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Australian Natural History

Spring 1991 Volume 23 Number 10 $7.95

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Front Cover
The 18-century French ornithologist, Le Vaillant, left a legacy of supremely illustrated bird books. His fanciful fiction coupled with genuine facts and observations led to a poor reputation as a scientist. However his famous book on parrots, which features this Palm Cockatoo illustration, has been republished by Imprime to help conserve the birds he wrote about.

EDITORIAL

FOOD FOR THOUGHT

BY FIONA DOIG

MANAGING EDITOR

At a recent dinner party, I discovered several guests thought avocados were native to Australia. Home grown maybe, but they are native to central America. In fact, the 'traditional' Aussie meal presented consisted of roast lamb (sheep originate from the Middle East), potatoes (from the Andes), peas (Eurasia) and pumpkin (Mexico and Guatemala).

The macadamia nuts saved the evening. No token representative, either: they are our only large-scale commercially farmed native food plant.

We complain that Australia doesn't have a traditional fare. But thousands of generations of Aborigines thrived on bush foods, and settlers left a legacy of recipes for such delicacies as kangaroo-tail soup and Quandong pie.

Its a pity we didn't continue developing it. I often fondly recall one glorious sunny day in the Gulf of Carpentaria feasting on fresh crocodile. But despite the thriving crocodile farms, like kangaroo meat, archaic laws restrict its sale. If it was available in butcher shops, I'd be a regular buyer.

We are still clinging to our imported European cuisine and our land is suffering: farming hard-hoofed stock promotes land degradation. But before condemning farmers, start by looking at your dinner plate. Who is *eating* it?

We *should* harvest species that are adapted to the environment, like kangaroos. The meat is better for us, too: it's low in cholesterol and fat. But if sales are restricted, no one benefits. In Queensland, it is illegal to sell kangaroo meat for human consumption; in New South Wales you can sell it only if it's not stored with other meat (for no logical reason). In Victoria ministerial approval must be obtained. Yet Emu meat is legal in all States. To really splash out, visit the Northern Territory where you can also dine on buffalo, camel, donkey and crocodile.

If these absurd laws were lifted, farmers could *use* many animals they now *destroy* as pests. We could have a thriving export industry. Diversity of resources gives security against tough times, something our farmers need.

But what about conservation? All species have sustainable limits: any animal can be harvested without threatening the ecosystem as long as the sustainable yield is not exceeded. *This* is where appropriate legislation belongs. Research ensuring a law's fitness would benefit the knowledge—and thus the survival—of many species.

When it comes to seafood and fish, we readily consume local species. Unfortunately many, like the Murray Cod, are threatened by introduced exotic species. So developing our cuisine is more than just about eating local foods. Careful management is vital.

When it comes to food plants, our track record is appalling. And production isn't hindered by obscure laws. Limited diversity of food plants is not a local problem, either. The vast bulk of food eaten around the world comes from an extremely narrow range—about eight cereals and grains, seven vegetables and about four fruits.

One person is working to change that. Sydney-based bush food supplier Victor Cherikoff experiments with new uses of bush foods and assists farmers to produce them. Wild tomatoes, Quandongs, wattle seed, bunya nuts, lemon aspen, wild rosella, Lillipillis and Kakadu Plums are all being produced commercially and some are used in such delicacies as wattle seed ice-cream.

Vic's philosophy is simple: we need to diversify food production and we need to do this by growing locally native plants. In the desert we would grow desert foods; in the rainforest, rainforest delicacies. We end up with a variety of unique, locally distinct cuisines.

Most native food plants are unsuited to monoculture. Unfortunately, we commonly think of plants as 'native' to Australia, rather than an area. Australia's enormous regional diversity underlines a need for nurseries to specialise in locally native food plants. Nurseries are just one starting point. Introducing bush food cultivation into agricultural courses is also vital. And an Aboriginal training program in native food production and harvesting is a must, so that we can both teach and learn all about local bush foods from traditional Aborigines and future research. This not only promotes cultural exchange, it also encourages ecologically sound agriculture. We have much to learn about this part of our heritage. Let's stop ignoring it.

Meanwhile, I'll just sit back and munch on my Quandong pie with justifiable pride in the knowledge that I am accelerating our return to a long-neglected traditional fare. ■

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IN THIS ISSUE

BY GEORGINA HICKEY

SCIENTIFIC EDITOR

IN THE LATE 1700S, FRANCOIS LE VAILLANT WAS A 'BEST-selling' travel writer who was known to skim over the truth for the effect. However, the turn of the century saw the turning of a new leaf for Le Vaillant. His long-time interest in birds, and his desire for scientific credibility, led to the production of *The natural history of parrots*, a milestone publication that was to have a far-reaching and lasting effect on these birds. In the article by freelance writer Murray Bruce, we learn more about this amazing Frenchman and his works.

Pictured is Peter Whitehead from the Conservation Commission of the Northern Territory. For the last three years he has studying the biology of Magpie Geese and the effects they have on exotic fruit horticulture. In his article he discusses possible 'ecologically sustainable development' strategies that might enable the continued expansion of this relatively new and potentially successful industry without adversely affecting nearby wetlands.

In other articles, Australian Museum's Tim Flannery questions the view put forward by politicians and economists that Australia is the 'lucky country'; and we look at some of Charles Darwin's recently discovered notebooks, which reveal some interesting reptile.observations made in Tasmania in 1836.

Our regular writers cover the topics of fish poisoning methods used by early Aborigines (and contemporary Indians); the achievements of a Greenhouse-guru-cum-Winnie-the-Pooh-collector; the mechanisms by which species remain separate; and the evidence or not for the existence of a human soul.

Fluorescing feathers, whale feet, hot sex in plants, and why we *feel* sick when we *are* sick, are just a few of the other items covered in this issue. Our poster is a 19th-century French illustration of crabs. And last (but let's hope not *the* last), we are proud to announce ANH's fifth consecutive Whitley Award for Best Zoological Periodical (1991).

Articles

Regular Features

Columns

LETTERS

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

Counting on Trouble

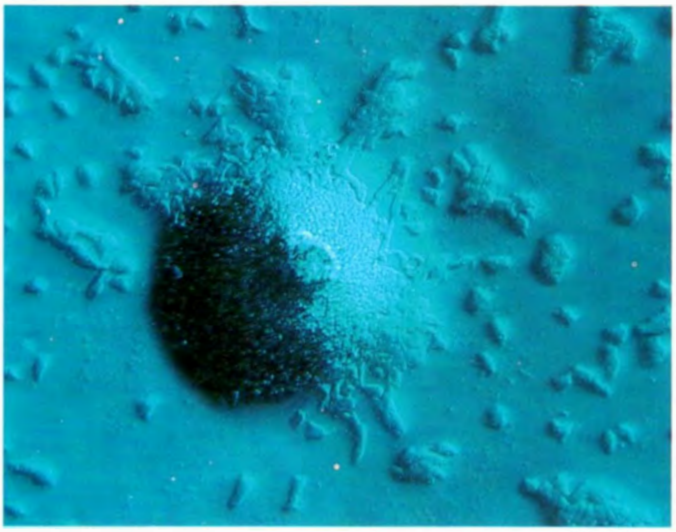
In their excellent article on slime moulds (ANH vol. 23, no. 8, 1991), Susannah Eliott and Keith Williams use 'billion' in the sense of a million million. It is delightful to remember this rational system. But unfortunately recent domination of scientific literature in English by Americans now makes it confusing.

There are two ways out of this. One is to modify spelling (as is done when we want 'stationery' to mean writing materials)—'billeon' for the English–Australian usage, perhaps? Alternatively we could make nouns out of prefixes and refer to gigan, teran, petan, exan; in this case "100 teran (10^{14}) cells."

Many American reforms in spelling and usage are good. But when they adopted a system that calls the fifteenth power of ten a quadrillion, they were having a bad day. I agree with Eliott and Williams that we should not slavishly follow so poor a lead.

Thanks for the fine magazine.

—Peter Fannin
Uluru Natural History
Yulara, NT



RON OLDFIELD

An aggregation of slime mould amoebae.

Traditionally an Excuse

In the Last Word article "Whaling: The Cultural Gulf" in the Autumn 1991 issue (ANH vol. 23, no. 8), much of the information offered by the authors is accurate and it is true that cultural considerations are an important component of international dialogue. A few points, however, are worth noting.

Whaling nations, not only Japan, regularly introduce the topics of tradition and racism into an otherwise rational debate over the killing of whales. Many of the pro-whaling nations have been taking whales even longer than the Japanese. The fact of the matter is that these perennial red herrings are at least as 'emotional' and 'irrational' as some Western claims regarding cetacean spiritualism.

Tradition is about as hollow an argument as can be put forward when the survival of a species is at stake. Japan shared many traditions with the West 500 years ago, including human slavery and the wholesale slaughter of animals for sport. 'Tradition' is an explanation of (or excuse for) the practices of the past; it is not a valid justification as to why such practices should continue in the light of new information and understanding. Otherwise, why has that country discarded so many of the 'classist' and sexist traditions of its feudal past? The proponents of traditional arguments seem to be selective in the extreme.

The analogy of Inuit people is also invalid. Although the take by native Arctic peoples places pressure on the depleted Bowhead Whale

COURTESY GREENPEACE

Japanese whaling: is tradition a hollow excuse?

population, the quotas are low, the methods used are similar to those 'traditionally' used for centuries, and the whale flesh and bone are consumed or traded locally. A far cry from the Japanese who have traded their oars for engines, their nets for harpoon cannons, subsistence for the gourmet market and generally compromised their traditions almost beyond recognition.

The allegation of racism is another handy tactic to introduce when one seems to be losing the debate. Conservationists and the anti-whaling nations within the IWC have consistently opposed all commercial whaling, including whaling conducted by the Soviet Union and even Australia when whaling in those countries was still in business. Countries such as Norway and Iceland are currently the subjects of boycotts and sanctions for their whaling activities. In which case, of course, out comes the 'tradition' argument again. Allegations that the Japanese cannot come to terms with Western philosophical or material concepts lose credibility in view of that country's swift rise to economic and industrial supremacy. Their environmental awareness is evidenced by their tendency to exploit the resources of other nations rather than their own. While Japan's drift nets strip-mine other oceans, they are banned within 1,000 kilometres of their own shores.

Ultimately, beyond claim and counterclaim, beyond what their 'experts' say and what ours say, the issue is whether or not we are prepared to gamble once more with the few whale species still existing in 'commercial' numbers. One by one, over half the species of great whales have been sentenced to the endangered species list in a horrendous planetary game of Russian roulette while new but greed-based management techniques were tried and found wanting. The whaling nations could not even play by the rules during the moratorium.

Once again they are telling us they have it right—this time. We are simply not prepared to believe them any more.

—Paul Hodda (Chairman)
Australian Whale Conservation Society
North Quay, Qld

Points to Ponder

The quality of the pictures in ANH is without peer. Often I am astounded at the colours and incredible resolution. I opened the Summer 1990–91 issue (vol. 23, no. 7) to Photoart and had a knee jerk when I read "The multi-faceted orbs of some Tabanid flies (March flies) double up as beacons to display bands of vivid hues." In Canada and much of the rest of the world, tabanids are called 'horse-flies', 'deerflies', or 'bulldogs', depending upon their size or genus. I was about to call you on this one, but a quick check in my copy of CSIRO's *The insects of Australia* confirmed that in Australia tabanids are indeed called 'marchflies'. I apologise for my thoughts!

Tabanids: known as March flies in Australia.

STEVE WILSON

Then the Autumn 1991 issue (vol. 23, no. 8) contained, yet again, a stunning collection of articles and photos rarely seen. But I wish to argue two points. First, in the Quips, Quotes & Curios item "Snakes that Know When to Rise from the 'Dead'", as a biologist keen on spiders and snakes, I would correct the first statement in this article, which read "Most North American kids have seen the non-venomous Hognose Snake...". I doubt even one in 100 has even heard of the snake and that one in 1,000 has seen even one. I have seen at most a dozen in the wild and I've been looking for them in eastern USA.

Second, in the Archives article "The Tale of William Wall's Whale", the second-last paragraph infers that the species, *Catodon australis*, has been synonymised with another species, *Physeter macrocephalus*. Species *names* are synononised, not species. In this case, the name *Catodon australis* has been declared a junior synonym of the name *Physeter macrocephalus*, the senior synonym.

—Robin Leech
Northern Alberta Institute of Technology, Canada

Night Parrot Reward

ANH readers may be interested in an update of events connected with the story of the Night Parrot's rediscovery (ANH vol. 23, no. 9, 1991).

In October 1989, Mr Dick Smith, chairman of the Australian Geographic Society, offered a reward of $50,000 for the first acceptable evidence of the Night Parrot's continued existence. This offer was valid for two years from its announcement.

When Wayne Longmore, Max Thompson and I found the dried carcass in October 1990, we were unaware of this offer. We stopped in Boulia to ring the Australian Museum and tell a few people of our find, before disappearing for another week of fieldwork in remote country. During this time we were oblivious to the growing excitement surrounding our discovery and the consternation at the Museum's inability to contact us.

After our return to Sydney, the Australian Museum made a claim on the Australian Geographic reward. In February, Dick Smith presented the cheque for $50,000 to Dr Des Griffin, the Director of the Museum.

The confirmation that the Night Parrot survives has raised hopes of finding living individuals and studying them in the wild. By finding out more about this elusive species we can determine if its existence is threatened and start to make informed decisions about its conservation. Such a program will not be easy—nor inexpensive.

Thanks to Dick Smith's generosity and commitment to the Australian environment, we have been able to establish the Australian Geographic – Australian Night Parrot Fund to finance fieldwork dedicated to finding and studying the Night Parrot.

Australia is a big country, and the distribution of the Night Parrot occupies the majority of it, albeit much of it remote. This species seems to move according to local conditions. To avoid a 'needle in the haystack' situation, we hope to start our hunt by following up recent, reliable sightings. In this endeavour, the Museum would be grateful to hear of any good Night Parrot reports in the future. Updates on this project will be made periodically.

—Walter Boles
Australian Museum

Mothball Mystery Solved

I was very interested to read the item "Millipedes, Marigolds and Mothballs" in the Quips, Quotes & Curios column (ANH vol. 23, no. 8, 1991). My Australian wife Shirley and I saw four grackles performing the mothball 'anting' procedure in our garden on 20 June 1985. She had scattered a few mothballs on a small patch of freshly planted grass in an attempt to repel squirrels, under a group of three Douglas Fir trees beside our driveway. We observed the birds picking up the mothballs and rubbing them on their backs, under their wings and elsewhere on their bodies, over a period of ten minutes. We thought we had seen something new but soon discovered we hadn't. I consulted our copy of John K. Terres' *The Audubon Society Encyclopedia of North American Birds* (Alfred A. Knopf, New York, 1980) and on page 19, in the section on "Anting", found that "grackles in 'anting' will even use mothballs in their feathers as a substitute for ants. A woman in Milwaukee, Wisc., put mothballs in her vegetable garden to prevent cottontail rabbits from eating the young green plants, and observed one morning that a flock of grackles were picking up the mothballs in their bills and preening with them, rubbing them under their wings and over the feathers of their bodies."

We had the pleasure of visiting Australia last April. The highlight was seeing a mother and baby wombat crossing a forestry road during daylight!

I musn't fail to tell you how much we enjoy your great publication. We have subscribed to ANH for about 25 years and have nothing comparable here. I get a lot of pleasure in reading and rereading our collection!

—Alan Brown
Oakville, Canada

CARL BENTO/ AUSTRALIAN MUSEUM

The mothball mystery solved for one ANH reader.

COURTESY EARTHWATCH

Earthwatch volunteers.

Honey of a Trip

I read with interest the article by Graham Pyke "Apiarists versus Scientists: A Bittersweet Case" (ANH vol. 23, no. 5, 1991). ANH readers may be interested to know that they can help find some possible solutions to this dilemma.

Earthwatch is an organisation that funds scientific field research by placing paying volunteers out into the field to work with scientists. Such an expedition is being led by Dr David Paton on the effects of introduced Honeybees on native flora and fauna of Kangaroo Island. Paying volunteers are still needed to help the scientists monitor wild bee populations, measure pollen loads, identify plants, and study the interactions of bees and native pollinators. Volunteers will work on two-week teams at Flinders Chase National Park, Kangaroo Island. They need no scientific knowledge, or experience, just enthusiasm, a willingness to work hard and a desire to help and learn. Readers can find out more about the 1991 and 1992 teams by calling Earthwatch on (02) 290 1022.

—Hayley Anderson
Earthwatch, NSW

Microscopical Club

Readers of ANH may be interested to know about the Postal Microscopical Club of Australia. It enables members from all parts of Australia to participate in the microscopical sciences—particularly natural history specimens. The Club circulates sets of prepared microscope slides together with a comments book to all members to study in their own time. A newsletter, *Amateur Microscopist* is sent to members, which includes articles on techniques, history, formulae and letters. Although members are scattered throughout Australia, we keep in touch via the newsletter and by sending slide sets. The club encourages members to prepare their own slide sets and to meet other local members for excursions to places of interest and collecting specimens for examination. Enthusiasm rubs off onto newer members, who can participate in this hobby without fear of isolation. The club is a non-profit organisation and accepts anyone over 11 years with an interest in microscopes and microscopy. Teachers are also encouraged to promote the club and its activities, as this is where an interest in microscopy should be started.

Anyone interested in joining or needs more information can contact The Secretary, PMCA, 28 Valley Road, Hazelbrook, NSW 2779.

—Michael Dingley
PMCA

Not in Conflict

In the Still Evolving article "The Tempo of Speciation" (ANH vol 23, no. 8, 1991), Glen Ingram and Ralph Molnar give the impression that Eldredge and Gould's hypothesis of evolution by punctuated equilibria is in opposition to Darwin's theory of the origin of species. Gould and Eldredge maintain that species tend to remain more or less unchanged for long periods and that the origin of one species from another often (but not always) is the result of rapid evolution in a small outlying population of the parent species. Should this happen, the parent and daughter species are much more likely to be preserved in the fossil record than the intermediate forms between them.

Since co-authoring the hypothesis nearly 20 years ago, Gould has taken pains to point out that it is not anti-Darwinian, that it relies upon natural selection, and that it involves biological continuity between species. It does not contradict Darwin's view that an absence of intermediate forms between one species and its presumed descendant is due to an imperfection of the geological record. In fact, it strengthens Darwin's case by explaining why such intermediates are likely to be confined to a small area and a short time span (thousands or tens of thousands of years). In common with much of our current understanding of evolutionary processes, it is a *refinement* of Darwin's theory.

The question raised by Ingram and Molnar ("Are species individuals or abstractions?") can be answered. They are abstractions, each being linked to a parent species by a series of generations, some of which cannot be attributed to either species. Sometimes we can find such intermediates, as between *Homo erectus* and *H. sapiens*; often they elude us.

The article was ill-served by the accompanying illustration. Two axes of the three-dimensional diagrams were labelled 'morphology', whereas one was presumably intended to measure geographical separation. The dashes, representing 'speciation events' were almost invisible and the colouring (presumably intended to indicate geographical separation) was incomprehensible

—Ronald Strahan
Australian Museum

Regarding the diagram, unfortunately the colour did not print as well as the original. As for the 'morphology' label on two axis, it is correct and as it appears in the original (as stated, it is based on Eldredge and Gould, 1972).
—Ed.

'Freckles' in her twilight.

Obituary for a Lizard

Recently our pet Blotched Bluetongue Lizard 'Freckles' died. She was already an adult when purchased in 1966 from a pet shop in Campsie. She outlived all the other animals we have kept over the years, including two other Blotched Bluetongues ('Boney' and 'Little Fella'), two dogs, a cat, ducks, a goose, a chook, budgies, rabbits, guinea pigs, fish and various others.

'Freckles' bore four little ones soon after we acquired her but unfortunately none of them lived long. We don't know how long Blotched Bluetongues are supposed to live, but 'Freckles' must have come close to being a record.

The secret of her long life would definitely have been lack of stress. Every day she would crawl out from under the banana leaves in her pen, have some snails or banana to eat, lie in the sun, then crawl back under the banana leaves in the evening. There was not much else she could do, really.

She always behaved herself and never bit anyone. She is sadly missed by us all.

—Michael Shea
Mt Colah, NSW

Maybe Misleading

Mike Archer's article on conservation and the fossil record (ANH vol. 23, no. 8, 1991) raises some interesting questions. He develops the hypothesis that studying the fossil record gives us a good idea of which species are likely to become endangered or extinct, suggesting that species whose lineages gradually dwindle, or that have never been very species rich, may be in danger of extinction. But does this hold for modern Australian extinctions? In all, 20 mammal species have now become extinct since 1788, of which one (the Thylacine, the example used in Archer's article) fits his case. It has a long fossil record, which has lately become diminished in range and species. Of the remaining 19, however, nine were murid rodents, which come from one of the most rapidly radiating and widespread lineages of mammals. None had shown the least sign of going extinct before 1788. The remaining marsupials were also widespread and from very speciose groups. No less than six were rat-kangaroos and wallabies, many of which were spread over vast expanses of the Australian continent. The other extinct species were bandicoots, again mostly widespread. The late Pleistocene extinctions of Australia were no different. It was often the widespread and common species from rapidly radiating lineages, such as *Diprotodon*, that went extinct.

Conversely, many species that, according to Archer's view, should be endangered, are not. Although suffering locally (like all of our indigenous fauna), the Platypus and Koala remain widespread. The Musky Rat-kangaroo has not declined at all, while the Queensland Lungfish appears to have expanded its range (albeit initially with human help).

I have a feeling that we live in strange times, when the normal rules of extinction do not hold. To use the fossil record in ways that Archer suggests may result in us using all of our resources to protect the wrong species.

—Tim Flannery
Australian Museum

The now extinct Gould's Mouse (*Pseudomys gouldii*).

More Hurley Burley

Frank Hurley produced many other coloured photographs of New Guinea life during World War 1, an earlier date than stated in Photoart (ANH vol. 23, no. 8, 1991). Many of these are in the possession of the Australian War Memorial, and others, according to the book *Hurley at War* (1986), are held by the State Library of New South Wales. The author, Daniel O'Keefe, points out in his introduction that Hurley's photographs of Flanders (now Belgium) and Palestine were not hand-tinted. Frank Hurley used a pioneer colour process, with two plates being exposed, one producing a black-and-white positive and the other a colour screen, the result being sometimes patchy with a limited colour range. Notes accompanying an exhibition of Hurley's work I saw some years ago claimed that he was the first outdoor colour photographer.

It was also revealed by O'Keefe that Frank Hurley used combination printing to enhance his work. In fact, many of his most famous Flanders photographs were given an artistic lift, often because conditions were so atrocious that good prints were impossible, and his additions annoyed war historian C.E.W. Bean.

One cannot blame Frank Hurley for helping along his New Guinea works, adding artificially the vivid colours his camera was frustratingly unable to capture in the early 1920s.

—Ellen Waye
Rosebud, Vic.

One of Hurley's war photos.

P O T P O U R R I

QUIPS, QUOTES & CURIOS

COMPILED BY GEORGINA HICKEY

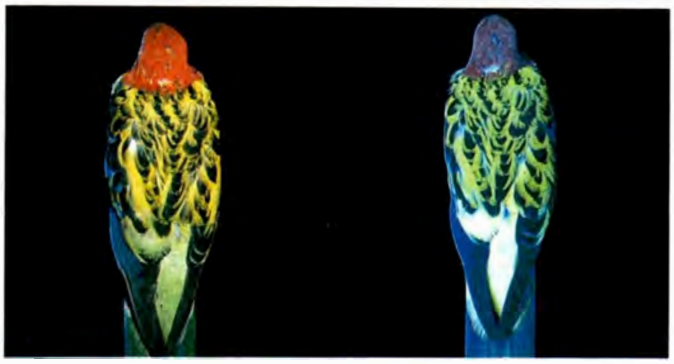
SCIENTIFIC EDITOR

Black-light Signature for the Birds?

Birds are highly visual animals, as their brightly coloured plumages would suggest. The means of colour production are much the same in all animal groups—birds just take it to unrivalled heights. The colours of the feathers result from two major sources: pigments and structure, or an interplay of the two.

Structural colours owe their existence to the way light is reflected from the surface layers of the feather. The true colour of such feathers is not that which the observer normally sees. Blue is the most prominent structural colour. It arises when the feather absorbs all the other colours, reflecting only the blue portion of the light (similar to the reason the sky is blue). 'Blue' feathers are really brown. The other well-known structural phenomenon is iridescence, such as in the feathers of the peacock and birds of paradise.

Pigments are responsible for the other colours of feathers. Blacks, browns and some oranges are usually caused by melanin pigments; yellows, oranges and reds result from carotenoid pigments, manufactured from carotene in their food. In almost all cases, the colour in most green feathers comes from the combination of yellow pigment with a structural blue. These two groups of pigments are found in almost all groups of birds. Less widely distributed are porphyrins, which are usually warm brown but may occasionally be green (turacoverdin, found in only a few bird families) or magenta (turacin, restricted to the turacos or plantain-eaters of Africa).



Eastern Rosella under normal light (left) and ultraviolet light (right).

Two other feather pigments are known—but only just (their chemical structures have not yet been discerned). One is yellow, the other may be yellow, orange or red. Both pigments have been reported only in parrots. One of the yellow parrot pigments has a fascinating property: it fluoresces under ultraviolet (UV) or black light.

This fluorescence was originally reported by Otto Völker in 1937 (*J. Ornithol.* 85: 136–146) but, for some unknown reason, little has been done on this unusual property since. It is usually relegated to a throwaway line at the end of textbook discussions on feather pigments.

In early 1991, Max Thompson (Southwestern College, Kansas) and I, for no other reason than to satisfy our curiosity, decided to witness these 'glowing' parrots for ourselves. Borrowing a very basic UV apparatus from the Australian Museum's Mineralogy Section, we turned out the room lights and proceeded to wave a range of parrot specimens under the UV source. Several reacted strongly from many parts of the body; others fluoresced only from restricted areas; and some showed no evidence of the special pigment at all. Cockatoos and most Australian rosellas and grass parrots fluoresced strikingly, but lorikeets were found to be UV inert.

Certain conditions are apparently necessary to obtain the desired reaction. First, the parrot must have yellow in its plumage or at least mixed in green feathers. Thus the plumage of the pink and grey Galah (*Cacatus roseicapilla*) does not fluoresce under black light. Second, the yellow has to be the correct yellow. A number of parrots have only the non-fluorescing yellow or have both yellows distributed on different parts of the body.

Our initial reaction was that this was an unusual but not particularly Earth-shaking phenomenon; however, after more specimens passed through our hands, our observations started to suggest that this was possibly more biologically significant than we had first thought. Species such as the Eastern Rosella (*Platycercus eximius*) and Hooded Parrot (*Psephotus dissimilis*) glowed more or less all over; in other species the pigment was restricted to those areas often associated with social or courtship displays (foreheads, napes, crests, cheeks and shoulder stripes). The crest of a Sulphur-crested Cockatoo (*Cacatua galerita*) fluoresces brightly, but is outdone by the forehead of the Budgerigar (*Melopsittacus undulatus*), which looks like the glowing end of a torch. Perhaps the most intriguing species tested is the Golden Conure (*Aratinga quarouba*) of South America. Except for some dark green feathers on the wing, the entire bird is a uniform golden yellow. Yet, when it is placed under the UV, a bright square patch appears on its nape, contrasting with the non-reacting yellow feathers on the rest of its body.

These observations strongly suggest that parrots can see into the UV range. Few studies have been carried out on UV perception in birds. Hummingbirds, like bees and other nectar-feeding insects, can pick up UV 'signposts' on flower petals directing them to the food source; and work on the navigation systems of pigeons implies that they, too, can detect UV. But parrots have not been the subject of similar perceptual studies.

The ability to perceive certain colours can be detected by looking at the vision pigments in the retina of the eye. In most birds that have been studied there are three such pigments in the cone receptors, one each sensitive to red, blue and green. This gives birds the same trichromatic (three-colour) perception as humans. In pigeons, a fourth cone pigment has been discovered, one apparently sensitive to UV. This would give them tetrachromatic (four-colour) perception. Similar work may demonstrate that parrots, too, have the visual capacity to perceive UV.

There are obviously many unanswered questions arising from our little bout of curiosity. Attention to the biochemistry of the fluorescing pigment and to visual perception of parrots (and other birds) will fill some gaps in our knowledge. Of particular interest is the significance of the apparent UV signals on some species of parrot. Behavioural studies may show that 'glowing' body parts are important in the day-to-day interactions of these birds. Conversely, these may amount to little more than just another colour in a visual spectrum that exceeds that of humans.

—Walter E. Boles
Australian Museum

CARL BENTO/AUSTRALIAN MUSEUM

South Australian Platypus

Things are looking brighter for South Australia's Platypus (*Ornithorhynchus anatinus*). There is a ray of hope in a State where populations of the little monotreme have suffered very serious declines in the wild.

John Wamsley manages "Warrawong" Fauna Sanctuary in the Adelaide Hills. He reintroduced Platypuses to the Adelaide Hills when he released six animals, captured on Kangaroo Island, into man-made ponds on his property between 1988 and 1990. The sanctuary is surrounded by a fence that excludes foxes, cats and dogs. The pond environment has been modified to provide the Platypuses with suitable habitat by lining the edges with a thick cover of dead tree branches and trunks. This measure performed a dual role: first, it provided a large area of substrate for invertebrate larvae, which are a critical food resource for Platypuses; and second, it provided cover under which the monotremes could construct burrows.

John Wamsley with one of the juvenile Platypuses bred in South Australia.

FORD KRISTO

In January this year Wamsley sighted at least one, and possibly two, juvenile Platypuses on one of the ponds. Excited by his observation, he contacted Platypus biologist and ecologist Tom Grant to verify his sighting. After setting nets on the pond Grant almost immediately caught a Platypus. Disappointingly, however, it was an adult female—not one of the juveniles they were seeking. Twelve hours later, after a gruelling all-night ordeal of watching and waiting, one of the juveniles (a three-month-old male) finally swam into the net and was captured.

Wamsley maintains that these juvenile Platypuses represent the first successful breeding of the Platypus in captivity for 47 years and the second ever successful captive breeding. Other schools of thought argue that the Platypuses are 'semi-restrained in a captive stream' and are not captive in the true sense. Leaving this argument aside, Wamsley has proved it possible to breed Platypuses in confinement and shown that it is also possible to reintroduce them into situations of suitable habitat and lack of predator pressure. The progeny from projects such as this might one day be used to bolster South Australia's declining wild Platypus population, provided other factors that limit their survival in the wild can be modified.

Interestingly, the Platypuses captured on Kangaroo Island by Wamsley, and which are the core of his breeding program, were descendants of animals released there by David Fleay in 1940. The Platypus had not existed on Kangaroo Island before this release. Fleay is also responsible for the first captive breeding success of Platypuses at Healesville, Victoria, in 1944.

—Ford Kristo
Animal Image Photography

Tell-tale Tail

Sea snakes of Australia's Great Barrier Reef lead a secretive life. They spend most of their time concealed among corals in order to dodge predators such as sharks and White-bellied Sea-eagles, and risk exposure usually only when foraging for food, courting and mating, or surfacing to breathe. It follows that complete concealment—including the tail—is important for a sea snake. A tell-tale tail protruding from a clump of coral could be, literally, a dead give away of the snake's presence to a predator.

But how does a sea snake tell when it is completely hidden? This was the question asked by biologists Ken Zimmerman and Harold Heatwole from the University of New England, Armidale, after underwater observations of the Olive Sea Snake (*Aipysurus lævis*) indicated that the tail was sensitive to light.

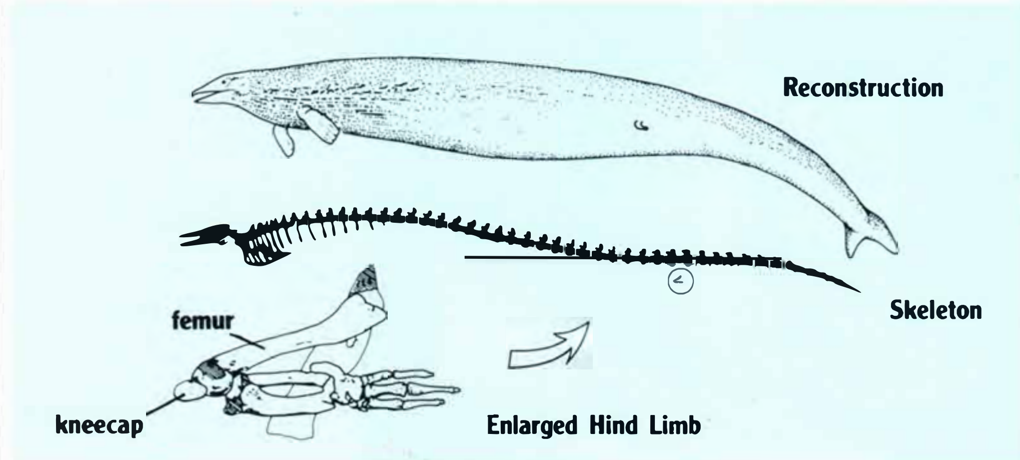
During underwater observations made at night it was found that when a torch beam was directed near but not onto an inactive snake, onto the head or onto the midbody, the snake moved only two, four and two per cent of the time respectively, but when the tail was illuminated movement occurred 78 per cent of the time (*Copeia* 1990: 860–862). Further experiments in laboratory aquaria showed that Olive Sea Snakes will directly remove their tails from light and that tails are concealed more often in daytime than at night, supporting the hypothesis that this 'light sense' in Olive Sea Snakes increases the effectiveness of concealment by removing the tail from view of predators. As the authors explain, when both ends of the snake can detect that they are out of the light, it is likely that the whole animal is concealed.

The Olive Sea Snake has a photosensitive tail to ensure it is pulled out of sight of predators.

AUSTRALIAN PICTURE LIBRARY

The exact nature of the light-sensitive receptors in the sea snake's tail remains unresolved. In a variety of frogs, toads and salamanders, the skin has been shown to be photosensitive, and in mammals, fish and amphibians electrical responses to flashes of light on skin have been recorded. However, no single type of receptor has been found and it is thought that different forms of receptors may be involved in each case.

—S.H.



LYNNE ALBERTSON

The fossil whale *Basilosaurus isis* used its hind legs to guide itself during mating.

Fossil Whale Feet

Skeletons of hundreds of long-extinct whales have been discovered by scientists under the drifting desert sands of the Zeuglodon Valley in the Fayum of northern central Egypt. The remains are mostly those of *Basilosaurus isis*, a long, serpent-like creature that lived some 42 million years ago in ancient seas that once covered North Africa. The most exciting aspect of the find is that these whales had *hind legs* (*Science* 249: 154–156; 1990). They will thus help us understand one of the most fascinating but little-known evolutionary transformations—that from terrestrial, four-footed land mammals to fully aquatic, legless whales.

Until now, there has been frustratingly little known about the skeletons of early whales. In modern whales, the front legs are paddles and the hind limbs have disappeared almost entirely, all that remains being part of the pelvis. (A few whales have bony nodules, which were once limb bones, embedded in the muscles of the body wall.) The Fayum discovery is helping to fill in the gap: it seems that, although the hind legs of this 42-million-year-old whale may have been greatly reduced (comprising only three per cent of the animal's total length), they were probably nevertheless still functional.

US scientists Philip Gingerich, Holly Smith and Elwyn Simons have found that the femur ('thigh' bone) faced forward and evidently lay within the body wall. The rest of the leg lay outside the body, pointing to the rear with the ankle extended and foot facing upward. From this resting position, the animal could move the hind limbs a little, rotating them down and outward. The authors argue that, because there is little sign of degeneration in the bones and joints and fittings for powerful muscles, and the knee has a powerful locking mechanism, then it is likely the legs had a function.

Although the hind legs of *B. isis* were probably all but useless for swimming and could not have supported its weight out of water, they may have served a different purpose—as important aids in reproduction. (In modern whales, remnant pelvic bones anchor the reproductive organs.) In the ancient *Basilosaurus* the legs were perhaps used as positioning guides during copulation which, the authors suggest, may have been quite tricky in such large, serpentine aquatic animals!

—S.H.

Stay-at-home Flatbacks

A rare insight into the lives of Flatback Turtles, and a possible explanation for the uniquely restricted distribution of this marine species, has been found in sea-eagle nests.

Unlike the other six species of sea-turtle, which all have pan-oceanic distributions, the Flatback (*Natator depressa*) is restricted to the Australian continental shelf.

The pan-oceanic species are generally thought to achieve their wide distribution via a pelagic (open-ocean) juvenile phase, during which they are at the mercy of the currents. Hatchlings enter the ocean shortly after birth and are rarely seen until they emerge as young adults in shallow coastal waters.

Queensland biologists Terry Walker and John Parmenter inspected the feeding stations of the White-bellied Sea-eagle (*Haliaeetus leucogaster*) on 35 Great Barrier Reef islands and found evidence that Flatbacks do not have a pelagic phase. (*J. Biogeog.* 17: 275–278; 1990).

C.J. PARMENTER

The Flatback Turtle is the only sea-turtle that is restricted to the Australian continental shelf.

Despite the fact that adults from all but one sea-turtle species are found in Great Barrier Reef waters, and that two of these species nest in the area, the only juvenile sea-turtle carcasses found in sea-eagle nests belonged to Flatbacks. The explanation preferred by Walker and Parmenter is that juvenile Flatbacks remain in the same shallow coastal waters as the adults of the species. Presumably juveniles of the other species take to the open ocean before they can fall prey to sea-eagles.

Reproductive strategy in marine creatures tends to favour either the large clutch of small offspring broadcast widely as a pelagic phase, or the small clutch of larger-sized offspring not widely dispersed so that the individual has a greater chance of surviving initial predation pressure. The Flatback Turtle, with its clutch size much smaller than that of other sea-turtles and offspring up to three times larger than its pan-oceanic relatives, appears to have adopted the latter strategy.

—K.McG.

Dr Suzanne Hand, a biologist at the University of NSW, and Karen McGhee, a freelance science writer living in Newcastle, are regular contributors to QQC.

But What About the Mosasaurs?

We've all heard of the extinction of the dinosaurs 65 million years ago, but what about the mosasaurs? These were a group of marine reptiles that, together with three other major reptilian groups (pterosaurs, ichthyosaurs and sauropterygians), also vanished from the face of the Earth at this time. Recent research on mosasaurs by two Belgian scientists, Theagarten Lingham-Solier and Dirk Nolf, has produced significant results that may shed some light on the mysterious 'Cretaceous–Tertiary boundary event' that caused the extinction of the dinosaurs (among other animals) (*Bull. Inst. Roy. Sci. Nat. Belgique Sci. Terre* 59: 137–190; 1989).

Mosasaurs were giant relatives of goannas that lived during the late Cretaceous, 80 to 65 million years ago. Throughout most of their history mosasaurs seem to have been uniform in structure: they were large (some over 15 metres long) with limbs converted into paddles and deep, flattened tails for swimming. During the 1980s an American palaeontologist, Judy Massare, made a classification of how the Mesozoic marine reptiles fed. She noted that at the very end of the Mesozoic, during what is known as Maastrichtian time, the divergent mosasaur *Globidens* appeared. Most mosasaurs probably ate large fish or ammonites but *Globidens* was a 'clam-buster'. It fed on shellfish, bivalves and the like, by crushing the shells and extracting the soft bodies.

Lingham-Solier and Nolf have examined and re-examined other mosasaurs from the Maastrichtian and found that there was a diversity of feeding habits at that time. *Carinodens*, a small western European mosasaur, had laterally flattened teeth for dealing with crustaceans or nautiloids. In one species the teeth were multi-cusped. *Goronyosaurus*, from Nigeria, had a long, narrow snout with relatively few teeth and may have fed on the young of other marine reptiles; while *Prognathodon*, found in Belgium and the USA, had projecting teeth (hence the name) that may have been used to extract prey from under rocks or out of soft mud. *Plotosaurus*, a Californian mosasaur, had a large number of evenly sized, backwardly curved teeth, probably used for catching fish.

Mosasaurs underwent an adaptive radiation just before they became extinct.

ILLUSTRATION BY WILLIAM STOUT

So it seems that mosasaurs had embarked on an adaptive radiation into several different feeding modes just before they became extinct. Lingham-Solier and Nolf also believe that different types of swimming were evolving at this time. *Plotosaurus* seems to have had a more advanced type of undulatory swimming than other mosasaurs, and *Plioplatecarpus* seemingly developed its paddles into hydrofoils and swam, or rather 'flew', through the water like modern sea lions.

It has been argued, not always convincingly, that dinosaurs were actually declining in numbers and diversity when they became extinct; but not so for mosasaurs. They were in the process of becoming more diverse in both feeding and swimming behaviour when they were caught by the extinction event. Whatever caused the extinctions at the end of the Cretaceous came abruptly for mosasaurs and was not the result of a gradual deterioration in their environment.

—Ralph Molnar
Queensland Museum

Feeling Crook

Feeling lousy is part and parcel of being ill. We want to sleep, our joints ache, we feel cold and feverish, we look terrible, and food and sex lose their appeal. Scientists have identified more than 60 diseases that produce the same array of symptoms, despite the fact that they infect different organs. As Robert M. Sapolsky, a neuroendocrinologist at Stanford University, explains these crummy symptoms are caused by the body's efforts to rid itself of an invading pathogen (*Discover* July 1990: 66–70). Central to this is the immune response, which involves a variety of cell types scattered throughout the body. To communicate with far-flung members, the immune system uses chemical messengers that travel in the bloodstream and lymph fluid. These include interferons and interleukins.

One of the interleukins, IL-1, influences the brain, affecting such things as temperature regulation and causing the hypothalamus to release a substance called corticotrophin-releasing factor (CRF). It is IL-1 that makes us sleepy and our joints ache by making neurons more excitable so that they are inclined to react to things they would normally ignore. CRF is best known for preparing the body for the 'fight or flight' reaction to stress. CRF blocks energy storage so that energy is diverted to the muscles and dampens appetite, the sexual drive and reproductive processes.

It seems that CRF is also needed to fight infection. As Sapolsky explains, a showdown with a virulent pathogen can require as much energy as a showdown with a rampaging rhino. To mount a defence against infection, the immune response requires a great deal of instant energy—cells must divide and migrate at a tremendous rate, cytokines (chemical messengers) and antibodies must be hurriedly synthesised and secreted—and CRF keeps the necessary fuel readily available. At the same time, sleepiness and aching muscles tend to curb our activities and conserve our energy while the expensive business of reproduction is inhibited until a more opportune time.

IL-1 also causes one of the most striking of flu symptoms: fever. It does this by raising the temperature at which you feel comfortable, so that at the normal basal temperature, 37°C, you will be feeling cold and various warming responses will be activated. This represents a big investment of energy. For example, in malarial fever, metabolism increases by almost 50 per cent with much of this energy expenditure going towards generating heat through shivering.

Running a fever, however, helps fight infection. As evidence, Sapolsky quotes experimental work by Matthew Kluge, from the University of Michigan Medical School, in which cold-blooded lizards that were infected by a bacterium chose to become feverish by moving to a warmed area of a terrarium where their basal temperature rose a few degrees. When lizards were prevented from going to the warmer area, Kluge found that they were less likely to survive the infection.

The immune system, it seems, works better when you are running a fever: T cells multiply more readily and antibody production is stepped up. Also, many viruses and bacteria multiply most efficiently below 37°C: when fever is induced their doubling time slows and, in some cases, pathogens stop dividing entirely. (But not all bugs are inhibited by heat, and too high a fever will damage you along with the bug.) Sapolsky concludes that the observations suggest that fever-reducing drugs such as aspirin may not always be such a good idea, and perhaps the best remedy for the flu may simply be to endure feeling crook.

—S.H.

CARL BENTO/AUSTRALIAN MUSEUM

Why do you always get that same crummy feeling when you're sick?

COURTESY GREENPEACE

The use of explosives in the tuna-fishing industry is likely to affect the hearing and echolocation of dolphins.

Seal-bombing Dolphins

Explosives used by the tuna purse-seine fishery in the eastern tropical Pacific could be causing widespread deafness, disorientation and stress problems among dolphins. The mammals are subjected to the explosives during a technique known as 'setting on dolphins'.

Large Yellowfin Tuna (*Neothunnus macropterus*) and dolphins form mixed schools, which makes it convenient for fishermen to net their tuna catch by locating and herding dolphins. When bombarded with explosives (often of a type known as 'seal bombs' because they were originally designed to keep seals away from fishing operations) the dolphins become confused, slow down and form protective schools on the surface. The fishermen then set their purse-seines, drawing them around the dolphins and associated tuna schools. More bombs are dropped at the open side of the net as the two ends are drawn together to discourage the escape of dolphins and tuna.

It is well documented that many dolphins drown from fatigue or injuries sustained during this procedure. However, what is not fully understood but concerns researchers and conservationists is the likelihood that the close-range detonation of explosives causes temporary or permanent hearing loss in those dolphins that survive the physical stress of the nets. Because of the reliance by these animals on echolocation and hearing for communication, social interactions, navigation and foraging, the ramifications for an afflicted dolphin could be potentially fatal.

In April 1990 the US Congress introduced a ban on the use of explosives on US tuna fishing vessels, coinciding with a decision by three of the country's major tuna canners not to buy any tuna caught by the method of setting nets on dolphins. However, explosives and the setting on dolphins technique are still being used in the eastern tropical Pacific by vessels from the fleets of other countries including Mexico, Venezuela and Panama. And it is noteworthy that a number of US tuna fishing vessels have, since the April 1990 legislation, changed their country of registration to Mexico.

—K.McG.

MIKE GRAY

Going, Going, Gone

Spider wasps of the families Pompilidae and Sphecidae feed on a genteel diet of nectar, fruits and honeydew, but their larvae insist on meat. To satisfy this demand the female wasps hunt, sting and paralyse spiders (sometimes after spectacular battles) to provision burrows or clay cells for their carnivorous offspring. After provisioning, the female lays a single egg within each nest and seals it. Within these secure confines the wasp larva hatches and immediately begins the voracious consumption of its live but helpless spider companion(s).

From a spider's viewpoint pompilid wasps could be termed Public Enemy No. 1, spiders being their only prey. They are remorseless hunters, pursuing their victims into crevices and silk retreat tubes. Some are powerful insects (up to 35 millimetres long) that are capable of attacking large spiders, like wolf, huntsman and trapdoor spiders. Such pompilids need only one spider to stock each nest. This is usually a previously excavated soil burrow to which the prey must be dragged some distance overland, the wasp navigating by brief reconnaissance flights. These wasps bite off the legs of larger spiders so that they are easier to carry. One pompilid even attacks funnel-web spiders but, as with trapdoor spiders, these large, burrowing spiders are not dragged off. They are simply left paralysed within their own burrows, each accompanied by a single wasp egg.

By contrast, the generally smaller sphecid wasps hunt insects as well as spiders. The spider-hunting species favour smaller prey, especially small orb weavers, jumping spiders and flower spiders. These may be flown or dragged to the nest site. Most of these wasps build contiguous clay cells ('mud daubers'), each packed with several paralysed spiders plus a single wasp egg.

A less pampered life is led by the larvae of the Red Collared Wasp (*Platyderes collaris*). This robust pompilid wasp chases and grapples with large spiders, like the *Olios* huntsman spider pictured. It inserts its stiletto-like sting until the spider collapses, but this time the paralysis is only light and soon wears off. Meanwhile, the wasp lays an egg on the front of the spider's abdomen near the waist. In this position the spider's legs cannot brush off the tiny larva when it hatches and begins biting into its host's cuticle. Soon recovered, the spider continues its usual life, seemingly oblivious to the little maggot-like larva chewing a hole in its back. However, as the larva grows, gorging itself on abdominal tissues and blood, the spider rapidly becomes more and more debilitated. The photographs were taken when the parasitised but still active spider was first observed, then 24 hours later when the spider already appeared to be dead, and after 36 and 72 hours, by which time the spider had been devoured and the engorged larva started spinning its cocoon. The wasp emerged from its golden pupal case 34 days later. This particular specimen, however, did not survive to terrorise another generation of spiders and now resides on a pin in the Museum's insect collection.

— Mike Gray
Australian Museum

An *Olios* huntsman spider was parasitised and slowly devoured over a 72-hour period by the larva of a Red Collared Wasp. In the last frame the adult wasp is shown emerging from its cocoon.

Hot Sex for the Voodoo Lily

Sex in plants isn't always the passive and uninspiring event it seems. In some plants reproduction has evolved into what could almost be described as an elaborate act of passion during which the temperatures in the flowers soar. The generation of heat during blooming has been reported in a wide variety of plants including palms, water lilies, cycads and aroids (arum family), to which the voodoo lily belongs. The heat serves to volatise compounds produced in the blooms, which are then broadcast as putrid odours attractive to would-be insect pollinators.

Experiments in the 1930s identified the natural trigger of heat production in these plants as calorigen. However, much more recently Ilya Raskin and colleagues from Du Pont in Britain purified calorigen from the Voodoo Lily (*Sauromatum guttatum*) and identified it as salicylic acid—the active ingredient in aspirin (*Proc. Natl Acad. Sci. USA* 86: 2214–2218; 1989). Their work has also revealed the reproductive act in the Voodoo Lily to be even more elaborate than previously thought.

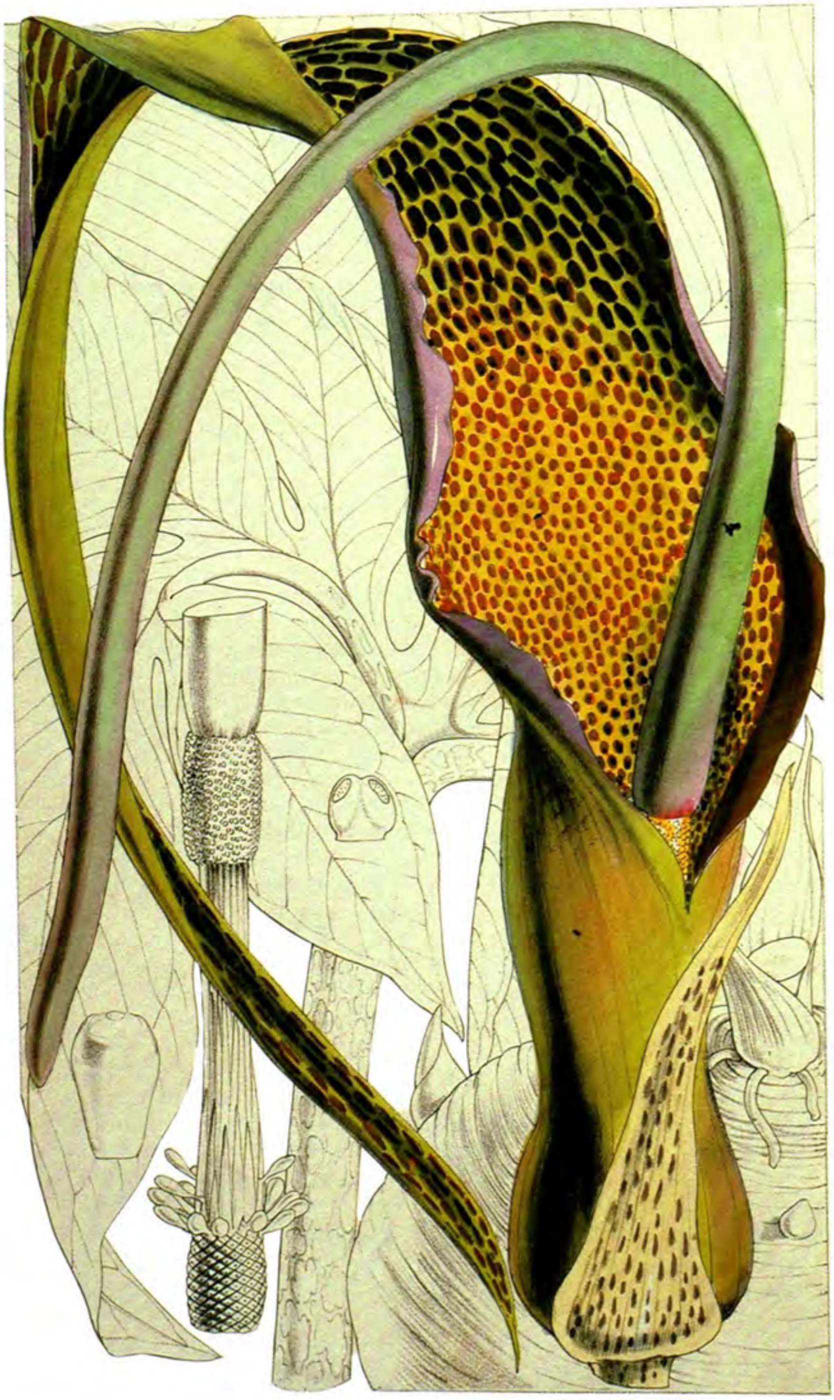
The flower of the Voodoo Lily is a seductive lure of masterful design. A long, thin central column (the spadix) is concealed within a sheath called the spathe. The floral chamber is formed by the base of the spathe and surrounds the lower end of the spadix. A ring of female flowers and club-shaped organs are located at the base of the chamber. And perched between the only entrance to the chamber and the female flowers are the male flowers.

Blooming involves two heating events. The first, and most spectacular, is the heating of the upper spadix (or appendix). On the afternoon of the day before blooming there is a dramatic, almost 100-fold rise in salicylic acid along the length of this organ. Blooming begins as the first glimpses of morning light appear with the spathe unfolding to expose the appendix. Between three and four hours later heat production peaks (at more than 12 degrees above ambient temperature) as the appendix undergoes a salicylic acid-triggered metabolic explosion. The stench of volatised compounds lures potential pollinators to the bloom and the floral chamber. They become physically trapped by nature's clever design of slippery concave walls and the hedge of club-shaped organs.

During the following night a second heating episode begins in the centre of the floral chamber. This lasts about 14 hours, twice as long as the first episode, with temperature peaking at more than ten degrees above ambient.

A sweet odour produced by the club-shaped organs during this second phase is thought to increase mating activity among the trapped insects. At the peak of this second heating, pollen is showered down from the male flowers onto the excited pollinators. Now the whole flower begins to die and shrivel, releasing the insects to cross-pollinate with other flowers.

—K.McG.



Sex in the Voodoo Lily is characterised by two heating events.

WALTER HOOD FITCH

FROM THE ARCHIVES

"Documentation photography is like insurance: expensive and possibly unnecessary until the day you need it."

A PHOTOGRAPH IN TIME...

BY RIC BOLZAN

PHOTOGRAPHY SECTION, AUSTRALIAN MUSEUM

"DURING THE EARLY YEARS OF THE camera, everyone had a private idea of its usefulness." So wrote Gail Buckland in her book *First photographs* to describe a seven-and-a-half-pound potato photographed in the 1850s, presumably to confirm its existence for the record. Something as apparently straightforward as a documentation photograph is considered useful or useless depending on whether it satisfies the needs of the viewer.

The Australian Museum has been collecting, documenting, and storing items of scientific interest for over 150 years, and photographing some of those for just over the last 120 years. These photos were taken firstly using the collodion wet plate process from the 1850s, then the silver gelatine dry plate process from the 1880s and finally flexible film from the turn of the century. Thus the Australian Museum not only has some of the earliest scientific photographs taken in the world, they also form part of a continuous photographic record of the investigation of the natural environment and indigenous peoples of this region. The early collection contains about 10,000 glass plate negatives with images as diverse as manta rays, animal habitats, plant fossils, starfish, thylacine skeletons, archaeological specimens, ethnographic artefacts and Aboriginal people.

The collection, however, is not static. The Photography Section is still involved in the documentation of material gathered for research, display and publication. One constant challenge for museum photographers has been what to document and to what degree. During the period of the collodion process, each glass plate had to be coated, exposed and then processed before the emulsion dried. Hence a photograph was not made without some careful consideration of its usefulness. The emulsion consisted of guncotton dissolved in ether, containing potassium iodide, and sensitised on the spot with silver nitrate. They are identifiable by a creamy-brown colour, and usually an uneven emulsion coating. Today the equipment and materials are less expensive and easier to use, but the demands for both quality and quantity are higher.

CHARLES CLUTTON/AUSTRALIAN MUSEUM PHOTOGRAPHIC ARCHIVES

The original documentation photograph of a feathered back ornament, which was part of a ceremonial costume used by the Marind-Anim people in the *Dema Goes* ('ghost of the crab' ceremony). It was taken in 1916 by Charles Clutton and has since been used as a guide to its conservation and reconstruction.

This raises the issue of the value of documentation photography, and the reasons for maintaining those photographic records. Will the photograph ever be used, and if so, when and how? The attitude taken at the Australian Museum is that documentation photography is like insurance. Expensive and possibly unnecessary until the day you need it. It was for this reason that a project was undertaken in 1985 to photograph fragile items from the Museum's Pacific anthropology collection prior to transfer into a newly constructed and higher quality storage area.

During the photography of these fragile items an intriguing mystery emerged. About 50 objects originating from the Marind-Anim people of Irian Jaya were recorded as six ceremonial costumes. They shared the same few registration numbers, but didn't seem to fit together. A conservation project was being planned by the Anthropology and Materials Conservation Departments at the time, so it was decided to conserve these objects and unravel the mystery. This was not only because of their fragility, but also their cultural importance, having been used in an 'angai' (feast), and being representative of Marind-Anim material culture. The Marind-Anim people have lost much of their cultural heritage through contact with European missions and government. According to Walker and Mansoben (1990), "The loss of ritual and ceremonial life and the breakdown in the traditional belief system has left these people somewhat dispirited and directionless".

The larger pieces were constructed from sago spathe, covered in ochre, decorated with seeds (Giddy Giddy and Jobs Tears), and held together with fibre and sticks. Smaller pieces were made with sticks, cut feathers and bits of wood and looked like some kind of dart. Under close examination all the pieces showed signs of repair with the same materials, indicating that they had been used a number of times for ceremonies and were prone to disintegration under normal conditions of use and storage.

The obvious questions were asked as to why they were no longer complete. Had some larger objects fallen apart as a result of poor storage or were they separated for ease of storage? Was there some error in registration in the past? What did the original objects look like?

The search was on. Written records showed that in July 1915 W.W. Thorpe,

RIC BOLZAN/AUSTRALIAN MUSEUM

A recent colour documentation photograph of a portion of the same Marind-Anim feathered back ornament shown in the black-and-white photograph, taken during the conservation project.

RIC BOLZAN/AUSTRALIAN MUSEUM

Detail shot showing the seeds and ochre that form part of the decoration of this and other ceremonial costumes made by Marind-Anim people early this century.

the Museum's ethnologist, had asked Mr L. Berkhout, Assistant Resident at Merauke, south-eastern New Guinea, if he could collect any 'ethnographica' from that area for the Australian Museum. In reply, the Museum received from Berkhout a letter and three cases of material in October 1916. Berkhout stated "The ethnographica is gathered from some feasts of the 'Marindanim' (the people that live on the coast between the Bensbach River and the Marianna Street...) at Wendoe, Dutch South New Guinea." In exchange he requested that the Museum send him "...a collection of poststamps from Australia, New Seeland, Papua New Caledonia and other Colonies, for I am collecting stamps...". Thorpe replied, undertaking to send a collection "...in due course", and requested more information about the use of the objects. However there are no records of any further correspondence and thus limited information about the objects, how they were used, their significance or whether Berkhout received his stamps.

The search provided some information, but the project was hampered by a lack of visual information about the original appearance of the costumes. Finally four glass plate negatives were found in the photographic archives, made in 1916 when the objects were acquired, and new prints were made. These prints showed how the parts of the costumes were assembled, their original condition and made it possible to determine how much deterioration had occurred. Thus, due to a decision to photograph some of those objects and keep the negatives, a more accurate reconstruction and conservation was possible 75 years later. In the case of the Marind-Anim ceremonial items this early decision to take documentation photographs was most fortunate indeed.

But does the photograph only serve that purpose? A conservator is interested in the physical construction of an object, an anthropologist in its design and context, and a photographer in the total appearance of the image. Incidental or peripheral details may contain indicators about the culture or practices of the time the photograph was taken. For example, how many portraits taken in the last century are now more interesting for the clothing fashion, or details of vehicles or buildings in the background, than the identity of the subject? It can also reveal information about the photographic process. In the plate reproduced here, it is possible to deduce from the weatherboards in the background and the diffused but direct lighting that the photograph was taken outdoors on an overcast day using daylight rather than studio lighting. But to the original photographer the object itself was the aim of the photograph and the background was irrelevant or incidental. That principle is still the same for all Australian Museum photography, however with the availability of more 'dedicated' equipment, it's possible to produce negatives in which all non-essential information is excluded. But by doing this we are now eliminating evidence about the photographic process and possible clues for future pictorial analysis.

There have been many changes to the Australian Museum collections over the years, in attitudes, priorities, resources and documentation methods, as well as the condition of those objects within them. The Museum is no longer seen as just a repository for curiosities, collected for their own sake, but a resource for information and understanding. Research and the maintenance and improvement of the collections are central to that aim. ■

Suggested Reading

Van Bal, J., with collaboration of Verschueren, Father J., 1966. *Dema: description and analysis of Marind-Anim culture (South New Guinea).* The Hague: Hijhoff. K. Instituit voor Taal-, Land-, en Volkenkunde translation Series 9.

Walker, M. & Mansoben, J., 1990. Irian Jaya cultures: an overview. *Irian* 18: 1–10.

Mr Ric Bolzan is Manager of Photographic Services and the Archival Photographic Collection of the Australian Museum. The collection contains some of the earliest natural history photographs in the world and an excellent collection of ethnographic images.

"The destruction of Speaking Tube Cave has endangered the entire central Queensland population and shows how vulnerable cave-dwelling bats really are."

THE GHOST BAT

BY SUE CHURCHILL

CONSERVATION COMMISSION OF THE NORTHERN TERRITORY

THE GHOST BAT (*MACRODERMA GIGAS*) is one of Australia's most unusual bats. It differs from all other echolocating bats (as distinct from fruitbats) in its large size, pale fur and carnivorous diet. Its facial characteristics combine very large ears, long noseleaf and unusually large eyes, allowing Ghost Bats a variety of hunting techniques. They either hunt on the wing, like other bats, using echolocation, or find prey by passive listening from a perch. Once the prey is located they swoop down for the kill, guided by hearing and eyesight alone, in much the same way as an owl.

The Ghost Bat's diet includes a variety of large insects and vertebrates, including frogs, lizards, small mammals, bats and birds. They return to a perch to eat their meal, either in trees or sometimes in small open caves. Beneath these feeding roosts accumulate mounds of dung and discarded prey parts, such as wings or legs, providing ample evidence of their preferred prey. Some of these can be quite large items, belonging to animals such as rats, Peewees and bronze-winged pigeons, and weighing almost as much as the bats themselves.

Ghost Bats once occurred throughout mainland Australia, with fossil and subfossil material found in New South Wales, South Australia and Western Australia. Indeed there is some evidence that Ghost Bats lived in the Flinders Ranges of South Australia up until the time of European settlement, although no specimens or records of live Ghost Bats have been collected from that area. It appears that the Ghost Bat's range has been steadily declining ever since.

In central Australia there are several records of colonies found around the turn of the century, but even at that time the populations were small and declining. In 1983 I spent several months searching the hills and ranges of central Northern Territory, Western Australia and South Australia looking for evidence of Ghost Bats. Conversations with local Aboriginal people indicated that Ghost Bats still occurred in the area but it was only the old men who knew of them. The Ghost Bat, until about 50 years ago, had played an important role in 'man-making' ceremonies and all the known Ghost Bat caves were regarded as sacred sites.

I was fortunate enough to be taken to several of these caves and, although appearing small and unsuitable, they all contained signs of Ghost Bat occupation in the form of old dung mounds. The Ghost Bats, however, were long gone. Evidence of large colonies of Ghost Bats can be seen in some of the caves around the base of Uluru with thick stratified layers of old dung covering the floor.

The scarcity of suitable roosts in central Australia indicates that the populations would have always been low, but we have not been able to determine the reasons for their complete decline. This decline coincides with that observed for many other mammal species in the area.

Further north the populations are still strong. During the last few years I have conducted a survey of cave bats in the Top End of the Northern Territory. Ghost Bats appear to be widespread and relatively common, occurring in a quarter of all caves examined. This data is encouraging as it implies that the species is 'safe' in the Top End. However, as we do not know what has caused the decline in central Australia, it is equally difficult to know if the trend is continuing.

The populations of Ghost Bats in Queensland are not as encouraging. The destruction of Speaking Tube Cave in 1988 at Mt Etna in central Queensland by the Queensland Cement Company has endangered the entire central Queensland population and shows how vulnerable cave-dwelling bats really are. The status of populations in the Pilbara and Kimberley regions of Western Australia are largely unknown. Brief surveys show they are certainly not as common as they are in the Top End.

The overall status of the Ghost Bat is currently under debate and is referred to as 'vulnerable'. At present it is not considered 'endangered' due to the large populations in the Top End. These categories, however, can change rapidly. At the moment the reopening of an old gold mine in Pine Creek is threatening the largest known colony. The destruction of this one site will reduce the Top End population by almost a half. And, if this was to happen, we may well have to change its 'vulnerable' status to that of 'endangered'. ■

Ghost Bats.

COURTESY TARONGA ZOO

Suggested Reading

Churchill, S.K. & Helman, P.M., 1990. Distribution of the Ghost Bat, *Macroderma gigas*, (Chiroptera: Megadermatidae) in central and South Australia. *Aust. Mammal.* 13: 149–156.

Molnar, R.E., Hall, L.S. & Mahoney, J.H., 1984. New fossil localities for *Macroderma* Miller, 1906 (Chiroptera: Megadermatidae) in New South Wales and its past and present distribution in Australia. *Aust. Mammal.* 7: 63–73.

Kulzer, E., Nelson, J.E., McKean, J.L. & Moehres, F.P., 1984. Prey catching behaviour and echolocation in the Australian Ghost Bat, *Macroderma gigas* (Microchiroptera: Megadermatidae). *Aust. Mammal.* 7: 37–50.

Sue Churchill has been working as a consultant zoologist for the Conservation Commission of the Northern Territory. Her research deals primarily with distribution and cave use of Australia's tropical bats.

NAVIGATING BY THE SUN, MOON AND STARS, EVERY NOW AND THEN THE HUMPBACK WHALE'S JOURNEY ENDS IN DISASTER WHEN IT BECOMES STRANDED IN SHALLOW WATER.

Excuse me, do you have a bucket?

DETERMINED TO DO EVERYTHING POSSIBLE TO SAVE OUR RARE, REMAINING WHALES, ONE OF THE NATIONAL PARKS & WILDLIFE FOUNDATION'S SPECIAL PROJECTS OF 1991 IS A WHALE STRANDING KIT FOR COASTAL USE.

The Foundation is an independent, non-government body working closely with the National Parks & Wildlife Service (that manages and maintains the Parks) to fund special projects, such as the Whale Stranding Kit.

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For 20 years the Foundation has been working quietly to preserve some of the best features of our natural heritage, putting money towards National Parks, endangered species, historic sites and facilities for Park visitors. Each year nearly one million dollars is raised for special projects through individual supporters, corporate sponsorship and donations.

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I want to help save the whales with a donation to the Whale Stranding Kit. I understand that my donation is fully tax deductible. ☐ $ ________

Please accept my cheque/money order enclosed, or debit my Bankcard/Mastercard No. ____________________

Expiry date ___ / ___ / ___ Cardholder's name ____________________ Signature ____________

Address ____________________________________ Postcode ________

National Park entry permits correspond with both the financial year (July 1 to June 30) and calendar year (January 1 to December 31). Subscriptions paid after May 1 and October 31 will join the succeeding entry permit full year.

Please return this form to:
The Chief Executive, National Parks & Wildlife Foundation of NSW
GPO Box 2666, Sydney NSW 2001 telephone (02) 247 7971

W I L D   F O O D S

"This technique resembles the white man's way of killing fish by dynamiting pools, and Derris *on Dunk Island became known as 'wild dynamite'."*

POISONING FISH

BY TIM LOW

NATURE WRITER

Mullet and Garfish were caught by Aborigines in central Queensland using Quinine Berries (and an unknown plant). These very bitter berries were also used by bushmen to treat fevers.

LAST YEAR I WENT TO INDIA AND STAYED two weeks at Mudumalai Wildlife Sanctuary in the mountains south of Mysore. I was walking along the river bank one day, keeping an eye out for elephants, when I came upon a man and two women at work in the shallows. They were wading about in muddy pools formed in the eroded rock, hunched over intently, gathering up small shiny objects. As I got closer I realised these objects were dead fish. The women's sarees, folded at their backs to make deep pouches, held at least a kilogram of fish each, and the man's bag contained a similar amount. From my reading of Aboriginal hunting techniques, I knew these people had used a fish poison.

In the early literature on Aborigines there are many accounts of Aborigines throwing pounded plants into pools to intoxicate or kill fish, which were then gathered up, cooked and eaten. E.J. Banfield, for example, author of *Confessions of a beachcomber*, told in 1909 of Dunk Island Aborigines using the creeper *Derris trifoliata*: "The Aborigines tear up the plant branches, leaves, flowers and all, coarsely bundle them together, and, wading into an enclosed pool where fish are observed, beat the mass (after dipping it into the water, and while held in the left hand) with a nulla-nulla. The action is repeated until the bark and leaves are macerated, and then the bundle is thrown into the pool. In a few minutes the fish rise to the surface gasping and making extraordinary efforts to get out of the infected water. Death ensues rapidly, but the fish are quite wholesome as food."

A haul of small fish gathered from the muddy pools at Mudumalai after the poison was applied.

This technique resembles the white man's way of killing fish by dynamiting pools, and *Derris* on Dunk Island became known as 'wild dynamite'.

Other accounts of fish poisoning were given by northern Queensland ethnographer Walter Roth in 1901, by R. Hamlyn-Harris of the Queensland Museum and Frank Smith in 1916, by Sydney ethnobotanist Joseph Maiden in 1917, and more recently in 1985 by Jeremy Russell-Smith working in Arnhem Land. Described were a range of techniques employing the pounded fruits, leaves, bark or roots of more than 30 different herbs, vines, shrubs and trees, including Water Pepper (*Polygonum hydropiper*), Quinine Berry (*Petalostigma pubescens*), Tape Vine (*Stephania japonica*), Coolibah (*Eucalyptus microtheca*) and various acacias (*Acacia* species). These poisons appear to have been most widely used in northern Queensland but were unknown in

The bark of the Cocky Apple (*Planchonia careya*) was widely used as a fish poison in northern Queensland. According to Banfield it was "an effective narcotic".

PHOTOS BY TIM LOW

Tape Vine was a fish poison of Aborigines near Nerang in southern Queensland. Lengths of the beaten stems thrown into waterholes or rock pools were said to act very quickly.

Tasmania, and central and South Australia.

Hamlyn-Harris and Smith tested many of these poisons against captive fish and found marked differences in potency. Some plants did not seem to work at all, while others were effective in concentrations as low as 1:10,000. The active constituents appeared to be either alkaloids, saponins, or the less effective tannins.

The fish poison used at Mudumalai, according to local biologists, is the green fruit of a local shrub *Randia dumentosa*. I sought out this plant and found that its crushed seeds had a very soapy feel, indicating the presence of saponins. When thrown into a small confined pool, the crushed seeds strongly repelled small fish. Saponins were also the active constituent in the Foam-bark Tree (*Jagera pseudorhus*) and the vine *Faradaya splendida*, two very powerful fish poisons used by Queensland Aborigines.

Most descriptions of fish poisoning in Australia are cursory or anecdotal, and important details remain unrecorded. While it is clear that both salt- and freshwater fish were poisoned, it is uncertain whether fish could be poisoned in open stretches of water, or only in small confined pools. At Mudumalai I noted that the fish poisoners had very carefully blocked off the pools where they worked. At the upstream end a well-built wall of rocks reinforced with earth sods were stilling the flow of water, while the downstream exit channels had been blocked with rocks and stems of nearby plants (*Polygonum* and *Ludwigia* species). The enclosed area of pools and channels was about 20 metres wide, 25 metres long, and averaged about half a metre in depth. A short way upstream I found an earlier poisoning site of a similar length but only four to six metres in width.

The fish poisoners at Mudumalai are tribal people of the Kurumbas tribe. They are thought to be descendants of early hunter-gatherers who settled in India thousands of years ago. Even today their farming skills are limited, although they are very adept at the trapping and training of elephants for local forestry work. They still depend on the forest for their needs, gathering wild honey, catching fish (with small lines and hand-held nets as well as poisons), and even scavenging meat from the kills of Tigers. Their fish poisoning skills probably date back thousands of years, and may give us an insight into the methods deployed by Australia's Aborigines, among whom the practice is largely forgotten. ■

Suggested Reading

Banfield, E.J., 1909. Blacks as fishermen. *Qld Geog. J.* 24: 43–62.

Hamlyn-Harris, R. & Smith, I., 1916. On fish poisoning and poisons employed among the Aborigines of Queensland. *Mem. Qld Mus.* 5: 1–22.

Maiden, J.H., 1917. Fish-poisons of the Australian Aborigines. In *The forest flora of New South Wales*. Vol. VI. Government Printer: Sydney.

Russell-Smith, J., 1985. Studies in the jungle: people, fire and monsoon forest. Pp. 241–267 in *Archaeological research in Kakadu National Park*, ed. by R. Jones. Aust. Natl Pks & Wildl. Serv. Spec. Publ. No. 13.

Tim Low, a nature writer living in Brisbane, is the author of four books about plants, the most recent being Bush tucker *and* Bush medicine.

"Henderson-Sellers sees the greenhouse warning as, in a way, good news, because it has focused world attention on an urgent spring-clean that was long overdue."

A WARM WARNING

BY ROBYN WILLIAMS

ABC RADIO SCIENCE SHOW

HER MISLEADING TITLE IS PROFESSOR OF Physical Geography (Macquarie University) but she is, in fact, a mathematician. After she arrived in Australia from England three years ago, more than one person described her to me as 'formidable'; yet she is also a collector of keepsakes from Winnie the Pooh, with the world's largest library of Pooh books written in over 20 different languages! Whatever the confusions, Ann Henderson-Sellers is just the sort of scientist we need in the '90s: an expert on changing climate.

She was born in Sheffield on 7 March 1952 and, despite attendance at the Universities of Bristol and Leicester, retains that Yorkshire forthrightness that comes in so handy when arguing about the significance of greenhouse. Having shown a startling propensity for doing sums when young, she naturally concentrated on maths and physics at school and for her first degree. But then came the worry: "where is all this leading?" She didn't fancy being locked up in a cold cell with pencil and pad, or even a flash computer. She preferred being out in the world, preferably with an eye on the sky—she is a keen astronomer. So what better than climatology?

She was just in time for the greenhouse debate. She became deeply embroiled in it almost as soon as she set foot in Australia. Her book *The greenhouse effect: living in a warmer Australia* (1989), written with Macquarie University colleague Russell Blong, came out after she'd been living here barely a year. It is a clear guide for the non-expert, a handy summary of the facts. Throughout, the emphasis is on the complexity of climate, the extraordinary interplay of cloud, wind, sun, ocean currents, volcanoes and, indeed, ourselves and our wastes.

About the human factor she has no illusions. "The rate of buildup of greenhouse gases in the atmosphere is now accelerating so fast it can be confidently estimated that by about AD 2030 mankind will have added sufficient quantities of them to cause a climatic disturbance equivalent to an effective doubling of CO_2 alone over its pre-industrial level."

Of course, policy-makers are wary, especially in government, of making commitments three years ahead, let alone 50. So Henderson-Sellers asks "When will we be certain that mankind's pollution is having a global-scale effect so as to cause climatic change?"

The word "certain" bothers her as a scientist. They don't go in for concepts like certainty. "I was expecting demands of high levels of confidence from the scientists in the same way as I imagine most of us would want to be pretty near certain, say 90% sure, that our bank is in a sound financial state. I was startled to discover that the vast majority ask for only 50% confidence from the scientific community before political action should be taken about greenhouse."

This conclusion came as a result of a survey she did in conjunction with the Greenhouse 88 campaign organised by the Commission for the Future. So there is the conflict: between the caution of the professional scientist and the politician, always wanting to refine data and avoid uncomfortable haste, and on the other hand, the citizen and activist, who finds that a 50 per cent chance of oblivion is far too much to tolerate.

Henderson-Sellers recognises that the social decisions are a matter of value judgment and properly so. "By the time we scientists are all absolutely certain it will be much too late to avert most of the changes that mankind is currently facing." Therefore, we must act immediately. Henderson-Sellers sees the greenhouse warning as, in a way, good news, because it has focused world attention on an urgent spring-clean that was long overdue. She is also impatient with media ping-pong about whether greenhouse alarms are suddenly void because new information has come along. She sees such news stories as inevitable and annoying, a product of the newspapers' desire always to dredge up some new angle, preferably in contradiction to the last.

Meanwhile, she surges ahead with her research. It is various: numerical modelling and monitoring at a global scale of atmosphere, hydrosphere, cryosphere, land surfaces and biosphere; and studying clouds by means of satellites. She is also a principal investigator in NASA's Earth Observing System project for the 1990s. Some of the land-surface studies take her to the prairies of Kansas where, as part of the World Meteorological/UNEP studies, they are examining the way the grasslands handle solar radiation and moisture.

It is fascinating to behold where a talent for doing sums can take a bright young woman these days. Not only to the crucial and most sensitive regions of scientific analysis, but to centre stage of political debate. The sky's the limit, no doubt about that. I only hope that Pooh, the bear with little brain, doesn't become forgotten in the process. ■

As Executive Producer of the ABC Radio Science Show, Robyn Williams has the opportunity to interview many interesting people in science.

Professor Ann Henderson-Sellers.

COURTESY MACQUARIE UNIVERSITY

You can learn a lot about the history of Macquarie Street just by looking at the pavement.

Macquarie Street's Sydney Hospital hasn't always enjoyed such an established and conservative title.

Last century, the site was occupied by a hospital which was named after the preferred liquor of the day, namely, Rum.

In 1810, three Sydney businessmen built the city a magnificent hospital in exchange for the coveted monopoly over the city's Rum trade.

This became the Rum Hospital, and stood complete until 1876, when the central block was demolished to build the present Sydney Hospital.

Further down the street you'll find the site where the Female School of Industry once stood.

In 1826, before anybody had even heard of 'Feminism,' the colony ran short of servants.

Accordingly, the ladies of the colony set up the Female School of Industry in order to teach their lesser sisters "every branch of household work." The site is more appropriately occupied now by the Mitchell Library.

The fact is, Macquarie Street is more than just another city street.

It is Sydney's, if not Australia's, most interesting thoroughfare.

In an effort to pay tribute to this, Caltex, in association with the NSW Public Works Department, has laid twenty commemorative footpath plaques along Macquarie Street, each marking a historical site.

So if you want to find out what Sydney was really like in the early days, look out for the Caltex Commemorative Plaques on your next stroll down Macquarie Street.

You could learn a lot simply by watching where you walk.

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CARL BENTO/AUSTRALIAN MUSEUM

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AUSTRALIA: OVERPOPULATED OR LAST FRONTIER?

BY TIM FLANNERY

MAMMAL SECTION, AUSTRALIAN MUSEUM

AUSTRALIA IS AN ENORMOUS LAND. AT 7.6 million square kilometres, it is nearly the size of the United States of America, yet it currently supports only 17 million people. Such simple figures and comparisons have long led economists and politicians to propose that Australia could become a southern giant, as dominant in our sphere of economic and political influence as our northern ally. But recently a new perspective on our future has been voiced. It is the view, propounded by many biologists and geographers, that Australia is a poor and already overpopulated land. Which view prevails will dictate the quality of life for all Australians in future. The purpose of this article is to examine these perspectives, and their planning and policy implications.

To biologists it is clear that Australia's capacity to support a human population of a given size depends largely on the productivity of its ecosystems. Economists argue that we can ignore such factors and sell our human resources (through manufacturing etc.) to buy food and whatever else we need. But, as I will explain later, this may not be an option in future. Furthermore, to assess Australia's carrying capacity for humans solely upon land area is wrong.

Is Australia already overpopulated?

GUNTHER DEICHMANN/AUSCAPE INTERNATIONAL

A.H. TOLHURST

Australia is unique in the extent it is influenced by the ENSO (El Nino–Southern Oscillation) cycle, hence the continent's extreme droughts and deluges.

AUSTRALIAN ECOSYSTEMS ARE VERY different to those of other regions. The most striking feature of almost the entire continent and its surrounding seas is its low biological productivity. The causes are very thin and infertile soils, and an erratic climate.

On a continent-wide scale Australia is unique in its geological stability. This means that no significant new soil is being created because there is no available source of raw materials. Large-scale mountain building (which leads to rock breakdown and thus soil formation) ceased long ago in Australia, and ash-producing volcanoes (another good source) are largely absent. What soils we have are generally thin because they have been stripped away and not replaced over the aeons, and they are leached of nutrients because they are so old. In a sense our soils are a 'fossil' resource as they are no longer being made in usable quantities.

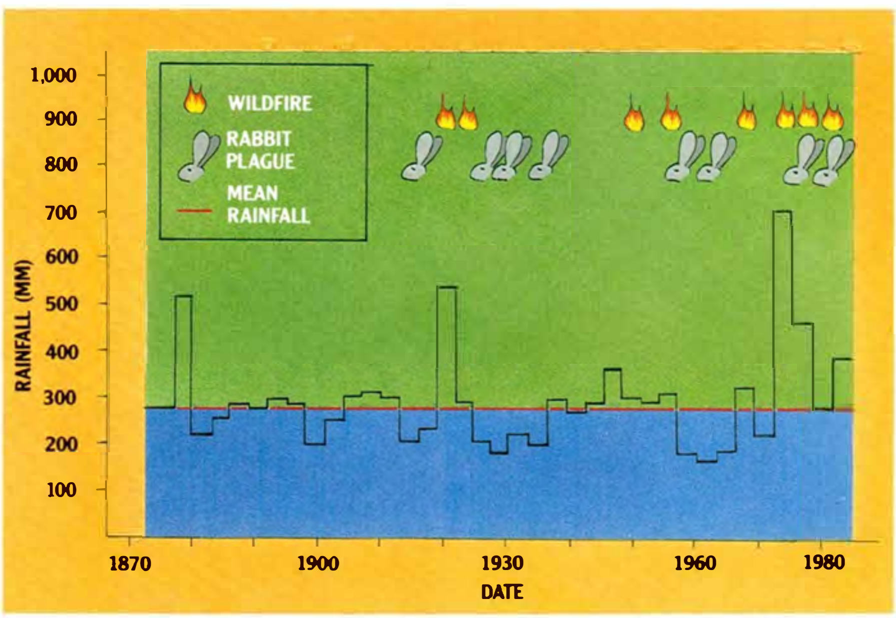
The Australian climate is also unique worldwide in the extent that it is influenced by the ENSO (El Nino–Southern Oscillation) cycle. The ENSO cycle results from changes in sea surface temperatures over the Pacific, and a single cycle is around ten years in duration. No other continent is so influenced by ENSO, which is responsible for Australia's extreme droughts and deluges. During El Nino years major droughts crucify our agricultural and pastoral industries. Then at another (shorter) part of the cycle Australia experiences rainfall much above the 'average' (in practical terms there is no average—it's either bucketing down or dry!), flooding major river systems and filling ephemeral lakes. This happens around once a decade, with much larger floods at greater intervals.

Innumerable biological phenomena reflect these aspects of our soil and climate. An everyday example comes from our gardens. Anyone who has tried to grow Australian native plants knows that an application of fertiliser is the kiss of death to many species. This is because over millions of years Australian plants have adapted to infertile soils. Many develop lignotubers that allow them to store scarce nutrients, others recycle nutrients in ways not seen in plants from elsewhere, and most simply grow slowly. Phosphate, that essential element for plant growth in agriculture, is toxic in 'normal' levels to many Australian natives. Phosphates also change the soil biology, allowing certain fungi to grow and insects to thrive. In our naturally poor soils these organisms, against which our plants have no defences, are held in check.

Also testimony to Australia's poor bioproductivity are our native animals. Reproductive rates of Australia's oldest native rodents (which arrived five million years ago) are far lower than those that arrived around two million years ago. But even these relative newcomers are slow breeders compared with the rats that arrived from overseas in 1788 (see table). This situation may have arisen because, over time, the rats have lowered their reproductive rates to match the low fertility of the environment. And low rates of reproduction are only part of a general biological slowdown. It is thought by some that this phenomenon may be part of the marsupials' secret of success in Australia. Marsupials have lower metabolic rates (that is, lower 'running costs') relative to placental mammals such as ourselves, and so may have a positive advantage over placentals which, because of their higher metabolic rates, demand more food and in more regular supply. No doubt the lack of large, warm-blooded carnivores in Australia (see "Mystery of the Meganesian Meat-eaters", ANH vol. 23, no. 9, 1991) is also due to low and erratic biological productivity.

Biologists are only now beginning to understand how all-pervasive the ENSO cycle has been in influencing life strategies in the Australian biota. Over most of Australia nesting among birds is truly aseasonal, being initiated by the onset of substantial rains. Many species are longlived but may not breed successfully for most of their lives. In a year when rainfall is high they can produce multiple broods in quick succession, and the young birds themselves mature very quickly and begin reproducing. Moreover, up to 30 per cent of Australian bird species are nomadic, wandering over the country in order to find locations where survival is possible.

It is also instructive to look at those Australians who have had the longest experience of surviving in Australia's unique conditions. Before European contact Aborigines lived in small, nomadic bands at far lower densities than Australians currently do. They never developed agriculture. This is not because they were 'primitive'; rather it is probably a deliberate adaption to Australia's extreme conditions. Under ENSO conditions one can never store enough food to outlast the long and frequent droughts. Furthermore, very few regions possess sufficiently fertile soil to even make the attempt worthwhile. The highlands of New Guinea provide striking proof that the lack of agriculture among Aborigines is not



Rainfall over much of Australia is highly irregular. Once every few decades great floods sweep over the inland, bringing a surge of vegetation growth, followed by rabbit plagues and fire. For the rest of the time, rainfall is minimal.

IAN FAULKNER

simply the result of isolation or culture. There, a genetically and technologically similar group of people, who were also long isolated, had developed agriculture by 10,000 years ago. Today some highland valleys support up to 1,614 people per square kilometre—the highest rural population density on Earth. These rare and privileged areas are an extraordinary contrast to the situation in Australia. Indeed, other supposedly 'primitive' aspects of Aboriginal culture may be adaptations worthy of our notice and possibly imitation. The hunter-gathering lifestyle is the only truly sustainable one that we know about. Agriculture, on the other hand, has an appalling long-term track record. The key to the success of hunter-gatherers is that they normally keep their population so low that they rarely exceed 20–30 per cent of the carrying capacity of their territory. They thus never normally damage their environment (an important exception, of course, is when people first invade a new land).

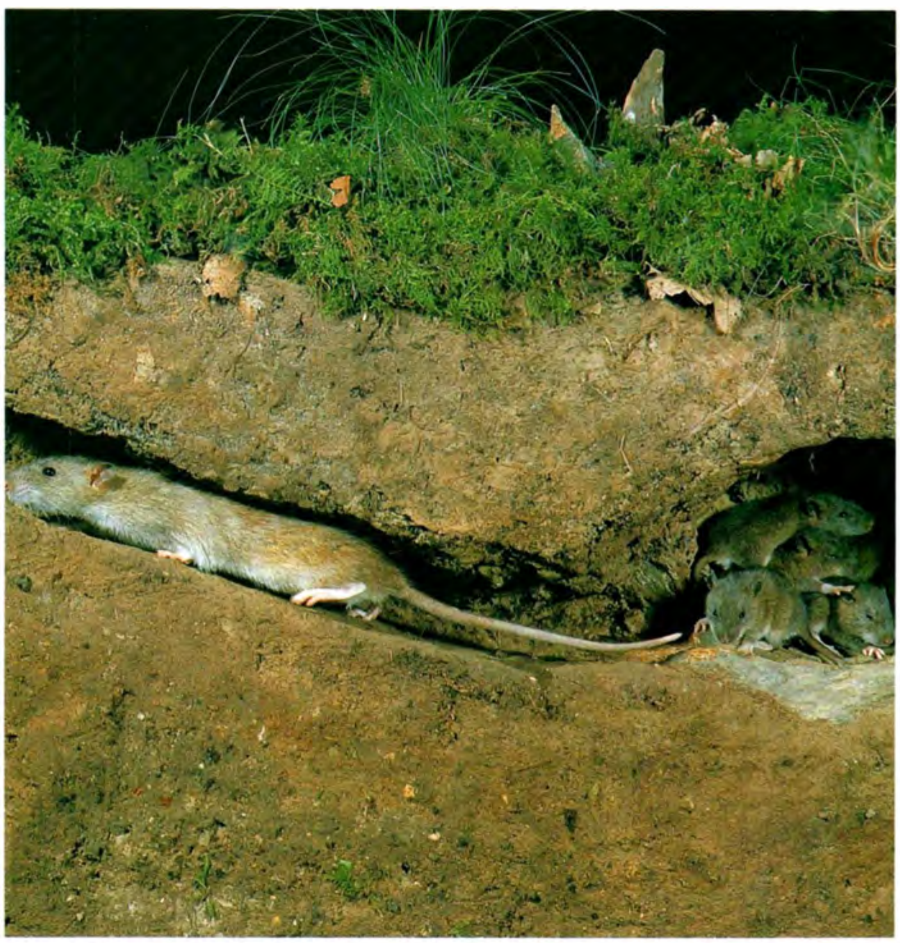
So there is ample evidence that Australia is an extraordinarily poor continent in terms of primary productivity. What does this mean for us 20th-century Australians? The quality and quantity of arable land is a basic determinant of human population. Estimates made in the 1960s based upon rainfall statistics suggested Australia had just under 125 million hectares of arable land. In 1976 Dr H. Nix of Canberra, using a more sophisticated and reliable method based on climate, soil and terrain data, came up with an estimate of only 77 million hectares. More recent information, based in part upon satellite imagery, suggests that the real figure (not as yet calculated) is even less. Around 22 million hectares (the best of our land) is currently used for agriculture. Already 70 per cent of this is degraded and in need of soil restoration programs. Much degraded land will have to be taken out of production if current intensive use continues. Even if it could be rehabilitated (an enormous task), Australian food exports stopped, and national parks, forest and urban sprawl over the 77 million hectares transformed to farmland, Nix estimates that Australia is capable of feeding only around 50 million people. This is a maximum population, but clearly not an optimum or desirable one. Given the realities of soil loss, and the desire to keep some national parks and forests on better soils, a more realistic population may be 20–30 million. If we take into account our erratic climate, the uncertainty of the figures and of restoring our degraded land to full productivity, and the difficulties of reversing population growth, we could quite rightly be more cautious. Perhaps the lesson of the hunter-gatherers (to keep population within 20–30 per cent of carrying capacity) is a wise one to follow. If we did so, then we should aim to stabilise Australia's population at 6–12 million in the long term.

Modern economics and technology adds a level of complexity to these basic biological constraints. For humans, impact on their environment results from the interplay of three factors: population, affluence (= demand + consumption) and technology. If the interplay of these three factors results in environmental degradation, then we can say that a region is overpopulated. To an extent, overpopulation in this sense can be remedied by technological change and lowered consumption (the technology and affluence parts of the interaction) but, if we make assumptions about future change in such areas, we create a hypothetical species—one that might exist *if only* we could change our habits. We must deal with people as they have acted in the past, and as they exist now, in order to make progress in determining future action.

There is no doubt that, since 1788, European population, affluence and technology have led to enormous environmental degradation. As has been documented in previous issues of ANH ("Plague in the Pacific", vol. 22, no. 1, 1989), much of Australia's fragile and low-productivity fisheries and agricultural lands have been degraded or destroyed. It is possible to argue that much of this environmental degradation has nothing to do with human overpopulation. However, this is wrong. Certainly much damage was done when Australia's population was around five million, but then the technology side of the equation (lack of erosion control, inappropriate stocking rates etc.) was contributing disproportionately to the problem. Also, much damage, particularly in fisheries and soil loss, can be

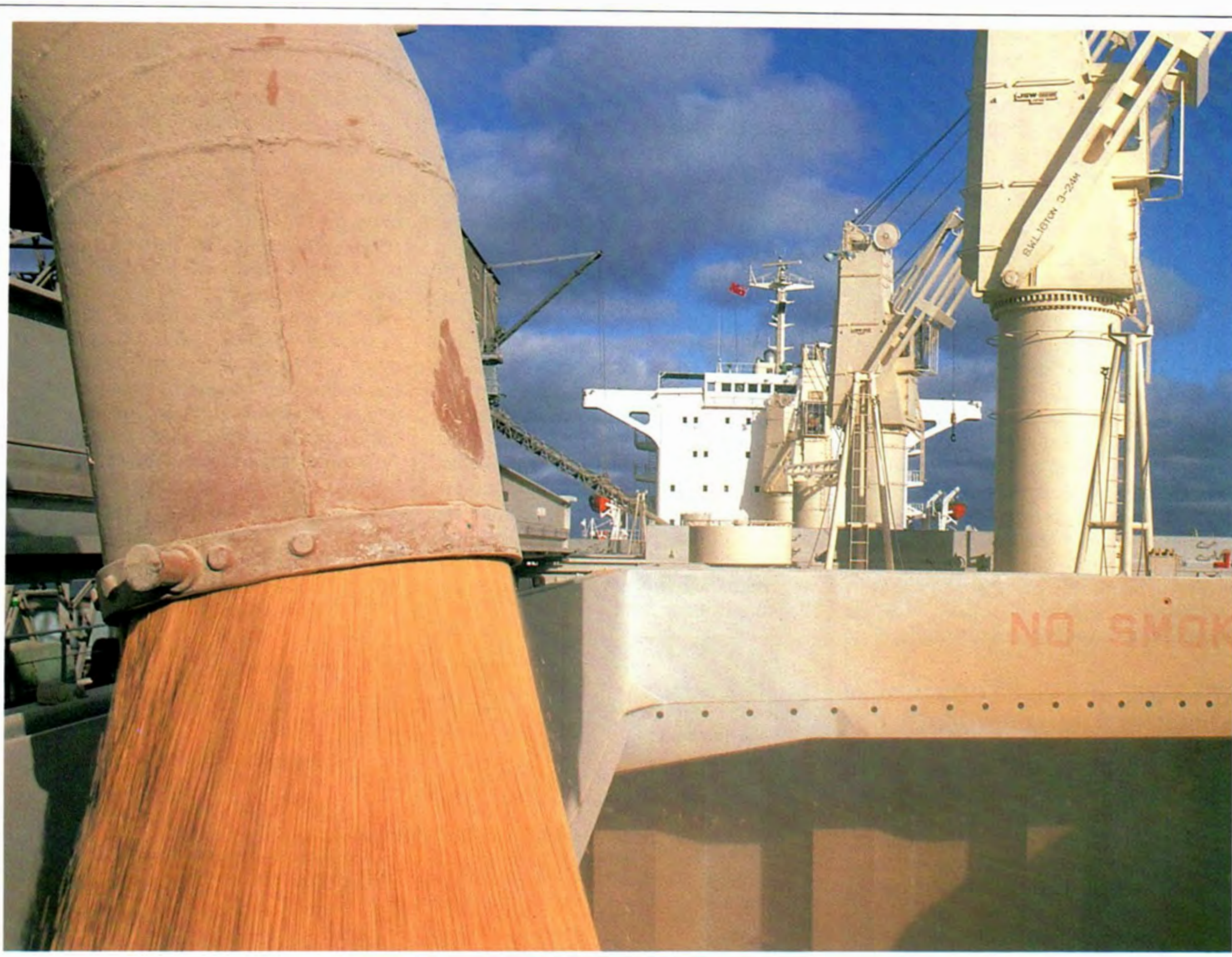
	litter size (av.)	litters/year (av.)	number after one year
old endemics	**2.5**	**1.5**	**2-5**
endemic *Rattus*	**4.5**	**2.5**	**9-25**
introduced *Rattus*	**8**	**6**	**hundreds**

Some reproductive data on Australian murids. The old endemics have been in Australia for around five million years, the endemic *Rattus* for one or two million years, and the introduced *Rattus* only since 1788. The slowdown in reproduction that correlates with length of time in Australia is probably an adaptation to Australia's low-productivity environment.



FERRERO-LABAT/AUSCAPE INTERNATIONAL

The introduced Black Rat (*Rattus rattus*) with its typically large litter.



GUY LAMOTHE/AUSCAPE INTERNATIONAL

Even if the population remains stable, Australia will find it difficult to boost its agricultural exports because of the erratic climate and poor-quality soils.

laid directly at the feet of overexploitation. Our resources were, and still are, simply being mined to support the unlimited growth of an affluent society.

Because we are part of a world economy, there are ways that we could continue to fuel such growth if we really wanted. We could sell our minerals, labour or tourism potential at an even faster rate in order to buy food for a population larger than 30 million. Many economists argue that Australia's population must reach a 'critical mass' so that our manufacturing industry has a sufficiently large domestic market to be competitive. Defence experts also argue for a larger population for defence reasons. A quick look at the state of the world, however, suggests that building Australia's population beyond our land's carrying capacity would be very foolish. Australia is one of only half a dozen reliable food-exporting regions worldwide. Presently world population stands at 5.3 billion, increasing at a rate of nearly 100 million people per year. At the same time our soils, forests and oceans are all rapidly being exhausted. Any nation that counts on buying products such as food very far into the next century is extremely foolish, for the procurement of the most simple needs will become a major problem for many nations within a short time if current trends continue. The loss of Australia as a gross food exporter would only hasten the situation.

So what are the implications of continued population growth, or a population reduction, for Australia? At the current rate of growth (which is the fastest in the Western world) Australia's population will continue to grow indefinitely. It will reach 26 million by 2030, the bulk of whom will inhabit cities of six or more million people. Amenities will of course become more and more squeezed. On the resource side, the need to increase national income will become paramount. It will not be difficult to find reasons to pillage the last of our renewable resources to solve an immediate problem. Environmentalists who oppose such moves will be easy to discredit. Indeed, I very much fear that this trend has already started, with the recently passed 'resource guarantee' legislation. Ultimately, of course, continued growth has no future. But the point at which it ceases determines the wealth available for a given population from then on.

And what of the option of ceasing growth now? Perhaps the most dramatic scenario imaginable in this regard involves an immediate cessation of immigration and a rapid fall in the birth rate to around 1.3 children per couple (that of Catholic Italy, which has the smallest family size of any nation). Were this to happen, our population would probably peak at 17–18 million, then begin a gradual decline. What impact would such an event have? The greatest immediate effect would be to slow the pace of 'development'. The urban sprawl that consumes Sydney's environment at an unprecedented pace today would cease. Likewise the development of freeways, bridges, tunnels and such like would slow as the need for them, which is driven by an ever-increasing population, became less. Some kinds of development, however, would not slow. Large tourist developments, including new coastal tourist cities, would probably not be affected as their demand is not driven by local growth. Likewise, there would still be a need for expansions of airports, hotels etc. as the need for them is partly driven by tourism. The down side of such changes would be a need for redeployment of labour as the housing and construction industries shrank. Positive effects would include a release of capital from the property and land

Land degraded by overstocking of sheep and in need of restoration.

KATHIE ATKINSON

development markets, and the nine billion dollars spent each year in infrastructure for our population increase could be put towards developing alternative industries and improving technology. The pressure for sawlogs would be reduced such that much old growth forest would be left untouched. And our cities, and the cost of living in them, would become more bearable.

A falling birth rate would mean smaller class sizes and a better quality of education. Indeed, savings could be made in many child-related areas. Clearly, the aged would be expected to contribute more to society than at present. Compulsory retirement would

Indigenous agriculture in Irian Jaya. Even before European technology, the highlands of New Guinea supported some of the highest rural population densities on Earth.

TIM FLANNERY

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

Ever-increasing urban sprawl: Australia adds one million people to its population every four years.

become a thing of the past, while compulsory saving schemes such as superannuation would become more important.

The populate or perish argument as it relates to defence is a bogus one. It entirely disregards the impact of technology (which is extremely important, as the recent Gulf War shows) and, in any case, it is certain that Australia could never support a population of 200 million. Does this mean that we will always be vulnerable to attack from Indonesia? It has also been argued that we must populate Australia 'fully' or people will come and take our land for themselves. The kind of invasion envisaged has never been fully resolved, although it is always assumed to be a military one. Demographic trends, however, suggest that Australia could face another kind of invasion soon—a flood of economic and ecological refugees. For example Indonesia, even with its excellent family planning program, will add another 100 million people over the next 20 years. Indonesian agriculture is presently running at full capacity, and it seems unlikely that sufficient food can be grown within this time to feed the increase. Food imports will probably be necessary. Military conquest to obtain our agricultural lands would be counterproductive in this situation, as fighting would break vital food supply lines, causing immediate and critical food shortages. Our best defence against both refugees and the military may be the means to help people at home—through a reliable food export industry, and expertise in managing growth and degraded environments.

Australians must decide how many of us there will be. The Hawke Government has caused Australia to support the most rapidly growing population in the Western world, and yet that government has no population policy. Because of the nature of demographic change, decisions made today will shape Australia in 2030. It is no longer sufficient to blunder on, blind to long-term consequences. If there ever was a critical time for a population policy, it is now. ■

Suggested Reading

Ehrlich, P. & Ehrlich, A., 1990. *The population explosion.* Simon and Schuster: New York.

Nix, H.A., 1990. The environmental base. Pp. 22–27 in *International agriculture.* Special Issue of *Agricultural Science.*

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HISTOIRE
NATURELLE
DES
PERROQUETS
PAR
F.LEVAILLANT

"Today we should remember Le Vaillant not as a 'liar', but as a man who made important contributions to ornithology. The conservation of parrots is a fitting memorial."

PARROTS, LIES & BIRD BOOKS: THE LEGACY OF LE VAILLANT

BY MURRAY D. BRUCE

FREELANCE NATURE WRITER, BIOCON RESEARCH GROUP

IN 1801, A 48-YEAR-OLD FRENCHMAN, François Le Vaillant, launched an ambitious publishing venture. He would simultaneously issue, in parts, three lavishly illustrated folio books of birds. Napoleonic France was at its zenith and there was a ready market for anything colourful, gaudy and expensive. Le Vaillant, as the most famous ornithologist of his day, was the perfect choice to attempt this feat. He had reached the pinnacle of his fame with books on his voyage of exploration to Africa but his observations were entangled in a fabrication of fanciful fiction. Now was his chance for scientific credibility.

This came with his book on parrots—the first of its kind to treat these birds comprehensively, an achievement demonstrating Le Vaillant's supreme grasp of the subject. It was also a work that was destined to have an impact on parrot conservation in Australia more than a century and a half after his death. This is a somewhat ironic and interesting extension of a French ornithologist's work, considering the man never set foot in Australia!

Born François Vaillant in 1753 in Paramaribo, Surinam (South America), his father was the Consul for France (the 'Le' was added to his name later when he began his travels). His love of adventure and the mysteries of the natural world came early in life when he accompanied his parents, both keen naturalists, on journeys into the South American rainforests. At ten, his family returned to northern France to settle in their home city of Metz. François became an apprentice apothecary to a M. Bécoeur, who also then had the largest private collection of European birds. By the time of his first visit to Paris in 1777, François was an excellent marksman, having notched up 14 years' experience in hunting, collecting and studying birds around Metz and neighbouring parts of Germany. For three years he studied the bird collections available in Paris and continued with collections in Holland.

Le Vaillant was anxious to explore and collect in an area hitherto unknown for its birds, in an effort to build up a collection, make a contribution to science and become famous. There was little support for him in Paris but his Dutch contacts and Dutch background in Surinam together with his familiarity with the Dutch language made the Cape Colony of southern Africa an ideal choice. He departed from Holland in December 1780, arriving at Cape Town in April 1781. He made two extensive journeys eastward and northward before returning to Europe with a col-

As if to reinforce the fictional side of his writings and later reputation as a 'liar', Le Vaillant's title page illustration is not a real species, but resembles his 'Rajah Lory-Parrot', a presumed variant of the Purple-naped Lory (*Lorius domicellus*) of the Moluccan Islands, Indonesia.

COURTESY IMPRIME

Lizars sc.

AUSTRALIAN MUSEUM RESEARCH LIBRARY

Le Vaillant, the eccentric 18th-century French ornithologist, shared his passion for nature with three wives and ten children.

COURTESY IMPRIME

lection of over 2,000 birds, plus mammals, insects, plants and ethnological material.

Back in Holland in November 1784 he sold most of his collections to a wealthy friend and Treasurer of the Dutch East India Company, Jacob Temminck. Interestingly, Temminck's son inherited the collection and sold it to the Dutch Government in 1820 to form the nucleus of a public museum in Leiden with himself as Director. In January 1785 Le Vaillant returned to Paris and presented to the natural history museum a stuffed giraffe he shot on his second journey. It was the first complete specimen to reach Europe and became a great exhibition prize for the Museum. It also demonstrated Le Vaillant's taxidermic skills, which greatly enhanced the value of the specimens he sold to rich, private collectors. He was now well on his way to becoming rich and famous.

THE EAGERLY AWAITED BOOK OF HIS TRAVELS appeared in 1790 as *Voyage de Monsieur le Vaillant dans l'intérièur de l'Afrique par le Cap de Bonne Espérance dans les années 1780, 81, 82, 83, 84 et 85*. It was a book that captured the public imagination and became a 'best-seller'. Many translations appeared within three years. It was also used and misused by the Revolutionary Government to compare the equality of French people with the image of the 'Noble Savage' (an idyllic lifestyle free of the trappings of civilisation) as presented by the philosopher Rousseau. Rousseau considered nature as not simply a philosophical principle and the source of all rational and scientific investigation, but also a criterion that could be used for the elimination of oppression and injustice. Le Vaillant was a more romantic follower of Rousseau's doctrines and even dedicated a bird to Narina, the attractive daughter of a Hottentot chief he had met, and named another after his servant. Because of his poor writing style, the book was edited anonymously by his father, who based it on notes, sketches and conversations with his son.

The French Revolution had stopped his hunting trips in the country but he was kept busy organising his collections and working on his books. During the Reign of Terror (1793–1794), during which people were executed for opposing the government, Le Vaillant was imprisoned for some months and only narrowly escaped the guillotine with the fall of Robespierre, an influential political figure, in July 1794. A sequel, his *Second Voyage*..., finally appeared in

A female Red-cheeked Parrot (*Geoffroyus geoffroyi*), named after Professor Geoffroy St Hilaire (zoology, National Museum of Natural History, Paris). Le Vaillant notes a male and female were brought back by Captain Baudin from Timor. However, this species was not definitely reported from Australia until 1914.

Of the 'Blue-faced Parakeet' (Rainbow Lorikeet, *Trichoglossus haematodus*, most probably from the Moluccas or New Guinea) Le Vaillant says "Mr Holthuysen could not tell me from which part of India this specimen of his collection came." On the question of its being specifically distinct from the 'Blue-headed Parrakeet', Le Vaillant says "let us then leave these questions unanswered, rather than poorly solved, for natural history has too many of these conjectures already!"

1795, but only after the fervour of revolution had subsided. For this book Le Vaillant hired a professional writer, Casimir Varon, who was very liberal with the text. Le Vaillant's desire to increase his popularity, as well as the emotional upheaval of imprisonment, may well explain his deliberate oversight of Varon's wilder flights of fantasy. The sequel was also a best-seller, with many translations issued. Both books ran into several editions during Le Vaillant's lifetime.

In spite of such artistic license, few travel books have captured as much public attention or stimulated and focused as much interest in Africa. By contrast, the Scottish explorer of Ethiopia and the Blue Nile, James Bruce, published an accurate account of his travels in 1790. Although this too was a best-seller, he was not believed and was scathingly satirised by vulgar comparisons with the adventures of the fictional Baron Munchausen, created by Rudolph Raspe. Le Vaillant's success during the French Revolution, the Reign of Terror and the rise of Napoleon suggests it was a welcome diversion for his readers. Today these books would be described as 'travel journalism' with,

Eclectus Parrot (*Eclectus roratus*). Le Vaillant stated that this was a male, but it is now known that males are predominantly green and females red. This is unusual in birds.

COURTESY IMPRIME

in Le Vaillant's case, a racy narrative skimming over truth and inaccuracies alike to keeping the reader engrossed. Le Vaillant's writings have also been described as literary gems that enchant the true ornithologist, for both his *Voyages* were replete with bird observations and the author's youthful enthusiasm.

Le Vaillant was now ready for his first and most famous bird book, *Histoire naturelle des oiseaux d'Afrique*. It was issued in 51 parts from 1796 to 1812 and formed six volumes (a seventh remains unpublished). Other editions and two German translations also appeared. The book reveals Le Vaillant's familiarity with European bird collections and his taxidermic skills. However, in a critical review in 1857, the Swedish ornithologist C.J. Sundevall pointed out that, of the 284 species included, at least 50 came from outside Africa and another ten were based on artefacts (specimens composed of the parts of two or more species). For example, in 1806 Le Vaillant described—and claimed to have observed feeding on a carcass—a cuckoo from South Africa that was revealed many years later to occur only on the island of Java where it is now endangered (the Sunda Coucal, *Centropus nigrorufus*).

Edgar L. Layard, in his *Birds of South Africa* (1867), dismissed Le Vaillant as a liar, on the strength of Sundevall's conclusions. Later workers have been kinder and pointed out that, by overlooking the faults, Le Vaillant's contributions laid the foundation for African ornithology. In the second edition of Layard's book, the author R.B. Sharpe said "it is greatly to be regretted that [Le Vaillant's] work contains a large number of species introduced into the book as African which are in reality inhabitants of totally different countries; in fact, on many occasions he admits the circumstance. The late M. Jules Verreaux, who knew [Le Vaillant] personally, told us that it was quite by accident that these extraneous species were introduced into his work, that his intentions were perfectly honest, but that many of his specimens were lost, and were not at his disposal when he wrote his book in Europe. He consequently figured many species in his book which he fancied that he had seen in Southern Africa, and that he had no deliberate intention to deceive. In the case of several species which were made up of two or three different kinds of birds, Verreaux stoutly held that [Le Vaillant] was himself deceived, and that he really believed the specimens placed in his hand to be individuals of some

A variant of the Red Lory of the Moluccan Islands (*Eos bornea*). Le Vaillant says this bird is "more commonly found on Borneo Island." Salvadori, in the parrot volume of *Catalogue of birds in the British Museum* (1891), records that he thinks this to be an artificial bird, but without explanation.

Le Vaillant perpetuated an error by stating the Seven-coloured Parrotlet (*Touit batavica*) was common on Java. Its original describer, Boddaert, gave it the scientific name '*batavica*' (Batavia = Jakarta) in 1783. Possibly both were misled by reports of Sonnerat "who saw this Parakeet on Luçon Island" and "describes it in his voyage to New Guinea". But this is impossible as this bird comes from South America.

COURTESY IMPRIME

species which he remembered to have seen in South Africa." After all, such faults were not unusual in his day. Australia has the famous example of Pierre Sonnerat who claimed in 1772 to have found the Laughing Kookaburra (*Dacelo novaeguineae*) in New Guinea (hence the name), where it has never been recorded. Sonnerat had used this and other species to enhance the results of his covert expeditions during which he and his uncle smuggled spice plants to Mauritius in an attempt to break the Dutch monopoly in the East Indies (now Indonesia).

Today Le Vaillant is not as well known as he should be because he adhered to Count Buffon's older method of French nomenclature, rather than the system of scientific nomenclature introduced by the Swedish botanist Carolus Linnaeus (the one still used today), which rapidly gained a foothold in France after the death of the influential Buffon in 1788. Even though others stole the credit for Le Vaillant's new species, often recognising his discoveries by adopting the distinctive French names, Le Vaillant refused to adopt the 'artificial' systems of Linnaeus and his followers. Indeed, he used his books to criticise that system by drawing on his extensive field experience with African and European birds. He was interested in the behaviour of birds and had no interest in the anatomical studies of the 'cabinet' naturalist.

During this controversy with his French compatriots, and with his *Birds of Africa* still being issued, he began his new enterprise in 1801. Le Vaillant had studied more bird collections and seen more birds in the field than any of his contemporaries, and what better way to demonstrate this than by issuing grand, illustrated works! But there was another reason behind his new venture. The famous artist Jacques Barraband had introduced the new process of copper engravings partly printed in colour with retouching by hand (already used experimentally in Le Vaillant's African volumes), and a large rival work exploiting this technique was about to begin publication. With Barraband's plates and Le Vaillant's texts, three separate works emerged: *Histoire naturelle d'une partie d'oiseaux nouveaux et rares de l'Amerique et des Indes*; *Histoire naturelle des oiseaux de paradis et rolliers* (1801–1806), including a supplement (1818); and the third and most famous, *Histoire naturelle des Perroquets* (1801–1805). His work on parrots was issued in 24 parts and formed two volumes with 145 plates featuring 90 species of parrots. It is regarded as the cornerstone of parrot literature and so impressed two Frenchmen that they each published a supplementary volume: A. Bourjot St Hilaire in 1837–1838 and C. de Souancé in 1857–1858.

IT IS DIFFICULT TO IMAGINE HOW THIS eccentric 18th-century French ornithologist who had never been to Australia could have an impact on the conservation of Australian parrots. Strangely enough, this is indeed the case, for in 1988—over a century and a half after Le Vaillant's death—and on the other side of the world, a unique presentation copy of Le Vaillant's great work on parrots was acquired by the conservationist Lord Alistair McAlpine. He obtained it from Sydney antiquarian Brian Chester, who had purchased it

Le Vaillant described the Eastern Rosella as "Indisputably one of the most beautiful of the rich parrakeet tribe". The specimen illustrated was owned by Madame Josephine Bonaparte. She had a profound influence on the natural sciences and her estate boasted a unique array of plants and animals from around the world including kangaroos, Dwarf Emus (now extinct) and Black Swans.

Bloody Parrot Swindle

Le Vaillant gives a detailed and well-argued discussion of what might cause variegation or spotting in the feathers of parrots. He kept a live Chestnut-breasted Macaw for two years and noted that extra red feathers appeared with each moult. At that time some naturalists believed that "such spotted Parrots have undergone a particular process, invented by savages. This process, they ascertain, involves plucking the feathers from the bird and then rubbing the new growth with the blood from a species of tree-frog which is common to Guiana". Instead, Le Vaillant believed that disease was the cause. He was remarkably close to the truth, for recent work by Rosemary Low, Curator of Loro Parque in the Canary Islands and author of *Parrots of South America* (J. Gifford Ltd, London, 1972) puts the condition down to a nutritional disorder. She has mentioned that it can be diet-induced by adding fish oil to the diet of hand-reared birds. This practice was followed by Amerindians who collected nestlings, hand-reared them and sold them to bird-traders, who paid a premium for unusually coloured birds. The condition need not be a permanent one, as appropriate diet can result in the development of normally coloured feathers. Given that the microstructure of feathers and details on how colour in feathers is formed are only relatively recently known, Le Vaillant's reflection is quite interesting.

—Graeme Phipps
Taronga Zoo

Chestnut-breasted Macaw (*Ara severa*).

COURTESY IMPRIME

from a private French library. This remarkable copy, which had been presented to the famous zoologist and administrator of the Paris natural history museum, Count Bernard Germain Etienne de la Ville de Lacépède, includes 14 life-sized watercolour head-studies, a frontispiece and a special hand rendering of 143 of the original engravings by Barraband and Pieter Barbiers, with foliage and flora.

The incentive to contribute to parrot conservation, as well as make this historic work available once more, soon led to plans to produce a facsimile, which Brian Chester and Lord McAlpine published in 1989 in two editions. The total of 158 colour prints, with original French letterpress plus the text translated into English for the first time (a vast improvement on the often misleading contemporary English translations of Le Vaillant's travel books that did not help his reputation in England), and presented in two hand-crafted boxes, has been selling at an after-publication price of $20,000. Also available is a single-volume library edition for $375 (smaller format, without the French letterpress). The proceeds of the sales of these new editions, expected to total around $3.5 million, are earmarked for the conservation of parrots through a special captive breeding program at the Pearl Coast Zoo at Broome in Western Australia.

Set up by Lord McAlpine, breeding pairs of all but the rarest of threatened species are kept in a complex of smaller aviaries away from the main public areas. Foreign species are also represented. The breeding program features incubators and brooders for hand rearing young birds, while nesting material is replenished in the breeding aviaries to encourage renesting (double brooding) during each breeding period. Pearl Coast Zoo has bred more of the threatened Hooded Parrot (*Psephotus dissimilis*) than any other zoo in the world. This gives an opportunity for a future release program.

Graeme Phipps, General Curator of Taronga Zoo in Sydney, provided the ornithological commentary and updated nomenclature for the reprinting. He points out that three of the species featured by Le Vaillant are now extinct and half of Australia's amazing variety of parrot species may be extinct within the next century unless drastic action is taken *now*. The Royal Australian Ornithologists Union's report *Threatened birds of Australia* (1990) lists 11 species of parrots, including two already considered extinct (the Paradise Parrot, *Psephotus pulcherrimus*, and the Norfolk Island Kaka, *Nestor productus*). The remainder, although from different regions of Australia, share the common problem of having specific habitat needs and retreating under the onslaught of habitat change by humans.

Biologically, parrots have a slow

Is Le Vaillant's macaw Cuban or Hispaniolan? This question is somewhat academic now that the macaws of both islands are extinct.

COURTESY IMPRIME

breeding and replacement rate but can, if not too disturbed, maintain stable populations within a given area. This means larger parrot species that are unable to adapt to changes face an unpredictable future if their habitat is destabilised. A major problem worldwide for the survival of many parrot species is that not enough is known about them in the wild. Field studies have often provided a key to survival and the development of population management plans (for example, locating preferred nesting sites, understanding feeding habits and preferred food plants). The Puerto Rican Parrot (*Amazona vittata*) is the classic case. However, in too many cases the survival of a species may only come from captive breeding programs to ensure a viable stock of individuals in order to maintain some degree of genetic diversity (a captive gene pool). This is a key role for zoos. Reintroduction into the wild of captive-bred stock may be possible.

Parrots are popular as pets and the trade in live birds is now threatening to increase the likelihood of population crashes of whole species or significant parrot populations. The pet trade is blamed for the demise of the world's rarest parrot, Spix's Macaw (*Cyanopsitta spixii*) of north-eastern Brazil, with 1990 reports indicating only one wild specimen known to still survive! Unfortunately, most parrots live in tropical rainforests and deforestation is an added—if not the major—threat. While most parrots are hardy and long-lived birds that adjust well to captivity, an ever-increasing number may be doomed to survive only in captivity, if they can be saved at all.

An exception may be the ongoing efforts to save New Zealand's flightless Kakapo (*Strigops habroptilus*) by establishing populations on uninhabited, vermin-free islands (a successful technique for other endangered New Zealand birds). There may be a middle ground. While a number of species have been pushed to the brink of extinction, with some famous examples of recovery, it is also important to breed species in captivity whose numbers are still reasonably secure, not only to develop and improve breeding techniques, but perhaps also to keep some species from getting on the critical list.

Lord McAlpine's captive breeding program deserves all the support it can get. We can't afford to lose any more parrot species nor can we afford to lose too much time tackling the problem. There are a number of such programs for parrots around the world and this is one of the few groups where the support of aviculturists may be considerable.

Le Vaillant, who inspired this important contribution to parrot conservation, possessed a lifelong passion for his birds that continued until his death in 1824. Today we should remember Le Vaillant not as a liar, but as a man who made important contributions to ornithology. The conservation of parrots is a fitting memorial to one of the great pioneers in the study of birds. ■

Suggested Reading

Forshaw, J., 1989. *Parrots of the world*. 3rd ed. Sydney: Weldon.

Le Vaillant, F., 1989. *Histoire naturelle des Perroquets [Natural history of parrots]*. Facs. ed. Imprime: Sydney.

Low, R., 1984. *Endangered parrots*. London: Blandford Press.

Quinton, J.C. & Robinson, A.M.L. (eds), 1973. *François Le Vaillant: traveller in South Africa*. Libr. of Parliament: Cape Town.

Wetherbee, D.K., 1985. The extinct Cuban and Hispniolan Macaws (*Ara*, Psittacidae), and description of a new species, *Ara cubensis*. *Carib. J. Sci.* 21: 169–175.

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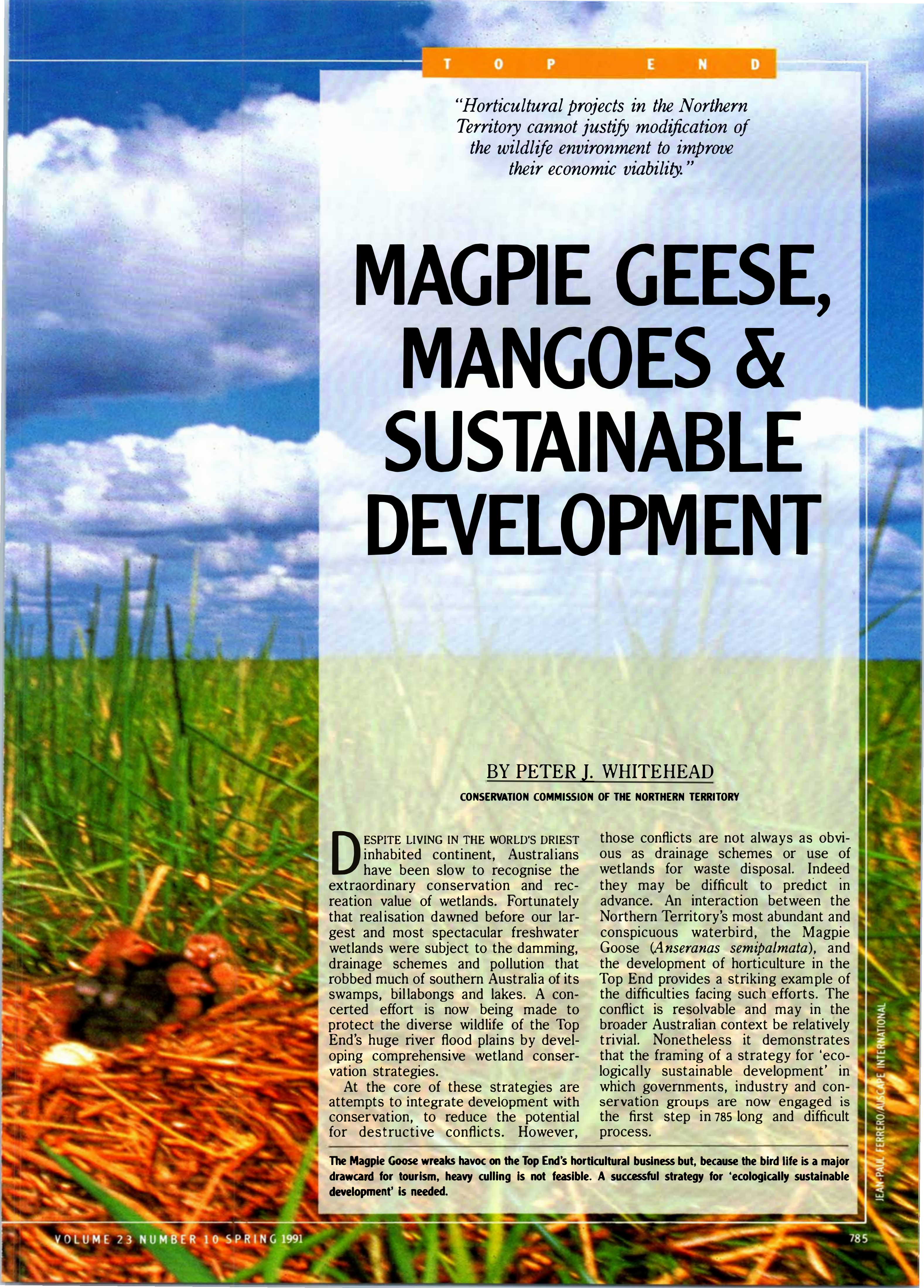


"Horticultural projects in the Northern Territory cannot justify modification of the wildlife environment to improve their economic viability."

MAGPIE GEESE, MANGOES & SUSTAINABLE DEVELOPMENT

BY PETER J. WHITEHEAD

CONSERVATION COMMISSION OF THE NORTHERN TERRITORY

DESPITE LIVING IN THE WORLD'S DRIEST inhabited continent, Australians have been slow to recognise the extraordinary conservation and recreation value of wetlands. Fortunately that realisation dawned before our largest and most spectacular freshwater wetlands were subject to the damming, drainage schemes and pollution that robbed much of southern Australia of its swamps, billabongs and lakes. A concerted effort is now being made to protect the diverse wildlife of the Top End's huge river flood plains by developing comprehensive wetland conservation strategies.

At the core of these strategies are attempts to integrate development with conservation, to reduce the potential for destructive conflicts. However, those conflicts are not always as obvious as drainage schemes or use of wetlands for waste disposal. Indeed they may be difficult to predict in advance. An interaction between the Northern Territory's most abundant and conspicuous waterbird, the Magpie Goose (*Anseranas semipalmata*), and the development of horticulture in the Top End provides a striking example of the difficulties facing such efforts. The conflict is resolvable and may in the broader Australian context be relatively trivial. Nonetheless it demonstrates that the framing of a strategy for 'ecologically sustainable development' in which governments, industry and conservation groups are now engaged is the first step in 785 long and difficult process.

The Magpie Goose wreaks havoc on the Top End's horticultural business but, because the bird life is a major drawcard for tourism, heavy culling is not feasible. A successful strategy for 'ecologically sustainable development' is needed.

JEAN-PAUL FERRERO/AUSCAPE INTERNATIONAL

FEW ENVIRONMENTS FLUCTUATE MORE erratically than Australia's seasonally dry tropics. The wet season's spectacular storms and monsoonal deluges alternate with dry-season droughts that may last for more than eight months. The wetland fauna not only has to cope with the extreme seasonal cycle, but must also deal with great year-to-year variation in the total amount of rain, its timing and its distribution across the landscape. Rates and depths of wet-season flooding at particular wetland sites are unpredictable, causing equally capricious shifts in the representation and persistence of different types of wetland vegetation that provide food, shelter and nest sites.

Such variable environments do not favour the evolution of highly specialised animals, because a resource exploited today may be gone tomorrow. The animals that dominate such places tend to be generalists, with the ability to exploit a range of resources that wax and wane in their relative availability. The ecology of Australia's unique Magpie Goose exemplifies this principle.

This unusual bird has defied simple taxonomic categorisation. The generic label *Anseranas* literally translates as duck–goose, while the specific name *semipalmata* recognises the partial webbing of its heavily clawed and most ungoose-like feet. Recent biochemical studies have confirmed the species' divergence from the true geese and ducks (family Anatidae), established its greater affinity with the equally unusual screamers (family Anhimidae) of South America, and resulted in its elevation to a family of its own, the Anseranatidae.

The ability to perch in trees away from predators is one reason for the Magpie Goose's success in the Top End and one of the features that have made it a significant pest of tree crops. The feet are partially webbed and heavily clawed, allowing the bird to exploit a wider range of habitats than are available to true geese and ducks.

KATHIE ATKINSON

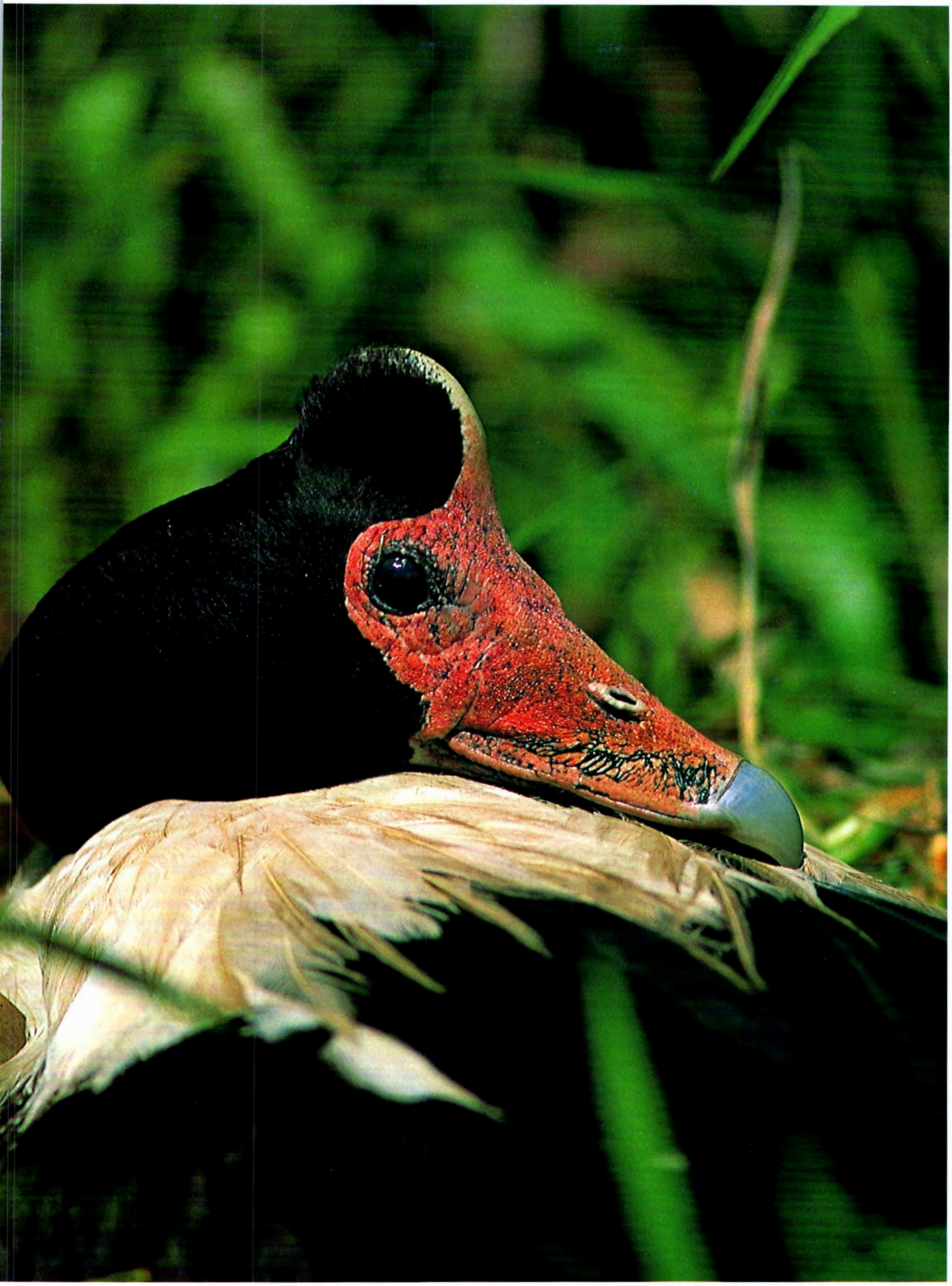
As recognised by Stephen Davies and the late Harry Frith, who did much of the early CSIRO research on Magpie Goose ecology, the unusual feet and other morphological oddities contribute to the bird's capacity to exploit a range of habitats. While weakly webbed feet may compromise swimming and diving efficiency, the long unwebbed portion of the toes, including an opposable fourth toe, permit actions quite beyond true geese and ducks. Magpie Geese are adept at clambering through thick swamp vegetation, grasping and manipulating grass stems for nest building or bringing seed heads within reach, and perching in trees away from potential predators. The clawed feet are also used as weapons in disputes between males and for defence against predators. The robust hooked bill is well suited for digging up roots and bulbs in dry soils, but the bird also retains the fine structure of bill and tongue needed to separate small seed and other organic particles from water or mud.

Behavioural and physiological flexibility complements this morphology. Magpie Geese usually nest in flooded grasslands or sedgelands but, when these habitats are unavailable, they may nest in low shrubs or trees. By waterfowl standards, Magpie Geese usually produce unusually large clutches of eggs. But, if suitable food supplies are low early in the wet season, they may not nest at all. When all else fails, they abandon unfavourable sites and fly long distances in search of better conditions.

Clearly the Magpie Goose is admirably adapted to exploit a range of variable habitats that are patchily distributed in space and time. But a refined ability to exploit such a habitat jigsaw does not guarantee survival, especially if some elements of the puzzle are entirely lost. By about 1900, conversion of the temperate wetlands of Australia's southern States to cattle and sheep pasture was so advanced that no amount of ecological flexibility could compensate, and huge regional populations were totally extinguished. The Magpie Goose persists in large numbers in the Northern Territory (surveys between 1984 and 1990 have returned estimates ranging from 1.1 to 2.4 million) and other parts of tropical Australia because modification of wetland habitats for agriculture has been minor.

Fortunately, there is little pressure in the Top End to repeat the drainage schemes of southern Australia for pastoralism. Indeed, pastoralists and conservation authorities are cooperating to restore freshwater wetlands damaged by saltwater intrusion. Some land-

Magpie Goose at nest. Note the hooked bill, which is ideal for digging in dry soils as well as for sifting through mud for small food items.



DAVID CURL

holders (although by no means all) have also agreed to exclude exotic pasture species from Magpie Goose breeding sites. Surprisingly, developments in well-drained upland areas present the more immediate conflicts.

HORTICULTURE BASED PRINCIPALLY ON exotic fruits and sustained by dry-season irrigation is seen to have considerable potential in the Top End. Sites with soils, drainage and a water supply suitable for horticulture do not include wetlands, but they often abut them. Environmental issues arising from a conjunction of horticulture with natural wetlands include impacts of irrigation on regional water regimes, and the risk of pollution with biocides (herbicides and insecticides) or fertilisers.

Unregulated use of subterranean waters may interrupt flows to spring-fed swamps and fringing rainforests, and so degrade or destroy these habitats. Many of the Top End's major seasonal freshwater wetlands overlie sediments of marine origin, and adjoin tidal rivers. Excessive drawdown of the freshwater aquifers used for irrigation may cause intrusion of saline waters. Evaporation concentrates the dissolved salts from water brought to the surface for irrigation, whether contaminated with marine salts or not, and so increases mineral loads in runoff to adjoining wetlands. Careless use of biocides or fertilisers may result in pollution of aquifers or of the runoff from horticultural sites, affecting wildlife or humans who depend on the aquifer for their domestic supply.

These effects are at least potentially controllable. A second source of serious conflict between horticulture and wildlife is less simply regulated: the Magpie Goose has developed a taste for exotic fruits.

Native fruits are not a significant component of Magpie Goose diets. Fruit-bearing trees do not occur in preferred sedge and grassland habitats, and are too dispersed in adjoining *Eucalyptus* woodlands and forests to support flocks of such a large bird. Regular consumption of fruits such as mango, rambutan, and a variety of melons is, therefore, further evidence of the behavioural and morphological flexibility of the Magpie Goose.

The birds are probably attracted to

DAVID HANCOCK

new horticultural plots by ploughing or other soil disturbance that makes for easy digging to extract roots, tubers and rhizomes. Irrigation also stimulates growth of grasses to provide grazing like that exploited by Magpie Geese after early wet-season rains. Puddles of water from spray or drip irrigation attract birds in the late dry season, as natural water bodies contract and become increasingly crowded and fouled. Magpie Geese consume a lot of water, much of which appears to be used for evaporative cooling. Growing trees also help the birds avoid extremes of temperature by providing shade. And, at the core of the problem, the plots ultimately provide a rich and convenient source of food.

Magpie Geese like to eat a range of exotic fruits cultivated in the Top End, like honeydew melon (shown here), mangoes, rambutan, watermelon, rockmelon and sweet potato.

Magpie Geese feed on windfalls, but also attempt to consume ripe or unripe fruit from the tree. Many birds seem to confine their attentions to low-hanging fruit that they can reach by extending to their full height of about 80 centimetres, or jumping from the ground. Others clamber about in trees to take fruit from higher branches and, in the process, dislodge fruits that are eagerly consumed by birds lurking below. The strong hooked bill that is such an efficient digging implement also deals effectively with the tough skins on fruit like mangoes. Even when fruit are not consumed, they are often so marked as to be unsaleable.

Magpie Geese also make good use of layouts designed to facilitate orchard management and end-of-season harvests. Neat spacing of trees provide useful flight paths for arrivals and departures of these large and relatively clumsy birds. Pruning of lower branches gives free access to irrigation points and low-hanging fruit under individual trees, while providing an uninterrupted view of potential predators, including horticulturists. The number of birds exploiting these characteristics of exotic fruit orchards is now sufficient to cause major damage, including total losses of some experimental crops like rambutan. Sprawling melon crops are even more vulnerable. Root crops are so far little grown in the Top End, but Magpie Geese are accomplished foragers for succulent roots and tubers, and have shown a willingness to sample sweet potato crops at local experimental farms.

JEAN-PAUL FERRERO/AUSCAPE INTERNATIONAL

Newly hatched Magpie Geese. Nests are usually made in flooded grassland and these birds produce much larger clutches of eggs than most other waterfowl of similar body size.

With the benefit of hindsight it is perhaps unsurprising that a highly mobile generalist herbivore should find such man-made environments irresistible. These gardens concentrate all of the major resources sought by Magpie Geese in the late dry season. Nonetheless the problem does not appear to have been predicted by either agricultural or wildlife authorities. It can be predicted, however, that in the absence of an appropriate management response, the problem will increase. First, Magpie Geese are long-lived birds (up to 27 years in the wild) and the fruit-eating habit once established will persist in populations. Second, the social behaviour of the Magpie Goose will ensure effective transmission of a mango-eating 'tradition' between generations. Goslings remain with their parents for the first year of life and, during this time, probably learn locations and

A.H. TOLHURST

Newly ploughed land attracts Magpie Geese because it is easy to dig for roots and tubers.

DAVID CURL

Peter Whitehead (right) and assistant Kurt Tschirner preparing a Magpie Goose for banding in order to track movements of family groups from nesting areas.

methods of exploiting dry-season food resources. Third, unless compensated, increasing diversion of water resources to agricultural and urban development may tend to reduce the dry-season stability of natural wetlands, forcing Magpie Goose populations into greater dependence on alternative habitats, including the horticultural oases.

During their major studies of Magpie Goose ecology in the 1950s, Frith and Davies recognised that destruction of local breeding sites would be the most effective way to halt Magpie Goose depredations on rice crops. Experience at rice farms showed that killing birds at the crop site and attempts to deter them with lights or noise were ineffective. Adult birds have few predators, and the response to even the largest of Australian raptors (the White-Bellied Sea Eagle, *Haliaetus leucogaster*) is little more than a temporary crowding together. Thus kites or other silhouettes of birds of prey tend to be ignored. On very small plots, active dogs may offer some relief but are likely to tire on larger plots, or when they have to cope with large numbers of geese.

PETER WHITEHEAD

Mangoes chewed by Magpie Geese.

Aversive conditioning, like chemical treatment of the most accessible fruit to render it distasteful or cause temporary distress (such as emetics), would have to be carried out on a large scale over long periods. Magpie Goose flocks are extremely fluid and, although birds tend to return to the same general areas to feed, the composition of individual flocks and their precise foraging sites change from day to day.

Experience across the world shows that by far the most effective pest control methods involve physical exclusion. Good perimeter fences help, but exclusion of aerial pests requires total enclosure of individual trees or plots with suitable netting. Appropriately designed netting (that is, relatively conspicuous and fine-meshed) is a good general response to pest problems because it can exclude all of a diverse suite of winged pests, including fruit-bats. Netting can deal with some large insect pests like moths, and so reduce insecticide use. Disadvantages include high installation and maintenance costs, and complication of orchard maintenance or harvest.

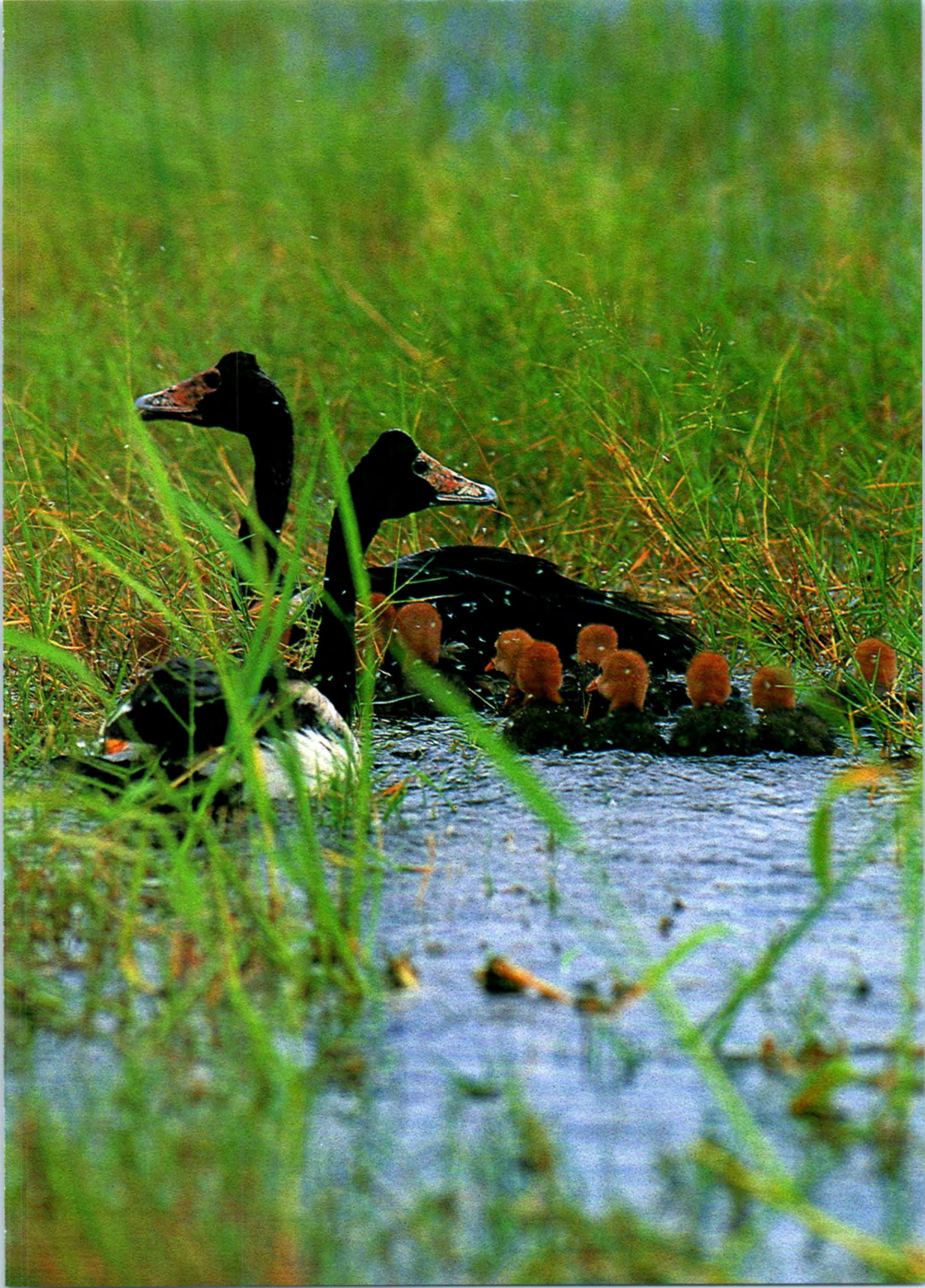
EXPANSION OF HORTICULTURE HAS BEEN identified as a significant development objective for the Northern Territory. Diversion of natural resources to this end is justified on economic grounds, including the need to diversify a narrow industrial and commercial base. But the Territory's most significant industry by far is tourism, which is highly dependent on wildlife. Thus the environmental impact of horticulture has a direct economic as well as a conservation dimension. No longer can the extirpation of entire populations, nor the destruction of significant numbers of Magpie Geese on crops be contemplated as legitimate protection measures.

A commitment to sustainable development obliges regulatory and planning authorities to avoid the knowing creation of destructive land-use conflicts. Horticultural projects in the Northern Territory cannot justify modification of the wildlife environment to improve their economic viability. Rather they should attract support only if they remain commercially viable in the face of crop losses to wildlife, or continue to be profitable despite the costs of non-destructive pest exclusion measures.

The obligation to minimise conflict extends to the need to balance compe-

Magpie Geese and goslings.

DAVID HANCOCK



DAVID HANCOCK

The author observes a Magpie Goose. An airboat has to be used to get through the heavily vegetated swamps.

tition for water resources between developed and natural systems, and to avoid pollution. The proportion of available water resources that can be diverted without significant off-site detriment is not easily predicted, and management regimes should include the capacity to respond rapidly to evidence of adverse change detected during ongoing monitoring programs. In some cases this might include the local supplementation of water at spring-fed swamps or rainforests that appear particularly sensitive to reduced water flows or aquifer drawdown.

The history of broad-scale agriculture in the Northern Terrtory is a dismal one, characterised by costly failures. Constraints like infertile leached soils, a capricious climate, and an abundance of vertebrate and invertebrate pests have been too often ignored or underestimated. Prospects are brighter for a diverse horticultural industry based on scattered small holdings, sited to exploit patchily distributed suitable soils. But neither the interests of individual growers nor the collective health of the industry will be served by underestimating known and potential vertebrate pest problems.

While it may be unreasonable to expect all problems potentially arising from a development to be anticipated, a willingness to promptly acknowledge and correct mistakes is indispensable. Otherwise the strategy for 'ecologically sustainable development' that is attracting so much attention will do no more than add to the collections of pious conservation platitudes already cluttering bookshelves. ■

Suggested Reading

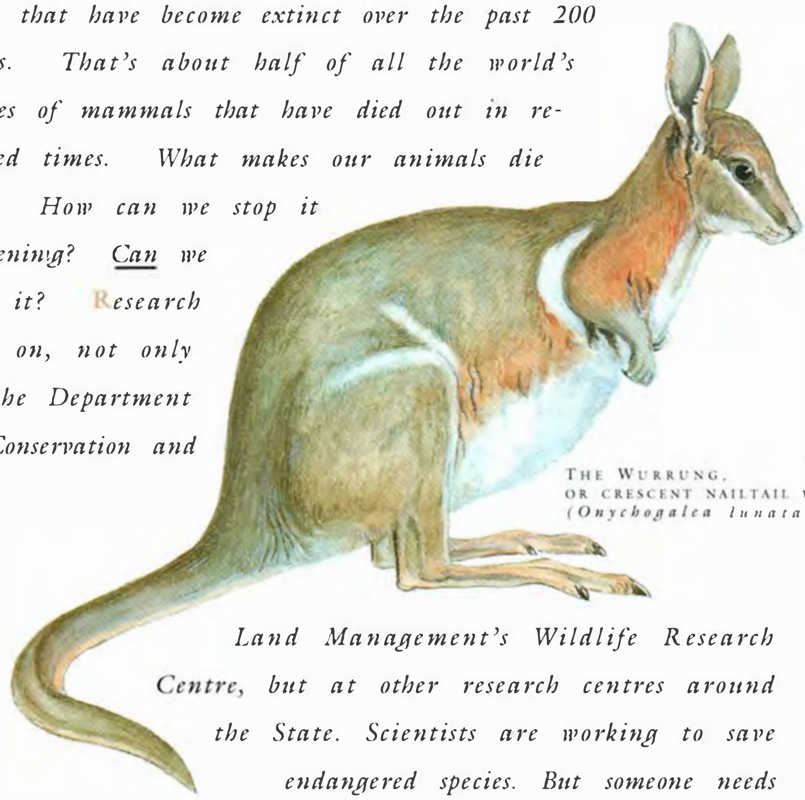
Frith, H., 1967. *Waterfowl in Australia*. 2nd ed. Angus and Robertson: Sydney.

Whitehead, P.J., Wilson, B.A. & Bowman, D.M.J.S., 1990. Conservation of Northern Territory coastal wetlands: the Mary River floodplain. *Biol. Conserv.* 52: 85–111.

Peter Whitehead is a wildlife biologist with the Conservation Commission of the Northern Territory in Darwin. He works primarily on conservation and management of wetland fauna and their habitats. After a period working on aspects of the biology and management of crocodiles, he is now concentrating on waterfowl, including the Magpie Goose.

EXTINCT

The last time anybody saw the crescent nailtail wallaby was in 1956. It's just one of the 18 species of Australian mammals that have become extinct over the past 200 years. That's about half of all the world's species of mammals that have died out in recorded times. What makes our animals die out? How can we stop it happening? Can we stop it? Research goes on, not only at the Department of Conservation and Land Management's Wildlife Research Centre, but at other research centres around the State. Scientists are working to save endangered species. But someone needs to watch and to report. That's where **LANDSCOPE** *magazine comes in.* **LANDSCOPE** *is WA's premier conservation quarterly. Our stories on wildlife, forests, reserves, and national and marine parks are well informed and scientifically researched. We pack each issue with facts, problems, solutions and achievements, and we care about the future of our planet. We think you do, too. That's why we want your continued support. If you'd like to subscribe to* **LANDSCOPE**, *for yourself or a friend, please write or telephone.*



THE WURRUNG,
OR CRESCENT NAILTAIL WALLABY
(*Onychogalea lunata*)

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window on the west

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Charles Darwin, circa 1880.

"He made significant discoveries about reptile biology that were many years ahead of their time."

CHARLES DARWIN IN TASMANIA

BY RICK SHINE & MARK HUTCHINSON

DEPARTMENT OF BIOLOGICAL SCIENCES, UNIVERSITY OF SYDNEY
SOUTH AUSTRALIAN MUSEUM

Most educated Australians would recognise the name of Charles Darwin—not only because one of our capital cities is named after him, but also because of his discovery of evolution via natural selection. However, many people do not realise that Darwin actually visited our shores during his famous voyage on HMS *Beagle*, or that he explored several parts of this country. Until very recently, even the few who knew of Darwin's visit were unaware of any particularly interesting discoveries he made here, and the most frequently repeated quote from Darwin's Australian travels concerns his general disappointment about the place and its inhabitants: "Farewell Australia, you are a rising infant and doubtless some day will reign a great princess in the South, but you are too great and ambitious for affection, yet not great enough for respect; I leave your shores without sorrow or regret". An exciting recent discovery, due to detective work by an Australian scientist and a librarian, has changed that picture quite dramatically. Darwin not only collected specimens here (many of them species that would not be formally described by scientists until much later), but he also made significant discoveries about reptile biology that were many years ahead of their time.

Hobart around the time of Darwin's visit.

COURTESY CAMBRIDGE UNI LIBRARY

Frank and Jan Nicholas discovered and laboriously transcribed some of Darwin's original notebooks, including those detailing his visit to Hobart in February 1836.

CARL BENTO/AUSTRALIAN MUSEUM

Frank Nicholas is an animal geneticist at the University of Sydney, and Jan Nicholas is a librarian at the Mitchell Library. While researching for their recent (1989) book on Charles Darwin's travels in Australia, they discovered that some of Darwin's original notebooks—kept in his home in Kent, southern England—had never been transcribed. Darwin's niece, Norah Barlow, had transcribed and published most of her uncle's notebooks, but it appears she became tired of the task. Quite a lot of Darwin's notes from his Australian travels had apparently lain undisturbed since his death. When Frank and Jan transcribed them (no easy task, because Darwin's handwriting was atrocious!), they found a gold mine of original biological observations.

The most exciting section of the notebooks (at least to us, because we are both evolutionary biologists interested in Tasmanian lizards) concerns Darwin's observations on the reptiles in the vicinity of "Hobart Town", where he visited in February 1836. (His notebooks of the time are actually headed "1835": it's nice to know that even Darwin could make simple errors!) He spent 13 days in Hobart and its environs collecting fossils and observing the local wildlife and geology. He spent most of one day in an unsuccessful attempt to climb Mount Wellington, trying to move through the thick vegetation on the wetter southern side of the mountain. Realising his error, he climbed the mountain successfully the following day, using a different route. Still, these must have been two very strenuous days, and bear testimony to Darwin's physical fitness at this time, one day before his 27th birthday.

To a professional biologist, however, Darwin's observations on the local animals were the most interesting aspect of his activities revealed by the Nicholas' investigations. Even if you are interested exclusively in very 'modern' branches of biology (like molecular genetics or highly mathematical ecology), it's still fun to look back at the activities of earlier workers who have been concerned with the same types of animals as oneself. When the 'earlier worker' in question is the father of evolutionary biology, the thrill is even greater. Combine this with the fact that little scientific work has ever been carried out on the Tasmanian reptiles, and you'll begin to understand why the discovery of Darwin's forgotten notebooks was so important to us. Not only had someone bothered to look at 'our' animals over 150 years ago, but that 'someone' was probably the greatest biologist who ever lived.

As one of the first trained biologists to visit Tasmania, Darwin put a lot of effort into collecting, describing and preserving examples of the species he encountered. His descriptions went into his notebooks, and the specimens themselves were killed, preserved and labelled so that they could be shipped back to England for more detailed study by Darwin himself or by other experts. The first challenge for us, obviously, is to try to work out exactly what species were actually described by Darwin. To do this, you can usually hope to have two sources of evidence: the actual specimens themselves, preserved and lodged in a museum, and the descriptions and/or sketches made at the time. Clearly, the specimens offer the strongest evidence but in this case most of them can't be found. We've looked in the British Museum (Natural History) in London and the Museum of Zoology in Cambridge—the two likeliest places for Darwin to send his specimens—and drawn a blank in both places. Perhaps they were lost in transit, or destroyed, or are sitting at the back of some dusty shelf to be eventually rediscovered—like the notebooks—in years to come. In any case, all we have to go on for most of the specimens is Darwin's descriptions.

The job of identifying the species is complicated by the general similarity in size, shape and colour of many of the Tasmanian lizards. Recent biochemical research—comparing blood proteins and liver enzymes—has shown that there are quite a few very similar species that can be hard to tell apart without close examination. For example, as you travel up Mount Wellington, you'll often see small brown lizards scurrying across the rocks, all

One of six paintings by Augustus Earle that make up a panorama of Hobart. These were drawn in the 1820s, about ten years before Darwin's arrival.

the way from the base to the summit. Most of these were always considered to belong to a single species, the Tasmanian Tree Skink (*Niveoscincus pretiosus*), but recent detailed research has shown that the lizards at the top of the mountain are a different species, now called the Southern Snow Skink (*N. microlepidotus*), because they only occur in alpine habitats. Where they occur together, around the tree line, the two types don't interbreed; that is, they behave as separate species. Biochemically they are also distinct and on closer inspection are subtly different in size and colour. In these and other species it's hard to be certain of identification unless you're prepared to go to the trouble of counting the number of scales around their bodies. And just to make it worse, there are other parts of Tasmania where the distinction between the Southern Snow Skink and a third species, the Mountain Skink (*N. orocryptus*), breaks down so that they form hybrids and no longer behave as separate species. It's a marvellous demonstration of evolution in action, and Charles Darwin probably would have loved it if he was around to see it today. He might have been particularly interested in the fact that these skinks are all Tasmanian endemics (that is, they are found nowhere else), because this type of evolutionary radiation of animals on small islands (especially in the Galapagos) turned out to provide important clues to Darwin as he pondered the origin of species. Still, the similarities in colour and size of the Tasmanian skinks mean that it can be pretty difficult to tell what kind of lizard you have simply from a written description.

Fortunately, Darwin left fairly detailed descriptions of the reptiles he collected, and there are only a dozen or so species in the area because it is so cool. Hence, we have a pretty good chance of working out exactly what species he actually found. In all, he described six lizards and one snake. Frank Nicholas has kindly given us his transcription of Darwin's notes, and we think that we have a reasonable idea as to the identity of most of the animals that Darwin collected.

THE FIRST LIZARD HE DESCRIBES ("NUMBER 1358") had "scales on the centre of back light greenish brown, edged on sides with black; scales on upper sides of body greyer with less black; on lower sides reddish; belly yellow with numerous narrow irregular waving transverse lines of black—these lines are formed of the lower margin of some of the scales being black. Head above grey, beneath whitish. Motion of the body when crawling like a snake—not *very* active: in stomach beetles and larvae: common in open wood." The colour of this animal, and its snake-like crawling motion, indicate that this was a She-oak Skink (*Cyclodomorphus casuarinae*). Indeed, the preserved specimen survived the voyage and was identified and described by Thomas Bell when the zoological results of the *Beagle* voyage were published in 1843. The specimen now sits in the British Museum, one of only three of Darwin's Australian lizards to have found its way to its intended resting place. Bell found only beetles and larvae in the stomach of his specimen, but a recent study by Sydney University biologist Glenn Shea showed that these lizards have very broad diets. They eat large numbers of small snails, and one that Glenn examined had even eaten a small venomous snake.

The second of Darwin's lizards ("number 1359") had "two longitudinal black bands, marked with chains of yellowish white spots: upper parts of sides irregularly black with ditto marks: belly whitish: tail simply brown—soles of feet pale coloured". The "chains of white spots" show that this specimen was a White's Skink (*Egernia whitii*). This species, with its striking dots-and-dashes colour pattern, is one of the few for which we have some detailed ecological information, due to the work of J.L. Hickman of the University of Tasmania who reported on its habits and diet in a 1960 article. White's Skink digs warren-like burrows under stones or in sandy soils. Like most Tasmanian reptiles (there are only three exceptions) it produces live young rather than laying eggs. The babies seem to stay in the same burrows as their parents for the first year or so of life.


MARK HUTCHINSON


A.E. GREER


MARK HUTCHINSON

Darwin collected a total of six lizards and a snake from Tasmania. Clockwise from top left, the lizards are: the She-oak Skink, White's Skink, Spotted Skink, Metallic Skink, Blotched Blue-tongue Skink and Mountain Dragon.

The third and fourth lizards that Darwin described were both smaller species, the kinds often encountered in large numbers in the suburbs as well as the bush. Lizard "number 1360" ("above pale brown, with very numerous little transverse undulating irregular black narrow bands; sides richer brown,—tail same as body but paler; soles of feet black") was probably the Spotted Skink (*Niveoscincus ocellatus*), whereas "number 1361" ("whole upper surface dark blackish brown, each scale with 4 to 6 minute longitudinal streaks—the black colour far preponderant. Belly reddish: throat white: soles of feet black") was probably the Metallic Skink (*Niveoscincus metallicum*). The Spotted Skink is a rock specialist, using crevices and cracks for shelter, and basking and hunting for prey on the rock surface. Its handsome colouring is very effective camouflage on lichen-covered boulders. The Metallic Skink is primarily a terrestrial dweller of the leaf litter and is probably the most common reptile in Tasmania. It is certainly the most widespread, from sea-level to subalpine elevations and from the dry midlands to the saturated western coast. This success, rather surprisingly, does not carry over to the Australian mainland, where the Metallic Skink is generally uncommon and confined to southern Victoria. The red belly noticed by Darwin is characteristic of the species and develops in most (but not all) adults of both sexes. As with many aspects of Tasmanian lizard biology, the function (if any) of this bright colour is not known.

Darwin's fifth lizard ("number 1362") is recorded to be "same genus as 1358" and "slightly dark 'Wood Brown' with central longitudinal band crossed by about five broad very irregular bands of 'Umber Brown': tail with ditto and generally darker.—Beneath paler with most obscure undulating dark lines: top of head reddish Brown: iris orange, pupil black...Held by the tail, collapses its front legs, close to body...Tongue, coloured fine dark blue". There is no doubt that this animal was a Blotched Blue-tongue Skink (*Tiliqua nigrolutea*)—no other Tasmanian lizard except the She-oak Skink has a blue tongue, and no other species has such a colour pattern or would allow anyone to hold it up by the tail without dismembering that part of its body to escape. This identification is confirmed by Darwin's notes on its behaviour: "Animal so torpid and sluggish a man may almost tread on it, before it will move. I lay down close to one and touching its eye with a stick it would move its nictitating membrane and each time turn its head a little further: at last turned its whole body, when upon a blow on its tail ran away at a slow awkward pace, like a thick snake. Endeavouring to hide itself

CARL BENTO/AUSTRALIAN MUSEUM

Biologist Glenn Shea with a copy of ***Zoology of the voyage of HMS Beagle*** **(1843) and a She-oak Skink. The bottom figure in the book is the She-oak Skink, described by Thomas Bell who found only beetles and larvae in the stomach of Darwin's specimen. Glenn has since discovered that the She-oak Skink's diet is actually quite broad and includes large numbers of small snails and even a venomous snake.**

ANDREW DENNIS/ANT PHOTO LIBRARY

A Blotched Blue-tongue Skink displays its vivid tongue to intimidate an aggressor.

in a hole in the rocks—appears quite inoffensive and has no idea of biting." All of these details fit in with the identification of the animal as a blue-tongue. Although now placed in separate genera, blue-tongues and the She-oak Skink are close relatives as Darwin suggested. However, this relationship was not widely accepted by professional biologists until long after Darwin's original insight.

Darwin devoted a lot of space in his notebook to the blue-tongue, undoubtedly impressed by its large size, beautiful colouration and unusual behaviour. Darwin reported that this species was "not uncommon on sunny grassy hills". Blue-tongues are still common in the warmer parts of Tasmania, as evidenced by the distressing frequency with which they are killed on roads during the spring mating season. Contrary to Darwin's experience, Blotched Blue-tongues can be most irascible when first encountered, hissing and gaping to expose the blue and pink tongue and, if given the chance, biting hard. Their size is impressive compared to the other much smaller Tasmanian lizards, so much so that they are commonly misnamed 'goannas' by Tasmanians unfamiliar with the much larger monitor lizards to which this name is correctly applied. Monitors are absent from Tasmania. Darwin also dissected his blue-tongue and discovered a remarkable fact. He records "stomach capacious full of pieces of a *white* mushroom and few large beetles...: hence partly herbivorous!" We now know that herbivory is common in many groups of large lizards, but this was almost certainly the first scientific record of herbivory in a skink. Indeed, there has still been very little in the way of detailed scientific study of the diets of any of the Tasmanian lizards, and overall we know little more in 1991 than Darwin did in 1836.

One final lizard described by Darwin is harder to identify. He described "lizard 1364" as having "along the back, a space ash coloured, which contrasts over the loins: in centre of this chain of transverse marks connected together of richest brown: within these marks, white spots, and central pale brown line down whole back:—sides mottled with all the above colours. Belly ash, with few minute longitudinal dark streaks. Head with transverse ones of the dark brown: common: I believe also at Syd-

MARK HUTCHINSON

ney." We are fairly sure that this animal was a Mountain Dragon (*Tympanocryptis diemensis*), although it is surprising that Darwin didn't mention the roughened scales characteristic of this group. Our confidence comes from an entry in G.A. Boulenger's 1885–87 *Catalogue of the lizards in the British Museum (Natural History)*, which lists a male and female of this species, collected by C. Darwin, Esq., in Tasmania.

Lastly, Darwin also collected a snake and seems to have had no idea of how close he may have come to an untimely end. In Britain (and, indeed, most of North America) venomous snakes are very easy to distinguish from harmless species. The harmless ones (like grass snakes and the Garter Snake) are long and thin, whereas the dangerous species (like vipers and rattlesnakes) are short and fat. Unfortunately, the same rule doesn't hold completely true in Australia (or Asia or Africa, two areas that Darwin never visited). The venomous family Elapidae consists mostly of long, thin snakes, but these include deadly species like cobras, mambas, taipans and the like. All three species of Tasmanian snakes are elapids, so they are all venomous. One species (the White-lipped Snake, *Drysdalia coronoides*) is so small that it is fairly harmless, but the other two—the Black Tigersnake (*Notechis ater*) and the Copperhead (*Austrelaps superbus*)—are highly venomous. Darwin almost certainly didn't realise this, because he refers to his specimen as "Coluber"—that is, a member of the

Darwin mistakenly identified the Black Tigersnake (family Elapidae) as harmless. However, he correctly reported it bears live young, the first scientific record for this family.

family Colubridae, the harmless snakes.

Darwin described his snake as "Hair Brown with much Liver Brown—beneath mottled grey". This regrettably terse description could apply to any of the three Tasmanian species, although the Black Tigersnake is perhaps the most likely based on its colour, distribution and abundance. If so, it's sobering to think that one unlucky bite could have changed the history of biology. As it was, Darwin obviously decided to err on the side of caution and apparently thumped the snake to death with a stick. He was not bitten and actually made a very interesting observation: "The abdomen being burst in catching the animal: a small snake appeared from the disrupted egg: hence ovoviporous: is this not strange in Coluber?" Up to that time, the conventional wisdom was that vipers were the only viviparous (live-bearing) snakes (hence their name), and that all other snakes reproduced by laying eggs. As we now know, live-bearing habits have evolved independently in about 100 different types of lizards and snakes, usually in cold areas like Tasmania. However, as far as we can tell, Darwin's observations were the first scientific record of live-bearing in an elapid snake.

So, remarkably, Charles Darwin not only collected a fair proportion of all the Tasmanian reptile species, but he also made some interesting observations about their natural history—like herbivory and viviparity—that would not be rediscovered for many years. The diets of lizards and the sex lives of snakes may not rank highly as conversation topics to many people, but they are important to understanding the basic biology of these poorly known little creatures. Speaking personally, as professional biologists, it gives us a warm glow to think that some of the first accurate scientific observations on 'our' animals were made by that intrepid young Englishman who was later to change the way we all view the natural world. ■

Suggested Reading

Hickman, J.L., 1960. Observations on the skink lizard *Egernia whitii* (Lacépède). *Pap. Proc. R. Soc. Tas.* 94: 111–118.

Nicholas, F.W. & J.M., 1989. *Charles Darwin in Australia.* Cambridge University Press: Cambridge.

Shea, G., 1988. On the diet of the Sheoak Skink, *Cyclodomorphus casuarinae*. *Herpetofauna* 18(1): 7–8.

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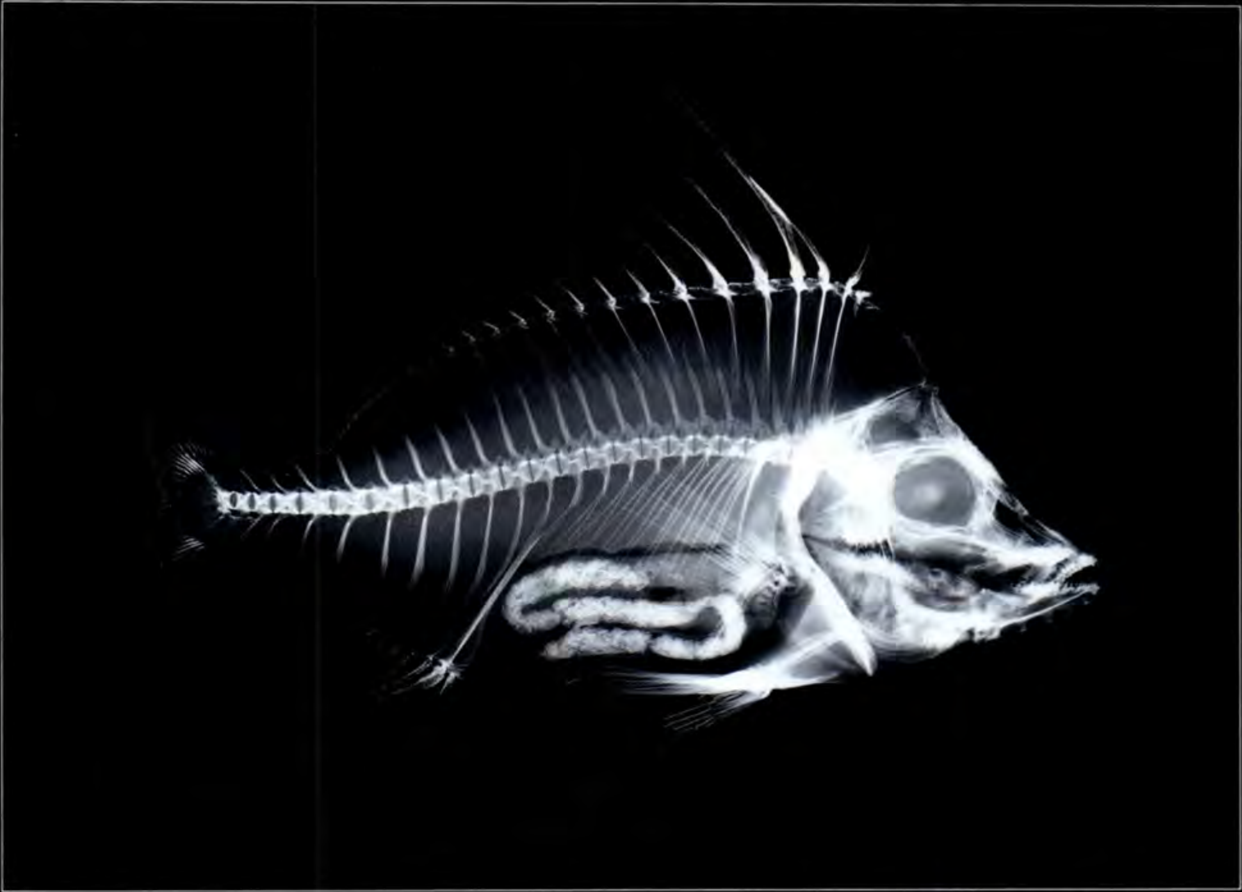
X-rays reveal that this Black-belly Swamp Snake (*Hemiaspis signata*) is pregnant.

X-RAYS



The boarfish *Paristiopterus labiosus*. The pharyngeal teeth just below and behind the eye are used to crush the invertebrates that make up its diet. The intestine is clearly visible because the ingested sand is opaque to X-rays.

BY MAURICE ORTEGA

PHOTOGRAPHER, AUSTRALIAN MUSEUM

It is not only in the field of medicine that X-rays are an important diagnostic tool. In many other areas of research, they play a vital role. X-rays are used by research biologists, conservators, palaeontologists, engineers and metallurgists around the world.

X-ray photography, or X-radiography, is quite different to conventional photography. Conventional photography uses reflected light to record an image on film, whereas X-radiography records the shadow image created by radiation penetrating the subject. X-rays break the direct visual relationship with the subject that normally occurs

This male gecko has regenerated its tail with cartilage, which is obvious by the lack of vertebrae.

X-RAYS

The elongate shell *Terebra maculata* was collected in the Torres Strait, northern Queensland.

in conventional photography. With X-radiography there is always an element of the unknown and anticipation as each X-ray reveals more of the complexity and beauty of nature.

To a biologist an X-ray of an animal may provide important clues in species identification. With bats, for example, one species-defining characteristic shows up in the shape of a small bone in the penis. Fish are often difficult to identify without looking at the skeletal structure, and often the skeletal structure is too fragile to be dissected, or it may be a type specimen (the original specimen that first identified the species) and thus cannot be interfered with. In these cases, an X-ray can provide the internal information required. It may also show that the animal was pregnant or the remains of its last meal.

A conservator can use X-rays to see how artefacts are constructed and whether any non-visible damage exists. In paintings, an X-ray can reveal the type of paint used, which can aid in dating and identification. It can show how many layers of paint are on a canvas, indicating whether another painting lies beneath. Flaws in wood items such as artefacts and musical instruments can be detected to help diagnose structure and determine an accurate treatment. Even a certain type of fossil can be X-rayed. Rocks and minerals are X-rayed to check the structure, flaws and purity.

The Australian Museum uses an industrial X-ray unit that can provide up to 1,199 kilovolts: strong enough to X-ray metal and cement structures. As most of the Museum's X-rays involve soft-tissue, a much lower strength of 30–40 kilovolts is used, with exposures ranging from 15 seconds to five minutes. The variation depends on a number of density-related factors, such as the amount of bone, soft tissue and the age of the subject. Older specimens and those that have been kept in alcohol are less dense than newer ones because of the lower level of water present, and so require less exposure. However, even the one subject may have such a broad variation of densities that a single exposure may not be able to record all the information needed. Medical X-rays of live subjects use much shorter exposures, filters and intensifying screens to avoid tissue damage, but this type of X-ray gives lower resolution and sharpness, and so is unsuitable for the Museum's diagnostic purposes.

For me, the use of X-radiography has opened a new area of interest and I find that an X-ray image not only reveals the diagnostic information, it is also an exciting visual experience.

A four-day-old female baby Mandrill (*Mandrillus sphinx*) that was donated to the Australian Museum by Taronga Zoo after its premature death in June 1977.

A young adult tube-nosed bat (*Nyctimene* sp.).

"Is there a biological basis for a distinction between body and soul evident in the activities of the mind?"

IN SEARCH OF A SIMPLE SOUL

BY MICHAEL ARCHER

SCHOOL OF BIOLOGICAL SCIENCE, UNIVERSITY OF NEW SOUTH WALES

THE FIRST ABC SCIENCE SHOW I EVER heard included an interview with a Hare Krishna who declared that NASA had deliberately misled the world into thinking that the Moon was a lifeless wasteland. He knew this because Krishnas had already travelled there, by mental projection, and discovered a paradise with lakes of milk and moon maidens. Scientologists, followers of Ron 'If-you-want-to-get-rich-invent-a-religion' Hubbard, are similarly convinced that, if they are sufficiently 'clear', they can visit Venus while their mindless bodies await their return. Reality-bender Uri Geller lay down on a couch before five witnesses; when he got up he explained he had just been for a stroll on the beach at Rio de Janeiro—and tipped sand out of his shoe to prove it.

Most religions are committed to a distinction between body and soul, the former being made of Earth matter, the latter some unexaminable, spiritual ether. To approximately 75 per cent of all Australians committed to this shell-and-spook view of human life, death marks the final separation of body and soul when the body once again returns to mud and the soul drifts off to become a spirit, reincarnated lawn prickle or whatever.

Intuitively convinced of our schizophrenic nature, we ask questions like 'What would things have been like if I had been born a lion or a duck?' or 'Would life be more exciting if my mind were in someone else's body?', as if our inner 'self' has an inherent existence of its own, capable of shifting without change to another body. Surely this is because most of us *want* to believe that at least the thinking part of us, bundled up with memories, will survive the ravages of the 'worm', this guarantee being the carrot priests jiggle over the doorway to divinity.

Self-awareness and memories are clearly key components of the concept of 'soul', for what, after all, would be the point of reunions with defunct loved ones if we were neither aware of our postmortem selves nor able to recognise anyone else? Because mental activity and memories are the source of our sense of individuality, it is these that invite closer examination. Is there a biological basis for a distinction between body and soul evident in the activities of the mind? Is there something inside us, be it soul, self, or consciousness, that cannot be accounted for by the sum of the body's Earth stuff?

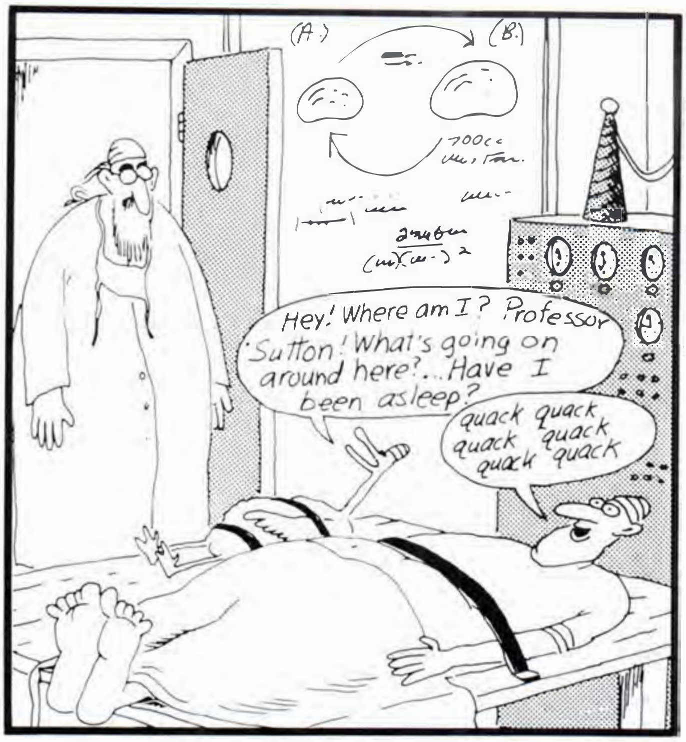
"... most of us *want* to believe that at least the thinking part of us ... will survive ..."

The human brain is an organ consisting of billions of neurons (nerve cells) with trillions of intercell junctions (synapses) where about 20 to 30 different chemicals relay or terminate electrical impulses between the ends of adjacent cells. In creatures with smaller brains, there are fewer cells and far fewer interconnections, but brains develop basically the same way in all animals. Embryology and the fossil record demonstrate how the nest of ensnared neurons in our nut evolved: by S-bend folding and gradual enlargement of the anterior end of the much smaller, tube-like nerve cord of our ancestors. In the evolutionary passage from fish to primates, the brain became larger and more complex with particular regions committed to coordinating particular parts of the body. Yet even simple creatures such as flatworms learn to run mazes, a task that requires memories as well as instincts and goals that relate the animal to its environment—mental attributes that should urge us to consider that many creatures other than ourselves have a sense of 'self'.

Psychobiology is the study of the way the 'minds' of animals work. It is a relatively young science whose focus comes closest to addressing questions about the distinction between body and mind. What do psychobiologists conclude about concepts of 'mind' and 'self'? William Uttal suggests that "mind is to the nervous system as rotation is to the wheel", rotation being the sum of the wheel's organised movements and not an independently existing thing. Morgan Hunt suggests that mind is to the brain as a flame is to a candle or digestion is to the stomach. The brain is what is; the mind is what the brain does. Should we, he argues, conclude that digestion is a spirit that inhabits the stomach, or that flame is a ghost that lies dormant in a candle? These and other psychobiologists are convinced that all of what they study as 'mind' is explicable as attributes of the material substance of the brain, there being no known brain activity that requires the presence of a non-substantial flatmate.

Given that memories are products of the mind's activities, and presumably a prerequisite for self-aware 'souls', it is appropriate to consider how the brain develops and stores memories. Psychologist Marvin Minsky concludes from his research that it stores information about an object in different areas of the brain, as nerve clusters, and links these clusters to each other by a dynamic web of intercell connections—these bundles of interconnected nerve cells being the tangible and whole stuff of memory.

The mental concept of 'apple', for example, consists of a network of cellular connections each of which codes for one of the apple's attributes. For example, connections representing taste are constructed in response to nerve impulses received by the brain from the sensory nerves of the tongue. These are linked to another cluster of connections for smell formed in the brain when stimulated by the olfactory nerves that innervate the lining of the nose. And so on for other attributes such as shape, colour and texture. Even the sound of the spoken word 'apple' is converted to connection clusters and these cross-linked to other clusters (such as for the word 'red'), the sum of these intercell connections being our concept of 'apple'. In turn, the various clusters used to store the mental concept of 'apple' are cross-linked to others such that, for example, clusters for the *word* red and *colour* red, which form part of the integral concept of 'apple', would also be bound into another web of linkages collectively representing the *shape* of the letter 'S' on Superman's leotard.



Psychobiology suggests that our sense of 'self' arises soley from the physical stuff of the brain

It has been speculated that a person's intelligence is at least in part a measure of the number of such *interconnections* the brain develops, which in turn suggests that IQ ought to be enhanced through the process of continued learning with its increase in intercell linkages. Conversely, Alzheimer's disease and other conditions that reduce brain function may involve a loss of previously formed connections or at least a reduction in the efficiency of the interconnection network. Ultimately, if memory is the sum of these vital interconnections, death of the body upon which the brain depends must undo the sense of 'self' that emerged from the network of nerves, just as decomposition of the substance of a candle must snuff out its flame.

Could 'near-death' sensations provide evidence for a self-aware substance that leaves the inanimate body after death? Perhaps; but there are also rational, mechanistic explanations for these impressions, which can also be artificially triggered in healthy individuals by drugs. Psychobiologist Susan Blackmore points out that one of the most common features of near-death experiences is memory of a tunnel with a light at the end. While some would like to think of this as the passage for the soul towards a Heavenly light, Blackmore suggests these sensations may be the last glimmerings of the brain's neural nets as they shut down around the tubular, most basic and last to be sacrificed part of the brain—the hollow brain stem. Storage of concepts as dismembered, cross-filed and often repetitious bits within a self-rearranging maze of billions of interconnected neurons might not seem like a system we would design if faced with the task of constructing an artificial intelligence. But, like other organs of the body, the brain's functions have evolved over time. What may now seem a jerry-rigged and frequently fallible electrician's nightmare arose from a simpler and hence probably more efficient ancestral condition. But once the much smaller, minimally sufficient mechanism for brain function became established as part of the ancestral genome of animals, like the inefficient structure of the vertebrate eye with its built-in blind spot, basically we were stuck with it.

But so what if our heads are filled with an untidy, tangled mess of fatty cells? Inefficient eyes see; jerry-rigged blobs for brains create music as exquisite as Allegri's *Miserere* and—more remarkably—recall from memory every note of such complex creations (a feat performed by the 14-year-old Mozart).

So it is not surprising that psychobiologists, intrigued by the possibility of developing an artificial intelligence, have tuned into computers. Already these synthetic minds make optimally efficient decisions, play brilliant chess, sing songs and design perfectly shaped shells for molluscs that haven't yet evolved. But when we sit in judgement of the 'creative' products of computers, we are not as easily impressed—computer creations seem just a bit *too* perfect, perhaps because they never fail to follow their training. Human creativity often arises from failure to follow some previously accepted set of 'rules'.

Is there biological evidence for something inside us that is more than the sum of the body's Earth stuff? The best answer at present seems to be 'no'—or at least none that any psychobiologist has found essential to explain the complexities of mind. Of course, that is not to say that there *isn't* something else inside us, something unseen, unexaminable. But, if a non-material sentient 'ether' does dally within, as more of the biological basis for the magic of mind is understood, the possible relationship between this 'ether' and the material stuff that accounts for the flame of the brain becomes tenuous to the point of faith. ■

Suggested Reading

Anon., 1984. The mystery of consciousness. Pp. 16–27 in *Origins*. Bhaktivedanta Book Trust: Los Angeles.

Bergland, R., 1986. *The fabric of the mind*. Viking: New York.

Beyerstein, B.L., 1988. The brain and consciousness: implications for psi phenomena. *The Skeptical Enquirer* 12: 163–173.

Blackmore, S., 1988. Visions from the dying brain. *New Sci.* 5 May 1988: 43–46.

Gordon, H., 1987. Out of body travel and other new age wonders. *The Skeptical Enquirer* 11: 348–350.

Hunt, M., 1982. *The universe within: a new science explores the human mind*. The Harvester Press: Brighton.

Legg, C.R., 1989. *Issues in psychobiology*. Routledge: London.

Uttal, W., 1978. *The psychobiology of the mind*. L. Erlbaum: New Jersey.

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"Mating between species is like mating between individuals. If you can't stop it, then there has to be a prophylactic."

INFERTILITY: A CONDOM FOR SPECIES?

BY GLEN INGRAM & RALPH MOLNAR

VERTEBRATE ZOOLOGY, QUEENSLAND MUSEUM
VERTEBRATE FOSSILS, QUEENSLAND MUSEUM

DRAMATIS PERSONAE

The Biological Species Concept
The opinion that species are groups of individuals that breed among themselves but are reproductively isolated from other such groups.

The Recognition Concept of Species
The opinion that species are groups of individuals, both male and female, that share a common fertilisation system.

Reproductive (Premating or Postmating) Isolating Mechanisms
Characteristics of organisms that ensure different species either do not mate or, if they do, the mating is unsuccessful or, if it is successful, the hybrids are infertile.

Fertilisation System
Characteristics of organisms that contribute to bring about fertilisation.

THE FINAL ACT

The rainforest smelled of rotting things. The humidity was overbearing. A creek limned in silver by the moon softly murmured as it ran through a rock pool. Above, in the fork of a Black Bean, sat a Koala. Every now and again he adjusted his position but his eyes never left the bushes by the rock pool. He was not the only one who stared intently there. Incredibly, next to him sat a Baza. In the moonlight, the eyes of the bird-of-prey seemed to glow. Both animals were obviously waiting for something to happen.

Baza: Croak.
Koala: Shush!
Baza: Croak, croak.
Koala: What are you doing? You'll spoil everything.
Baza: I'm trying to get the frogs to call. I'm tired of waiting.
Koala: We wouldn't have to be here if it weren't for you. It's all your fault. If you hadn't eaten the rainbow skinks right in the middle of our last experiment, we'd have been able to choose between the Biological Species Concept and the Recognition Concept of Species (see ANH vol. 23, no. 3, 1989–90).
Baza: Speaking of food—croak, croak, croak.
Koala: I had all but proven to you the correctness of the Biological Species Concept when you flew down and ate the experiment out of spite. Now we have to do it all again. Although I don't know why I bother. You Recognition Concept people are so wrong.
Baza: Croak, croak.
Koala: And, besides, that's not the call of *Litoria chloris*, the Southern Orange-eyed Treefrog. Only the Common Green Treefrog croaks.
Baza: Well, what is their mating call? We haven't got all night.
Koala: I'm not sure. I heard a tape recording once. It...
Baza: Ribbit, ribbit, ribbit.
Koala: That's an American frog. This is not "Sesame Street".
Baza: Pop, pop, pop...
Koala: Stop it!
Baza: ...pop, pop, pop...
Koala: Arrgghh!

Just then, the bushes by the rock pools exploded in a series of screams. Arrgghh Arrgghh Arrrggghh Arrrrggggghh. *The screaming intensified as more and more frogs joined in and soon the whole creek reverberated.*

Koala: Now I remember.
Baza: Impressive Fertilisation System!
Koala: Impressive Premating Isolating Mechanism!
Baza: Rubbish! The call is a signal by which the female is attracted to the male. It's just part of the Fertilisation System in which they share.
Koala: While it may be part of a Fertilisation System, the call functions to isolate the species from all other species.
Baza: You seem to be saying that, because there are species, there is a Fertilisation System. On the contrary, species are a consequence of a Fertilisation System. They are accidents of sex.
Koala: Species are not accidents of sex. They are the basic units of evolution. Species evolve because of natural selection acting on the isolating mechanisms.
Baza: I can agree with you to a certain extent, only in that natural selection acts on Fertilisation Systems. If we assume Fertilisation Systems are roughly equivalent to Premating Isolating Mechanisms—which they aren't—then our mechanism for speciation is the same. For example, a small number of Southern Orange-eyed Treefrogs may become isolated in a new habitat. The new habitat is a new world of environmental parameters. In it there are new selection pressures that act to select a different mating call. Voilá, a new species. And, by the way, this also explains why organisms are restricted to specific habitats. The Fertilisation System works effectively in the habitat in which the species evolved.
Koala: I accept what you say. Frankly, you have just mouthed classical theory induced from the Biological Species Concept: founder populations and all that. As I've always said, you Recognition people have nothing different to say from us. Your argument has always been about semantics.
Baza: I beg to differ. While you may have thought of the idea of small, founder populations, you couldn't come up with an explanation for what actually happens during the process of speciation. You never thought of the idea that Fertilisation Systems are adaptations to the environment, that there is a close connection between habitat and the Fertilisation System. And you know why? Because you were too hung up on isolation. You can never have a Reproductive Isolating Mechanism that is an adaptation to environment. Your concepts and words restricted you.
Koala: Semantics, semantics, semantics.
Baza: If Reproductive Isolating Mechanisms were just about premating ones, maybe there'd be some truth to what you say. But they also include postmating mechanisms.
Koala: So what?
Baza: According to you people, species may be isolated from each other even if they do mate. Subsequently, either fertilisation is not successful or the offspring die during development or, if they live, they are infertile, or they may be inviable over several generations. In other words, the integrity of the species is maintained despite interbreeding. The mule and the hinny are good examples of sterility of hybrids.
Koala: I couldn't have said it better myself.
Baza: But it isn't true and I will prove it to you. You have chosen the venue for our last two experiments. Now it is my turn.

Koala looked around. It was useless to stay on there. All the frogs had fled at the sound of their arguing. So he reluctantly agreed to leave. The location of their next experiment was a rainforest hundreds of kilometres north. And, just like the last time, they sat in a tree and stared intently at the bushes by the creek.

Koala: Croak, croak.
Baza: Shush! That's not the mating call of *Litoria xanthomera*, the Northern Orange-eyed Treefrog!
Koala: What is it then? We've been here for hours.
Baza: That's a surprise. Now be quiet!
Koala: Pop, pop. Whaak, whaak. Whaak.
Baza: Arrgghh!

Just then, the bushes by the rock pools exploded in a series of screams. Arrgghh Arrgghh Arrrggghh Arrrrgggghh. The Koala had a terrible fright. But almost immediately his fear turned to curiosity. He sensed that Baza had set up some sort of trick.

Koala: There are Southern Orange-eyed Treefrogs here too?
Baza: Nope!
Koala: Sounds like them to me. What are they then?
Baza: Northern Orange-eyed Treefrogs! And the mating call is exactly the same as the southern species!
Koala: Then why is it called a different species?
Baza: Because they have done genetic analyses and decided that the two forms were sufficiently genetically distinct from each other such as to warrant specific status.
Koala: I see. And because there is genetic difference, they have hypothesised that the offspring will be inviable if interbreeding does occur. And because the mating call is the same, there is no Premating Isolating Mechanism and so interbreeding can occur. Does it?
Baza: The question can't be answered naturally. The two forms are separated by a large gap in the rainforests. However, they have done *in vitro* fertilisation and raised the young. These have shown deformities and are thus assumed to be inviable, or partially so.
Koala: Then I agree with their decision. This is a classic case of a Postmating Isolating Mechanism.
Baza: There you have it! We have now reached the central part of our disagreement. And it is not a question of semantics! I disagree strongly with the decision. According to the Recognition Concept, they are the same species: they share the same mating call and thus the same Fertilisation System.
Koala: Rubbish! They are reproductively isolated from each other.
Baza: Then you tell me what part is played by Postmating Isolation Mechanisms in speciation. For example, how is sterility selected for by natural selection?
Koala: What do you mean? You're not very clear.
Baza: It's simple. Your Postmating Isolating Mechanisms are about not having offspring; but how can you select for not having offspring? For change to come about through time, there must be offspring. Darwin himself was aware that Postmating Isolating Mechanisms couldn't be selected for and thus had no part in speciation, *and* thus were not characteristic of species.
Koala: Be it not me to criticise the great man but it wouldn't be the first time he was wrong. I'll answer you simply. Imagine a burrow of water rats in which, by mutation, the parents have produced a litter where all the siblings are reproductively isolated (postmating) from all other individuals but not each other. When they grow up they mate with each other and produce more reproductively isolated individuals. Voilá, a new species is born.
Baza: Simple but stupid. If this litter did grow to adulthood, they'd have to mate just with each other in a large population. The probability of this is low. In fact, it has been shown experimentally that, even with large numbers of organisms that have partial or full reproductive isolation but share 'Premating Isolating Mechanisms', after several generations only individuals of one population were left. Usually the population that survived was larger numerically in the beginning. It is simple mathematics: the more numerous kind has a bigger chance of mating with its own kind and thus having offspring; the less numerous kind has a bigger chance of mating with the other kind and not having offspring, which will lead to their elimination in the end.
Koala: All right. Let's imagine the parents are totally isolated from the parent population and their offspring successfully found a new population.
Baza: So what? If the populations ever do come together again, one will be bred out.
Koala: Now don't be pedantic.
Baza: To make it simpler for your eucalyptus-addled brain, imagine your mutation was for polka dots. Soon there would be polka-dotted rats cruising the streams but no-one necessarily would call them a new species. Like polka-dots, Postmating Isolating Mechanisms can be characters of species but not necessary features. But there the analogy ends because polka dots may be part of the Fertilisation System: they may be the signal by which mates recognise each other. Postmating Isolating Mechanisms can never be part of the Fertilisation System. Thus they are irrelevant to speciation and useless for recognising species.
Koala: Listen vermin-eater, polka dots are not characteristic of species: reproductive isolation is. And, if mating does occur, Postmating Isolating Mechanisms maintain the integrity of species!
Baza: Condoms!
Koala: I beg your pardon!
Baza: You're confused by condoms. That's your problem.
Koala: I've never been so insulted!
Baza: Don't get your pouch in a twist. It's a metaphor. Your ideas of Postmating Isolating Mechanisms are just like condoms. You Biological Species people seem to think that mating between species is like mating between individuals. If you can't stop it, then there has to be a prophylactic. But speciation is not like...
Koala: Please!
Baza: And if I carry the analogy further, you can say I'm saying that it is best to say "No" in the first place; and species do say "No". While you're saying they try to say "No" but...
Koala: Arrgghh!
Baza: ...

But Baza's words were drowned out by a renewed chorus of Northern Orange-eyed Treefrogs—or was it Southern? ■

Ligon: a sterile hybrid between a male Lion and female Tiger.

Suggested Reading

Beardsell, G.R., 1989. Hybridization of *Litoria chloris* and *L. xanthomera* (Anura: Hylidae). *Trans. R. Soc. S. Aust.* 113: 221–224.

Ingram, G.J., 1989. Bestiality and the recognition of sexual mates. *Aust. Nat. Hist.* 23: 256–257.

Lambert, D.M. & Paterson, H.E.H., 1984. On 'Bridging the gap between race and species'. The isolation concept and an alternative. *Proc. Linn. Soc. NSW* 107: 501–514.

Paterson, H.E.H., 1988. On defining species in terms of sterility: problems and alternatives. *Pac. Sci.* 42: 65–71.

Dr Ralph Molnar is Curator of Palaeontology at the Queensland Museum. His research has been directed towards filling the vast gap in knowledge of Australian vertebrate history between the Devonian and Miocene. Dr Glen Ingram is interested in evolution and the philosophy of science. In 1987 he received a special commendation from the BBC Wildlife Nature Writing Awards.

QUESTIONS & ANSWERS

COMPILED BY JENNIFER SAUNDERS

EDITORIAL COORDINATOR

Ocean Hues

Q. The wonderful blue colour of the ocean on the cover of ANH vol. 23, no. 3, 1989, together with a recent holiday to the West Indies (where the ocean looks more turquoise than blue), has led me to ask what it is that makes the sea a different colour in different parts of the world.

—Carl Barwell
Miranda, NSW

A. When light strikes the ocean it can either penetrate or be reflected from the surface. Of the light that penetrates, a varying percentage will be absorbed and the remainder will be backscattered towards the surface. It is this backscattered light that accounts for the colour of the sea's surface. Different colours are observed because different wavelengths of light do not penetrate equally. Infra-red and ulatra-violet wavelengths, for example, are absorbed rapidly in the top ten metres. In clear water, yellow–red wavelengths do not penetrate as deeply as the blue–green wavelengths of the spectrum, so it is the blue–green wavelengths that predominate in the light reflected from below the water's surface. Therefore, in the clear waters of winter or nutrient-poor oceans, blue light is predominantly backscattered and so we see a blue ocean. In spring, summer and more biologically productive turbid coastal waters, more green light is backscattered and so we see a greener ocean. In coastal waters where there is a greater amount of phytoplankton, runoff from the land and suspended matter, the water colour varies within short periods from extremes of red–brown to green or yellow due to the differential absorption of the light by various substances. It is interesting to note that sometimes the water's colour is due to the pigmentation of minute organisms. 'Red tides', for example, are caused by red–brown dinoflagellate algal blooms.

The shade of colour can also vary. If, for example, in clear water, the seabed is shallower than 30 metres and of a high reflectance material like light coloured sand, then a blue–green light will be reflected rather than a blue one. In these circumstances a turquoise ocean will be visible, such as the one observed in the West Indies.

Don't forget that the colour we see also depends on the distribution of light-sensitive cells in the retina of the eye and so, even if the ocean may look deep-blue to you, to another person it may appear grey–blue.

—Anna Murray
Australian Museum

Why is the ocean blue?

TSUNEO NAKAMORA/APL

Snake Myths

Q. I've been living in the bush (Otway Ranges, Victoria) for five years now and, like all ex-city people, I get to hear some very unusual tales about wildlife. One local belief is that Eastern Tiger Snakes (*Notechis scutatus*) become very aggressive in February, supposedly their breeding season. I see dozens each summer, but none does anything more than issue a polite warning when taken by surprise and then move away. (Of course, these may be too small to breed, as none of them reaches the four-metre average length reported by other locals!)

Copperheads (*Austrelaps superbus*) are also common here, especially in my waterplant nursery where they hunt for frogs. I find Copperheads are even better behaved than tigers, but several confused tales are attached to their behaviour in water. One school claims they can't or won't open their mouths while in water (which would make it rather difficult to catch frogs), while another school regards them as exceptionally dangerous when in water. As far as I can see, a person would be lucky to get near a swimming Copperhead to find out either way. What comments do you have on these apparent myths about snake aggression?

—Nick Romanowski
"Dragonfly Aquatics", Vic.

A. I agree that these stories are indeed myths—snakes are not usually aggressive and they are entirely capable of opening their mouths under water. Both of these myths are international and unfortunately their obvious inaccuracy doesn't seem to have decreased their popularity.

—Rick Shine
Sydney University

Bird Adoption

Q. Recently we have been lucky enough to have a flock of Rainbow Lorikeets inhabiting our neighbourhood. I suspect this is because of all the flowering native plants that surround us, but they may also be encouraged by a neighbour who puts food out for them. I have heard that the sugar/honey bread mix that they are so fond of can be harmful for them. Could you please tell me what sort of food is best to put out for these birds?

—Julia Bierton
Balmain, NSW

A. Many people like to encourage native birds such as Rainbow Lorikeets to their gardens by feeding them an artificial diet. However, this is often not a suitable diet and may cause problems such as nutritional deficiencies and the spread of disease.

The best way to attract lorikeets to your garden is by growing lots of native plants that can provide these birds with a natural source of food. Some planting suggestions include Coastal Banksia (*Banksia integrifolia*), Old Man Banksia (*B. serrata*), Silky Oak (*Grevillea robusta*), Broadleaf Paperbark (*Melaleuca quinquenervia*), kangaroo apples (*Solanum* spp.), cestrums (*Cestrum* spp.) and flowering gum trees. A birdbath in an open area of your garden can also be useful in attracting lorikeets. (There are many books available on this subject and often your local nursery can offer advice.)

Rainbow Lorikeets bring more responsibility than most people realise.

DAVID BALL/APL

If you do want to feed the lorikeets, there are a couple of points you need to consider. First, the birds will fast become dependent on the regular feedings to the point where it would be detrimental to them should you suddenly stop—even for annual holidays someone should continue the feeds while you are away. And second, hygiene is of the utmost importance. All feeding areas should be kept very clean in order to prevent the spread of disease.

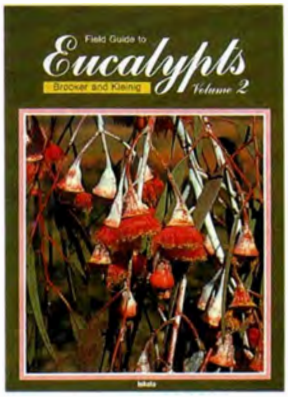
However, if you are willing to accept these responsibilities, then a good diet that is easy to prepare should include a wide variety of fresh fruit such as apples, pears, grapes and oranges; a seed mixture as is sold for Budgies; mixed greens and sprouted seed; Wombaroo lorikeets mix (made fresh daily and available at some pet shops or veterinary surgeries) *or* nectar mix made up of three parts Heinz high protein baby cereal, one part honey plus one teaspoon Petvite vitamin supplement per cup of nectar mix. Add enough water to make the mixture of porridge consistency. The nectare mix should be used only at a rate of one teaspoon per bird while the rest of the diet can be given freely. Additionally, it is a good idea to place the food in a shaded area to prevent it spoiling.

—Liz Notley
Taronga Zoo

REVIEWS

COMPILED BY JENNIFER SAUNDERS

EDITORIAL COORDINATOR



Field Guide to Eucalypts Volume 2

By M.I.H. Brooker and D.A. Kleinig. Inkata Press, Sydney, 1990, 428pp. $76.95.

Ian Brooker and David Kleinig are well qualified to write on *Eucalyptus*, both having worked with this genus while in the CSIRO Division of Forest Research. David Kleinig also contributes hundreds of excellent colour photographs that have been beautifully reproduced to form one of the main features of this book. In this volume, the authors deal with the eucalypts in the area of Western Australia below 26° C, most of South Australia (except the south-east which was in volume 1), and the area of New South Wales west of the Darling River. The excellent introductory chapters deal with the characteristics of eucalypts via mini-glossaries, figures and photographs. These sections of the book are essential for efficient use of the clearly printed and spaced botanical keys. There are five keys for Western Australia, two for South Australia and one for New South Wales. One minor drawback is the use, in a few places, of juvenile leaves and seedlings as characters. Many people are unfamiliar with these leaves and they are often not available.

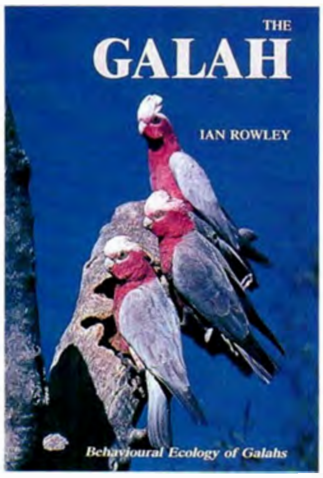
Each of the 326 taxa dealt with (including 11 recently described and 78 not yet properly named) has a clear botanical description. Each description includes features to aid in identification printed in bold type; excellent photographs; a small distribution map; almost always the habit, bark, buds and fruits; sometimes the juvenile leaves and/or adult leaves showing oil glands; and occasionally the flowers. This information forms the bulk of the book and, in conjunction with the keys, should be helpful in identification.

Forty-five of the taxa are listed as 'ined.' (meaning they have not yet been properly published according to the International Rules of Botanical Nomenclature); another 26 are given alphabetical names, for example '*Eucalyptus* sp. D', because they are being dealt with by other botanists; and seven are given informal names such as 'sessil fruit'. If the authors had been able to publish even brief Latin diagnoses with the 'ined.' and other informally mentioned taxa, then this book would have been invaluable as the legitimate publication venue for the new taxa. This problem shows the difficulty of trying to be complete in the treatment of any botanical group, and this is further borne out by the Appendix, which lists 38 more taxa from Western Australia alone that were discovered or described since the completion of the book. It makes me think that, when all these new taxa are formally described, a few more eucalypt trees will need to be cut down to provide paper!

One last point: the invention of common names, as is done in this book, is always a vexed question. If the plant has no *commonly* used name, then perhaps it should be left like that, rather than inventing one for the sake of a common name. The use of Aboriginal names when used by the original people, as has been done in some cases, is far more acceptable.

This book, which is 27 centimetres tall and weighs 1.5 kilograms, is hardly a 'field' book, but it is a most useful addition to any botanist's library and should prove most valuable to people living within the areas covered.

—George Chippendale



Behavioural Ecology of Galahs

By Ian Rowley. Surrey Beatty & Sons, Sydney, 1990, 188pp. $39.60.

Few results of long-term studies of Australian animal populations have ever been published. Therefore, it is refreshing to come across a book that summarises several years of study of one species population—the Galah in the wheatbelt region of south-western Western Australia. This publication, which is really a lengthy research paper, will be of interest to the serious ornithologist, population biologist, classical ethologist, behavioural ecologist and, to a lesser extent, the conservation biologist. It is also a narrative that is informative and interesting to the general birdwatcher.

The study upon which this book is based was initiated by the CSIRO Division of Wildlife Research in 1969, but most of the work described was conducted between 1970 and 1977. Manmanning, a town in the south-west wheatbelt, was chosen by the author as the study site for examining the pest status of Galahs in grain-producing areas. However, the book also presents some results from Mileura Station (located in semiarid mulga woodland) and Coomallo Creek (in coastal heathland) for comparison.

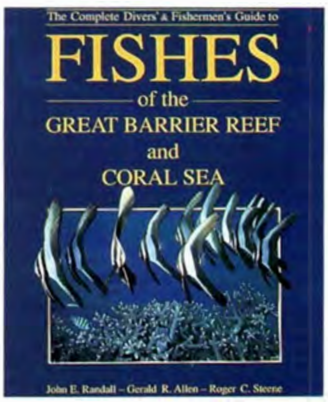
Chapter 1 introduces the Galah to the reader, detailing nomenclature, plumage description and geographical distribution. The study areas (location, history of European settlement, climate, topography and vegetation) and the methods used in the study are described in Chapter 2. Subsequent chapters deal with the Galah's feeding ecology, behavioural displays (individual and social), social organisation, patterns of daily activity, the complete breeding cycle (from the parents' selection of a nest hollow through to the post-fledging phase), and productivity and survival of populations.

Overall presentation of the book is very high in quality. The text is well spaced, there are large and clear reproductions of line drawings and tables so that detailed examination can be made in comfort, and there are few typographical errors.

This book, along with many other of Rowley's publications, demonstrates the author's love of natural history as well as his expertise as a professional biologist. The magnitude of the study and the amount of data presented in the book are impressive. However, I feel that a theoretical biologist would be disappointed that Rowley seldom ventured into theoretical discussions of the data, nor was there much comparison with other species, especially other cockatoos. How has the Galah's reproductive strategy ensured population growth and a massive expansion of the species range, and does the same strategy work for other parrots? Does the population growth of the Galah conform with theoretical models of population growth? Which theories of foraging ecology are best supported by the Galah data? Perhaps Rowley made a conscious decision to steer away from the more theoretical aspects of the study. He has certainly presented the detailed data in a concise fashion, which should allow many theoretical biologists to draw their own conclusions about the Galah's life-history strategies.

While acknowledging the pest status of Galahs, Rowley indicates that the advent of modern agricultural machinery and improved grain storage facilities has reduced the need to introduce pest control measures. In fact, in his concluding statements, Rowley is more concerned for the future of Galahs and other cockatoos, and stresses the importance of conserving mature trees that provide nest hollows—a message that should be heeded, not just by farmers, but by us all.

—Stephen Ambrose
Australian Museum



Fishes of the Great Barrier Reef and Coral Sea
By John E. Randall, Gerald R. Allen and Roger C. Steene. Crawford House Press, Bathurst, 1990. 507pp. $69.95.

Australia is richly endowed with fishes (more than 3,600 different species) and the Great Barrier Reef has more species of fishes associated with it than any other area. Due to this abundant number of species, identification has always been a problem, and previous guides have not attempted a comprehensive coverage. At last, a book has been published with a majority of the species (over 1,100) well illustrated with good colour photos accompanied by concise descriptions.

The book begins with a map of the area, eight pages of outline drawings of 104 of the 111 fish families covered (essential for the novice identifier, as no keys to families or species are included), and 12 pages of text and general photos that include descriptions of different reef areas and a "How to use the book" section (scientific nomenclature, distribution and identifying characters such as fin ray counts and body measurements are discussed here). A double-page spread of fish photos with labelled parts handsomely replaces the diagrams found in most fish identification books. The main text is followed by a four-page glossary of technical terms and a 20-page index. Surprisingly, there are no references to previous works or further reading.

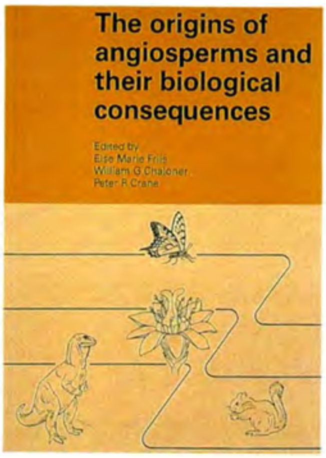
The bulk of the book is made up of colour photos of fishes together with brief species descriptions. The photos are supplemented by seven plates of Roger Swainston's colour paintings of hard-to-photograph fishes. Each family introduction includes information on the general biology and habits of the species, while the brief species accounts are largely limited to a description of diagnostic features, maximum size and distribution. With the exception of the sharks, individual notes on species biology are not included. Each description is directly adjacent to the colour photo(s) of that species and these are large enough to be used for identification purposes. Where colour patterns are different in males and females, or juveniles and adults, two or even three photos are included.

Only a few errors were found: the milkfish family Chanidae is misspelt and its larva is not a leptocephalus, but more similar to that of a sardine (page 48); a third species of pineapple fish occurs in the south-eastern Pacific (page 59); and the longspine burrfish occurs in New Guinea (the New Zealand species is *Allomycterus pilatus*; page 480). The authors have a wealth of experience with coral reef fishes, and all have written a large number of fish books. Nevertheless, I cannot resist some suggestions for improvements in future editions or to mention some aspects I found either irritating or frustrating. My first three are technical and should not bother the typical user. The species newly recorded from Australia (ten noted in the first 100 pages) are, in general, not clearly stated as such, and no specific localities are listed. This will therefore require further research from future compilers. The first use of new name combinations is also frustrating. While the use of the most up-to-date names is commendable, hopefully publication of the justifications will soon follow in the scientific literature. The dropping of '-id' from the spelling of some family names, resulting in grammatically incorrect forms, seems arbitrary and subjective.

Of more general concern is the absence of any information on the details of distribution within Australia or the area covered for any of the species. Also, some fishermen may be concerned with the minimal coverage given to such groups as the sardines, anchovies and mullets. Perhaps the addition of a few more of Swainston's paintings would solve the problem. A sentence in the family introductions stating the total number of species in the area would also give an idea of the percentage covered. My final concern involves the colour reproduction. This is a minor quibble, as all of the figures allow identification of the species illustrated. However, the colour is not perfect and Swainston's plates in particular suffer, with too much black when compared with their better reproduction in Allen's book on north-western Australian fishes. Comparison of the photos here with those of the same species in Steene's virtual companion volume, the magnificent *Coral reefs, nature's richest realm* by the same publisher, shows the difference between good and excellent; improvement is possible for the next edition.

The above criticisms are minor and should not deter anyone from this volume. *Fishes of the Great Barrier Reef and Coral Sea* represents a quantum leap forward, giving everyone the opportunity to identify the vast majority of species in the area. I have used it a number of times and have yet to be disappointed. As many species have broad distributions, this volume can be of value in northern New South Wales, Fiji or Tahiti. It is destined to be a classic, and hopefully will be reprinted when sold out, as it is unlikely to be surpassed in the foreseeable future.

—John Paxton
Australian Museum



The Origins of Angiosperms and their Biological Consequences

Ed. by E.M. Friis, W.G. Chaloner and P.R. Crane. Cambridge University Press, Cambridge, 1987, 358pp. $51.00.

The scientific credentials of Friis, Chaloner and Crane guarantee this book's value and importance to all botanists, ecologists, palaeontologists and informed readers whose disciplines it encompasses. It is refreshing to find the origin of angiosperms (flowering plants) presented in a multidisciplinary context, and in a format that is midway between a textbook and one aimed at a non-specialist readership.

Chapters in this book summarise the present state of knowledge of the origin of angiosperms and their evolutionary stages, the changing climate and palaeogeography at the time when flowering plants and mammals were diversifying and modern-style fauna and flora were originating, and the interrelationships between flora and fauna. That this book is based entirely in the Northern Hemisphere is inevitable, as so little is documented for the Southern Hemisphere. However, the overview and summary presented are most useful, and books of this sort, which synthesise all the information from specialist scientific papers that are not readily available, are rare. In general, much that is described for the Northern Hemisphere applies to Southern lands as well, as flowering plants originated and started to spread and diversify during the beginning of supercontinent fragmentation.

The coevolution of insect pollinators and flowers; the influence of dinosaurs on vegetation (and *vice versa*); and the inferences that can be drawn about the nature of vegetation from a knowledge of the size, variety and abundance of animals at a specified time, are also discussed.

While much of the text of *The origins of angiosperms and their biological consequences* is fairly technical and requires some specialist knowledge, there is much to interest non-specialists. The comprehensive bibliographies for each chapter are particularly useful and an excellent glossary enables understanding of the scientific terminology.

—Mary White

Dinosaurs

By Eugene S. Gaffney. Western Publishing Company, USA, 1990, 160pp. $US4.50.

Yes, yet another popular book about dinosaurs. This one is roughly written in the format of a guidebook—a camp approach to dinosaur books overdone by British publishers. Popular books on dinosaurs are largely written either by non-professionals or by palaeontologists who do not specialise in dinosaurs. This book is no exception; Gene Gaffney is an expert on turtle evolution. What is different about this book is that it can be browsed or read with profit by the layman, the student and even the palaeontologist who does not specialise in dinosaurs.

Dinosaurs is a basic introduction to the subject. The content is divided between general topics and information on individual types of dinosaurs. The topics covered include how dinosaurs are reconstructed, whether or not they are 'warm-blooded', how large they were, and their ancestors and descendants. A refreshingly up-to-date classification is given and some of the more significant character states on which it is based are presented. To my knowledge this is the first popular book presenting such information.

The dinosaurs discussed are, not surprisingly in a book produced in North America, mostly North American. Even one type (*Iguanodon*) included as not being from North America has recently been discovered there! However, because North America has an almost complete sequence of dinosaurs, from Triassic through Cretaceous forms, representatives of all the major groups appear. It is not surprising that there is little mention of the few Australian dinosaurs, as even John Long's recent *Dinosaurs of Australia* spends only 23 of its 80 pages on Australian dinosaurs. Too little is known of them at present to attract much international attention, although recent discoveries in Queensland should change that.

Contentious issues are handled with admirable caution and scepticism, particularly in the areas of warm-bloodedness and extinction. This is one of the few books that, in discussing the brains of dinosaurs, points out that the so-called 'sacral brain' is not unique to dinosaurs, but is found in most other tetrapods as well. There are few things to complain about, however I was disappointed that in the discussion of extinctions a very important, but admittedly little known work, was not mentioned. Philip Signor and Jere Lipps demonstrated that, since the fossil record is incomplete, it is logically impossible to distinguish between abrupt and reasonably gradual extinctions. This implies that too many arguments on dinosaur extinction rely on faith, not facts (*Geol. Soc. Amer. Spec. Pap.* 190: 291–296; 1982).

Complaints apart, and they are small enough, this little book may be recommended to anyone wishing a general introduction to our current understanding of dinosaurs. Many popular and children's books in this area are anywhere from 20 to 50 years out of date; this one is not. Finally, look at the picture on page 51. Gene Gaffney could be counted on to sneak a turtle into this book somewhere, and there it is.

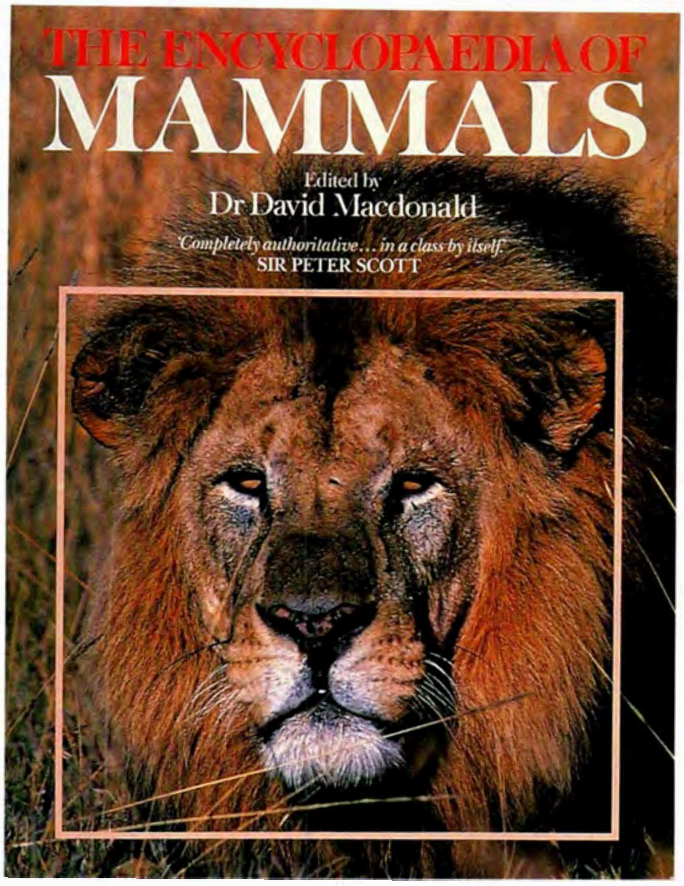
—Ralph Molnar
Queensland Museum

The Encyclopaedia of Mammals

Ed. by D. McDonald. Allen & Unwin, Sydney, 1989, 922pp. $99.00.

The encyclopaedia of mammals is a great work. It is certainly a most useful compendium, and with 22 advisory editors (three of which are now resident in Australia) and a host of contributors, there can be little doubt as to its accuracy. The information given is also up to date, but by far the most impressive (and indeed from an editorial point of view most taxing) aspect of the information is its sheer bulk. The book is nearly 1,000 pages long, and densely packed with facts. It is a tribute to the world's mammalogists that so much has been learned of this mostly cryptic group (about two-thirds of all mammal species are bats and rodents). Because of the uniquely comprehensive fossil record of mammals, acceptable diagrams showing the evolution of most groups can also be given.

An explosion of recent field studies means that many aspects of behaviour and ecology, unknown as little as a decade ago, are also available. Some of these will amaze even the most jaded of readers. Indeed, I suspect that anyone who reads the section on Naked Mole Rats (page 711) will come away a changed person. The vision



of these naked, pink and sausage-like rodents, which are unable to control their body temperature, surviving in deserts where temperatures of over 60° C have been recorded, is remarkable enough but it is only the beginning. The 'queen' Naked Mole Rat seems to control everyone's hormones. She is the only breeding female in the colony and when she is pregnant all other mole rats (whether male or female) resemble females externally. This mass sex change is achieved through pheromones excreted in the queen's urine, contact with which can change external sexual characteristics and stop you from breeding—if you're a Naked Mole Rat!

There must be about a thousand figures in this book, all serving to illustrate some interesting point that is expounded upon in the text. All are well laid out, visually attractive and easy to understand. The photographs are likewise numerous and of the highest quality. Many species are illustrated that I have not seen before, while others are seen in unusual and revealing situations. The listing of genera within subfamilies and families, and of species within major groups that appear on pages printed on grey paper, are useful summaries of mammalian diversity.

I can really only pick one major fault with this book, and it is an editorial one. Remarkably, the book treats only four of the five species of Hominidae; the world's most abundant and ecologically important mammal, *Homo sapiens*, has been left out! Indeed the family is still called Pongidae rather than the now widely accepted (and correct) Hominidae. Surely another seven pages (the space given to the Gorilla) could have been profitably used to give a concise synopsis of the anatomy, ecology and evolution of this most interesting species. This is really quite an inexcusable omission in what is otherwise a fine book.

Despite this dreadful error, I encourage anyone interested in mammals to buy this fascinating and information-packed book. Just don't forget that we belong to this amazing group of animals as well. Indeed, humans seem somewhat less remarkable when viewed in the company of their lactating brethren.

—Tim Flannery
Australian Museum

"Why should we worry about the loss of one more species when we have survived the loss of so many others?"

BIODIVERSITY: WHY SHOULD WE PRESERVE IT?

BY M. JULIAN CALEY

SCHOOL OF BIOLOGICAL SCIENCES, UNIVERSITY OF SYDNEY

RECENTLY, I WAS ASKED WHY WE SHOULD bother conserving species, particularly species that have only recently been discovered. The implication of this question was that we were no worse off when we did not know of the existence of these species, so why worry about them now that we do? The answer to these questions is to be found in the inescapable fact that the survival of humans as a species is absolutely dependent on the proper functioning of complex ecosystems. All of our food and oxygen are products of other species, and plants constantly filter our water supply. We cannot survive wholesale ecological destruction. Yet, ecological destruction is what we face in the 1990s. Never in the history of the world have species been exterminated at the rate we have managed in the last 100 years, and this rate is accelerating.

Still, why should we worry about the loss of one more species when we have survived the loss of so many others? We directly depend on only a subset of species for our minimum requirements, and therefore it may not be necessary to save them all. So which ones should we save?

If the goal is to ensure the survival of humanity, the requirement would be to save a subset of species that was sufficient to keep the ecosystems that support us functioning. To determine which subset is sufficient we would need to know which species are out there and understand their ecological roles.

To date, approximately 1.5 million biological species have been described. This is an impressive number, but the estimates of the total number of species on Earth range from three to well over ten million. So at best, we are familiar with the existence of only half the presently extant species; at worst, less than ten per cent. New species in all taxonomic groups continue to be described. Even now these recently described species include primates, dogs, marsupials, bats, rodents and a whole host of others. While these species had previously escaped the notice of taxonomists they are in no way insignificant or unimportant players in the habitats we now know them to occupy.

No species, human or non-human, exists in ecological isolation. Therefore, even if we had complete knowledge of species diversity, it would be a daunting task to then attempt to understand all the interactions between species. But without this information we are unable to predict the effects of the extinction of one species on another, or the point at which ecological collapse would occur. What we do know, however, is that the loss of individual species from a biological community can have profound effects on the community as a whole, affecting species that had interacted with the extinct species either directly or indirectly. Also, because of the complexity of these interactions, it is possible to push a system past the point of collapse before any danger signs can be detected. Therefore, the decision to preserve any one species, either locally or across its entire range, is extremely important and the cost of making the wrong decision immense.

"We cannot afford the luxury of more extinctions"

While we do not understand the exact role of most species in biological communities, we do know for certain that we have the ability to cause mass extinctions and ecological disruptions, and that such interference by us carries a great cost. Reductions in local species diversity have resulted in the famines in northern Africa, the worsening of floods on the Indian subcontinent and the degradation of farmlands throughout the developed and less-developed world. We also know that we have the ability to push ecosystems past the point of recovery. Some species of whales have not been hunted for decades yet their numbers remain low, and the early inhabitants of Easter Island appear to have rendered it virtually uninhabitable for their descendants. The list of ecological disasters goes on and on, and the costs of the loss of species are beginning to be felt throughout the world in terms of reduced productivity of agricultural land, increased costs of foreign aid, and human suffering.

Remember, though, that so far we have only considered the maintenance of enough species diversity to ensure continued human survival at some minimal level. If, however, we add on additional benefits that can be derived from maintaining a diverse biota, the argument for preventing further losses of species becomes even more compelling. There are many well-known examples of benefits derived from biodiversity that enhance the quality of human existence over and above our basic needs. These benefits include access to wild genetic stocks of our domesticated plants and animals, new species for domestication, medically active compounds, and the availability of species for the biological control of pest species, to name but a few. However, it is difficult to appreciate the total benefits that could be derived because we are unfamiliar with so many species, because we continue to derive new benefits from familiar species, and because we cannot anticipate future needs. In this situation, maintaining biodiversity can only provide more benefits than we can presently anticipate.

And what of the costs of maintaining biodiversity? Because continued human survival depends on it, it is hard to imagine a cost so great that it could tip the balance in favour of not maintaining biodiversity. Nevertheless, the costs are certainly trivial compared to the billions of dollars being spent on the search for extra-terrestrial life, an orbiting telescope, and mapping the human genome. Yet, billions are not being spent on maintaining biodiversity. The reason for this is that conserving individual species is commonly perceived as a luxury we cannot afford. On the contrary, the costs of previous extinctions are telling us very clearly that we cannot afford the luxury of more extinctions, whether or not the species is familiar or one that was described only yesterday. ■

Julian Caley is a Ph.D. student at the University of Sydney. His thesis is on the ways biodiversity is maintained in communities of coral-reef fishes on the Great Barrier Reef.

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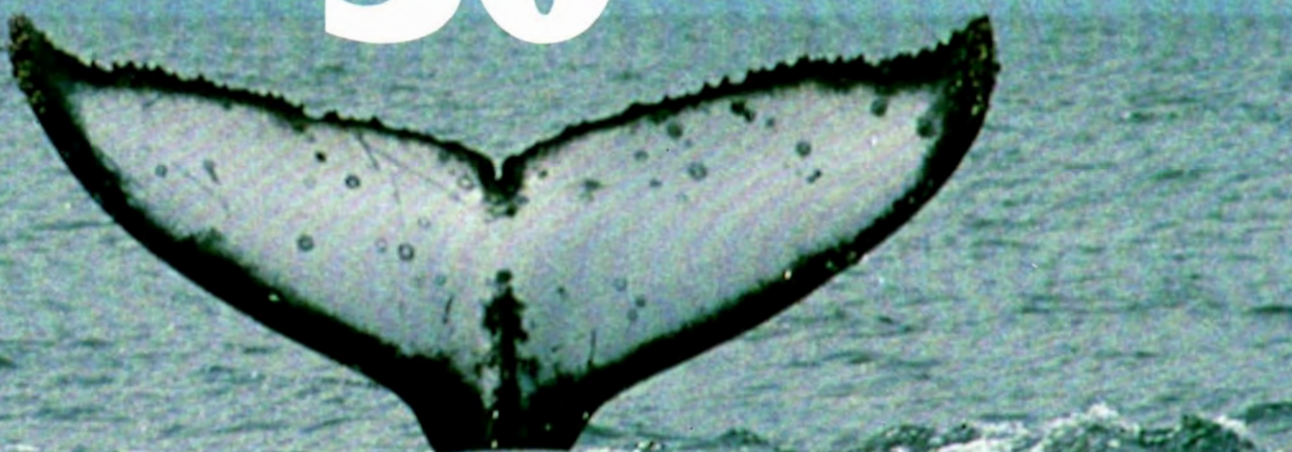

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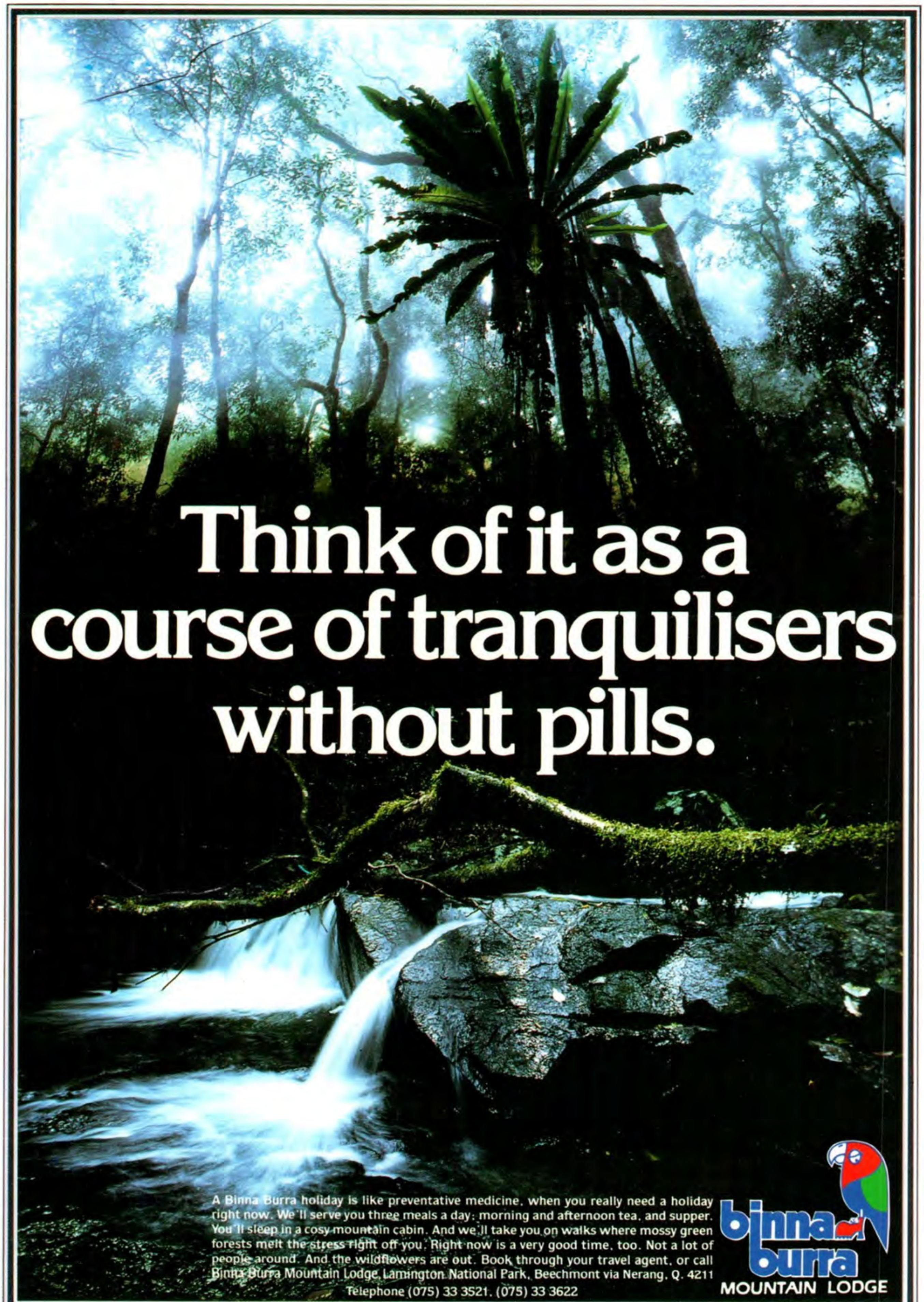
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