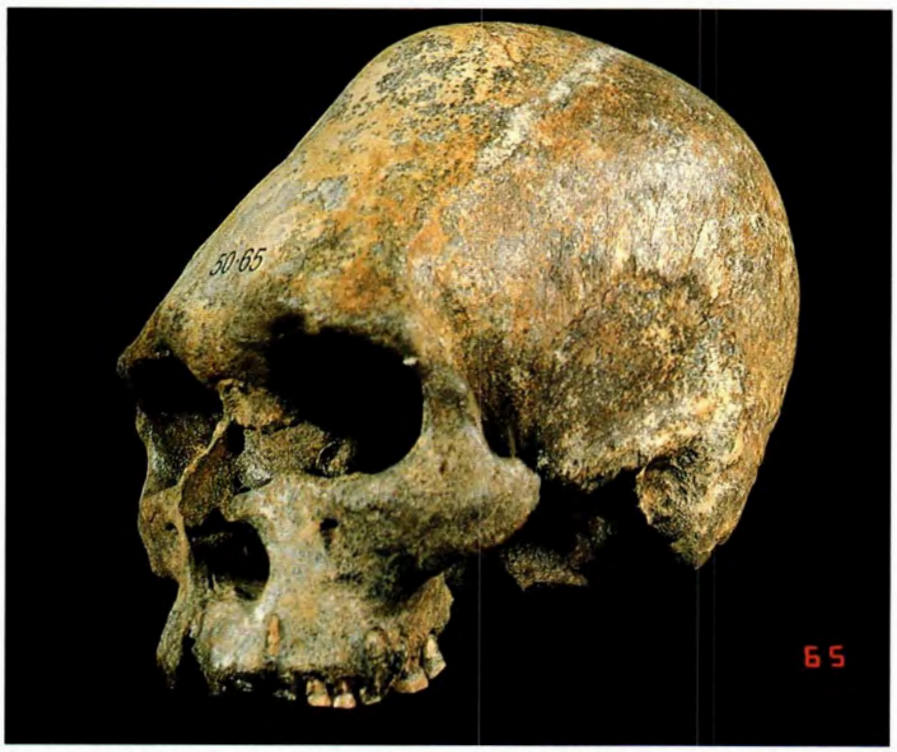
In this saga human burials figure prominently, particularly those at Lake Mungo, Kow Swamp, Roonka and Nitchie. Careful excavation and radiocarbon assays enhance the quality of evidence. The world's oldest known cremation ritual occurred at Mungo about 25,000 years ago; even older was a grave powdered with ochre, a practice comparable with burials on the contemporary French Riviera. Such intellectual insights ensured World Heritage status for the Willandra Lakes. Equally significant are the decorative items and indications of tooth avulsion (knocking out teeth during a ceremony) at Nitchie and Roonka, pointing to great antiquity for traditional rituals.

What have these stirring times for white academics, Aborigines may protest, to do with them or the Murray Black burials? Significantly, they have quantified the Dreaming; it is commonplace for land rights claimants to assert 40,000 years of land tenure. Discoveries highlight important artistic, cultural and economic changes through time, reflecting increasing environmental knowledge and social complexity. Aboriginal society demonstrably was neither culturally monolithic nor incapable of economic adaptation. Australia's linguistic and cultural diversity had ancient roots, while the antiquity and variety of art and other symbolic systems, including burial modes, are outstanding in global terms. Diversity and achievement in the face of environmental challenges are the message, a source of pride to all Aboriginal people. That much of this data may be reconciled with Dreaming traditions is a subject meriting consideration, not condemnation.

The Murray Black collection contributed vital information to this story. Its

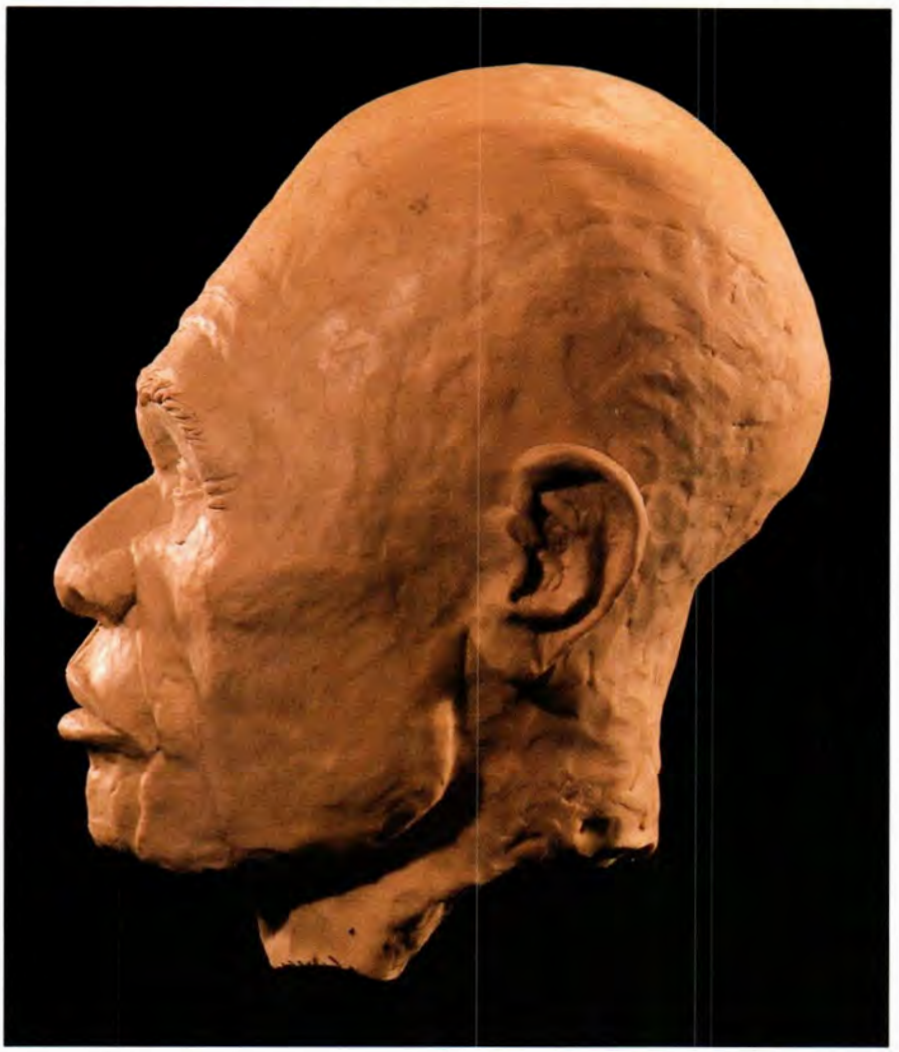

D.J. MULVANEY

The carbonate-encrusted bone fragments of the Lake Mungo female cremation. Dated to around 25,000 years ago, it is the world's oldest known human cremation and implies complex ritual. This photograph shows the eroded remains in 1969, when first recognised as human.



PETER BROWN

The Coobool 65 cranium from the Murray Black Collection (1950) showing the results of artificial deformation during infancy, resulting in a marked frontal recession, producing an elongated and flattened profile. A uranium thorium date of 14,300 ± 1,000 years has been obtained for this skull.



PETER BROWN

Reconstruction by Peter Brown (University of New England) of what the artificially deformed Coobool 65 probably looked like.

significance is magnified because all the burials belong to one environmental region. Further, European onslaught extinguished much traditional knowledge, so local communities derive deep insights into their own cultural identity from the clues provided by their ancestors.

Some people resent their ancestors being examined by non-Aboriginal experts. A future alternative is for Aboriginal scholars trained in archaeology, human biology and ecology to analyse this material. Despite assertions to the contrary, many young Aboriginal students express keen interest. Their research will be possible only if human remains are not totally destroyed and if there is no embargo on their future investigations. Reburial of recent remains, but the

PETER BROWN

An artificially deformed and a normal skull from Coobool Creek.

custodianship of the remainder in museums staffed by appropriate Aborigines, or in conservation-secure keeping places, offer alternatives.

Human bones and teeth provide diverse insights into past life and culture and, with expanding scientific knowledge, these will increase. That is one reason why archaeological finds can never be classified as totally researched. The Murray Black burials have already provided the following types of information: metrical data on stature, body size and sexual dimorphism (Aboriginal crania reduced in size and robusticity through time); life expectancy patterns; dietary and nutritional changes; pre-1788 health and diseases; surgical knowledge and ritual practices; the nature and extent of injuries; and clues to population density or stress and to past biological and culturally adaptive qualities. Fresh insights are promised by new techniques for blood group genetic research on bones. Communities could establish their genetic affinities with their territories, with distant communities, or trace ancestral migrations.

Some Coobool crania, on the Wakool River north of Swan Hill, combine antiquity exceeding 10,000 years with evidence for a rare cultural practice. Numerous adult skulls had been deformed artificially during infancy. Possibly following fashion's dictates for an elongated, flattened profile, each mother probably exerted hand pressure to modify her baby's head. Only Cape York's Gudang people practised such deformation in 1788, but that trait obviously flourished in the ancient Riverina. Such evidence for past cultural life is deeply relevant to local communities. It is worth reflecting that, despite terrible violence to their graves, ancestral spirits may approve that knowledge was conveyed through centuries to present generations searching for greater cultural identity.

Like all human burials, the Murray Black collection offers material proof of living conditions and ideological factors through countless (but dateable) generations. In one sense, for those Aboriginal children growing up in the general Australian community and lacking direct contact with vibrant traditional communities, it constitutes priceless 'deeds' to their country and insights into their cultural heritage.

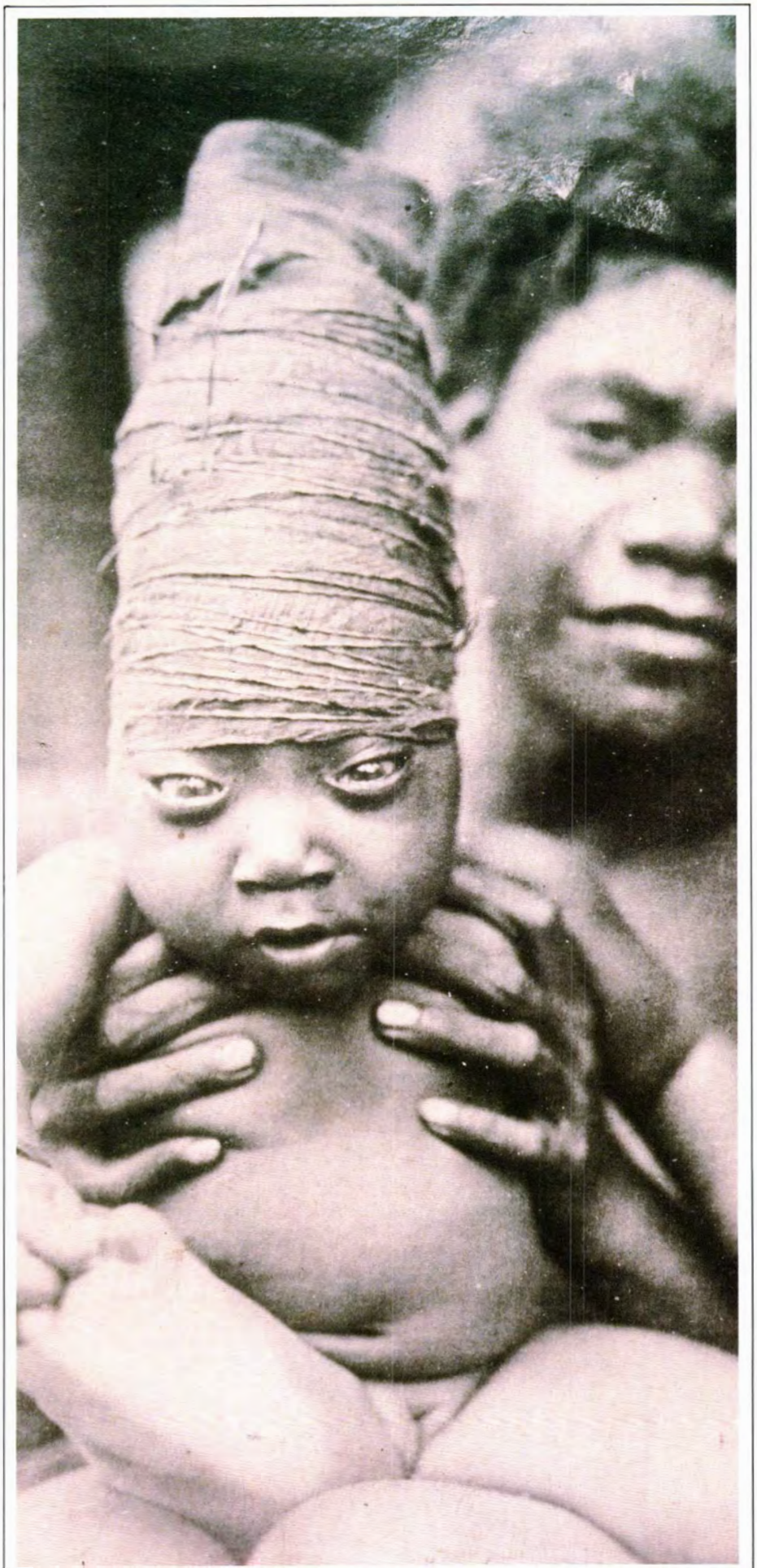
The study of a continent's past cannot be a racial monopoly. Aborigines constitute only one of those races that humanised the Earth. As all peoples are interdependent in future global affairs, Aboriginal scholars will need to experience and study the lifeways of other races. Reciprocally, African archaeologists, Chinese geneticists, Indian biologists, Russian ecologists, will need to research Australian data. Ancient human remains or their exact replicas are priorities on any list.

Any decision taken by Aboriginal communities today that involves destruction of ancient evidence, or bans studying segments of human existence, suggests gross insecurity. It replaces European cultural dominance by an equally aggressive cultural imperialism. To claim total knowledge of the past and deny the rights of others to question it, challenges the intellectual freedom of all Australians, particularly future Aborigines. ■

Suggested Reading

Brown, P., 1981. Sex determination of Aboriginal crania from the Murray River Valley. *Archaeology in Oceania* 16:156–167.

Mulvaney, D.J. & White, J.P. (eds), 1987. Chs 1–5 in *Australians to 1988*. Fairfax, Syme and Weldon Associates: Broadway.



Artificial cranial deformation as practised by the Arawe of Southern New Britain.

Competitions provide a forum for keen amateurs to learn new techniques and styles. But just what does make a winning shot? A look at some winners of last year's New South Wales Field Ornithologists Photographic Competition.

NSW FIELD ORNITHOLOGISTS CLUB
1988 COMPETITION RESULTS

ROB DRUMMOND

A BIRD IN THE LENS

Entries for this competition were judged on three aspects: artistic, technical and ornithological value.

Above: this Yellow-billed Spoonbill, clearly showing its breeding plumage, won first prize in the 'In Flight' category. The photographer stalked it in a swamp with a Minolta XG-2, 400mm lens, tripod and bellows, using Kodachrome 64 film.

Above Right: taken from a floating hide with a Minolta XG-2 and 400mm lens, using bellows and a tripod, this Yellow-billed Spoonbill was voted best photo overall. Good lighting and a clear visual of breeding plumage and habitat won points for this photo.

ROB DRUMMOND

PETER ROBERTS

JANE MILLER

Left: first in the category 'At the Nest', this superb photo of a Yellow Robin was taken with a Minolta SLR and 70–200mm zoom Takuna lens, with a single flash, using Kodachrome film.

Above: this photo of a Great-winged Petrel, showing a good demonstration of underwing pattern, came second in the 'In Flight' category. It was shot using a Nikon F-2 and Nikkor 80–200mm zoom lens and 200ASA Ektachrome film.

JOHN HANDEL

A very rare immature Turquoise Parrot taken at Swamp Creek, New South Wales. One of the 'Best of Ten' category, taken with a Canon F-1 and 500mm lens, using Kodachrome 64 film.

A BIRD IN THE LENS

JOHN HANDEL

Above: a rare shot of a Black-eared Cuckoo at Round Hill Nature Reserve using a Canon F-1, 500mm lens and Kodachrome 64 film. This photo won first prize in the category 'Away from the Nest'.

Right: this Rainbow Bee-eater came third in the category 'Away from Nest', using a Minolta XG-2 camera, tripod, 400mm lens and bellows. Film is Kodachrome 64.

ROB DRUMMOND

DAVID TURNER

ROB DRUMMOND

Above: a clear indication of features won this Crested Tern photo third place in the 'In Flight' category.

Below: the very elusive Baillon's or Marsh Crake, a rare photo of this bird in its habitat won second prize in the 'Away from Nest' category. The photographer used a 'sit and wait' approach, armed with a Minolta XG-2 camera, 400mm lens, bellows, tripod and Kodachrome 64 film.

STAN SCOTCHMER

Third in the category 'At the Nest', an adult male Variegated Wren photographed in its habitat.

"In 1918, the Paradise Parrot was feared extinct. It is just possible a small remnant population may survive in a remote area."

PARADISE PARROT

BY ROD JULIAN

IT HAS BEEN OVER 60 YEARS SINCE THE last Paradise Parrot (*Psephotus pulcherrimus*) was seen in the wild—officially, that is. There have been numerous rumours of sightings, of people keeping them in aviaries and even of their illegal exportation, yet the fact remains that there has not been a single confirmed sighting since 1927. The lack of confirmed sightings has led to the widespread opinion that the Paradise Parrot is extinct. But extinction is difficult to prove. Several 'presumed extinct' Australian birds have been rediscovered, some comparatively recently: the Night Parrot (*Geopsittacus occidentalis*) and the Noisy Scrub-bird (*Atrichornis clamosus*) are two that come to mind. It is just possible that a small, remnant population of Paradise Parrots may survive in a remote area.

In the past this species was not so rare.

ANTHONY FARR

From John Gould's *Birds of Australia* (1848). It is likely that Gould used the type specimen, sent by John Gilbert from the Darling Downs in 1844, as subject material.

From the late 1840s to the 1880s these birds were often seen, mostly as pairs but sometimes in small groups, within their accepted range. When nesting these birds excavated a tunnel, opening into a nesting chamber, usually in a termite mound. The Golden-shouldered Parrot (*P. chrysopterygius*) and Hooded Parrot (*P. dissimilis*) are the only other parrots to excavate a nest in termite mounds. In country where no termite mounds existed, there are records of Paradise Parrots tunnelling into the steep banks of creeks; they are even said to have resorted to hollow tree stumps.

The *accepted* former distribution of this parrot is encompassed by the New South Wales towns of Casino and Inverell in the south and, into Queensland, the Balonne and Cogoon Rivers to the west, the town of Roma to the north-west and the city of Rockhampton to the north. They were once plentiful in the Brisbane River area, along the headwaters of the Dawson River, and on the Darling Downs. The first specimen was discovered in the Darling Downs in 1844 by John Gilbert—an experienced bushman and naturalist employed by that famous 'Bird Man' and publisher John Gould to collect specimens of natural history.

Soon after sending the first Paradise Parrot specimen to Gould, Gilbert joined the Leichhardt Expedition, which was attempting to reach Port Essington, near the present city of Darwin. The expedition left the then remote outpost of Jimbour, near Dalby, in October 1844. Gilbert regularly recorded further sightings of the Paradise Parrot until they reached the region of the present town of Rolleston. All these sightings were within the accepted range. Several months later on 17 June 1845, when the expedition was not far from the junction of the Mitchell and Lynd Rivers, Gilbert wrote: "I was rather surprised today to meet with my new *Platycercus* of the Downs [Paradise Parrot], a species which has not been observed since leaving. . .Comet Creek." Gilbert continued to record sightings of the Paradise Parrot. His final reference appeared on the 24th, when the party was about 100 kilometres from the Gulf: "The new *Platycercus* I saw in great numbers."

Gilbert's sightings along the Mitchell River have created controversy for years. Some accept them; the majority do not. The general attitude is that, as the similar Golden-shouldered Parrot is also found in this area, Gilbert mistook it for the Paradise Parrot. I find this hard to accept. In his letter to Gould, for instance, he used no less than 187 words just to describe the colouring of the Paradise Parrot. Gilbert knew what he was looking at.

Another viewpoint expressed is that it is unlikely to find two very similar birds

with similar nesting habits in the same area. However, this practice does exist. The Eastern Rosella (*Platycercus eximius*) and the very similar Pale-headed Rosella (*P. adscitus*), for example, can be found together in the coastal border country of New South Wales and Queensland. Besides this, we have the record of an observer who has seen both the Paradise Parrot and the Golden-shouldered Parrot on Cape York Peninsula.

In 1918, the Paradise Parrot was, as it is now, feared extinct. A naturalist and author of the time, Alec Chisholm, undertook an exhaustive search for it. He was eventually successful. Of all the reports he received, one is especially interesting. It came from Coen, Cape York Peninsula, where a police constable stated: "It was moderately plentiful at a certain point. . .of the Archer River. . .I have also seen the Golden-shouldered Parrot, and it is similar in habits to the Scarlet-shouldered [Paradise Parrot], *but not so plentiful* [my emphasis]."

A third piece of evidence was found when looking at a copy of the book *What Bird is That?* (1984), illustrated with the famous Cayley paintings. The attractively coloured male Paradise Parrot shown in this book was painted with the aid of a specimen held in the Australian Museum. Further checking revealed it was collected in 1894 at Cairns, northern Queensland. Currently, the data concerning this specimen is not considered absolutely reliable, but it cannot be ignored. Further investigations will clarify its accuracy.

"In his letter to Gould, for instance, he used no less than 187 words just to describe the colouring of the Paradise Parrot. Gilbert knew what he was looking at."

These three pieces of evidence when viewed together suggest strongly the existence, at least in the past, of a northern population of Paradise Parrots.

We still do not fully understand why this attractive bird declined so markedly that its extinction is likely. Heavy trapping pressure to satisfy the lucrative European demand of the time is just one factor. In the late 1800s, individuals clamoured to obtain live specimens of the new wildlife being discovered in Australia. Of the birds, the brightly coloured parrots were the most sought after, and of the parrots, the Paradise Parrot received the most acclaim. As one enthusiast of the time, W.T. Greene, wrote: "No-one can see it without desiring to possess so beautiful and graceful a bird, and large sums are constantly being paid for handsome specimens."

Today, the search goes on to find this elusive bird. A private expedition was mounted in 1988 to check rumours of sightings near the New South Wales–Queensland border. It was unsuccessful but another is planned. If a small remnant population is found, it is likely to be in a remote, sparsely populated area covered with plains of seeding grasses and dotted with termite mounds. There are parts of Cape York Peninsula that match this description completely. Unfortunately, of all the searches being planned, none will operate on the Cape. ■

"While most of the ancient gods died gracefully with the cultures that created them, Gaia has undergone a 'born-again' revival."

GODS, GAIA & THE WOUND OF HEAVEN

BY MICHAEL ARCHER
SCHOOL OF BIOLOGICAL SCIENCES
UNIVERSITY OF NEW SOUTH WALES

LONG BEFORE WE BEGAN THE STRUGGLE to emancipate our minds from centuries of accumulated, strangling superstitions (the devotees of pyramid power, crystal healing, astrology, numerology and dried rabbits feet had better stop reading here), we invented things to bow and scrape before: mostly terrifying gods—in all shapes and sizes for every conceivable purpose. Some served to rationalise and control aspects of the world we could not understand; others were hoisted on high to dictate our behaviour through self-serving priests who told us that they alone could relate the will of these omniscient, omnipotent creations to our insignificant selves. Fortunately, these once 'immortal' gods all have maximum life spans determined by the cultural survival of their creators. In fact, over 184 such 'dead' immortal gods have been identified.[1] While a few still grip our intellects like parasitic monkeys on the backs of addicts, most are fading hieroglyphs on crumbling stones.

Long before monotheistic Judaism took hold of the Middle East, possibly about 3,000 years ago, many religions promoted a plethora of anthropomorphic gods (polytheism) among which were a few that could loosely be described as 'Earth mothers'. Of these, Gaia was a Bronze Age Earth goddess who figures prominently in the mythos of the ancient Greeks. By their mandate, Gaia (pronounced 'Guy-a') *was* the Earth and her son Uranus was the Sky, at least until this particular hierarchy of gods and its highly creative culture gave way to later religions including, eventually, Christianity.

While most of the ancient gods died gracefully with the cultures that created them, Gaia has undergone a 'born-again' revival, this time in a manger in the barn-turned laboratory of Dr James Lovelock of Cornwall, England. Although there are no pentagrams, dried toad tongues or wooden crosses in Lovelock's lab, there is a very strong conviction that the ancient concept of a *living* Earth is closer to reality than the more conventional view that life is restricted to a scum on and just above the surface of the planet.

Lovelock proposed[2] that the Earth, its life and its atmosphere constitute one inseparable entity, the inorganic components being vital extensions of the organic world and *vice versa*. The whole Earth is in effect a single self-serving creature, inorganic and organic matter together, that *actively* maintains optimal conditions for life; a kind of planetary homeostasis. For example, the Earth has maintained a 'comfortable' global temperature over the last 3.5 billion years despite a calculated 25 per cent increase in solar energy (young stars enlarge as they age). This increase *should* have baked the surface of the planet and driven off its atmosphere much like it did to Mars.

If it seems strange to regard the vast non-living mass of the Earth and atmosphere as part of a superorganism separated and yet bound by a glue of living tissue, consider a 100-metre Tasmanian Blue Gum. It is 99.9 per cent dead matter over which there is a mere skin of living tissue; yet the colossal bulk of non-living wood is quite clearly an integral part of the single organism.

Lovelock's concept in its broadest sense is not new. James Hutton (the 'Father of Geology') suggested in the 1790s that the whole Earth was a superorganism and that its proper study was that of physiology. Lovelock too talks of 'geophysical' systems but, unlike Hutton, over 20 years he has tested his propositions with computer models and sought material evidence in the real world for his Gaian concepts.

'Daisyworld' is the hypothetical world invented by Lovelock to demonstrate how organisms could not only modify but in fact control their environment rather than just evolve adaptations to inexorable environmental changes. Suppose on Daisyworld there are two species of daisies, dark ones and light ones, and that neither can live if that world's temperature falls below 5°C or rises above 40°C. Given a cold beginning with a small young sun, the dark daisies would dominate because they would absorb

CSIRO ATMOSPHERIC RESEARCH

James Lovelock proposed that the whole Earth (its life, atmosphere and inorganic components) is in effect a single self-serving superorganism (called Gaia) that actively maintains optimal conditions for life.

relatively more of the scarce solar radiation than the light-coloured daisies; in so doing they would initiate a steep increase in Daisyworld's temperature by trapping more of its sun's radiant energy. As the planet became too warm for comfort, the light-coloured daisies would begin to dominate because they would be able to reflect more of the excess solar energy, cooling Daisyworld until it reached a temperature where the black daisies were once again at an advantage; and so on *ad infinitum*. The important point here is that the daisies and abiotic components of their environment are interacting in such a way that the conditions necessary for the daisies' own survival are maintained.

In the same way, Lovelock suggests that comparable interactions between the inorganic and organic world maintain an optimal balance of atmospheric gases such as carbon dioxide, sulphur compounds, salt concentrations in the ocean and, in short, virtually all aspects of the environment required for the maintenance of living creatures. To Lovelock, the complexities of these feedback systems depend on a high diversity of living creatures with differing needs. This would be one of the strongest rational arguments for maintaining the world's organic diversity—the ability of diverse life forms, Earth and the atmosphere to interact to preserve the conditions necessary for the whole of life may very well depend on it. As an example, the vast tracts of tropical forests transpiring water vapour are almost certainly tied up with the development of white reflecting clouds that in turn help to keep the Earth from overheating. Cut down the forests and the protective cloud cover declines (which would, according to Gaian theory, result in the growth of more forest, which would in turn restore the controlling cloud cover—but of course we do not allow the forest to regrow).

Critics of Gaia point out that Lovelock's *original* vision of a somewhat willful 'superorganism', one that anticipated its own needs and adjusted the Earth's climates accordingly, is not scientifically defensible because it involves the untestable hypothesis of the existence of a master plan for environmental stability—which *would* be religious. However, Lovelock and other Gaians (including Lyn Margulis of 'endosymbiosis' fame) point out that 'willfulness' is not required for the model to work.

Other critics have pointed out that the atmosphere *has* changed significantly since the origin of life on Earth. Maintenance of the status quo when life consisted of nothing but single-celled prokaryotes evidently was not on the Gaian agenda. About a billion years after photosynthetic bacteria first evolved, the original oxygen-deprived atmosphere had turned into a dangerously oxidative one. The result was that by 1.5 billion years ago, anaerobic organisms, which thrived in oxygen-free environments, had gone into a steep decline and oxygen-consuming organisms (such as plants and animals) ascended.

Lovelock admits all this but points out that the temperature of the Earth and other abiotic variables seemingly essential to *all* life forms remained reasonably constant throughout this episode of oxygen enrichment and that life, albeit changed, still survives.

In any case, a marriage here of 'megaconcepts' would easily smooth this particular wrinkle out. Recall that I have argued (ANH vol. 22, no. 11, 1988) that *all* of life is a single shape-changing, time-travelling organism—the 4D Bioblob. In this sense, Gaia is now and has always been the same single superorganism that it was at the birth of life. Perhaps it undergoes significant shape changes only when environmental changes exceed the capacity of Gaia to maintain global homeostasis?

Clearly there is much more to the Gaian philosophy than this and it seems poised to precipitate healthy upheavals in at least ecological and biochemical circles. The recent symposium on the subject[3] has to some extent legitimised Lovelock's revised Gaian concepts, and various tests of his predictions for specific environmental feedback systems are now underway.

The remainder of the ancient Greek myth that inspired Lovelock to name his vision Gaia is hopefully not prophetic. According to the Greek poet Hesiod in the eighth century BC, Gaia as the first being to exist gave birth to Uranus, the Sky, who later copulated with his mother to produce mythological beings known as the 12 Titans. The youngest Titan, Cronus, took such a nasty dislike to his father that he cut off the Sky's testicles with a scythe, while his father was coupling with his mother, thus bringing to a violent end his own source and the fertile union of the Earth and Sky. Ultimately Gaia successfully conspired with her other offspring to vanquish the vicious Cronus and a new cosmic balance was established.

If the origin of life on Earth is the result of the interplay of the materials of Earth and the atmosphere 3.5 billion years ago, is it not now the selfish spawn of this ancient union that is, metaphorically speaking, cutting off the testicles of its father by scything holes in the atmosphere's ozone layer with chlorofluorocarbons? Here surely is the stuff of yet another new religion, 'The Holy Apocalyptic Church of Uranus' Emasculation'. This one has as its doomsday scenario the albeit unwitting devastation we are about to inflict on the source and sustenance of all life on Earth. Perhaps we have already bet our lives on the short life span of this religion. ■

[1] Mencken, H.L., 1927. *Selected Prejudices, Second Series*. Jonathan Cape: London.

[2] Lovelock, J., 1979. *Gaia: A New Look at Life on Earth*. Oxford University Press: Oxford. See also: Lovelock, J., 1986. Gaia: The World as Living Organism. *New Scientist* 18 Dec.: 25–28.

[3] Pearce, F., 1988. Gaia: A Revolution Comes of Age. *New Scientist* 17 Mar.: 32–33; Kerr, R.A., 1988. No Longer Willful, Gaia Becomes Respectable. *Science* 22 Apr.: 393–95.

"It's a logical, not just a biological, necessity. Darwin's genius saw this as the explanation of how evolution took place."

NATURAL SELECTION

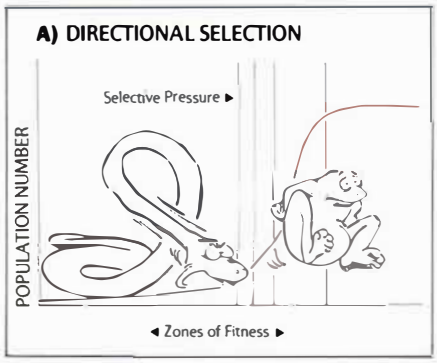
BY RALPH MOLNAR & GLEN INGRAM
VERTEBRATE FOSSILS
QUEENSLAND MUSEUM

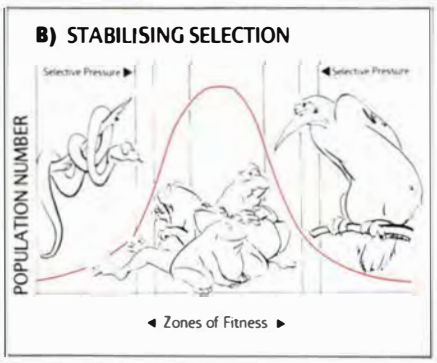
NATURAL SELECTION: THERE IS PROBably no other scientific concept more widely thought to be understood by people who, in fact, do *not* understand it. But the idea of natural selection is extremely simple. It is not even a biological idea. Rather, it is a logical idea that finds its application in biology.

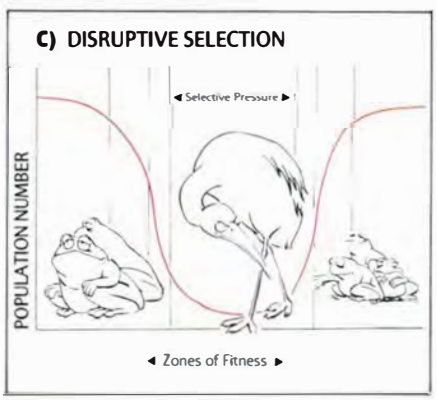
Given a few simple conditions natural selection is inevitable. First, each organism—animal, plant, bacterium or whatever—must differ in some way from every other organism. For the organisms with which we are most familiar—ourselves—this is obvious. Such differences are technically termed 'variation'. Second, some of these differences must be related to the ability to reproduce. These are known as differences in 'fitness'. Some individuals of a tropical butterfly (*Colias* species), for example, carry an enzyme (PGI) allowing its possessors to be more active than those that lack it. The individuals with PGI have more offspring than those without it and hence are more fit. Third, the characters that affect fitness must be hereditary. We see that children, although differing from their parents, resemble their parents more closely than they resemble any other people.

Offspring that survive to reproduce differ from those that do not. Statistically speaking, the survivors form a biased sample of all those that were born—biased in the sense that all of the survivors differ from those that did not survive. Furthermore, because individuals vary, the survivors differ from their parents. This difference of the offspring from the parental generation is evolution.

If the way in which the survivors differ from those that die is related to the survivors' ability to survive, and if that ability is passed on to their offspring because of inheritance, then we see natural selection. A 1965 study of House Mice on a farm in Missouri (USA) shows this. The mice lived in a granary from which cats were excluded. Among the mice were some mutant individuals with yellow coats. In December 1962 about one third of the mice were mutants. By January (1983) damage to the grain from the mice was so great that cats were introduced. The granary was dimly lit, and the usual dark coat colour of the mice was less obvious than the yellow of the mutants. By the following April, predation by the cats had eliminated the yellow individuals from the mouse population. In this case the trait conferring enhanced survival was the normal, dark coat colour. Both this and the yellow colour were inherited. The cats were the agent of selection. The link between dark colour and better survival, or increased numbers of offspring, is fitness.







COLIN STAHEL

To recap, all natural selection needs is individuals that are not identical, whose traits are inherited, whose offspring do not all reproduce equally, and whose fitness differences are related to the differences between the individuals. Given this there must be natural selection—it is a logical, not just a biological, necessity. It was Darwin's genius that saw this as the explanation of how evolution took place.

There are many aspects of selection that involve different phases of life. Anything that reduces the possibility of survival is known as survival selection. In sexual organisms reproduction requires a mate, hence sexual selection, the choice of a mate. Furthermore, some mates are more fertile or virile than others, hence fertility selection. Then the offspring must survive at least long enough to reproduce, so back to survival selection again.

The word 'selection' implies that something is being selected, but what? This is currently a 'hot' topic among evolutionary biologists. Early students of Darwin, such as Herbert Spencer, assumed that it was the individual organism that was selected. After all, it is the individuals that survive or die, is it not? Well, no, it is not: populations and species can also die, in which case death is dignified with the title of extinction. We have widely presumed in this century that it is the *group* of interbreeding individuals, known as a deme or population, that is affected by selection. However, even if it is the organism that lives or dies, and the population that allows reproduction, the traits that affect survival and reproduction are inherited with the genes. So some modern evolutionary biologists, such as Richard Dawkins and George Williams, have proposed that it is the gene that is selected. And palaeontologists like Stephen J. Gould have proposed that it is the species, the evolving lineage of all populations for which interbreeding is possible, that is selected. So different workers consider different entities to be selected: species, populations, individuals and genes. All of these seem exposed to selection, although the question of which one is the most exposed, and hence the seat of most change, is far from settled.

In addition, selection may be subdivided in terms of its results. These divisions are called modes of selection. Because all populations vary, selection manifests itself as the favouring of certain portions of the populations. If we consider a population to be represented by a bell-shaped curve, such as those beloved of statisticians, then by looking at which portions of the bell-shaped curve are favoured, we can distinguish between the different modes of selection. If one or the other end is favoured, the selection is described as directional. Directional

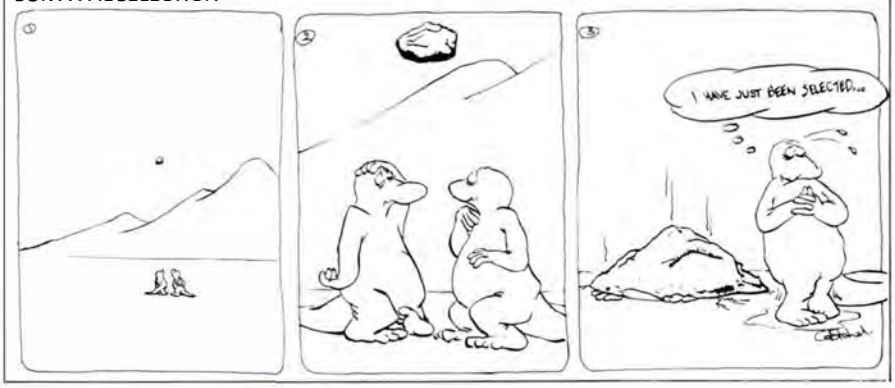
selection results in consistent change in one direction (becoming larger, smaller, faster etc.). Recently John Endler, of the University of California, Santa Barbara, found that this kind of selection appears to be the most common in nature. Another mode of selection occurs when neither end of the curve is favoured. This is called stabilising selection. Stabilising selection discriminates against the 'non-conformists', those that differ too much from the norm. There are some well-known examples of stabilising selection such as Bumpus' study, in the 1890s, of birds killed by a severe storm. Here birds much larger or much smaller than average tended to be killed, while those of average size survived. Endler's work shows that this kind of selection appears to be uncommon in nature—or, at least, there are few studies that have demonstrated it. Finally, if both ends of the curve are selected we have disruptive selection. Disruptive selection is so called because it will break up an original population into two new and different populations. This kind of selection has been demonstrated in the laboratory, and among whelks, newts and some North American lizards in the wild.

So natural selection may act at different points in the life cycle, on one or more entities and have at least three different types of results: but how effective is it in nature? Endler critically reviewed studies of the effectiveness of natural selection in the wild. Previous to his review it was generally believed that the effect of natural selection was much weaker (that is, there were fewer failures of reproduction per generation) than that of artificial selection. The cumulative effect of this weak selection over long periods of time was believed to account for evolution. Yet Endler showed examples of natural selection that were as intense as any selective breeding experiments. There is no evidence to suggest that intense selection is uncommon. So natural selection appears to be more effective than even most evolutionary biologists had believed.

Natural selection seems to many, including some scientists, to be an awkward method of evolution. The key to its importance may be that the natural world is vast and varied; and sometimes uncertain and unpredictable. Much recent interest among mathematicians, and mathematically inclined biologists, has centred on the concept of chaos. Even the word 'chaos' has taken on a new meaning; it no longer means something disorderly or haphazard. Chaotic processes are unpredictable, but not indeterminate. This may sound contradictory, but 'not indeterminate' means that a process has a well-defined cause, that it is not random; 'unpredictable' means that a process may not be well enough understood to predict its outcome. Chaotic processes, therefore, are not random or chancy; it is just that their outcomes cannot be predicted. Consider water in a stream, flowing around a rock. The water swirls past, creating ever-changing ripples and eddies that form and dissipate. We cannot predict when an eddy will appear, how long it will last or where it will move in the flow, but the motion of the water is still determined by the laws of fluid mechanics. The unpredictability arises because any small disturbance early in the flow can become amplified to completely alter the outcome.

The weather, as you might well guess, is also chaotic in this sense. And so too, but less obvious, are many biological aspects of the environment, such as the inexplicable (to humans at least) growth and decline of populations of some organisms. The uniqueness of natural selection is that it enables species to 'track' such unpredictable, chaotic changes; in other words to adjust to them. Because chaotic processes cannot be tracked by any other method, or predicted, and because evolving lineages of organisms must adjust to their changing environment to survive, natural selection allows continued existence in an unpredictable environment. This makes it perhaps the only serious candidate as an explanation of evolution in an uncertain world. ■

SURVIVAL SELECTION



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QUESTIONS & ANSWERS

A regular column where *your* questions about our natural world are answered by experts. Readers are invited to submit brief questions.

White Possums

Q: A friend of mine living in the south-east of South Australia has for some years fed and tamed the wild Common Brushtail Possum. Within the last year three white possums have been known and become tame. These white possums are not, I believe, albinos, as they do not have pink eyes. Are white possums a rarity?

—David Walker
Keiraville, NSW

A: White possums are indeed rare. The colour white is certainly not advantageous for a nocturnal mammal that needs to avoid predators such as owls or foxes.

There are two reasons why white possums (and other mammals) can sometimes occur in populations. Individuals may be born albinos, that is they lack the pigment melanin throughout their bodies, including their eyes, which then appear pink. In general, albino animals tend to be less fit than normal individuals; combine this with their obvious colouration and it is not hard to realise why albinos are rare. The second reason for the appearance of white in otherwise normal-coloured species is that these individuals are born with a positive white pigment, in which case they retain normal eye colour such as yellow or brown. The Common Brushtail Possum your friend has observed most likely fits into this category. White pigmentation has also been observed in other possum species, such as the recently discovered White Lemuroid Possum (*Hemibelideus lemuroides*) found only in a small forest north-west of Cairns. Perhaps through lack of predators these white individuals have been able to build their numbers up. There are also widely published reports of white lions and tigers. For these predatory animals, the ability to hide while stalking prey would be limited.

Whether the animal is white pigmented or albino, they do not generally survive long in the natural world. For these reasons there is little opportunity to assess how frequently either form occurs.

—Linda Gibson
Australian Museum

A rare white form of the Lemuroid Ringtail Possum.

ANDREW DENNIS/ANT PHOTO LIBRARY

Fly Speed

Q: We live in an irrigation district where flies are not unknown. I have a four-wheeler motorbike and spend part of every day scouting around our property, looking at the stock, attending to the watering and many other tasks. I would be travelling at 10–15 kilometres per hour while moving around. Now apart from having a large number of my little friends enjoying the trip on my back, I have others diligently exploring my ears and eyes and face in general. Some of these, having satisfied their curiosity with the audio arrangements on my right, will fly (we'll say) from east to west in front of my face to do an auricular examination on my left. Now the question is, if I'm travelling at 15 kilometres per hour, either north or south, how fast are the flies travelling? (If you think, perhaps, that I've been farming too long, don't despair; many others are of the same opinion.)

—Ross Austin
Berrigan, NSW

A: The first thing to realise is that velocity is relative to the observer. If the motorbike is travelling at 15 kilometres per hour (that is, with respect to the ground), and a fly is buzzing at your ear, then the fly is also travelling 15 kilometres per hour with respect to the ground. With respect to you the fly is stationary. If the fly then travels from your right ear to the left, it is effectively flying on a curve (made up of the sum of the forward and lateral components of direction). The fly must increase its speed to get to the front of your face and then decrease it to get back to your left ear. At every instant, the fly's speed with respect to the ground is the speed of the motorbike with respect to the ground, plus or minus the speed of the fly with respect to you.

—G.H.

DEACON PUBLISHING SERVICES

At a fly's pace!

Shark Bay for National Park?

Q: The article in ANH (vol. 22, no. 10, 1988) on the stromatolites particularly interested me as I had just completed a motoring holiday to Western Australia where I journeyed north as far as Shark Bay and Monkey Mia. I also visited the areas of Hamelin Pool where your article shows the stromatolite formations. However, I cannot understand why the whole Shark Bay region, including Dirk Hartog Island, the Peron Peninsula and the adjacent mainland coasts, had not been designated National Park status. The Monkey Mia dolphins are unique and the stromatolites are among the best examples of that type of organism in the world. Shark Bay is also, I understand, Western Australia's southern-most haunt of the Dugongs. Is the Australian Museum doing any urging to list the area as National Park? I would be interested to hear.

—P.N. Cox
Hendra, Qld

A: The Australian Museum, being financed by the State Government of New South Wales, is not involved directly with Shark Bay management. Through 1986–87, however, Western Australian Government undertook a planning study for the Shark Bay area. It resulted in the release last year of the draft "Shark Bay Region Plan" and its subsequent approval following a period for public comment. Early in 1989, the Government approved an implementation program to give effect to the recommen-

dations in the plan.

Readers should understand that the Shark Bay area is an enormous tract of land and sea, measuring 250 kilometres north to south, and 112 kilometres east to west. A national park over the whole area is simply not practical as a management proposal. Instead, the Government will declare four big national parks, including Peron Peninsula and Dirk Hartog Island, and one huge nature reserve in addition to the existing nature reserves. This will involve purchase of several pastoral properties. Negotiations to that effect are already in progress.

There will be multiple-use marine park over most of the marine areas. Hamelin Pool, site of the famous stromatolites, will soon be declared a marine nature reserve. Areas within the overall marine park that are particularly important as dolphin and Dugong habitat will also be given nature reserve status.

There will also be a special management agency established that will ensure integration of effort by the various management agencies involved.

The next two years will see these initiatives, and more, put into effect in Shark Bay. I believe ANH readers' concerns about protection of the extremely high conservation values there will be well satisfied.

—B.R. Wilson
Director, Nature Conservation
WA Dept of Conservation and Land Management

BILL BACHMAN

Shell Beach, near Hamelin Pool, Shark Bay: an important concern for conservationists.

Snake Slough

Q: I recently found a complete snake slough (a fraction short of two metres long) in a vine growing up a verandah post. Could you please tell me: how many times a year do snakes slough; can a snake be identified by its slough; and does the position in which the slough was found (about one metre from the ground) indicate it was probably a tree snake?

—S. Wolody
Annangrove, NSW

A: Sloughing in a healthy wild snake is largely determined by the growth rate. Therefore it follows that young snakes slough more often than older snakes and all snakes slough more often during late spring, summer and autumn than other times of the year. Vigorously growing young snakes may slough three to five times per year.

HARRY EHMANN/NPIAW

Small-eyed Snake (*Cryptophis nigrescens*) sloughing.

A snake can usually be identified by its slough. Although the colour pattern is only vaguely evident in a slough, taxonomically important scale characters, such as the arrangement and number of scales, are retained.

The fact that the slough was found a metre above ground may indicate it was a tree snake, but because birds often incorporate snake sloughs into their nests, this cannot be certain.

—Allen Greer
Australian Museum

Pet Snakes

Q: Neither a cat nor dog person, I've always admitted to a fondness for snakes, much to the chagrin of my boyfriend. I would like to be able to keep a snake as a pet but I'm told that it is illegal. What exactly are the requirements and is there any way that it's possible to keep snakes as pets?

—R. Syme
Terrey Hills, NSW

A: In New South Wales an individual is allowed to keep two reptiles from a selection of nine species without the need to obtain a licence from the National Parks and Wildlife Service. Of the nine reptile species, two are snakes: the Diamond Python (*Molelia spilita*, also referred to as the Carpet Snake) and the Swamp Snake (*Hemiaspis signata*). However, all reptiles are protected in New South Wales and it is an offence to take them from the wild. Also, reptiles cannot be legally traded so they are not available from pet shops. Consequently, the only legal way to get a reptile is from a person who is licensed to breed them.

Try contacting the Reptile Keepers Association, P.O. Box 227, Gosford, NSW 2250. This organisation may be able to put you in touch with a breeder and also provide advice on housing and husbandry. The latter point is important as most reptiles kept in captivity by amateurs do not live long, mainly through ignorance of proper care by their keepers. Refer also to the book *Care of Australian Reptiles in Captivity* by John Weigel, reviewed in the last issue of ANH (vol. 22, no. 12, 1988–89). Readers from other States should contact their State fauna authority as the laws vary from State to State.

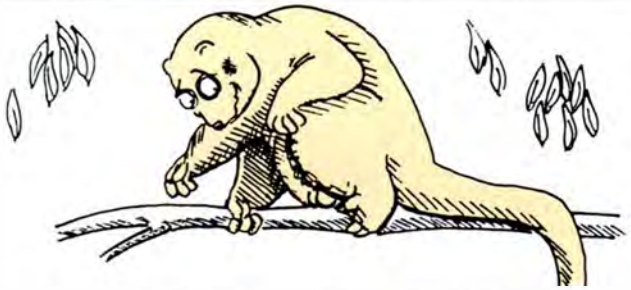
—Jeff Hardy
National Parks & Wildlife Service, NSW

The Long and the Short of It

Q: Recently, while my family and I were out driving on a country road, we ran over a large kangaroo. We stopped to inspect the damages to both the roo (a male) and the car. I'd never been that close to a kangaroo before—at least not to its rear end—and I noticed, much to my surprise, that this fellow's testicles were in front of his penis! Perhaps post-collision shock had affected my eyesight (or perhaps the roo's posterior anatomy?). Please, I beg you, tell me what's going on here.

—J. Robinson
Oatley, NSW

A: Kangaroos, like all marsupials, have the testes positioned in front of the penis. This is not usually apparent because the penis of marsupials is, when not erect, hidden in the cloaca (the urogenital opening of marsupials). Although this arrangement may seem curious to us placental mammals, it is indeed the logical way to arrange these organs: the penis originates from the urogenital area, which lies behind the abdominal cavity from where the testes



COLIN STAHEL

Young blushing possum, discovering that the marsupial scrotum is *anterior* to the penis (topologically speaking, it's 'a balls up').

originate. So it is really the placental arrangement, where the testes have migrated backwards, that is the unusual one. The 'reverse' arrangement in marsupials causes no problems for them because the penis is usually long and, when erect, reaches well in front of the testes.

The only unusual thing about the kangaroo that you saw seems to be the fact he was in a state of sexual excitement at the time of his demise. Had it not been for this fortuitous fact, you might never have been enlightened about the peculiar anatomy of our marsupials!

—Tim Flannery
Australian Museum

Dating Aboriginal Rock Art

Q: How is Aboriginal art work dated?

—Jan Heard
Lindfield, NSW

A: Unlike oil paintings, where the canvas and oil-based paints can be compared with similar materials from known periods, Aboriginal rock art is not so easily dated because the materials are geologically old rocks, ochres and clays.

In the past, the only way to estimate the antiquity of rock art has been by indirectly dating ochre found in soil layers of archaeological deposits, and by identifying animals and plants depicted in the art that became extinct at a known period of time, or that only survived under particular biogeomorphologically dated environmental conditions of the past. These methods are generally regarded as unreliable because they are based on evidence that lacks convincing scientific support and can be interpreted in several ways.

Until recently, few attempts have been made to date paintings and engravings by direct means because these methods rely on finding sufficient quantities of suitable substances in the physical components of the art itself, which can be extracted and analysed to reveal when the material was applied to the rock surface. For example, the carbon from charcoal drawings can be dated using accelerator mass spectrometry of carbon isotopes, for which only a few milligrams of carbon-bearing matter are needed.

Research into dating rock art is at an exciting stage because of recent advances in the study of pigments and their organic binders—micro-biological remnants on rock surfaces and carbon-bearing mineral crusts from patinas that partly cover engravings. In the near future, the true age of Australia's great Aboriginal art heritage will no longer be a mystery.

—Alan Watchman
School of Applied Science,
Canberra CCAE

LYNN CROPP

Aboriginal rock art: a new dating technique is now being developed.

Evolutionary wisdom

Q: My dentist told me that I only have three wisdom teeth. She said this is not unusual and they seem to be getting more and more people coming in that have none at all. Why do I only have three when both parents (and at least one grandparent that I know of) have the full quota? Is this a case of evolution in action? Are there other changes noted that could be examples of our own evolution progressing?

—T.V. Blomfield
Kalgoorlie, WA

A: Our current understanding of evolution is that, on the whole, it operates by the preferential survival and reproduction of those individuals in a population whose inheritable characteristics give them an advantage over the rest of the population. If people with less wisdom teeth than average tended to leave more offspring than those with a full set, one might expect to see human evolution in operation. That it should be seen to be operating in the lifetime of a dentist is almost incredible.

Nevertheless, over the past million or so years there has been—on average—a shortening of the human jaw, possibly associated with a diet of cooked, and therefore softer, food: in terms of survival and reproduction, the number of chewing teeth probably became less significant. This very insignificance probably has led to variation in the number of molars. I think it very likely that such variation will be much the same several thousand years hence.

To make the point, one might consider whether it is likely that we shall be brainier and less hirsute in the future. This is probable if, and only if, people with bigger brains and less hair produce more, and more successful, offspring than the rest of us. Regrettably, there is a high probability that human evolution is at a dead end.

—Ronald Strahan
Australian Museum

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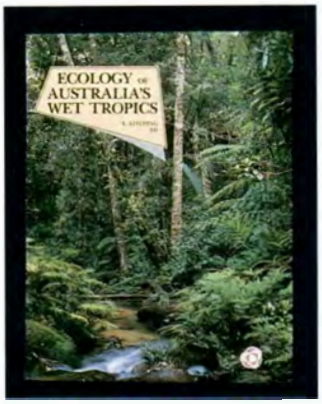


The Ecology of Australia's Wet Tropics

Ed. by R. Kitching. Surrey Beatty & Sons, Chipping Norton, NSW, 1988, 326 pp. $45.00.

This fine work, edited by R. Kitching, and which comprises Volume 15 of the *Proceedings of the Ecological Society of Australia*, represents a major advance in our understanding of Australia's wet tropics. The 35 articles that make up the volume include some outstanding contributions of great importance to the professional scientist, conservationist, forester and environmental decision maker.

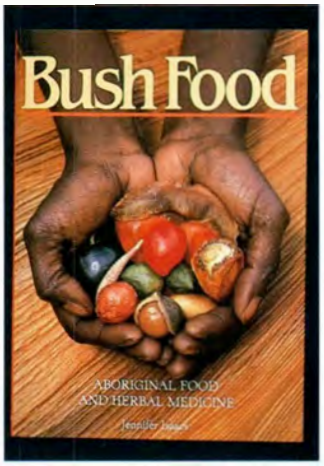
The plenary presentations that begin the volume make fascinating reading. We learn for example, in Barlow and Hyland's paper, that rainforest is a quintessentially Gondwanan phenomenon; for even the rainforests of South-East Asia arrived there first by rafting from Gondwana on the Indian plate, and then by overland dispersal. Thus the many plants that zoogeographers talk of as having invaded Australia from South-East Asia are in reality Gondwanan 'prodigal sons' that have finally returned to a fragment of their original homeland.

Other fascinating contributions come from Winter, who correctly shows that the absence of endemic rainforest mammals in southern Australia is due to events that occurred during the ice ages, over 15,000 years ago; and Christophel and Greenwood, who show that forests very similar to those of the Daintree area were once found as far south as southern Victoria.

However for myself the most important papers are those dealing with rainforest management. Several workers independently indicate that continued disturbance is necessary to maintain maximum diversity in rainforests. We also learn that 80 per cent of the rainforest present in northern Queensland in 1788 still exists, and that even such gross disturbance as mining in rainforest ecotones can be tremendously advantageous to rainforest, allowing it to spread well beyond its original boundaries. The view of rainforest that emerges from these studies is not one of an exquisitely sensitive environment that wilts at the touch of man; but of a dynamic, resilient environment that if properly managed may be more capable than most of coping with appropriate human exploitation.

The final paper of the volume (by Cassels *et al.*) should really be compulsory reading for all involved in the northern Queensland rainforest debate. The authors make it clear that we have a heavy responsibility to developing countries to show the way with sustainable utilisation of rainforest products. To simply lock our forests away is no solution; developing countries cannot afford such a luxury and, like it or not, they must utilise their rainforests. The authors have a vision of a regional centre for rainforest studies based in northern Queensland. Here, urgently needed research into rainforest ecology and management could go hand in hand with the development of the best methods of rainforest utilisation. Foresters and managers from throughout the Pacific basin and South-East Asia could come here to learn from these techniques. In reality, we are the only developed nation with substantial rainforest reserves, and thus the only nation capable of carrying out such a plan. If only this fine paper had been published before the northern Queensland rainforests had been locked away by the decision to accept world heritage listing. We can only hope now that the gilded cage into which we have locked this valuable resource does not turn into a tomb for the rainforests of the developing nations of our region.

—Tim Flannery
Australian Museum



Bush Food: Aboriginal Food and Herbal Medicine

By Jennifer Isaacs. Weldon, Sydney, 1987, 256pp. $39.95.

It matters little what I, or other reviewers, say about this book. The Australian reading public loves it. Just six months after its launching, 20,000 copies have been sold. It will be reprinted in 1989.

The book describes the foods and medicines used by Aboriginal people in Australia. Sixteen chapters cover hunter-gatherers as naturalists, the Australian environment, Aboriginal management and beliefs about land, cooking, plant food, animal food (marine, shellfish, billabong, swamp, insect and grubs) and finally herbal medicine. A combination of the two appendices (plant foods and herbal medicines) and the index makes it relatively easy to find a particular plant for those who wish to use the volume as a reference. (No comprehensive lists of animal foods are included.)

Bush Food is beautifully designed and full of superb colour photographs, however they are used rather gratuitously. For example, a portrait of an attractive Aboriginal girl on page 20 bears the caption: "The Arnhem Land outstation diet includes a high proportion of bush food. Children enjoy the rich harvest of numerous wild fruits". No wild fruits (or food of any kind) are included in the frame.

I was pleased to see that some Aboriginal words—the names of plants, animals, seasons and winds—are used throughout the text. Unfortunately, we are told only occasionally from which particular language the words are derived. As there are thought to have been some 200–250 languages spoken in Aboriginal Australia at the time of European contact, these omissions are of no small consequence. The terms could have been incorporated into the appendices, or listed separately.

My major disappointment with the book is that it describes rather than analyses. No attempt is made to understand all the wonderful information in terms of groups of people surviving in different parts of a large and varied landscape. Nowhere are we made fully aware of the great environmental differences in the continent or how Aboriginal people responded to these differences both culturally and socially. To be fair, the author has tried to cover the entire Australian continent (a daunting task), but even so, southern Australia receives less attention than it should have since it contains cool temperate zones extremely different from the desert and tropical savannas of northern Australia. Tasmania rarely rates a mention. Excellent historical sources exist for many parts of south-eastern Australia. An analysis of these could have greatly strengthened the author's story and encouraged readers to reflect on the data in a comparative framework, in terms of contrasting systems operating throughout the country. This lack of critical analysis puts the book fairly and squarely in the 'ghee whiz' category when in fact Aboriginal exploitation and management of subsistence resources warrants a more reflective appraisal of *systems* in which the collection of plants

and animals to eat, and to use as medicine, was only a part.

I am sure that this book will be a revelation to many readers who know little about the wild food resources available in Australia, or about the way in which Aboriginal people procured and prepared them. 'Bush food' and 'bush tucker' became the flavour of 1988: the success of Vic Cherikov's smorgasbord at the Fourth Australian Gastronomy Symposium at the Australian Museum in October 1988, and Major Les Hiddens' *Bush Tucker Man* on ABC Television, are excellent examples of this popularity. All this is heartening. At last the public-at-large are beginning to appreciate the way in which Aboriginal people harvested and prepared indigenous foods, and the fact that Australia contains a wealth of wild plants and animals good for eating, some of which could be successfully incorporated into our contemporary cuisine.

But let us hope that this new found enthusiasm for things indigenous will not result in a further devastation of our native plants and animals. Because of their smaller population and use of well-tested strategies, Aboriginal people were able to survive in Australia for 40 millenia. There are 15 million of us now and we have already crowded the continent with exotic species. Is it too late to look beyond our European roots and into the Australian bush for sustenance? Is bush food really a goer, or can it only ever be a luxury for those who are interested in culinary innovation and can afford to pay for it?

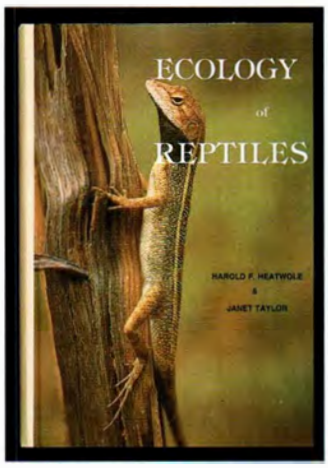
—Betty Meehan
Australian Museum

Ecology of Reptiles

By H.F. Heatwole and J. Taylor. Surrey Beatty & Sons, Chipping Norton, NSW, 1987, 325 pp. $36.90.

This is the second edition, much expanded and revised, of Professor Harold Heatwole's 1976 book called *Reptile Ecology*. The new version is a little over twice as long and much of its increased size is due to expansion of what could broadly be called population ecology. Presumably this is largely the contribution of Professor Heatwole's ex-student and now co-author, Dr Janet Taylor.

Like the first version, the book remains a general overview of reptile ecology based on a review of the world literature but with special emphasis on Australia. This approach stems from Heatwole's own background, having had broad interest in and experience with reptile ecology in various parts of the world, and being resident at the University of New England in Armidale and having trained some of the best

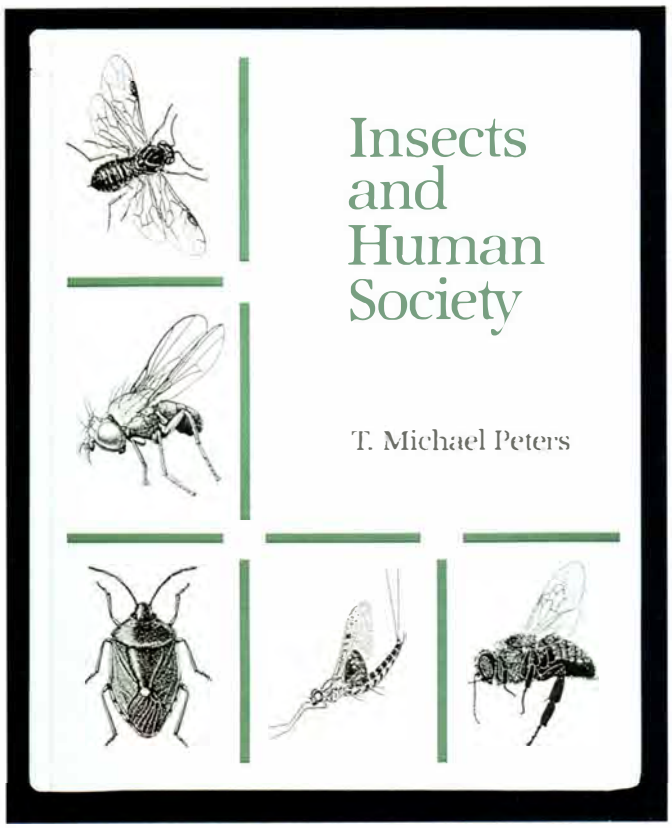


reptile ecologists in Australia.

The strengths of the book are its broad and very readable overview of a vast and disparate literature, its intimate knowledge and use of Australian examples, and its pleasing layout and design. The weaknesses in my view are the lack of a critical or synthetic approach to the literature (often the discussions read like a series of rather brief abstracts of the original papers), a tacit acceptance of occasionally shoddy science (such as zoogeographic scenarios that are generally based on flimsy knowledge of phylogenetic relationships), and espousal of a single point of view on what are really controversial topics (such as competition, which the authors seem to accept at all taxonomic levels). There is also a disappointing lack of illustrations showing animals doing something discussed in the text (the series of colour plates of Australian species are aesthetically pleasing but do not aid the text).

These criticisms aside, however, there is no doubt that the book will be of interest to a wide variety of readers from serious-minded high school science students keen for a readable introduction to an eclectic literature, through to professional zoologists wanting to peruse a section of the literature distant from their own area of speciality. And the underlying Australian flavour of the book will appeal to those of us who continue to marvel at the biological diversity of this remarkable continent.

—Allen Greer
Australian Museum



Insects and Human Society
By T. Michael Peters. Van Nostrand Reinhold Company, New York, 1988, 450 pp. $87.95.

American universities make their non-science undergraduates do science electives and Professor Peters offers this text for such a course. The title is misleading for the book tries to cover the whole of entomology, not merely the economic aspects.

The introductory chapter is followed by several on such topics as where the insects fit in the animal kingdom, insects as examples of animals, their structure and function, their physiology, ecology and behaviour and so on. As this may be the only biology to reach his students, Peters goes beyond the usual limits of entomology texts to discuss such topics as the DNA helix.

Most entomologists have been asked of what use is a fly, and since T.H. Huxley scotched the London Examination Board's answer that they served to keep warm air circulating in over-heated Victorian drawing rooms, they have been unable to come up with a decent reply, save that they can be used to test insecticides for killing flies. Peters, however, comes up with several uses for insects, including the cleaning out of gangrenous wounds.

On the credit side are pollination, honey, silk and pink icing for cakes. On the debit side, crop damage, termites in the woodwork and mosquitoes carrying malaria. Peters gives a good coverage, albeit with an American bias. The most striking photograph, however, is of a young African woman whose face is so covered with *Musca sorbens*, the Bush Fly's cousin, that she makes the export of bush hats fitted with corks on strings an economic proposition.

The rest of the book is concerned with insect classification and with pest control, a topic that contains an excellent introduction to pest management.

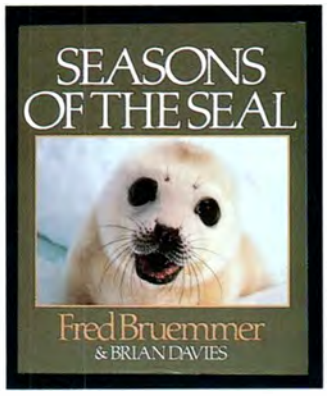
If you want to know as much about insects as you think an American non-science major should know, this is the book for you, but be prepared for some annoying omissions. Despite a little essay on the importance of scientific names, Peters is diffident about using them. There are six index references to the Japanese beetle but nowhere are we told that it is *Popillia japonica*, and hundreds of other insects are given only their local vernacular names. There seems to be no discussion of weed-control by insects, but even so Australians will be astounded that "Except for the silkworm. . .some pollinating species and the sheer aesthetics of some adult forms, the Lepidoptera are pestiferous whenever they are associated with humans." Perhaps Mr Paul Hogan in his American TV campaigns should invite all American non-science majors and professors of entomology to a barbie round the old *Cactoblastis* memorial in Dalby, Queensland. "Try the professor's mead recipe and chuck some more prickly-pear jelly on the prawns, dear!"

—**Arthur Woods**
University of NSW

Seasons of the Seal
By Fred Bruemmer and Brian Davies, Bloomsbury Publishing Ltd, London, 1988, 160 pp. $49.95.

Being a hardened and omnivorous reader, it is only occasionally that I am shocked and revolted by the printed word. Unfortunately, I experienced liberal doses of these feelings when reading *Seasons of the Seal*. At best, I can only suggest that it contains much unreliable information, is unscientific and sets out to be deliberately misleading. At worst, it could be seen as a carefully crafted propaganda tool, designed to subvert the young and vulnerable into accepting a barbarous and illogical philosophy.

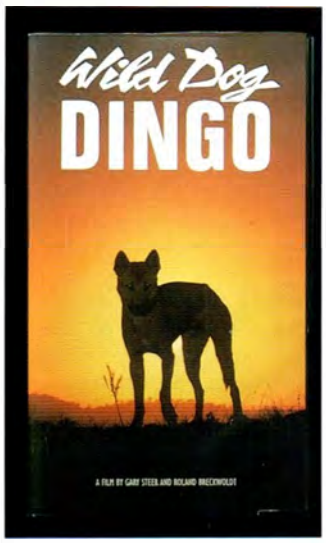
The book purports to tell the life history of the Harp Seal. It is full of photos of furry pups, but not a single photo of a copulation or example of male rivalry—both important aspects of a seal's life—is included. Many of the captions are misleading. On page 65, for example, is a photo of what looks to me like a seal scratching itself on a jutting piece of ice. The caption reads "An angry Harp Seal mother clutches a block of ice". The book is absolutely full of anthropomorphisms. Seals cry in sorrow and clutch in anger, page after page.



But it is not only the lies, half truths and biases of this book that anger me so much. It is the philosophy. It is clear that the authors will go to any lengths to get their way, which is to stop the use by humans of Harp Seals. They are far happier buying woollen and cotton garments, even though the production of wool and cotton is degrading soils in Australia and elsewhere, than buying a fur whose production entails no ecological cost. Just as the ecological implications of their philosophy go unchallenged, there is also no mention of the deaths and cultural decline that the cessation of the Harp Seal hunt has brought to North America's Eskimos. The costs of this philosophy in human lives and culture, in increasing environmentally degrading means of production, and in deception of the public at large, are all ignored in this book. Indeed, this pompous, self-righteous and inhumane philosophy is, I must conclude, perhaps the greatest danger to our survival through the 21st century. For if we cannot manage the world's resources rationally, we, and the beautiful, sustaining complexity of the world's ecosystem, have no future. The authors quote a

Canadian politician as saying of the Harp Seal hunt "This hunt is widely viewed as abhorrent both in Canada and abroad". One can only hope that their book, and their dangerous philosophy, will suffer the same fate.

—Tim Flannery
Australian Museum



Wild Dog Dingo
A video by Gary Steer and Roland Breckwoldt. Sky Visuals and National Geographic Society, 1988. 52 mins. $52.45.

In a continent with a large number of sheep and no native predators on the mainland except the Dingo, this dog looms large in the rural fact and folklore of Australia. So important is the animal in the eyes of the sheep and, sometimes, cattle owners affected by it, that it is difficult to obtain an impartial view of its real impact and even to do research on the species without interference.

GARY STEER

Laws have been enacted to provide for its control, Boards and advisory bodies established to enforce the laws, huge fences have been constructed to inhibit its movements, vast quantities of poison have been laid to kill it, doggers employed to trap it, and taxes and levees imposed to fund its destruction and containment.

A fundamental problem has usually got in the way of an impartial presentation of the Dingo as a beast. Most people in the bush do not like Dingoes because of what they can do to stock and rural income. Most people in modern cities like dogs and admire and wish to protect wildlife. This is a sure recipe for polarisation and conflict, most starkly evident in the strong views held by most people about the Azaria Chamberlain case.

Gary Steer and Roland Breckwoldt have succeeded where their predecessors have failed. In preparation of a film that was infinitely more difficult to make than it appears on screen, they have achieved a high degree of balance. They present the Dingo for what it is—a wild carnivore of modest efficiency with fundamental biological needs for habitat, food and reproduction; an animal with food preferences that run to domestic livestock if it's convenient, and no particular scruples for killing and maiming in excess of its own needs if it's convenient or amusing.

The cinematography is excellent and clearly shows the expertise and discrimination in production based on expert knowledge of wildlife, and how to present it. The diversity and quality of the footage is demonstrative of a great deal of patience, ingenuity and skill in showing aspects of physical and behavioural ecology necessary to effectively portray the animal in a factual light.

The dialogue is of good quality and effectively descriptive. In a couple of places, however, there were changes in sequence or emphasis that I thought could have been improved. These do not detract significantly from the quality of the film as a wildlife documentary.

In brief the film is certainly the best portrayal of the Dingo that has been done in either text or film. It is also one of the best and most educative wildlife films on a single species that I have seen.

—J.R. Giles
Taronga Zoo

"Passive collecting has led to a situation where social history stores are full of duplicates."

NEW LAMPS FOR OLD!

BY DAVID FLEMING
KINGSTON UPON HULL MUSEUMS & ART GALLERIES, UNITED KINGDOM

"Museums exist to collect, conserve, display. . .objects." This is an often quoted reason for the existence of museums of all kinds. Does it mean that anything collected must be kept? *Most* would say yes. Those funding museums, however, are increasingly asking—even demanding—that collections no longer as useful as they were once thought to be should be disposed of.

The costs of collecting are not just the purchase price but of identification, registration, storage and conservation. Those collecting are not always involved in the other activities. Therefore, they don't recognise the costs of those activities. Often, they insist, it would take too much time to cull the collections. Yet life, even in a museum, is a trade-off: time spent disposing of items of little value will yield space and money and time to devote to other more important objects and tasks. Certainly governments won't go on paying people to not make difficult decisions. Increasingly, life is becoming a zero sum game for those in cultural affairs.

Perhaps the real problem is recognising what objects are of real value and what are not. Or, is it the value that governments and the community place on activities like museums and galleries?

—Des Griffin
Director, Australian Museum

THE LAMPSELLER'S REFRAIN IN THE story of Aladdin always reminds me of the world of museums. There are curators at large whose dear wish is to unload some of their old collections in favour of new acquisitions. I know, because I am one, at least sometimes.

The disposal of museum collections is an extraordinarily sensitive issue, and while many curators believe in rational disposal policies, others regard disposal as the ultimate admission of lack of professionalism. At a meeting held in York (United Kingdom) in March 1987 under the joint auspices of the Museum Professionals Group and the Social History Curators Group, both sides of the barricade were manned. There are no neat divisions along discipline lines, no unanimity within any sector of our tiny profession.

Why is disposal an issue at all? Surely museums build collections that are intended to last forever. After all our prime function is to rescue *evidence* of natural or human development. Rescue it, conserve it, document it, store it, interpret it—that is the sequence. No room there for 'dispose of it', for goodness sake! We are talking about the nature of material evidence, which cannot be interrogated then discarded because it has nothing more to tell us. History is a continuum: historians, who write history, should be forever assessing and reassessing, if the writing of history is to have any cultural or scientific value at all. It follows that rescued evidence is forever, not just until the next post-adolescent curator decides that he or she would rather turf it out in favour of the flavour of the month.

The British *Code of Conduct for Museum Curators* and *Code of Practice for Museum Authorities*, and the Australian *Code of Ethics*, do not exactly inveigh against disposal, but they do attempt to create an atmosphere wherein disposal is discouraged on legal, rather than ethical grounds. There is no denying that pressure from within the profession is to not dispose. But it is not as simple as that, is it? If it were, I would not have problems here at Kingston upon Hull Museums, where the Keepers of Social and Maritime History wish to thin out their collections, one way or another.

So why should a curator wish to dispose? Usually the reason is space, or lack of it. Faced with the cold reality of a full museum in a world where collecting must continue, the mind is concentrated upon what is filling it, and why it is there. What if a museum is full—no more room on display or in the store? Perhaps the museum is full of type, cited and figured fossil specimens, or of paintings by Hals, Rembrandt and Vermeer. Surely then there would not, ethically, be the slightest temptation to dispose. But what if the museum is full of unprovenanced and exactly duplicated (or even closely duplicated) calculating machines, mangles and bicycles. What if the curator is then offered a houseful of original Charles Rennie Mackintosh furniture?

The fossil museum cited above has, one presumes, a collecting policy with a scientific base. The staff know what they have collected and why. Moreover, should the opportunity arise they will, because they are working scientifically, know what to collect next. Similarly, the museum with the Dutch Old Masters must have a rational collecting policy, because it has a rational collection. If it continues to collect, it will either build on strengths (more Vermeers) or fill gaps (collect Ruisdaels). Both museums are literally collecting material evidence in their own chosen areas, evidence that is of undoubted scientific or artistic importance, as perceived by the respective curators.

The museum with the calculating machines, by contrast, seems to have no scientific, artistic or historical collecting rationale. There has been no intellectual base for the collection, no structure to guide decision making. The collection is, in short, a load of rubbish.

Are my prejudices showing? I don't think so. I am a social historian. I *like* old pairs of shoes, beermats and pig scrapers. Nevertheless, I see no reason why I should have to be hamstrung in my approach to collection management because my predecessor(s) failed to apply rational, consistent collecting policies. Easier said than done, I know, particularly in social history, but it *is* possible. We all know that it is passive collecting that has led to a situation where social history stores are full of duplicates. Passive collecting can be stopped, but we are still confronted with museums full of its consequences.

Passive collecting is not the seeking out and rescue of material evidence: we need not be frightened of belatedly taking a rational approach towards collections amassed in this way. Thus do I seek to justify disposal. I should beware of advancing such views irresponsibly, and I do not confuse ignorance of collections with ignorant collecting. To dispose presupposes a sound subject knowledge, and sound reasons for weeding-out. These do not include mere changes of taste, although this could arguably be made to apply to collections of art, particularly contemporary art. Furthermore, 'disposal' need not inevitably mean the bonfire or the saleroom; it may be exchange, returns to donors, loans, or relegation to handling collections.

So take courage and apply rational thought. Take warning also. The only safeguard in all this is that it is a competent, highly trained curator, a subject specialist, who is initiating disposal. The unwary may find that others, be it boards of trustees, local authorities or even national governments, may wish to use disposal as a means of reducing commitment. They may be far less interested in arguments about the value of material culture as *evidence*, and more interested in its cash value. ■

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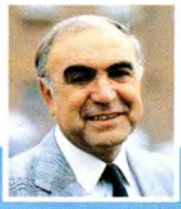
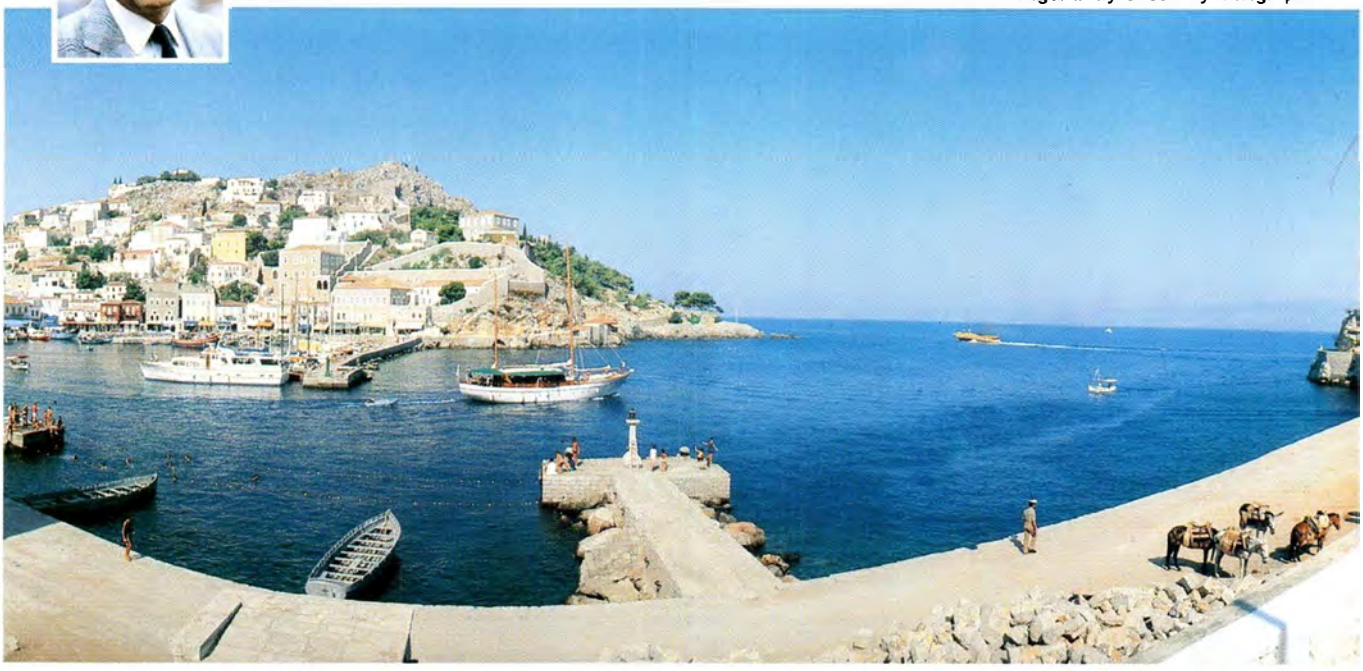


Frank Gallego, Daily & Sunday Telegraph.



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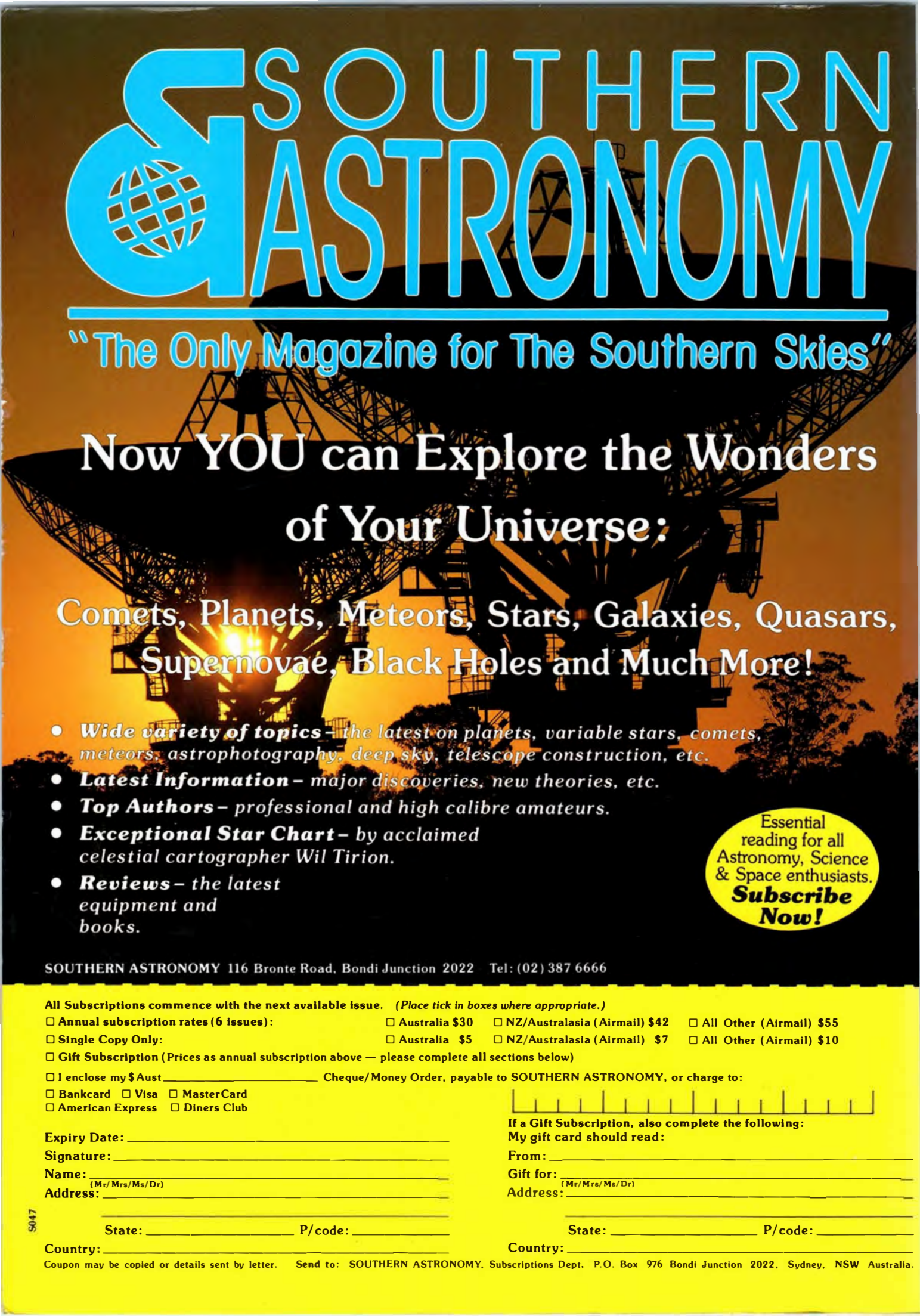

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