ANH

Australian Natural History

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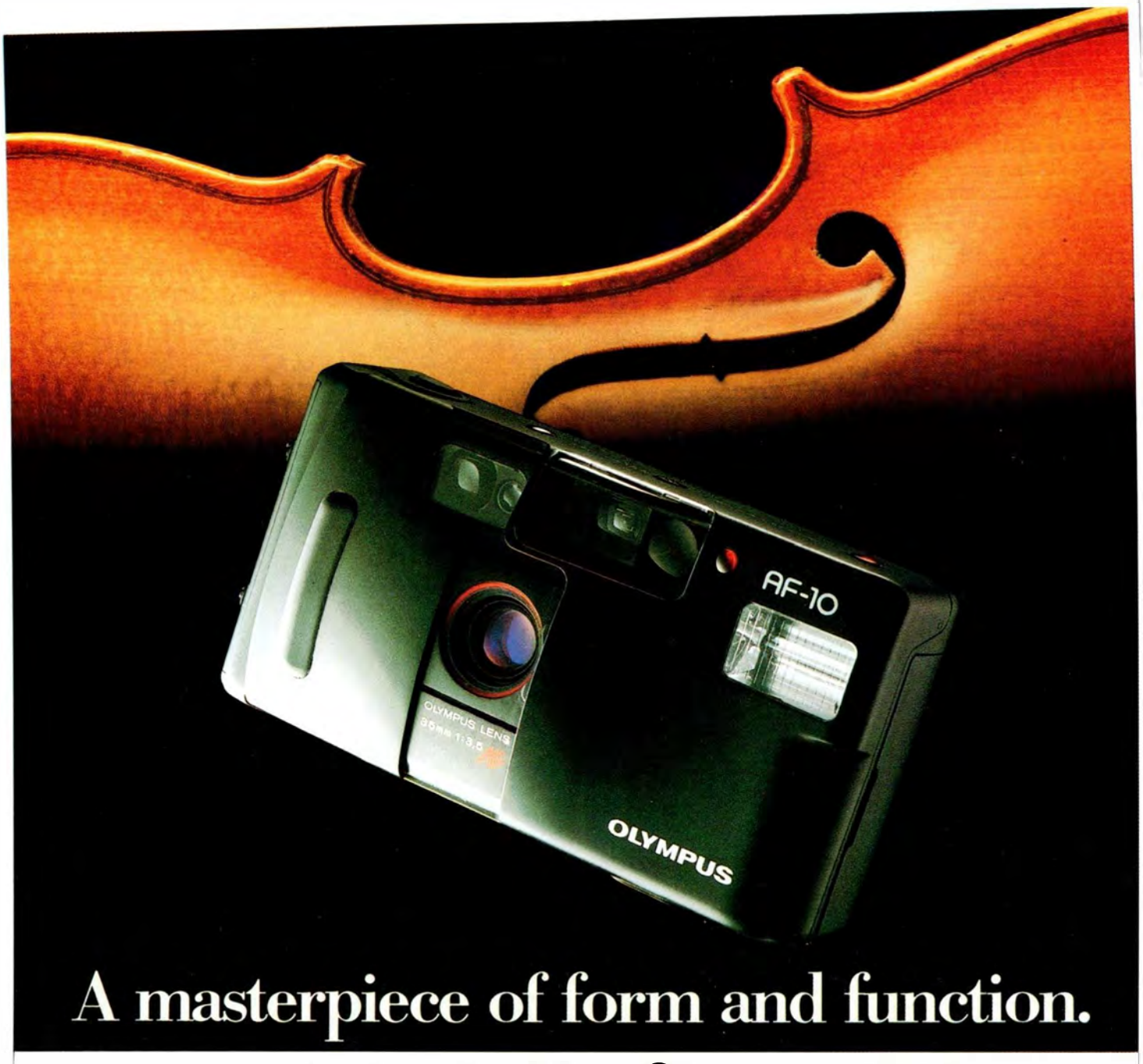
ALIENS
Reflections of Ourselves?

ARGONAUTS
Ancient Mariners

AUTUMN 1989 VOLUME 22 NUMBER 12 THE AUSTRALIAN MUSEUM



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Front Cover
A spectacular hypothesis for the extinction of dinosaurs implicates an asteroid impact. Illustration: David Kirshner.

EDITORIAL

COMMUNICATING SCIENCE

BY FIONA DOIG
EDITOR

METAMORPHOSIS. THAT IS HOW I describe the changing views of science. Scientific discoveries are being featured more prominently in newspapers; television shows such as *Beyond 2000* are leading the ratings; popular science magazines like *New Scientist* have brought out Australasian editions. There is something of a surge of interest in science: an information revolution is taking place.

The reason this didn't happen sooner, methinks, isn't through a lack of *interest* in the subject, but a conspiracy of silence between the media and scientists, based on an assumption that science is too difficult or boring for the average person. Now both groups have begun to realise that not only is it possible to communicate science clearly and effectively, it is *vital* that we do so. How can we even begin to understand the world we live in if important research is not presented so that everyone—particularly decision makers—can grasp it? The information *is* available, but what has been missing for too long is clear communication of that information.

But *who* is responsible for communicating science: the media or scientists? Scientists bag journalists because too often their information has been misinterpreted. Fair enough. But journalists need scientists to present them with information that's not too technical so that *they* can communicate it to the public. The problem, then, appears to lie in that grey area of communication between scientists and journalists: what journalists may not understand is that explaining scientific work often requires a lot of back-up information, and ordinary words have different meanings in a scientific context. What scientists often cannot grasp is the pressure of deadlines and the frequent necessity to edit large parts of material at deadline, leaving no time to check the final copy. I believe these problems can be overcome simply by both parties learning a little about how the other operates. That way scientists can understand the kind of information the media requires, and journalists can appreciate the kind of intense accuracy that is required in scientific work. Unfortunately, what often ends up happening is that both groups avoid each other.

Most scientists are aware of the importance of publicising their work; many are excellent self-promoters. Unfortunately, others are not and cannot understand why the media doesn't approach *them*. If scientists are interested in communicating their findings to the public, it is really *their* responsibility to do so and to make them understandable. The time is nigh for the media and the scientific community to support each other in being committed to a common goal: to educate. Isn't that what both are trying to do?

The need to communicate science brought this magazine into existence in 1921 and the editorial stated simply "As the *Magazine* is intended mainly for those that have no special knowledge of the technical details of natural history, the articles contained in it will be written. . .in non-technical language, and deal with subjects. . .likely to be of interest to the average citizen." This statement still forms the basis of *our* commitment to communicate the science of natural history clearly and effectively. Thus, having restated our aims, this magazine once again moves forward. . .

Mailing the magazine the old way.

IN THIS ISSUE

An excited voice trilled down the phone, "I've got the shot we wanted!" Nature photographer Kathie Atkinson had spent the best part of a year seeking unique shots of peripatus. Recently, one of the authors of the article, Noel Tait, dropped into the ANH office with some peripatus in tow (neatly tucked into his briefcase). He tipped a couple of these odd, velvety worm-like creatures into his hand. They really are fascinating creatures.

A thesis on Aboriginal women's subsistence took Jeannie Devitt into the desert to live with Aborigines. By following along on dozens of hunting and gathering expeditions, she learnt a great deal about their use of resources and became particularly interested in their ritual of digging for honeyants.

In the cooler climes of New Zealand, Philip Seddon and Yolanda van Heezik were drawn to study Yellow-eyed Penguins because they contrasted so strongly with other penguins. They were concerned that, although some breeding areas are a mere 20-minute drive from the city centre, these rare penguins have been neglected by researchers for 30 years.

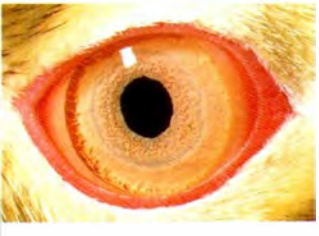
Ralph Molnar is Australia's dinosaur expert and an effusive talker. The fast-flowing theories of late on the dinosaurian demise was one fascinating discussion that ensued in the ANH office between Ralph, Georgina Hickey, the Scientific Editor, and Fiona Doig, the Editor and resulted in his running commentary on this lively debate.

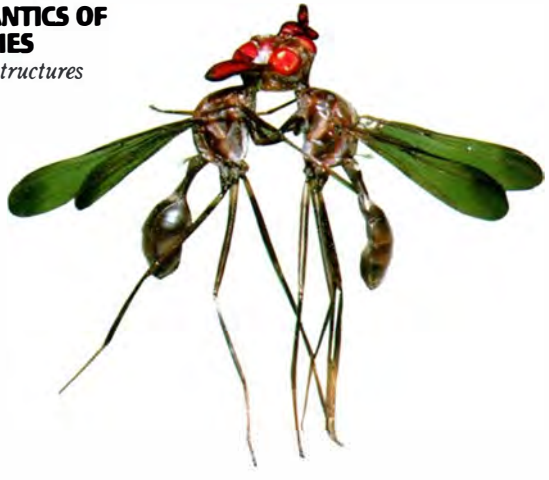
Studying rare antlered flies in Australia's far north was the culmination of a long-time dream for Gary Dodson. To study these odd insects requires long stays in virtually inaccessible bushland during the Wet season and there is no guarantee of finding any flies.

While studying deepwater squids, Mandy Reid developed an interest in cephalopods, so when a friend called her about a stranding of argonauts at Flinders Island, she jumped at the opportunity to study these unusual creatures.

Many changes have been made to ANH. New columns have been added: 'Still Evolving'—an update on evolutionary trends; and Question & Answer—a chance to have *your* questions answered. Other columns have been revamped: 'Forum' is now called 'The Last Word' and Robyn Williams adds wit to wisdom in 'Profile'. Hope you like the evolved ANH!

Articles





Regular Features

Columns

LETTERS

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

The Thick and the Thin

I was dismayed when reading Robyn Williams' "The Unfitness of Fat" (ANH vol. 22, no. 10) to discover him to be one of the self-righteous of that new religion, being THIN AND (allegedly) FIT. Any curved female between that and the dreaded Rubenoids (some pictured for our disgust) is, by his implication, an example of indolence and sloth.

Deadly sins are recycled, and fat, any fat, is the Devil.

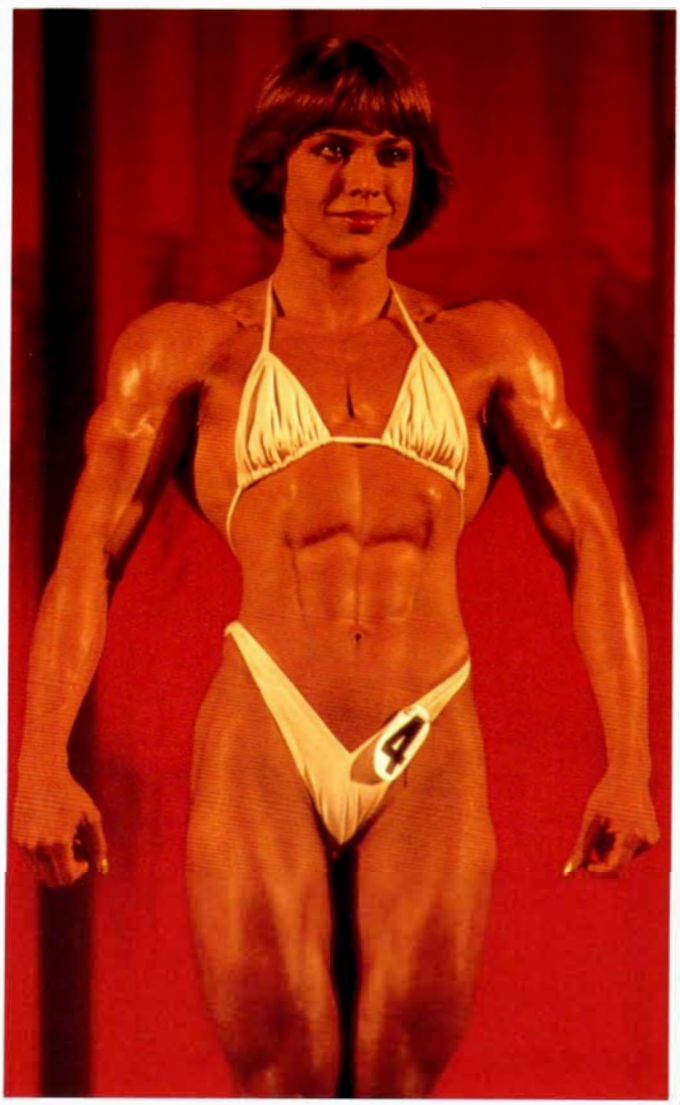
So, he prefers an athletic, post-menarchal nymphette with oligomenorrhoea and infertility. Why no picture of her for our admiration? Surely some great artist has painted her, with beauty unadorned, limp hair, shining skin stretched taut over muscle and bone, her boyish body with peanut breasts. Since she is not *yet* the gaunt anorexic, the sunken-eyed, skin-draped El Greco skeleton, all is well. But just how attractive is she to most males? This will be important to her. Do men always prefer little girls, these 'boy–girls', or will she be generally perceived as unattractive and sexually immature? Robyn Williams thinks she will exercise vigorously for that? He can never have listened to a real menarchal girl. Her stated remote advantage of a lower incidence of cervical and breast cancer may simply be due to other factors, including reduced genital exposure to carcinoma-associated papilloma viruses and an athlete's avoidance of smoking, this latter the young woman's pre-addiction aid to sophistication, sensuality and weight control.

Under guise of aesthetic sensibility he advocates protraction of puberty as the valuable application of the interesting studies of Rose Frisch. Just how does he terminate this physiological and psychological manipulation, based on aversion to fat, when infertility is no longer ideal?

Unfortunately not addressed in the Williams' article and attitude is a very real problem for females, that of the pressure exerted on a normal young woman to become, and her long unhappy struggle to remain, someone else's impossible ideal, a female Peter Pan.

—J. Grierson
Dundas, NSW

Robyn Williams' choice: an athletic, post-menarchal nymphette with oligomenorrhoea and infertility?



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A Taller Story

I was most interested in John Beard's letter in the Spring 1988 issue of your magazine (vol. 22, no. 10). I regret he is not a subscriber and had to have his attention drawn to it.

As to the origin of the name *diversicolor* for the Karri tree, my information came from that grand old man of Western Australian botany and conservation, the late Charles Gardner. I am grateful to Dr Beard for pointing out this is an error and would like the reference for von Mueller's statement. Perhaps he might also send this to the six authors of the CSIRO classic work *Forest Trees of Australia* who also do not know since they give the origin of the name "presumably alluding to the strongly discolorous leaves". The Baron must have had an off day when coining that name as it is found in so many kinds of trees.

As to Dr Beard's opinion on clearfelling, he is entitled to 'march to the conservation music' he hears. The vast majority of conservationists are marching to a very different drum and regard this new forestry technique as a disaster.

—Vincent Serventy
Hunters Hill, NSW

The comments of J.S. Beard of Forest Industries (ANH vol. 22, no. 10) on Vincent Serventy's article "A Tall Story" (vol. 22, no. 7) add up to an even taller story. Particularly the implication that the present clearing of forests to obtain woodchips is being carried out under world conservation strategy—which is far from the case. My comments relate to the Eden area, with which I am familiar.

Whatever use is made of the timber, our tall forests—or what is left of them—are being clearfelled. To call this logging is a mere euphemism. And, in spite of the rules, plenty of picturesque streams like the ones depicted in Forest Industries ads are being choked with debris by the bulldozers.

When clearing commenced at Eden some 20 years ago, it was claimed that the forests would regenerate. As this was not the case, a report was carried out for the Senate Standing Committee for Science and Environment, in which grave doubts were expressed by botanists and zoologists as to the regeneration of the forests, with or without loss of species. Research into the flora and fauna *before cutting* was an urgent recommendation of the report.

Has the Forestry Commission even commenced this research? It does not appear in the list given in the Harris Daishowa Environmental Impact Statement of December 1986. It is obvious that, unless the structure of the forest with all its diversity is known before cutting, it cannot be known whether new growth contains the same species or not.

This lack of detailed knowledge of the forests that were about to be cut became clearly apparent during the hearing *Jarasius v. Forestry* in the Land and Environment Court 1987–88, when the decision went

LEO MEIER/WELDON TRANNIES

'Logging' in a New Zealand forest.

against the Forestry Commission. Is this decision going to be set aside by the present government?

Mr Beard remarks on the experience of trained foresters. In actual fact the Forestry Commission was not set up until 1916, and has thus had only some 70 years (interrupted by World War 2) experience in dealing with forests that are predominantly eucalypt and like no others in the world. When the Commission came on the scene most of the accessible forests had already been overcut. Has sustained yield ever been effectively practised? Has the Commission ever had enough staff to see that it was practised?

Regeneration of the forests is a myth. Nearly half of the 300,000 or so hectares of the Eden area have been felled, but where are the new forests? Some 5,000 hectares of ten-year-old trees near the Eden Mill are all that the Commission can indicate. Meanwhile thousands of hectares of burnt scrub (Timbillica etc.) bear witness to the fact that there is no known method of achieving 'hazard reduction' in young, even-aged stands of trees.

—Rachel Roxburgh
Moss Vale, NSW

Fair Go for Farmers

I have just completed your reader's survey. If you feel my answers lack constructive criticism it is because I have none. Whenever I turn to an article that is outside my interests and feel I am about to be bored silly, the opposite occurs. I find most articles turn out to be of great interest.

I live on a sheep property in the Central Tablelands. We are currently upgrading a potentially good farm that has been neglected for several years. Consequently most of our income is literally ploughed back into the land. Finances are tight and my one extravagance is your magazine.

I was given several issues of *Simply Living* but was disappointed at the way this magazine targeted farmers as one of the major destroyers of wildlife. This seems to be an attitude of city-dwellers as well. I attended a party in Sydney recently where I was confronted by several guests (well-educated professional career types) who condemned my career as a sheep farmer for its destructive side effects. The argument reached a point of hysterical frenzy when I stated that it did not cause me any grief to destroy rabbits. It somehow proved to my fellow party guests that I was indeed a crazed killer!

Property owners are *not* the dedicated destroyers of native wildlife some would like to think. There are many landholders concerned about the dwindling wildlife numbers, so perhaps *more* articles on active conservation methods for working properties would help. A major revolution is taking place in the rural world to do with land management and usage techniques. The biggest problems we have to deal with as conscientious property holders are feral cats, goats, dogs, pigs, people, blackberry, tiger pear, briars, St John's wort, mining companies, army bases and, the most dreaded of all, the four-wheel drivers and bush-bashing bikers. Why is it, for example, that a family with a four-wheel drive vehicle that comes to the bush to commune with nature cannot bring themselves to walk the smallest distance to view some rarity but must drive to the very spot? The work we have done in stabilising badly cleared land or land eroded by gold mining is being destroyed by people who have forgotten how to use their legs!

Rave over, I would like you to know how much I appreciate the one affordable source of information on a great number of topics that you provide.

—Therese Harris
Sofala, NSW

Accolade for Alex

I wish to compliment you upon Alex Ritchie's article "Who Should Pay for Australia's Past?" in the Autumn 1988 issue of ANH (vol. 22, no. 8). I heartily endorse the sentiments expressed—that natural history museums are incorrectly perceived as being more educational than cultural and that the main function of natural history museums is "to investigate, record, preserve and display our natural heritage".

For some time I have been arguing these points with officers of various museums and in future I intend to quote Ritchie often. For it seems that some of our museum officers themselves are inclined to think that their main function is to educate.

Why else would curators put beautiful mineral specimens into storage and replace them in a gallery with horrible-looking plastic atomic lattices and push-button gimmickry? One capital city museum has 24 mineral specimens on display, the rest of the gallery being relegated to 'educating' the poor, benighted visitor. Another museum, I am told, will soon be 'going gimmicky'. Perhaps only mineral curators are guilty of trying to impress us with their superior knowledge so I may be wrong in blaming the malaise on all curators. Still, I do not think I am far wrong and I am very grateful that people of Ritchie's high intellect, perspicacity and modesty are at the Australian Museum. Some day I shall travel to Sydney to admire your new mineral gallery.

—Sir Howard Smith
Coolangatta, Qld

QUIPS, QUOTES & CURIOS

COMPILED BY GEORGINA HICKEY

Prickled, not Pricked

When Europeans first encountered Australia's monotremes—the Platypus and Short-beaked Echidna—they were indeed baffled. However, we were, and in many respects still are, not the only people to be beguiled by these extraordinary egg-laying mammals; for New Guinea's own monotreme, the Long-beaked Echidna (*Zaglossus bruijni*), poses a prickly problem for village naturalists.

In contrast with the other mammals they are familiar with, both male and female echidnas lack any sign of external genitalia. Young are hardly ever seen and the Long-beaked Echidna's means of reproduction remains a mystery to nearly all. Tavade hunters from Central Province believe that the Long-beaked Echidna reproduces by plunging a long, tube-like organ into the ground and bleeding through it. The young forms from a clot of blood, and the parent returns periodically to feed it urine and more blood, produced from the same extraordinary organ. The young digs its way out of the subterranean chamber only when nearly full-grown. Although seemingly far fetched, this account may be based on actual observations. Male Long-beaked Echidnas have a large and bizarre penis (it has four lobes at the end), which is usually retracted completely into the body. Perhaps some Tavade hunter was lucky enough to observe a male echidna rampant, so to speak, and deduced the rest.

The people of Hatam in the Arfak Mountains of far western Irian Jaya also seem to have got only half of the picture. They believe that the Long-beaked Echidna hatches from an egg laid by the Black-billed Sicklebill (*Drepanornis albertisii*), a bird of paradise whose beak bears an uncanny resemblance to the echidna's bill. The egg that hatches the echidna is one that has fallen from the nest onto the ground. There, its contents undergo the necessary metamorphosis. Although the Hatam people have discovered that echidnas do indeed hatch from eggs, the rest of the animal's reproductive cycle remains a mystery to them and is subject to fanciful interpretation.

Perhaps the strangest echidna story belongs to the Etolo people of the Southern Highlands Province, for they believe that echidnas do not reproduce at all! The Etolo distinguish four or five kinds of echidnas, which they name after game animals such as "tree-kangaroo echidna" or "cuscus echidna", and claim that very old animals actually transform into echidnas: the animal's head is slowly resorbed into the echidna's rear end, its tail shortens and stiffens to become the echidna's bill, and then the spines develop. However, even this extraordinary transformation sequence may be based upon some observation of wildlife. The Etolo have doubtless seen insects undertake equally remarkable transformations, and an echidna's feet *do* seem to face slightly backwards, perhaps suggesting some previous reversal in direction!

All these cogitations remind me of a 10th-century English riddle. In translation, it goes something like this:

I'm a strange creature, for I satisfy women,
a service to the neighbours! No-one suffers
at my hands except for my slayer.
I grow very tall, erect in a bed,
I'm hairy underneath. From time to time
a beautiful girl, the brave daughter
of some churl dares to hold me,
grips my russet skin, robs me of my head
and puts me in the pantry. At once that girl
with plaited hair who has confined me
remembers our meeting. Her eye moistens.
What am I?

The riddle works because our imagination is pricked by a phantom. Indeed, it looms so large that other explanations are overlooked. Perhaps the Long-beaked Echidna, with its multitude of prickles yet seemingly 'unpricked', has played a similar trick in the minds of many Melanesians. Oh how straightforward and boring life would be if echidnas had external genitals like the rest of us, and we could see straight away that the answer to the riddle was an onion!

—Tim Flannery
Australian Museum

The Long-beaked Echidna's lack of external genitalia posed a prickly problem for some New Guineans.

D. PARER & E. PARER-COOK/AUSCAPE

Hot-bellied Shark

When it comes to fast food, the Great White Shark has hit on a neat way to dine and come back for a second helping as soon as it can. Studies on a 3.5-metre male Great White Shark, *Carcharodon carcharias*, living off Dangerous Reef in South Australia, have shown that it could raise the temperature of its stomach by about 7°C during a meal (*Copeia* 1987: 195–197). For a cold-blooded animal this rise in temperature is even more unusual.

John McCosker, the Director of San Francisco's Steinhart Aquarium, managed to conceal a thermometer and telemetric transmitter inside a Southern Bluefin Tuna, which the shark was enticed to eat. Each time it ate, the shark's stomach temperature rose, apparently allowing it to quickly digest its food and come back for more: a useful trait for an animal whose prey, such as seals, is only sporadically available.

—B.B.

J. HOULDSWORTH/WELDON TRANNIES

The Sign of the Clap

Could you recognise your own clap in a crowd?

Several thousand people clapping together in the concert hall of the Sydney Opera House make one heck of a din, and you'd think it would be next to impossible to distinguish one clap from another. That may be true for most practical purposes, but Bruno Repp, an acoustics scientist at the Haskins Laboratories in New Haven, Connecticut, has devised a computerised 'clapper identification' system that suggests all of us have distinct clapping characteristics (*New Sci.* 114: 38, 1987). The computer was far better at identifying individual claps of test subjects than human listeners, but almost half the listeners could recognise their own clap. If Repp is right in believing that we each have a special 'clap signature', it may be possible to individually tune electronic devices to respond selectively to a person's clap: the ultimate for, say, remote-controlled and personalised robots or security systems.

—B.B.

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

Pyramid-building Technique

The pyramids of Egypt are among the seven wonders of the ancient world. They were erected as tombs for Egyptian monarchs. The First or Great Pyramid, one of the largest and most famous, is made up of over two million 2,000-kilogram sandstone blocks, and stands 140 metres tall (originally 150 metres). Just how the massive blocks were transported without the use of the wheel, the pulley or domesticated beasts of burden remains unknown. It has always been assumed that sheer manpower was used to drag the blocks up ramps to the site. However John Cunningham, in a letter to *Nature* (332: 22–23, 1988), proposed a much simpler mechanism that utilises "the weight-distributing principle of the suspension bridge with the energy-storing characteristics of the bow".

He noticed that in 5,000-year-old Egyptian artwork, loads were often depicted on poles, and suggested that heavy weights were lifted by placing them on slender bending poles arranged evenly and in parallel. A state of equilibrium is created between the rods and the load; each rod supports only the share of the object's weight acting directly above it (much like a bed of nails). If one rod end is lifted and chocked in that position, the other rods straighten slightly and the elevated rod bends more, raising the whole load slightly and maintaining the state of equilibrium. If all the rod ends are lifted the same distance, one at a time, and chocked, the load will have been raised the same distance as the individual rod ends. The process can then be repeated, lifting the load further. The more rods used, the less force must be exerted to raise the load a certain distance.

Note that this mechanism relies on flexible poles—not rigid levers. Lifting a lever end results in a force being applied to a large part of the entire load; and no force-multiplying effect would be gained by adding more levers. Unlike poles, levers do not bend to accommodate as individual supports are raised. The early Egyptians may well have used flexible bamboo poles to raise the pyramid blocks, bamboo being a natural material readily available to them.

The practicalities of the proposed method for pyramid construction, however, seem limited. The height to which blocks must have been raised would have been considerable: how would the multiple chocks have been supported? Also, the problem of lateral transportation remains. Perhaps this lifting mechanism was used, in some way, in conjunction with ramps and rollers.

—G.H.

The great pyramid of Egypt.

The most impressive arrival at Circular Quay since the Q.E.II. {Complete with its own brass fittings.}

Next time you're down at Circular Quay, you'll have the chance to view an extremely unique work of art. The Sydney Cove Map, commissioned by Caltex and the New South Wales Public Works Department.

It stands almost one metre tall and measures a massive 3.6 metres in diameter, and has been beautifully crafted out of solid brass and terrazzo by specialist artists using an Italian method that's virtually unseen these days.

In intricate detail, it depicts Sydney Cove as it was in 1808 (the year our first Government House was built), and, what's more, also shows the coastline as it is today.

Ideally located at the entrance of First Fleet Park, Circular Quay, the Sydney Cove Map was publicly unveiled at 11.15am on Sunday May 15, by His Excellency Air Marshal Sir James Rowland AC, KBE, DFC, AFC, Governor of New South Wales.

So when you're next down at Circular Quay, be sure to take a look at the Sydney Cove Map.

(And unlike the Q.E.II, it won't sail off in front of your eyes.)

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JEAN-PAUL FERRERO/AUSCAPE

Out of the cooking pot . . .

Painless Preparation of Crustaceans for Consumption

Many edible crustaceans, such as crabs, prawns and lobsters, are sold alive because the consumer has come to believe that a dead crustacean is a spoiled one. Whether this is true is unknown, but it has, at least, cut down on food poisoning.

Domestic preparation of crustaceans usually involves scalding them to death in boiling water. The violent manoeuvring of the animals when they hit the boiling water does nothing to suggest a 'painless' death. The issue of pain tolerance in animals, especially these 'lesser' animals, continues to be a contentious issue. So until we know better, surely it is more humane to prepare crustaceans in such a way as to elicit minimal reactions from them. This can be done.

Gordon Gunter, in an early edition of *Science* (87: 87, 1938) suggested a painless method. Place the crustaceans on a wire rack inside a pot filled with fresh water at room temperature. The wire rack prevents direct contact between the metal base and the animals, and fresh water has an anaesthetising effect as it leaches salt from the body fluids. *Slowly* heat the water to about 40°C (lukewarm). Most tropical marine invertebrates cannot survive in water over 37°C (and less for more temperate clines). The crustaceans die quickly without showing distress. At this temperature, they will still be limp, as coagulation of protein occurs only at higher temperatures. The heat can then be turned up and the water boiled quickly.

—G.H.

P. VON STROHEIM/WELDON TRANNIES

Preserving fruit with lobsters?

Keeping Fruit Fresh with Lobsters

Chitin is the main structural ingredient in crustacean shells, insect exoskeletons and the cell walls of fungi and yeasts. Being tough, biodegradable and non-allergenic, it can also be an excellent preservative in industry, as Dr Ernest Hayes, a chemist from Acadia University in Nova Scotia, has found (*New Sci.* 118: 48, 1988).

Dr Hayes has devised a process that overcomes earlier technical problems with chitin's insolubility, and has developed a water-soluble derivative of chitin called Nutri-Save. When sprayed onto fruit such as apples and pears after harvesting, it effectively 'puts them to sleep', forming a semi-permeable coating that slows down the exchange of gases that regulate ripening. Recent tests have shown that the storage life of apples can be extended by up to nine months. And when the fruit needs to be brought out of storage for sale, the chitin spray simply washes off in warm water.

—B.B.

The Missionary Position

When did our ancestors start copulating face to face, instead of back to front, as many of the other primates do? The answer, according to a recent study, stems from a seemingly unlikely source: the herpes simplex virus (HSV).

Humans are afflicted by two forms of the virus: HSV-1 is transmitted orally by kissing, and HSV-2 is transmitted genitally. But only one HSV virus, which relies on both oral and genital transmission routes, affects monkeys and, presumably, our ape ancestors.

Glenn Gentry and his colleagues at the University of Mississippi Medical Center looked at the evolution of the two human HSV types and, based on a comparison of their proteins, estimated that the two forms diverged between eight and ten million years ago (*Proc. Natl Acad. Sci. USA* 85: 2658–2661, 1988). For this to occur, the oral and genital transmission routes must have been effectively isolated. An upright posture may well have initiated separation of the genital and oral sites (both within and between individuals) and the switch to the so-called missionary position (with its oral–oral and genital–genital contact) would have promoted specialisation of the virus into its two distinct forms.

—B.B.

The herpes simplex virus may provide clues to the origin of the predominantly human face-to-face copulatory position.

NICHOLAS POUTSMA

Sheep Know who their Friends Are

Experiments some years ago at Oxford University's Department of Experimental Psychology established that monkeys and other primates have brain cells that respond preferentially to faces. They are located in the temporal cortex of the brain. More recently, Keith Kendrick and Bob Baldwin, of the Institute of Animal Physiology and Genetics Research in Cambridge, set out to investigate whether the same region in a non-primate's brain performed the same function (*Science* 236: 448–450, 1987). Indeed it does.

Using a horned breed of sheep and presenting them with a series of slides, they showed that these cells are most active when the sheep is looking at a close acquaintance of its own community, a sheep that appears to be socially dominant, or a potentially threatening individual from another species, such as a dog or human. The sheep responded particularly to pictures of species with horns (an important signal of sex and status), and the bigger the horns the more excited they became.

—B.B.

A sheep is a sheep . . . but not to a sheep.

HAROLD WELDON/WELDON TRANNIES

The Bite Electric

Snake-bite remedies have had a colourful history: drinking one's own urine and eating sheep dung boiled in wine are just two of the more exotic. The advent of antisera has changed all that, but there's still room for unusual new treatment methods.

Electrocution is one, based on recent studies reported in the British medical journal *The Lancet* (26 July 1986). An American farmer with a bee-sting allergy discovered by experiment that high-voltage, low-amperage shocks relieved his pain and swelling.

Research workers in Ecuador heard about it and tried the method out for snake bites. To their surprise, it worked: the bitten part of the body is electrically grounded as close as possible to the site, and a current applied via an insulated probe.

Outboard motors and lawn mowers provide just the right current to apply four to five shocks, with five to ten-second pauses in between. Applied within 30 minutes of the bite, the results have reportedly been remarkable, easing pain and swelling rapidly. Doctors in Irian Jaya, Indonesia and Peru have reported similar success with snake bites and insect stings.

No-one knows how or why the treatment works, but the authors of *The Lancet* article, Drs Ronald Guderian, Charles MacKenzie and Jeffrey Williams, suggest muscle spasms may impede the spread of the toxins, or the shock may degrade the toxin itself. —B.B.

Conventional first aid for snake-bite.

JEAN-PAUL FERRERO/AUSCAPE

A Diet of Glass

Marine sponges boast a formidable array of defences against predators, notably a range of noxious and toxic chemicals, or such a high silica content that eating them is a bit like tackling ground glass. But that doesn't deter some animals from munching on them. Sponges, for example, have been recorded in the stomachs of three marine turtles that occur in Australian waters: the Green, Loggerhead and Hawksbill Turtles. However, only in the latter species have sponges been found to contribute significantly to the diet.

A recent study of Hawksbills (which are endangered throughout their circumtropical range due to the tortoiseshell trade) in the Caribbean suggests they may feed almost exclusively on certain sponges, and that it may be a worldwide habit among the species (*Science* 239: 393–395, 1988). Before this report it was thought they fed indiscriminately on bottom-dwelling invertebrates. Anne Meylan, of the American Museum of Natural History, examined the gut contents of several Hawksbills. She found large quantities of glass-like needles of silica, some of them up to five millimetres long. Some of these needles were found to be embedded in the turtles' intestinal walls, with no apparent ill-effects. Such a diet is thought to be unique among reptiles.

—B.B.

FRANCOIS GOHIER/AUSCAPE

Hawksbill Turtle.

WHAT'S IN A NAME?

Drongo

Drongo, in the derogatory sense, refers to a slow-witted person. This use of the word derives from a racehorse of the same name, in the early 1920s, that never won a race. The 20 species of songbirds in the family Dicruridae, also called drongos, are not, as might at first be thought, named after the horse. Besides being named well before the horse, most of these birds are glossy black and graceful with long forked tails and appear anything but stupid. They are pugnacious and apparently fearless when attacking larger predatory birds. Their name, instead, is the native Malagasy term for *Dicrurus forficatus,* and has since been used universally for the family. The only Australian species is the Spangled Drongo, *D. hottentottus.* (The horse, incidentally, was out of a mare called Lanius—a bird genus. It seems that the owners of the dud racehorse decided to stick to the tradition of naming this line of horses after birds.)

—G.H.

FRITHFOTO/ANT PHOTO LIBRARY

Spangled Drongo (*Dicrurus hottentottus*).

QUESTION & ANSWER

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

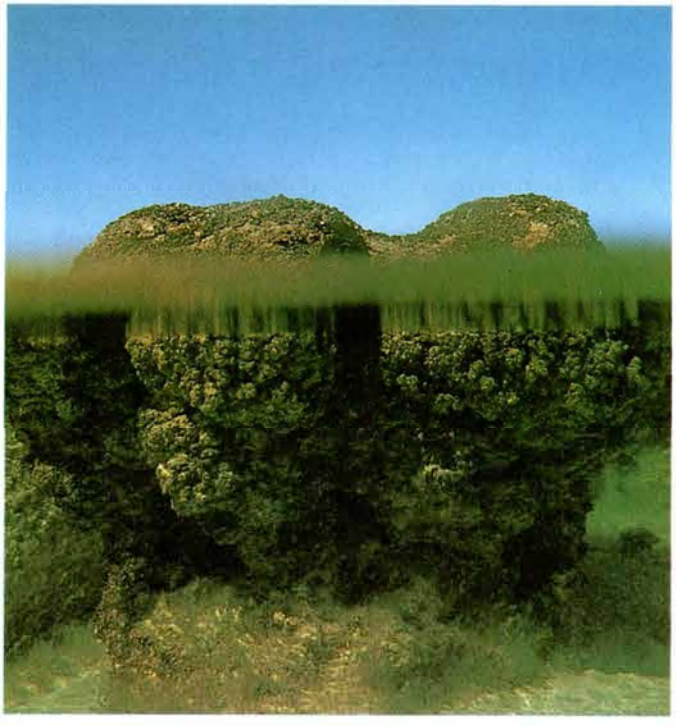
Days in a Year

Q: In his article "Stromatolites—The Ultimate Living Fossils" (ANH vol. 22, no. 10), Ken McNamara says "...it has been possible to calculate that about 1,000 million years ago there were about 435 days in the year." Could you explain how this was calculated?

—Marie Smythe
Castlecrag, NSW

A: Unlike trees, which only record seasonal changes, some invertebrates such as bivalves, corals, brachiopods and stromatolites record daily, monthly and annual events, with thin layers of calcium carbonate deposited daily. The effect of tides, under the influence of lunar cycles, shows up as bands comprising about 30 daily growth lines. Spacing varies according to seasonal sea temperature changes, allowing annual cycles to be determined. Studies of fossil corals 370 million years old show that about 400 daily growth rings were formed each year. Living corals show about 360. This means that day length was shorter 370 million years ago, being about 21.9 hours long (8,760 hours per year divided by the number of days per year 370 million years ago).

Stromatolites have been used in a similar manner to identify daily or annual cycles. Because the photosynthetic bacteria that construct stomatolites are active only during the day, they leave a daily trace of sediment deposition. Annual cycles are marked by the inclination of the columns. Being photosynthetic they grow towards the sun. As the height of the sun in the sky at noon changes during the year, so the axis of growth of the stromatolite columns changes. When a stromatolite is sectioned, this shows up as a curve—a sine wave. Counting the number of layers of sediment within one wavelength gives the number of days in the year. For a stromatolite that lived about 850 million years ago it was about 435. This makes the day length at that time about 20.1 hours (8,760 ÷ 435).



Stromatolite.

R. WOLDENDROPP/WA PHOTO INDEX

The increase in day length, and resultant decrease in number of days in the year, implies that the Earth's rate of rotation has been steadily decreasing over the last 850 million years at least. The reason for this is tidal 'friction', caused by the tidal bulge created by the moon's rotation around the Earth. The moon rotates in the same direction as the Earth, albeit much slower. Thus the point on the Earth where the tide is highest was, just a short time before, underneath the moon. High and low tides are slightly delayed by tidal 'friction', largely due to turbulence and drag in the sea. As the tidal bulge is largely caused by the moon, it tries to pull the bulge back into alignment. This imposes a torque on the Earth, thus slowing its rotation. Astronomical observations over the last two centuries have shown that tidal friction is lengthening the day by about two-hundred-thousandths of a second each year!

—Ken McNamara
WA Museum

Prehistoric Giants

Q: One thing that really puzzles me about prehistoric animals is that they all appear to be very big. Why were they all so large?

—E. Hain
Frenchs Forest, NSW

A: They *weren't* all large—at the time of the dinosaurs there were just as many small animals around. I think it's just our awe of size that has us focus on the biggest beasts. The other point is that the fossilised remains of large animals are, for obvious reasons, easier to find. Larger bones are also more likely to fossilise as they are less likely to erode.

In more recent history, it is easier to answer this question by turning it on its head—for the real enigma lies in why modern animals are, in general, so small.

With few exceptions, the landmasses of the world support a much smaller range of life forms and lack the really big species that were present as little as 40,000 years ago. There is a growing body of evidence that suggests all these large species disappeared into a very small hole: that orifice that lies between chin and olfactory organ in *Homo sapiens*. The disappearance of most of the world's large animals, you see, coincides with nothing except the arrival of humans. Australia lost 50 of its very largest mammals between 40,000 and 20,000 years ago, approximately when Aborigines arrived. In North America almost all the large animals became extinct about 11,000 years ago, when the palaeo-Indians arrived. In New Zealand 1,000 years ago, the Maoris made short work of the moas and much more.

Diprotodon.

PETER SCHOUTEN

To understand how people caused these extinctions it is instructive to look at the big animals that survived. In North America the big mammals that live there now (such as the Moose, Grizzly Bear and possibly the Bison) mostly came in with humans from Eurasia. Yet in Asia and Africa where modern humans evolved, the big fauna survived almost unaffec-

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ted. These animals all grew up with people; they evolved strategies to avoid human predation. We can see the disastrous effect people have on big animals that are unused to them by examining human exploitation of the Subantarctic and Antarctic. On Macquarie Island the enormous Elephant Seals allowed themselves to be herded and clubbed to death without the least resistance. Were it not for economies of scale, they and the great whales would have been extinct long ago.

So that's why things were bigger long ago. That was the norm for millions of years. Unfortunately, like the child that reaches for the piece of cake far too big for it, we always go for the biggest game. And it just can't take it.

—Tim Flannery
Australian Museum

The Wolf Creek Crater.

GUNTHER DEICHMANN/AUSCAPE

Ozone Hole vs. Greenhouse Effect

Q: What is the difference between the hole in the ozone layer and the greenhouse effect? Is there a relationship between them?

—Jim Walters
Hawthorn, Vic

A: Ozone (O_3) is a form of oxygen that filters UV radiation from the sun's rays. It is continually being created and destroyed in the upper atmosphere (stratosphere). At present more ozone is being destroyed than created. The reduction is more dramatic at the poles, particularly over Antarctica. Reactions involving chlorine and bromine are mainly responsible for the accelerated destruction of ozone. Chlorofluorocarbons (CFCs) used mainly in refrigeration, foam-blowing and aerosols, and halons in fire extinguishers, are the principle sources of the chlorine and bromine in the stratosphere.

The greenhouse effect results from a build-up of certain gases in the lower atmosphere (troposphere). Greenhouse gases trap heat that would otherwise escape to outer space. There has been a build-up of these gases over the last century due to human activity. The main problem gases are carbon dioxide, CFCs, methane and nitrogen oxides.

The ozone hole and greenhouse effect are connected in several ways. They both result from pollution; CFCs are important in both; damage to the ozone layer allows more energy (UV radiation) to reach the troposphere, thus contributing to the greenhouse effect; as the troposphere heats up there is expected to be a compensating decrease in the temperature of the stratosphere, which is likely to increase stratospheric clouds where most of the ozone is destroyed; and the greenhouse gas methane is a source of water in the stratosphere, which again is likely to create more of the destructive clouds.

—Alan Watterson
Australian Museum

Largest Meteorite Crater

Q: On a visit to the Wolf Creek crater in Western Australia, I was told it was the largest meteorite crater in Australia. Yet I have seen huge craters stretching for many kilometres in other parts of the country. Aren't these meteorite craters also?

—M. Osborne
Geraldton, WA

A: The Wolf Creek crater, measuring 880 metres in diameter, is the largest *proven* meteorite crater in Australia. It ranks twelfth on a worldwide scale. However, there are many other much larger craters of impact origin in Australia; such as Gosses Bluff in the Northern Territory, with a diameter of 22 kilometres, formed about 133 million years ago. Our biggest impact crater is Lake Acraman in South Australia, with a diameter of approximately 35 kilometres, formed about 600 million years ago. This structure is less obvious and more poorly preserved because of its greater age. It is really a question of definition—to be classed as a proven meteorite crater, fragments of meteorite must be found at or near the site. Whether or not other impact craters were caused by meteorites that left no trace, or by another space body such as a comet, is questionable. As comets are made largely of gases, they would not leave fragments at the impact site.

—Ross Pogson
Australian Museum

Phosphorescence

Q: During a period of record rainfall I observed 'smudges' of phosphorescence glowing on the path to my house. Whilst there was nothing associated with the first smudge, the second had two 'nematode-type' worms in the centre of it.

Is phosphorescence a purely biological phenomenon? How widespread is the distribution of glow-worms in Australia? Is 'glow-worms' a broad term used by lay people to describe a number of phosphorescent animals?

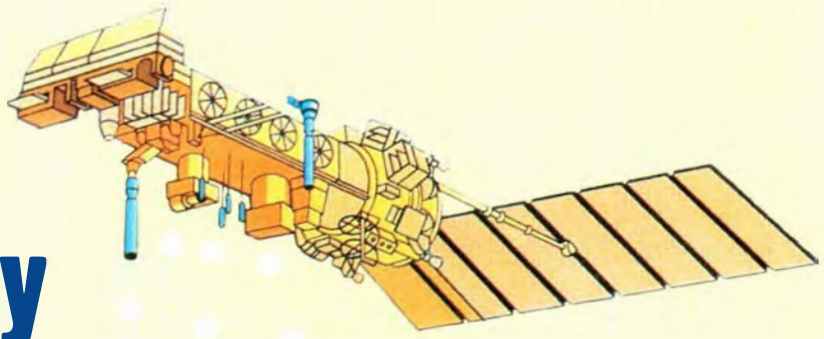
—Jeff Hirth
Springhurst, Vic

A: Phosphorescence refers to the property of being luminous in the dark, usually by slow oxidation, after previous exposure to light. It is not a biological phenomenon. It is often, albeit incorrectly, synonymised with the term bioluminescence—the production of light by living organisms. In fireflies (lampyrid beetles), for example, light is produced by the oxidation of a compound called luciferin in the presence of an enzyme luciferase. Other bioluminescent organisms include fungi, fish and glow-worms (mycetophilid fly larvae).

The 'nematode-type' worms that you observed may have been glow-worms. Glow-worms tend to be restricted to rather damp, cool grottoes and caves along Australia's eastern seaboard from Queensland to Tasmania.

—Geoff Holloway
Australian Museum

NB: There will soon be an article on bioluminescence in insects in *ANH*.



Where are they today? Argos knows.

Not only did it know the whereabouts of Dr Gordon Grigg's camels, Argos also had information regarding the location, movement, air temperature and barometric pressure of 553 drifting and moored buoys, 11 ships, 3 balloons, 392 fixed stations and another 72 animals including caribou, turtles, whales and dugongs.

Dromedary Camel

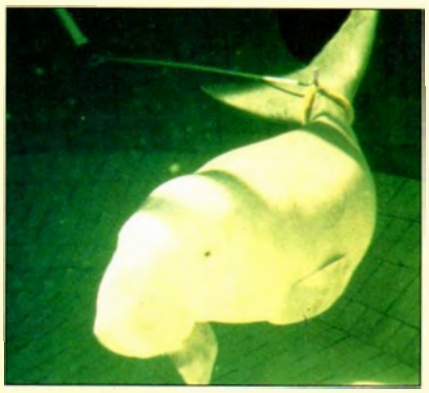
Australia is host to the world's only known population of feral camels. Introduced as pack animals after 1840, the advent of the car in the 1920's made them an outmoded form of transport. About 35,000 of them roam the harsh terrain of Western Australia, South Australia, Queensland and Northern Territory causing expensive damage to fences. Little was known about their biology in the wild so the **Argos** location system was used to gather more information about them. (See ANH Winter 1987)

Data Collection of Stromatolites

The understanding of the environment in which these ancient life-forms grow has been greatly enhanced by the use of the **Argos** satellite-based data collection system.

Drifting Buoy

The discovery and emerging understanding of the El Nino and "Southern Oscillation" phenomena owe much to drifting buoys tracked by the **Argos** system. These and similar phenomena are not only of immense importance to Australia and the weather we experience, but are among the most fundamental discoveries in recent times in oceanography, meteorology and climatology.



Dugong

The dugong, the only herbivorous mammal that is strictly marine, is considered vulnerable to extinction. The movements of dugongs have been monitored by **Argos** as part of a programme which aims to establish a sound biological basis for the management of dugongs in the Great Barrier Reef Marine Park.

For further information:
Stephen T. Dyson
CLS-ARGOS-Australasia
GPO Box 1289K
MELBOURNE 3001
Telephone (03) 669 4650

SLIME MONSTERS WILL BE HUMAN TOO

BY MICHAEL ARCHER
SCHOOL OF ZOOLOGY, UNIVERSITY OF NEW SOUTH WALES

KAMALA SCUTTLED ACROSS THE Mission floor on well-calloused hands and knees. Whimpering and cringing, she held up her left hand to show the Reverend a splinter projecting from her thumb. He removed the painful object to see her immediately race off on all fours to vigorously scratch at the door. She was let out into the night. After relieving herself in the corner, she sniffed happily around the dark perimeter of the yard to locate the dead chicken she'd buried the night before. Successful, she sated her hunger with its raw entrails before sitting back on her haunches. She scratched a flea then threw her head back to howl at the night sky.[1]

Kamala was a six-year-old girl 'rescued' in 1920 by Rev. J.A.L. Singh from a she-wolf that had raised her in a hollow termite mound in a forest near Midnapore, India. The she-wolf had been killed by Singh's hunting companions shortly before Kamala and a younger girl, Amala, were discovered intertwined with equally terrified wolf cubs in a 'monkey-ball' in the centre of the den. Neither wolf-child could speak or stand upright, although they could scuttle on all fours faster than an average man could run.

As infant girls, the two had probably been abandoned in the forest by their mothers (a then not uncommon practice in times of hardship) and serendipitously raised by the she-wolf that found them. Through all of the critical imprinting periods when 'civilised' human children *learn* to walk, talk and behave like 'normal' humans, Kamala and Amala had had a loving wolf for a tutor. The consequences were thought-provoking to say the least—for all practical purposes by the time they were found they had actually become wolves in mind and behaviour. When first encountered, they growled, rolled up the whites of their eyes, showed their teeth and savagely bit their captors. Is it any wonder that humans from different backgrounds have difficulty in understanding each other when cultural conditioning can result in end products ranging from 'wolf-children' to 'little angels'? As Singh peered out into the gloom of the night at Kamala baying at the moon, he surely must have wondered long and hard about the basic nature of humanity.

The amoral, 'inhuman' nature of these 'wolf-children' may have been a rare opportunity to look into a mirror normally visible only in our darkest, deepest dreams. The 'civilised', human attributes we seem to require for survival in crowded communities are almost certainly a veneer imposed by cultural conditioning on an inherited amoral primate brain, one with potential for considerable alernative programming. The raw unadorned human, one freed of the 'normal' conditioning, is probably very close to the basic, aggressive, defiant animal that raced across Rev. Singh's moonlit yard.

The 'wolf-child' Kamala scratches at the door to be let out.

One of Darwin's most insightful notions was that of the *struggle* for existence. Psychologists, biologists and geneticists alike have come to understand that every fibre of our being is selfish, every act committed in self-interest and every thought reducible to the notion of the need to survive at *whatever* expense to the rest of the world. The interminable struggle for survival in a world filled with amoral competitors could have *no* other outcome—competitively superior organisms must dominate ecosystems. It was not a new idea with Darwin but he demonstrated it far better than anyone before.

Thousands of years ago, we externalised and enshrined the competitive drives within us: we created omnipotent gods with human appetites and, at least in Christian societies of almost 2,000 years ago, convinced ourselves that the Universe was created primarily to sate these needs. Genesis records the Holy instructions to an 'innocent' Adam and Eve: reproduce, fill and subdue the Earth and take 'dominion' over all creatures.

Misconstruing our insatiable instinctive appetites as obedience to Divine instruction to dominate, through space travel we are now about to inflict humanity's logarithmically increasing needs onto the rest of the Universe. Ironically, I'm convinced that in this ultimate stage of human imperialism we will, for the first time, come face to face with our real nature without the need to contemplate feral children. Because out there, eventually, we will meet our own counterparts, equipped with *their* version of 'morality' (rules to facilitate competitive success). These creatures, just like us, would have shoved, clawed and probably blasted their way to the top of their own biological worlds.

Earth's palaeontological record makes the general point that most of the major space hurdles, taken by life in its passage through time on *this* planet, have occurred in predatory lineages—not the 'gentle' herbivorous ones. Amphibians arose from predatory fish (lobe-finned carnivores), reptiles from predatory amphibians (toothsome labyrinthodonts), mammals from the carnivorous cynodonts (advanced mammal-like reptiles with spectacular teeth), birds from the carnivorous dinosaurs and so forth. Predators claw their way into the future and probably outer space; herbivores get their evolutionary branches chomped off.

Science fiction addicts (yours truly being one of the most severely addicted) love to shudder at magnificently plausible intergalactic competitors like the 'Alien' mother and the extraterrestrial version of Rambo called 'Predator'. We recoil in hypocritical indignation at the notion of the 'Predator' being dropped off on Earth to

Alien depicts precisely the sort of creature we should expect to encounter in outer space—a predator just like us.[2]

test its skills against those of Earth's champion (who else but Schwarzenegger). And what about that parasitic, face-hugging larval 'Alien' and its metamorphosed sequel the chest-buster? Too horrific to contemplate they may be, but as a biologist this is *exactly* what I expect we will bump into when we rub tentacles with our first space-travelling alien life form. ETs and ALFs may be more appealing to us (at least in part because they present no threat to our ability to sate our own appetites) but they are most unlikely to be the products of competition for survival on another world.

Earth provides real life models for even the most gruesome of science fiction's nasties. For example, 'Alien' finds its amoral counterpart in the parasitic wasp that deposits an egg on the back of a live caterpillar. The egg hatches and the ravenous larva burrows into the living host to begin feeding on its insides. Eventually the metamorphosed larva bursts through the skin of its ravaged host to renew the parasite's life cycle.

As for an Earthly model for 'Predator', surely it is ironic that the victor in the movie was a human because he proved to be more 'inhuman' than the 'Predator' (recall the 'Predator', unlike the human, dropped his weapons in an attempt to give his 'prey' a better chance at survival). Hunting expeditions for sport are hardly a custom unfamiliar to our own species. Quite clearly, the 'Predator' is merely an unpleasant projection of ourselves—a mirror image we can only face by calling *it* the alien.

True, not all science fiction encounters with aggressive aliens result in one winner. In "Enemy Mine", where an aggressive 'Drac' meets an aggressive human in an intergalactic war born of competition, the two decide they need each other to survive in an environment hostile to both; a kind of intergalactic mutualism. Sounds nice from the reconnaissance position of a lounge chair but on the strength of our own unfailing, long-term intolerance of competing life forms on Earth (Siberian Tigers, English Lions, American Wolves and Australian Thylacines) I, for one, wouldn't count on the wolf-child within us to restrain its trigger finger when the first alien tentacle emerges from the hatch. ■

[1] *The Wolf Children* by Charles Maclean. Penguin Books, 1977.

[2] *Alien: The Illustrated Story* by Archie Goodwin and Walter Simonson. Heavy Metal Communications Inc., 1979.

In the wake of Cook's voyages, many of the artefacts were sold to private collections. Intricate detective work has traced this Museum piece back to Cook's wife, Elizabeth.

COOK'S FEATHERED CAPE

BY ADRIENNE KAEPPLER
ANTHROPOLOGY DEPARTMENT
SMITHSONIAN INSTITUTION, WASHINGTON DC, USA

ONE OF THE FIRST CELEBRATIONS of the bicentennial occasion of Cook's landing in Australia was an exhibition held at the Australian Museum in 1970 entitled "Cook, Banks & Australia". It included a remarkable assemblage of illustrations, navigational instruments, ethnographic objects and botanical specimens. Some of the ethnographic objects in that exhibition, in particular a Hawaiian feathered cape, can be traced back to Captain James Cook's wife, Elizabeth.

Elizabeth Cook (1741–1835) was preceded in death not only by her husband, but also by their six children. Many of her possessions were inherited by three great-grandchildren of her cousin Charles Smith. The feathered cape belonged to one of these great-grandchildren—the Rev. Frederick Bennett, a canon of Salisbury Cathedral. Another of Mrs Cook's cousins (once removed) was Isaac Smith (1752–1831), who sailed with Captain Cook on his first two Pacific voyages and later became an admiral in the British Navy. After his retirement, Isaac Smith resided with Mrs Cook, and some of his possessions were inherited by his sister Ursula's daughter who married a Mr Mackerell. In 1886, at the request of the Government of New South Wales, the Mackerells' son John put together a "Collection of Relics of the late Captain James Cook, R.N., FRS" and displayed it at the Colonial and Indian Exhibition in London. It included an array of some 78 objects including illustrations, letters and manuscripts, 'relics' and ethnographic specimens, which apparently belonged to Mrs Cook and her cousin Admiral Isaac Smith. After the exhibit was over, much of the material was purchased by the Government of New South Wales and today is housed in the Australian Museum and Mitchell Library.

Also in the Mitchell Library is a copy of the "Catalogue of Relics" and a legal document about their association with Mrs Cook and Isaac Smith. As important as these documents are, however, they do not convey what the objects actually looked like, how they were exhibited, or if specific objects are indeed the ones described. Fortunately, in 1967, an illustrated version of this catalogue turned up at Christies auction rooms. The catalogue, along with a few objects from the exhibition that had not been sold to the Government of New South Wales, were the property of L. Rickman-Adams, another descendant of Isaac Smith's sister Ursula. The illustrated catalogue is now in the collection of K.J. Hewett of London.

Perhaps the most interesting photograph in the catalogue is that of the Hawaiian feathered cape. The photograph illustrates how the cape was exhibited—along with a Hawaiian basketry helmet and a "waistcoat of Tahiti cloth. . .embroidered by Mrs. Cook for Captain Cook to wear at court, had he returned from his third voyage." The pieces that make up this waistcoat are now in the Mitchell Library. One wonders if Cook would have actually worn the strange waistcoat and, even more intriguing, if he would have worn the Hawaiian helmet and feathered cape.

One also wonders why Mrs Cook ended up with this particular feathered cape rather than any of the several others that Captain Cook once had. We know that, on one ceremonial occasion, High Chief Kalani'ōpu'u presented to Captain Cook six

Tereoboo, King of Owhyhee, bringing presents to Captain Cook. Watercolour by John Webber, R.A. (1751–93).

DIXSON LIBRARY, STATE LIBRARY OF NSW

RIC BOLZAN

The feathered cape collected during Cook's visit to Hawaii in 1779, now in the Australian Museum's collection. Could this have been one of the capes presented to Cook by the High Chief?

feathered capes and cloaks including the one he himself wore. Most of these went into the private museum of Sir Ashton Lever and were eventually sold at auction. This cape, however, stayed with Mrs Cook. Did Mrs Cook choose it? Perhaps she herself intended to wear it? Afterall, it is said that Mrs Cook made dresses to commemorate Cook's various landfalls. Perhaps this was the crowning glory to commemorate Cook's most famous landfall, as well as a memorial to his death?

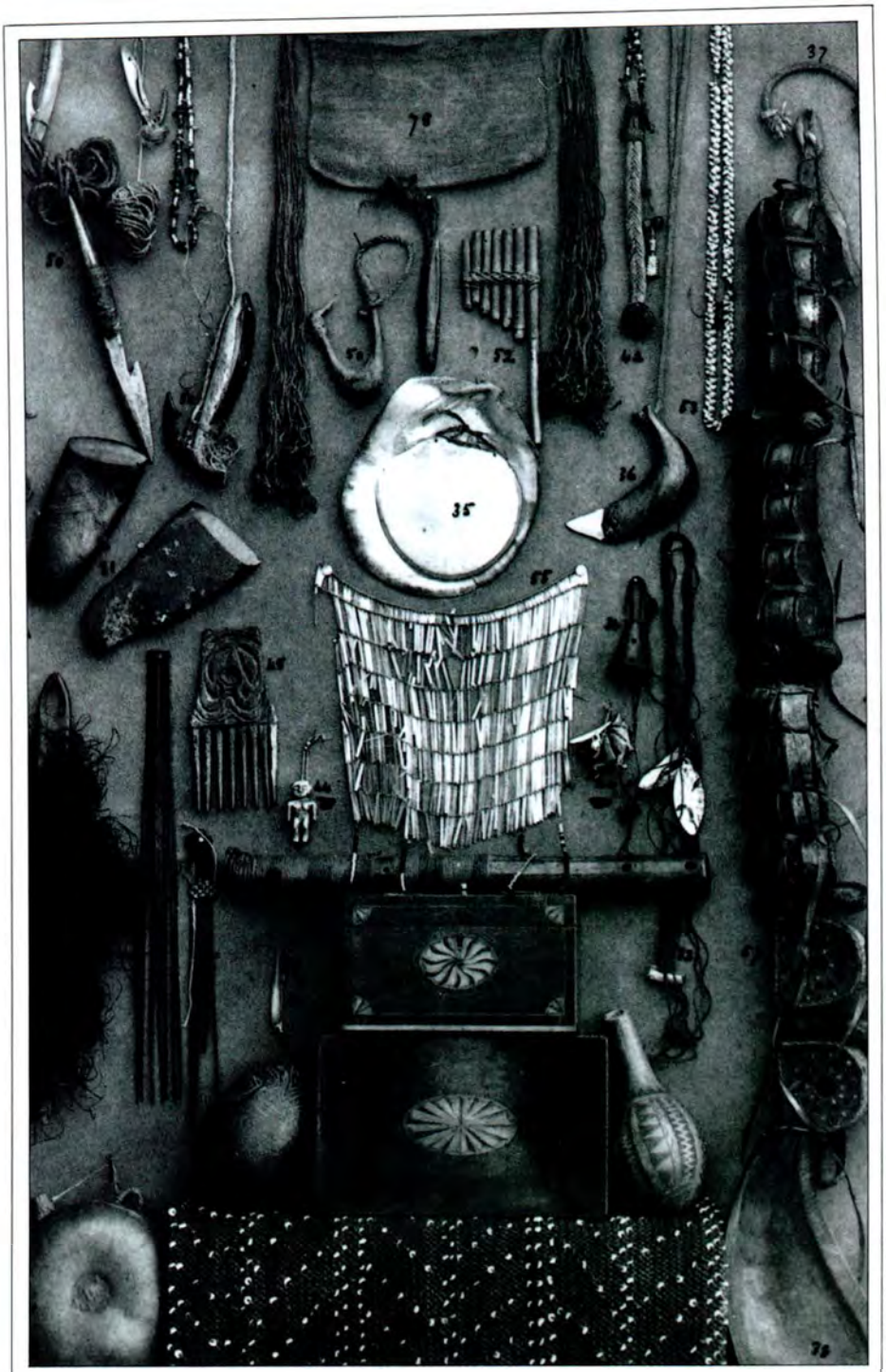
If Mrs Cook did choose it, she made an excellent choice—for this feathered cape is, in fact, unique. The cape is made of a netted backing covered with red and yellow

COURTESY K.J. HEWETT

The Hawaiian feathered cape, a basketry helmet and the barkcloth waistcoat photographed on display at the Colonial and Indian Exhibition in London, 1886.

feathers of the Hawaiian birds *'i'iwi*, *'o'o* and *mamo*, and overlaid with tail feathers of tropic birds. Tropic-bird feathers were highly prized and, judging by the number used in this cape, suggests that its Hawaiian owner was of high rank indeed.

Feathered cloaks and capes were visual objectifications of social inequality, worn by high-ranking chiefs during warfare and other dangerous situations. They embodied the visual metaphor that one's genealogy is



COURTESY K.J. HEWETT

A collection of Cook's artefacts as exhibited at the Colonial and Indian Exhibition in London, 1886. Most are now in the Australian Museum.

one's sacred protection. Protection derived from the process of making the garment as well as from the physical protection it afforded. Apparently, the netted backing was fabricated while chanting prayers, thus entangling them in the cape and spiritually protecting its wearer. The netting was covered with red feathers—a sacred natural product—giving it even more sanctity. In addition, capes were sometimes amended to renew their sanctity, and it is likely that the overlay of tropic-bird feathers in the Australian Museum cape is a unique example of such ritual renewal.

To a Hawaiian, the back and the top of a person's head were sacred. Chiefs protected these vulnerable body parts by wearing feathered capes and helmets that had been enhanced with entangled sacred prayers. Had Captain Cook understood this he might have worn one of his numerous feathered capes on that fatal day of 14 February 1779. ■

Suggested Reading

Kaeppler, A.L., 1978. *Artificial Curiosities: Being an Exposition of Native Manufactures Collected on the Three Pacific Voyages of Captain James Cook, R.N.* Honolulu: Bishop Museum Press.

Kaeppler, A.L., 1985. Hawaiian Art and Society: Traditions and Transformations. In *Transformations of Polynesian Culture*, ed. by Antony Hooper and Judith Huntsman. Auckland: The Polynesian Society.

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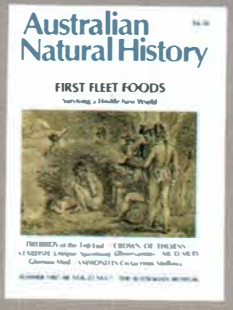

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PROFILE

DAVID SUZUKI

BY ROBYN WILLIAMS
PRODUCER, ABC RADIO SCIENCE SHOW

IMAGINE BEING A NORMAL LITTLE BOY in your home town, when one day you're told that you and yours are aliens. You must go away and be kept apart, your family split, your new 'home' a concentration camp. This was wartime Canada; the boy was David Suzuki. He was astonished to be told that his nationality had changed almost overnight. He was now deemed to be a small Japanese person.

That event, for which the Canadian government apologised formally in October 1988, affected Suzuki's thinking more than any other. It made him choose genetics as a discipline and ensured that he's remained devastatingly outspoken to this day. The fundamental insult, you see, is that young David was given to believe he had Japanese genes: his racial character was embedded irreversibly, in his very biology.

Later, after a brilliant career at high school in Canada and then Amherst in the United States, Suzuki learned that this 'biology' was balderdash—a twisted, vile misrepresentation of science, one that had been used for a century to condemn certain humans as inferior or unfit. It still goes on. Former Prime Minister Nakasone said publicly more than once that the United States had lost its lead economically and culturally because their 'stock' had been reduced in quality by mixing superior Anglo-Saxon blood with black and Irish strains. Nakasone was reflecting a common assumption in modern Japan.

But Suzuki, both as a broadcaster and professor of zoology at the University of British Columbia in Vancouver, has been inspired both by science done properly *and* an understanding that research has a place in history and a social context. In other words, you mustn't call on a geneticist to find out whether people should be treated well or with cruelty. It just so happens that the human species is one. If one day we do discover a separate 'less bright' breed of people somewhere east of the Urals, this would not imply that we could automatically use them as slave labour.

Suzuki is equally sceptical about the powerful tools that science is providing for us, which could be misused if we're not careful. IQ tests are a famous example. They were specifically excluded from use as a means of social audit by their French inventor Alfred Binet. But his warning was largely ignored. Easy categorisation of people, especially when streaming for schooling, is often too tempting. Such a cavalier use of intelligence measures assumes a genetic inheritance of profound rigidity. Scientists like Suzuki find this so much twaddle.

But he's also angrily outspoken against the newly launched 'biological equivalent of Star Wars'—the project to map the human genome. This four to five billion dollar enterprise has the backing of genetic luminaries such as Sir Walter Bodmer (Director of Research at the British Imperial Cancer Fund), Prof. Leroy Hood of the California Institute of Technology and, indeed, the man now nominated to lead the effort—none other than Prof. James Watson of DNA double-helix fame.

They believe that by analysing all the base-sequences of the human genetic code we shall be able to tell where, for example, genes for Altzheimer's disease or diabetes lie. Perhaps all of the genetically determined diseases and inadequacies can thus be pinpointed and, who knows, eliminated. But there's the rub, according to Suzuki. Here's another excuse for social audit, for a means to ascribe inferiority. If the information is there, it will be used and misused. In but a few decades it may become routine for employers, future spouses or any busybody to examine your genetic credentials for assessment of your suitability. And, with the enormous cost of analysing the incredibly complex code, it may be necessary to allow certain corporations to protect their investment by keeping a copyright to aspects of the sequence—another facet that worries Suzuki.

But the role of Jeremiah doesn't come easily to a good scientist and Suzuki hates being seen as a spoilsport. He's painfully aware that years of intensive training and an increasingly narrow focus make the average researcher ill-equipped to see the broader implications of the work. It is also very hard to jump about between disciplines: once you're an expert on the gastric juices of bugs it's pretty tough trying to turn even to another branch of biology, let alone cryogenics. So a quiet conservatism sets in and the cries of the few Suzuki's on Earth are received awkwardly. But to the thousands of ordinary folk in Australia, Canada and elsewhere, who flock to hear his startling stories and withering critiques, it all makes sense. In Melbourne, at the Commission for the Future talk on 'Can we Improve on Nature', and at a full-house lecture at the Australian Museum, it was obvious that Suzuki was striking chords. Perhaps all of us, in different ways, have at some time been told we're aliens too! ■

Don't whinge about world problems. Help solve a few.

Land of the Lightning Brothers.

Earlier generations of the Wardaman people have left a spectacular array of cliff paintings, dominated by the striped figures of the Lightning Brothers.

Archaeologist Dr Josephine Flood needs volunteers to help document them.

Staging area: Katherine, N.T.

Share of costs: $A1,290

Live Volcano.

When Arenal Volcano erupted in 1968 it was the most violent explosion in Costa Rica's history.

Geologist Dr William Melson and Dr Victoria Funk need volunteers to help study the volcano and predict future activity.

Staging area: Arenal Volcano, Costa Rica.

Share of costs: $US 1,350.

African Lake Fish.

Why do fish fall in love? Scuba divers are required to work in clear warm waters, at times with video cameras, putting Dr Irv Kornfield's recent hypothesis to the test.

Staging area: Lake Malawi National Park, East Africa.

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Orangutan.

The Orangutan is an endangered species. Habitat destruction, hunting and the pet market have drastically reduced its numbers.

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Honeyeaters.

Research shows there are no longer sufficient numbers of "Honeyeaters" to pollinate all the flowers of Kangaroo Island. Where have these birds gone? And how are introduced species affecting plant-pollinator relationships?

To further his research, Dr David Paton needs volunteers to help answer these questions.

Staging area: Kangaroo Island, S.A.

Share of costs: $A 1,290.

Wheatbelt Wildlife.

How well is wildlife surviving in the remaining strips of native vegetation between the wheatfields?

Volunteers are needed to help Dr Denis Saunders and Dr Graham Arnold find out.

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HEAVEN, HELL & HIERARCHIES

BY RALPH MOLNAR & GLEN INGRAM
QUEENSLAND MUSEUM

IN THE LAST 25 YEARS, THE SPIRIT OF evolution has changed. New information and new ideas have been brought forward.

You may be forgiven if you have missed the excitement. The public profile of evolution has been governed not by new ideas but by the evolution–creation confrontation. It has not been a good forum—not surprising as the confrontation is about winning hearts and minds, even souls. Also, biologists have been defensive, even antagonistic, to the new ideas in their discipline. This, too, is not surprising. When new thoughts are proposed, they are often seized upon as weapons by non-scientists such as creationists. The new ideas seem to challenge traditional evolutionary thought: they are excellent for exorcising the devil, Darwin.

There is a misunderstanding here. Exorcising Charles Darwin is not the same as exorcising evolution; Darwin and evolution are not synonymous. The question "was Darwin wrong?" raises different issues to "is evolution incorrect?" By way of comparison, Isaac Newton revolutionised physics but Einstein, Bohr and others showed where he was wrong. Yet physics is with us today and we still celebrate the genius of Newton.

Creationists rarely understand evolution, and even more rarely appreciate the role of the new ideas. But even critics of evolution who are themselves scientists and who criticise the idea of natural selection make this same mistake. Natural selection is often not well understood, so ideas that complement and extend it are taken instead to challenge it. Be that as it may, we will be celebrating Darwin for some time to come and evolution is here to stay.

One of the new ideas in evolution is the resurrection of the idea of catastrophism. Paradoxically, it is because it is *not* new that it engenders hostility from some biologists. Catastrophism—the theory that change happens because of some event that is disastrous in its consequences—has its roots in the Bible. The Flood is a good example. God in His wrath devastates the planet and the natural world is irrevocably changed. Creationists invoke catastrophes such as the Flood to explain the fossil record, but creationist misuse should not bias us against catastrophism as a mechanism for natural changes.

It is fairly certain now that there have been several catastrophes in geological time. Meteorites may have been important as instruments of mass extinction. Death can come suddenly and unexpectedly from space. Dialogue, too, can come suddenly and unexpectedly, especially to the healthy evolutionist:

Glen Ingram: *We need a taxonomy of death.*

Ralph Molnar: *Death is a paper tiger. For example, individual organisms die but species become extinct. The death of an individual is of hardly any consequence to a species. Extinction, however, is on another level. It is the end of an evolutionary lineage.*

GI: *Then we need a taxonomy of extinction. There appear to be many kinds of 'dying out'. For example, extinction of a species can take millions of years or there can be a 'boom' and it is all over. It's so annoying. The type of extinction seems to govern what words we can use. It was so convenient when we could say so-and-so died out because it was poorly adapted. But now, with mass extinction and the probability of the extraterrestriality of death, such a statement appears to be a hyperbole. Take, for example, "The dinosaurs died out because they had no adaptations to meteorite impacts." How can you be adapted against being squashed into pulp or being blasted into fragments?*

Charles Darwin: evolution is here to stay.

Life has survived many meteorite strikes. There is something about it that makes it resilient. This 'something' is not necessarily shared with species, genera, families and even phyla. The living kingdoms themselves survive. Is it possible, then, that selection has operated at the level of kingdoms? Are they adapted to survive meteorite strikes while their 'component parts', including species, are not? If so, this bucks the traditional ideas that natural selection operates only on the level of the population and that species are the basic units of evolution. Instead there appears to be hierarchy of evolutionary entities.

Hierarchies are well known in biology. Over two centuries ago, Linnaeus proposed his hierarchical classification, which is still used today. Humans are good at recognising hierarchies in nature. We do it all the time. For example, most Australians can recognise a kangaroo. To the question "What sort of kangaroo is it?" many are also capable of answering "Grey Kangaroo" or 'Red Kangaroo'. This example illustrates a simple natural hierarchy. 'Kangaroo' is a generic. All 'Grey Kangaroos' are 'kangaroos' but not all "kangaroos" are "Grey Kangaroos". Similarly, all kangaroos are marsupials but not all marsupials are kangaroos. That is, there is a higher level group and it cannot be a member of the group 'below' but the group 'below' is a member of the group 'above'.

GI: *The concept of evolving hierarchical sytems is extremely complex. How would you explain it simply?*

RM: *I suppose I would emphasise the simplicity of earlier ideas about evolution; species or populations were seen as the vehicles of change in time. Also, they were real. Species particularly were perceived as natural entities. But a hierarchical structure of nature has many entities. For example, Grey Kangaroos are an entity but kangaroos are an entity too.*

GI: *There it really becomes complex. What happens to kangaroos in time affects what happens to Grey Kangaroos, but what happens to Grey Kangaroos may*

'Destruction by the Deluge'. Creationists invoke catastrophes such as the Flood to explain the fossil record.

not be of consequence to kangaroos. If Greys became extinct, there would still be kangaroos. Maybe extinction is a paper tiger too?

RM: *I doubt it. But you can see the implications of hierarchies, which is only one of the many new ideas being proposed about evolution today.*

In this regular column we shall try to explore these new ideas and their consequences. As well, we shall re-examine a few of the basic foundation stones of evolution, such as the very concept of natural selection. New ideas and fresh approaches can change how we look at ourselves and our universe. ■

An odd eucalypt of lilliputian proportions has only recently been discovered.

THE RAREST GUM TREE

BY MICHAEL D. CRISP
AUSTRALIAN NATIONAL BOTANIC GARDENS

THIS YEAR IS THE BICENTENARY OF THE gum tree. In 1789, the French botanist L'Heritier named *Eucalyptus* from a specimen of the Messmate Stringybark (*E. obliqua*), collected in Tasmania. South-eastern Australia is the centre of diversity of the eucalypts. Since 1788, over 200 species have been found in this corner of the continent. Despite such a concentrated effort (more botanists have worked on *Eucalyptus* than any other plant genus), more are being discovered every year. Not surprisingly, it is the rarer species that are being found now. Often they are known from only a few tens of individuals occurring in one or two remote places, such as mountain peaks.

Probably the rarest of all is *Eucalyptus recurva*, a shrub growing in heathland near Braidwood, on the Southern Tablelands of New South Wales. In 1985, Robin Jean, a local landholder, discovered a single clump of five plants. Despite extensive searches of the surrounding countryside, no more plants have been found. Paradoxically, its habitat does not give the impression of a specialised niche. On the contrary, it grows in the kind of heathland, dominated by the Dwarf She-oak, *Allocasuarina nana*, which is widespread on poor soils of the hills on the eastern side of the Southern Tablelands. Perhaps *Eucalyptus recurva* has evolved only recently, and is localised only because it has not had the opportunity to expand its range of distribution. Hybridisation is one way in which a species may suddenly come into existence. However, this plant has so many unique characters that it is not possible to identify any plausible parents. More likely, it is a relic of a more widespread ancestor, and has existed as a small population in its present locality for a long time, where its survival may be due more to chance than to a specially favourable habitat.

In many ways this is a very odd eucalypt. The most striking feature is its lilliputian proportions. The plant itself is a 'mallee' shrub scarcely as tall as a person, and all its parts are miniscule. A typical gum tree has pendulous sickle-shaped leaves ten or more centimetres long but the leaves of *E. recurva* are short (two to four centimetres), erect and gently curved away from the stem. The Latin name of the species alludes to the last characteristic, which gives it the appearance of a wax-flower (*Eriostemon*) rather than a eucalypt. Oil glands are typical of eucalypts, but those in *E. recurva* are particularly large and numerous. If the species were easy to grow, it could be a valuable source of *Eucalyptus* oil. Every January, the plants flower like clockwork. Because the leaves are small, the flowers are conspicuous and the mass of delicate white stamens makes a pretty display.

Even in the absence of external threats, the single known population of *E. recurva* must be considered endangered by virtue of its extremely narrow genetic base. A colleague at the CSIRO analysed the genetic diversity of the five plants using enzymes that he extracted from the leaves. No variation was found, which could indicate that the plants are a clone—a single genetic individual. Given enough time, hundreds of years perhaps, the woody rootstock of a mallee eucalypt grows slowly at the edges, while decaying in the middle, forming a kind of fairy ring comprising several individuals, in a similar manner to toadstools. This may be how the genetically uniform 'population' of *E. recurva* came into being.

Alternatively, the population may have lost its genetic diversity through inbreeding. In fact, there is evidence to support this idea. Very few seeds are set (about one per capsule), and a good proportion of those seem to lack embryos. Attempts to propagate plants at the Australian National Botanic Gardens have met limited success. No seeds could be germinated at all until the technique of stratification was tried. This involved refrigerating seeds for several weeks and then placing them in an incubator to promote germination. Eucalypt seeds generally do not require such treatment, but a few species from sub-alpine habitats, such as the Tasmanian Varnished Gum (*E. vernicosa*), the closest relative of *E. recurva*, do respond to stratification. Treated in this way, a few seeds of *E. recurva* have germinated but growth has been poor. Those few that survived the initial stages have grown about ten centimetres every four months. The tallest is now about half a metre high after a little more than one year.

Eucalyptus recurva occurs on private land that at present is largely undisturbed, although the rootstock of one individual has been damaged by vehicles. As far as is known, the present landholder intends to preserve the population but, as long as the site is unreserved, it must have a degree of insecurity. ■

***Eucalyptus recurva* flowers like clockwork every January.**

MICHAEL CRISP/AUSTRALIAN NATIONAL BOTANIC GARDENS

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THE YARRABAH WAY

BY TIM LOW

ACROSS THE HARBOUR FROM THE ESplanade at Cairns stands a rugged, heavily forested mountain range. It is Cape Grafton, once the home of Kungganji Aborigines and now incorporated into the Yarrabah Aboriginal Reserve.

Yarrabah township was set up in the 1890s under odious circumstances. It was a Church of England 'orphanage' for half-caste children seized from Aboriginal camps around Cairns. These children were denied all traditional knowledge and were segregated from the 80 or so tribal Aborigines still living on the Cape. The latter became 'rice Christians', sitting in on Yarrabah church services in exchange for food.

Given its sorry history, Yarrabah seemed an unlikely place to learn about traditional Aboriginal foods. When I visited the reserve last year I was warned not to expect much. My guide for the day was Darryl Pollard, the groundsman at Yarrabah school. He drove me along a sandy road to a weedy patch of open forest on the edge of town.

I was astonished by the first plant he showed me. It was a vigorous vine with bright-green heart-shaped leaves, trailing over a dead fallen tree. I recognised it as an Asian species of yam, *Dioscorea alata*; Darryl called it the 'red yam' after the colour of its large edible tuber.

Darryl said he recently bought land, and was planting out red yam 'seeds'—actually aerial tubers, or bulbils. His grandfather had advised planting a flat stone under each yam to ensure it grew outwards and not deep into the soil. Darryl was surprised that the yam was not a traditional Aboriginal food. There were more surprises in store for both of us.

The next plant he showed me was the small flowering shrub 'gungjinarra' (*Fenzlia obtusa*). Its beautiful pink blossoms are followed by tiny sweet edible fruits.

We then came across two plants unknown to Darryl, but which I knew from historical accounts to be old Aboriginal foods. One was Wombat Berry (*Eustrephus latifolius*), with small sugary tubers; the other Painted Orchid (*Geodorum densiflorum*), which has tuberous rhizomes. I felt strange showing an Aborigine traditional Aboriginal foods, but Darryl didn't seem to mind. He liked the taste of the orchid.

We then came upon another yam, this

The bright pink flowers of *Fenzlia obtusa* draw attention to this showy shrub of coastal sands, the small fruits of which are edible.

PHOTOS: TIM LOW

time the native Long Yam (*Dioscorea transversa*), Darryl's favourite. With his grandfather and cousin, Darryl takes turns with a shovel digging a deep angular hole to extract the long starchy tuber. Even with the three of them it can take more than half an hour to dig one tuber, which is then cleaned and boiled. The top of the yam is replanted to ensure a future, although smaller, tuber.

Darryl gave the name of this yam as gungjinarra. When I protested that this was the name of the fruiting shrub we saw earlier, he became confused and said he wasn't sure about the old yam names.

We then came upon a Sweet Sandpaper Fig tree (*Ficus opposita*), one of my favourite wild fruit trees. But Darryl surprised me by saying the fruits were never eaten, they were 'parrot food'.

We looked at a few more plants, then drove back to town where Darryl introduced me to his grandfather, Mervyn Smith. Mervyn at least knew the red yam was introduced—'by South Sea Islanders'. But he confused me by talking about 'New Zealand apples', white fruits of the rainforest that supposedly came from New Zealand.

Later on, a local schoolteacher, Rob Hinxman, was able to clear much of my confusion. Rob has studied the local foodplants and maintains a native foods garden in the schoolyard. He hopes to foster interest among the schoolchildren in their traditional culture, and believes the way to do this is through their stomachs.

Rob said that knowledge of many foodplants, such as the figs, had been lost over the years, and that names of other plants had been transposed. The shrub *Fenzlia obtusa*, originally called gungunyu, has taken on the name of the long yam, which grows in the same sandy soils. Similarly, the traditional name of what I call Yellow Plum (*Ximenia americana*) is now applied to the Lollyberry (*Salacia chinensis*). Both plants grow together in the strand vegetation. Yellow Plum, having forfeited its traditional name, is now called 'wild apricot'.

The Long Yam, once a staple Aboriginal food, has a slender tuber that the plant replaces each year. In this specimen the new year's tuber is still young, crisp and white; the darker tuber from last year is starting to shrivel.

Darryl Pollard of Yarrabah identifies the local 'red yam', a species of Asian provenance.

Rob could not explain why the native white apple (*Syzgium forte*) is called 'New Zealand apple'. As for the Asian yam, he suggested it came in with island labour imported to make mission houses long ago.

Yarrabah is a strong community, and locals talk with pride of the 'Yarrabah way'. I can see that, where wild foods are concerned, the Yarrabah way is about practicalities, not rituals. Darryl eats red yams because he likes them, not because it's a traditional thing to do. Indeed, he could teach me next to nothing about Aboriginal tradition.

Perhaps I should feel sad that so much of Yarrabah's traditional knowledge has been lost. But I prefer to dwell on the richness of the culture as it exists now, and to marvel at its hybrid origins.

Among the Aboriginal foodplants Rob Hinxman has planted is the Wongi tree (*Manilkara kauki*), a species not native to Yarrabah and unknown to Darryl's forebears. If there is ever a renaissance of Aboriginal culture in Australia, as seems likely, I can imagine a 21st-century anthropologist visiting Yarrabah, and being solemnly shown a Wongi plum as a traditional food, with a traditional Yarrabah name. In such ways are traditions made. ■


'88

CONTROVERSY

Mass extinctions are regular geological events, but what causes them? A run-down of ideas on what has been called "a contentious issue of enduring fascination."

DINOSAUR EXTINCTIONS

BY RALPH MOLNAR and MARGRIET O'REAGAN
VERTEBRATE FOSSILS, QUEENSLAND MUSEUM

ONLY HALF A MILLION YEARS AGO the Earth was filled with fabulous beasts—woolly mammoths and rhinoceroses, and sabre-tooth 'tigers', diprotodonts and glyptodonts, giant kangaroos and capybaras. Now they are all gone. Seventy million years before that the world was inhabited by 'dragons'—dinosaurs on land, pterosaurs in the air, and plesiosaurs and mosasaurs in the seas. Had we lived then we would have thought they would last forever. But they didn't.

Why did they become extinct? This fascinating question, coupled in many people's minds with the worry that extinction might befall us too, is of perennial public interest. Recently it has experienced a surge of scientific inquiry. New questions, if not new answers, have emerged.

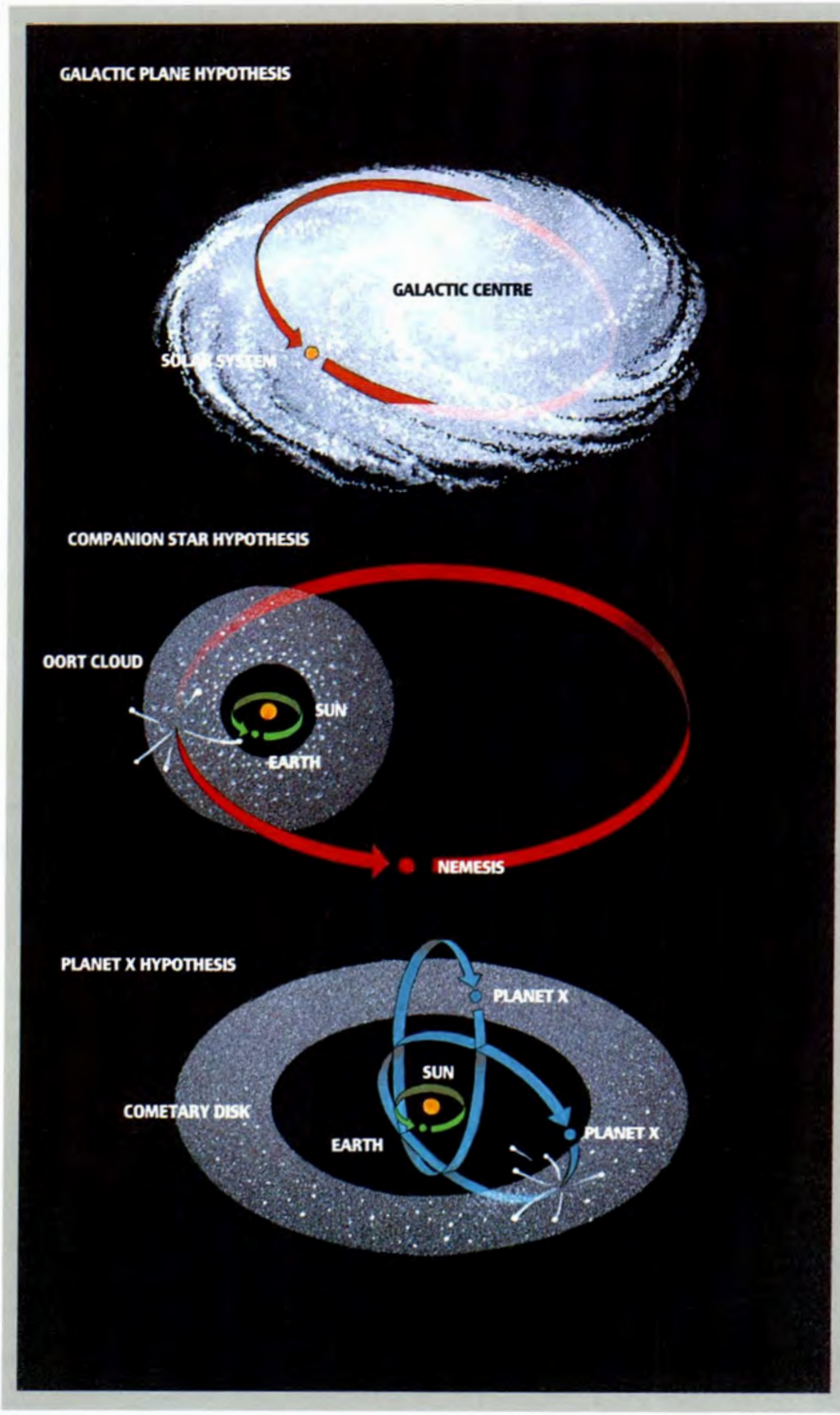
The postulated effect of an asteroid impact would be heavily clouded skies resulting in low temperatures. Such 'impact winter' conditions would kill off growing plants, but not spores and seeds, by obscuring sunlight necessary for photosynthesis. Cold-sensitive animals and those requiring fresh plant food would also be killed off. Seeds and spores, and small vertebrates such as placental mammals survived; marsupials almost became extinct. However, a cataclysmic winter could also be produced by other causes, such as extensive volcanic eruptions (known to have occurred at the end of the Cretaceous) or a nearby supernova.

ILLUSTRATIONS: DAVID KIRSHNER

ALL THE EXCITEMENT, CONTROVERSY, and "the most fascinating interdisciplinary crossfertilization in the history of science", to quote Jeremy Cherfas (*New Scientist*, 3 October 1985), started in 1980. *Science* published an article entitled "Extraterrestrial cause for the Cretaceous–Tertiary extinction" by Luis Alvarez (a Nobel physicist), Walter Alvarez (his son and leader of the team), Frank Asaro and Helen Michel—all from the University of California at Berkley. This was the debut of their extraterrestrial-impact hypothesis of dinosaur extinction.

The team had examined the 65 million-year-old, two-centimetre layer of clay separating Cretaceous rocks from overlying Tertiary strata near Gubbio, Italy. They found concentrations of the metal iridium 30 times higher than in the beds above and below. Because iridium is rare in the Earth's crust, this anomalous abundance needed an explanation. The team proposed that the iridium, and other related rare metals found there, were of extraterrestrial origin. The worldwide distribution of these metals suggested that they arrived here aboard a comet or an asteroid, 10–20 kilometres long and weighing around 1,000 billion tons. The impact would have released energy equivalent to 1,000 times the present global nuclear stockpile, and caused a cloud of dust and debris to sweep around the Earth, blocking the sunlight for weeks or months. In addition to the damage of the impact, the cold and darkness resulting from this cloud would have killed a vast number of plants and animals in the following 'cometary winter'. Eventually the airborne, iridium-rich debris would have fallen to Earth where it was deposited in contemporaneous sediments.

A flurry of chemical analyses followed these initial findings. By the end of 1983, iridium anomalies, sometimes 450 times higher than expected, had been found at



CAUSES OF PERIODIC EXTINCTIONS

Three astronomical mechanisms that could result in the periodic extinctions are claimed by Raup and Sepkoski.

Galactic plane hypothesis: Not only does the Earth orbit the sun, but the solar system orbits the galactic centre. This orbit does not lie in the plane of the galaxy. When the solar system passes through the galactic plane it encounters gas and dust clouds, and probably increased radiation as well. This occurs about every 33 million years (although the mechanism proposed for this is vague).

Companion star hypothesis: The sun may have a companion star, somewhat humorously called Nemesis (in view of its proposed role in causing extinctions). Such a star is obviously not very bright, or it would have been discovered millenia ago. Its eccentric orbit takes it well away from the sun and planets (where it is supposed to be now), but other times close enough to pass through the Oort cloud of comets. When it does pass through the Oort cloud, comets would be scattered and 'rain' into the inner solar system, one or more likely impacting on Earth. The outgoing comets are depicted with tails, but this is only to show direction of travel. Comets this far from the sun would not have tails and, even if they did, the tails would be directed away from the sun.

Planet X hypothesis: Unexpected motion of the planet Uranus led to the discovery of Neptune, and further unexpected motion of Neptune led to the discovery of Pluto. Pluto, disconcertingly, is not massive enough to cause the irregularities in Neptune's orbit. Thus some astronomers believe there is yet another planet to be discovered, called Planet X. One reason this planet remains undiscovered may be that its orbit does not lie in the plane of the other planetary orbits (the ecliptic). (Two positions of Planet X's highly inclined orbit are shown.) This being so, its orbit may pass through a hypothetical inner cometary disc (not the Oort cloud). There, like Nemesis, it would stir up the comets causing some to fall to Earth or in its vicinity.

It is important to bear in mind which of these factors exist and which are hypothetical. The passage of the solar system through the galactic plane does occur, and the plane does have clouds of dust and gas. The increased radiation is not known but is likely. Existence of the Oort cloud is accepted by many Western astronomers (some Soviet astronomers are unconvinced), but Nemesis is hypothetical. Planet X is also hypothetical, but with a difference: after all, something must account for Neptune's unexpected motion. The inner cometary disc is also hypothetical, but recent evidence supports its existence.

more than 50 Cretaceous–Tertiary (K–T) boundary sites worldwide. The analyses were done at seven independent laboratories in the United States, Holland, Switzerland and Russia, and samples from a single site were sometimes analysed at two or more labs. The anomalies were found in virtually all sedimentary environments, from deep sea to continental swamp. The initial results were no fluke. However, many scientists were concerned that few analyses had been done for times other than the K–T boundary. Iridium levels were tested from five other periods of major extinction: they too showed high levels of the metal. David Raup, in his book *The Nemesis Affair* (1986), cautions that these amomalies all need more work to verify their significance, for other sources such as volcanoes and micro-organisms can also deposit these rare elements in unexpectedly large concentrations. Thus the anomalies suggest, but do not prove, an impact origin.

IT WAS RAUP AND HIS COLLEAGUE JACK Sepkoski, both working at the Field Museum in Chicago, who started the mass extinction roller-coaster with their claim of a clear and statistically precise 26-million-year period between extinctions over the last 250 million years. So 'nice' was this periodicity that only astronomical regularities could account for it. In 1984 *Nature* published five papers in a single issue giving scenarios for extraterrestrial causes of cyclic mass extinction. The issue also included two cautionary comments by its editorial heavy-weights John Maddox and Anthony Hallam. Maddox did some mild wrist-slapping as well, for the excitement surrounding this news involved some near breaches of scientific etiquette, not to mention confusion. Raup and Sepkoski circulated their unpublished manuscript—a usual procedure—except that in this case the follow-up astronomical papers published in *Nature* almost preceded their publication of the initial periodicity finding, which was finally published in *Proceedings of the National Academy of Sciences (USA)*, February 1984.

Two of these speculative papers in *Nature* independently proposed that an unseen companion star, a highly eccentric buddy of Old Sol, wandering 90,000 times further from the sun than Earth, was responsible for the catastrophic visitation that vanquished the dinosaurs and other 'dragons'. Every 26 million years this tiny, cool, dim star—dubbed 'Nemesis'—would plough through the Oort cloud of comets at the edge of solar space, regularly causing some of the disturbed comets to collide with Earth as they careered chaotically out of their own far-flung orbits.

Few of us can resist the allure of such spectacular cosmic activity. However, despite the well-documented metallic anomalies, and some significant time correlations of large craters with recognised extinctions, these theories require more evidence.

Causes of Dinosaurian Extinctions

Many explanations have been offered to account for the extinctions at the end of the Cretaceous. We list here both the reasonable and silly and have, with restraint, refrained from commenting on some of the sillier 'explanations'.

Biological Causes

collapse of intervertebral disks
malfunction of endocrine systems
too large to hibernate
small brain and consequent stupidity
absence of redundant DNA
chromosomal upsets
malformations of eggshells
eggs developing into only one sex
inability to mate
sexual frustration
aggression (or 'warfare')
psychotic suicidal factors
competition with mammals
loss of eggs to egg-eating mammals
competition with leaf-eating caterpillars
poisonous substances in plants (in cycads or angiosperms)
absence of natural laxatives
sorting of plant communities resulting in absence of food plants[1]
sterilisation resulting from sperm death by excessive heat
deleterious effects of the Mesozoic climate on endothermy (this assumes 'warm-blooded' dinosaurs)
collapse of the trophic (food) web
runaway effects of group selection acting to check excessive reproductive rates
predator overkill (too many predatory species)
racial senility
overspecialisation
increased size and resultant clumsiness
not sufficiently progressive
parasites
disease
the red spot (alleged to still be present in the ocean off Los Angeles)[2]

Terrestrial (Nonbiological) Causes

climatic change (getting warmer, colder, drier or wetter, or less equable seasonally or latitudinally)
changes in atmospheric pressure
changes in atmospheric composition (for example, due to excessive oxygen production by plants)
floods
drainage of swamps and lakes
poisonous water
absence of necessary trace substances (such as calcium and selenium[3])
presence of poisonous minerals
too high a level of natural radiation
earthquakes
poison gases
volcanic dust
mountain building
fall of sea level and resulting rise of the average height of continents
rise of sea level
spillage of frigid Arctic Ocean water into warm southern seas
breakup of supercontinents by sea-floor spreading

Extraterrestrial Causes

blindness from solar radiation
reversal of terrestrial magnetic field allowing flood of cosmic radiation
shift of rotational poles
origin of the moon from the Pacific Basin
meteorites or comets
sunspots
supernovae
fall of a (hypothetical) previous moon

Miscellaneous Causes

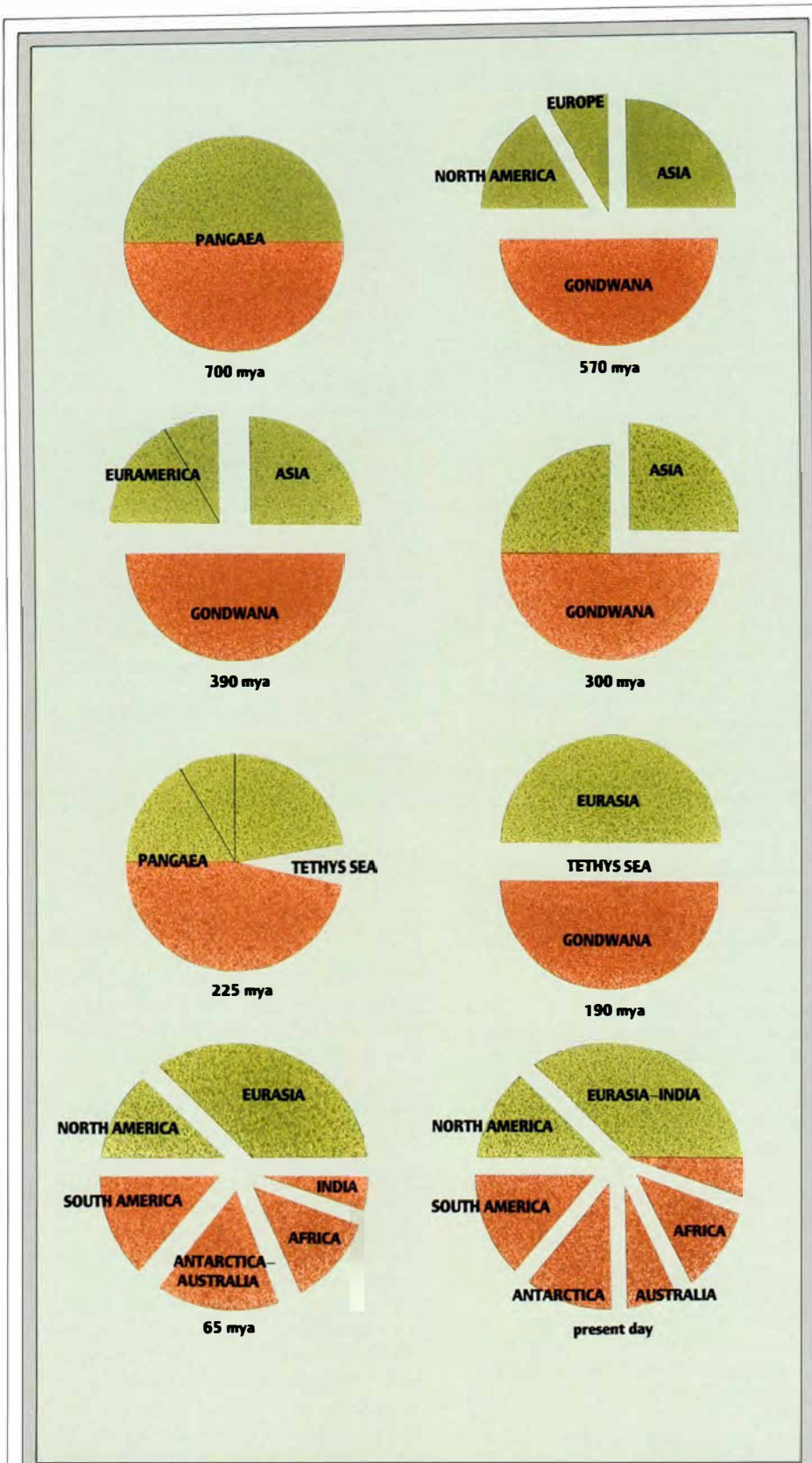
variation in the gravitational constant
entropy
hunting by little green men from flying saucers
Noah's Flood
God's will
unfitted to the Marxist dialectic ennui ('been there, done that')
various combinations of the above
and, of course, that they didn't[4]

[1] See notes to box on Events at the K–T Boundary.
[2] The 'red spot' is allegedly a disease unknown to medicine contracted by dinosaurs, which got it from marine reptiles. The disease organism lived in the Pacific Ocean, and the chap who told us about this, back in the '60s, said that he had noticed Los Angeles swimmers coming down with it. Need we say this is not one of the more credible explanations?
[3] Selenium is a 'trace element' that in low concentrations appears to prevent some liver and muscular diseases in mammals. In high concentrations it is poisonous.
[4] At least one Soviet scientist has claimed that extinctions simply did not occur. However, there is also a less frivolous reason to hold this view. If theropod dinosaurs gave rise to birds, then they did not become extinct in the usual sense of the word; they survived in the form of their descendants.

— R.E. Molnar

AN EARLY SUMMARY OF THE ISSUES WAS given by Michael J. Benton, an English palaeontologist, working in Queens University, Belfast. He proposed four explanatory categories for mass extinctions: extraterrestrial, terrestrial, biological and artefactual.

Extraterrestrial explanations are the most melodramatic and are strangely satisfying in their exotic appeal. Apart from 'Nemesis', other astrophysical phenomena have been proposed. Try this one: the solar system oscillates through the galactic plane every 30 million years, and the resulting



SUPERCYCLE OF THE CONTINENTS

The Earth's landmasses seemingly periodically break up and then re-coalesce into a single supercontinent, Pangaea. Starting at upper left, two cycles are illustrated here. About 700 million years ago there was a single supercontinent: the two colours represent those lands that make up the two Mesozoic supercontinents, Laurasia (green) and Gondwana (brown). By 570 million years ago, Pangaea had fragmented in four; 390 million years ago two of these four had fused; 300 million years ago fusion had continued, leaving only two landmasses. By 225 million years ago, Pangaea had been reassembled. Then 190 million years ago the next cycle of breakup had commenced. Sixty five million years ago, when the dinosaurs became extinct, supercontinents had become fragmented. Now, apparently, the continents have begun to reunite, India merging with Eurasia.

gravitational disturbance periodically scatters comets from the Oort cloud into the inner solar system. Another possibility is that an unknown Planet X, orbiting beyond Pluto, disturbs a closer cometary belt, precipitating an Earth-bound shower. Radiation from nearby supernovae, solar proton fluxes, and the Earth's passage through galactic density waves or galactic dust clouds, have also been suggested as extraterrestrial explanations of periodic extinctions.

Terrestrial causes involve geography and climate and, together with biological factors, form the traditional explanations of extinctions and biotic replacements. If grandeur, rather than instantaneous carnage, is what we hope for in our explanations for mass extinctions, then such views will not disappoint us. Consider the periodic breakup and recoalescence of the continents every 300 or 400 million years. This awesome event seemingly happened at least twice, with some of the most dramatic geographical, climatic and evolutionary events coinciding with the continents' global gavottes.

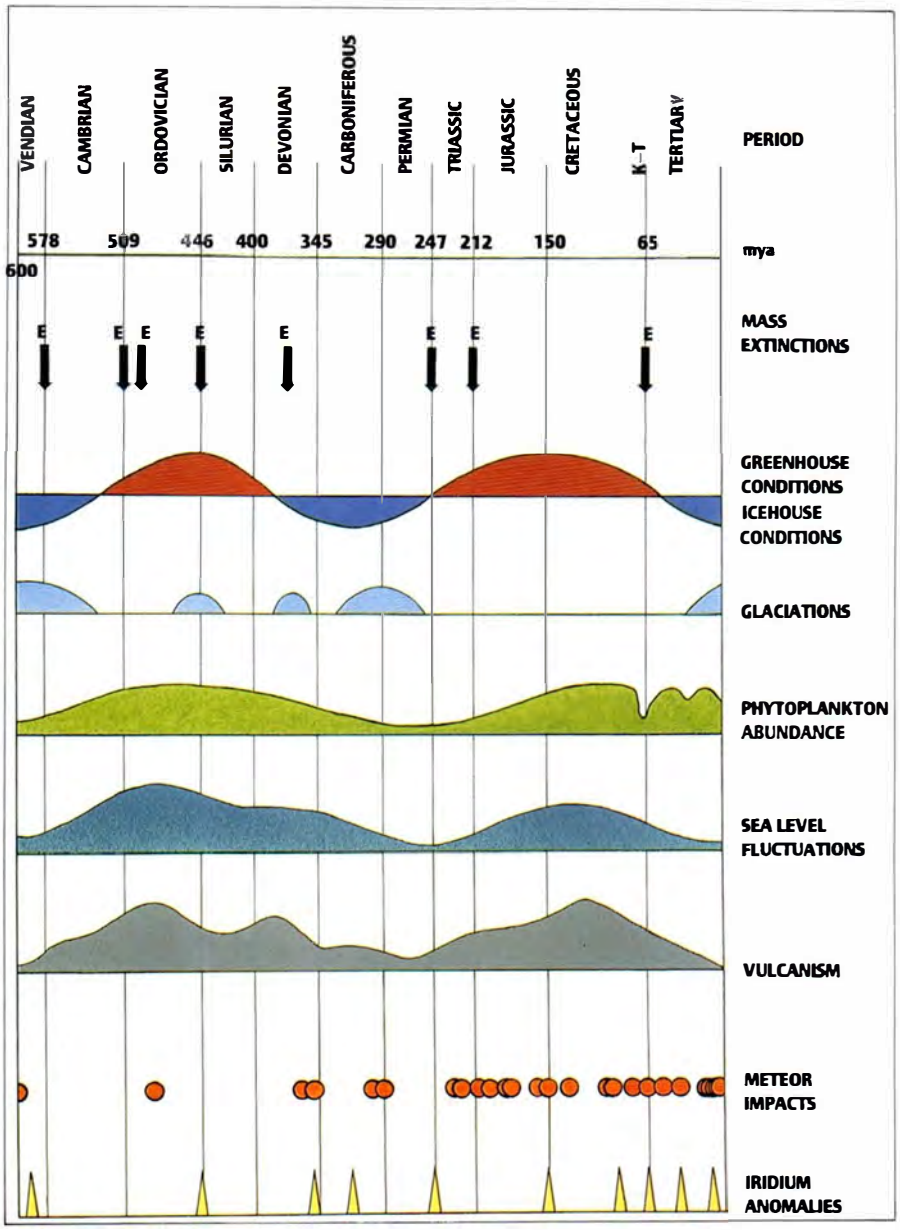
Alfred G. Fischer, of Princeton University, is into this kind of cycle. Supercycles, in fact, in addition to short-range ones. His 300-million-year supercycle involving the continental drift just mentioned is related to the deep subterranean convection currents of the Earth's mantle, which oscillate between slow and rapid motions. The currents create momentous surface phenomena, resulting in all major tectonic activities and great fluctuations in sea level. The faster upwelling mantle currents crack apart and drive the plates of the Earth's crust around like pieces of congealing slag during a smelter's pour-off. Periods of slower mantle convection allow the plates to clump together in a supercontinent. Such factors cause the entire planet to alternate between frigid 'icehouse' and steamy 'greenhouse' conditions. The 'greenhouse' results largely from high, heat-trapping levels of carbon dioxide released from volcanoes during periods of rapid mantle convection. The 'icehouse' conditions result from low levels of the gas associated with little volcanic activity and slower convection currents. This permits chilling on a global scale. What is the ultimate cause of these changing rates of convection? No-one knows, but the geological record attests to their presence.

A complete cycle takes approximately 300 million years, according to Fischer's calculations and, together with the 150-million-year crossover points between the two extremes, these events correspond to major extinctions in the Cambrian, Devonian, Triassic and Eocene. Unfortunately this model doesn't explain the biggest (the Permian) or the most popular (the Cretaceous) extinctions.

Fischer's smaller cycles include, among others, the Milankovitch cycles, which involve perturbations in the Earth–moon–sun orbital relationships that subtly but surely affect our climate. These cycles range from 20,000 to 400,000 years.

Other workers have stressed that sea level changes alone would be sufficient to account for extinctions. Apart from placing limitations on the amount and quality of land, these changes are associated with varying availability of the continental shelf habitat—vital to many marine organisms. Seas were sometimes wide, warm, sluggish and shallow, stagnant and deadly anoxic—as shown by extensive black shale deposits. At other times they were deep, narrow and plied by swift oxygenated currents, prolific with life. These fluctuations affect planktonic levels, which in turn affect atmospheric carbon dioxide, which in turn alters living conditions for all life forms.

Still others have focused on temperature fluctuations. Steven Stanley, of the Johns Hopkins University, Baltimore, noted that



EVENTS IN EARTH HISTORY

This diagram shows events throughout recent geological time that have been linked to mass extinctions (indicated by vertical arrows). Greenhouse conditions result from raised carbon dioxide levels in the atmosphere, which increase average temperatures. Icehouse conditions result from decreased carbon dioxide levels and are usually linked to polar ice caps or glaciations. Phytoplankton abundance is linked to oceanic chemistry, including calcium and oxygen levels, and follows sea level. Height of sea level is indicated by the distance of the curve above the horizontal line—sea level has varied from covering only 20 per cent of the continents (end of Permian) to almost 60 per cent (Ordovician). The volcanism curve indicates the amount of igneous rock formed in North America, which presumably reflects the number and intensity of volcanic eruptions. This curve also follows the sea level curve, although the similarity seems coincidental. Impacts of meteors (or comets) leaving craters ten or more kilometres in diameter, and iridium anomalies are also shown. The iridium 'spikes' are stereotyped and do not indicate that all are similar to one another.

Events at the K–T Boundary

So far no-one has gathered together in one publication all of the events that are known to have occurred at the end of the Cretaceous. This we have done here to allow you to review theories of dinosaur exinction for yourselves. We have tried to be complete, but doubtless have missed some events. The term 'spike' refers to an anomalously high concentration of the item so described.

Chemical Signatures
absence of calcium in soils
strontium 87 abundant relative to strontium 86
spikes of cobalt, gold, iridium, neodymium, nickel, osmium, palladium, rhenium, rhodium and strontium

Features Related to Impacts
micro-spherules[1]
sand-sized spherules[1]
shocked quartz
Manson crater (USA)
Kara and Ust-Kara craters (USSR)
Gusev and Kamensk craters (USSR)

Other Geological Features
soot 'layer' (on land)
clay layer (under water)
Deccan Traps (massive lava flows in India)

Climatic and Oceanic Events
cooling trend
local sea level minimum (regression)
oceans undersaturated in carbonates
evidence for 50–100-metre-high tsunamis

Extinctions
reptiles (dinosaurs, pterosaurs, sauropterygians, mosasaurs)
ammonites
belemnites (allied to cuttlefish)
ridistid clams
toothed birds (Odontornithes)

Partial Extinctions
calcareous plankton
brachiopods
calcareous (glass) sponges
multituberculate mammals
marsupials
freshwater fish
gymnosperms
laurels

Other Biotic Effects
fern (spore) spike
change in forest composition
sorting of plant communities[2]

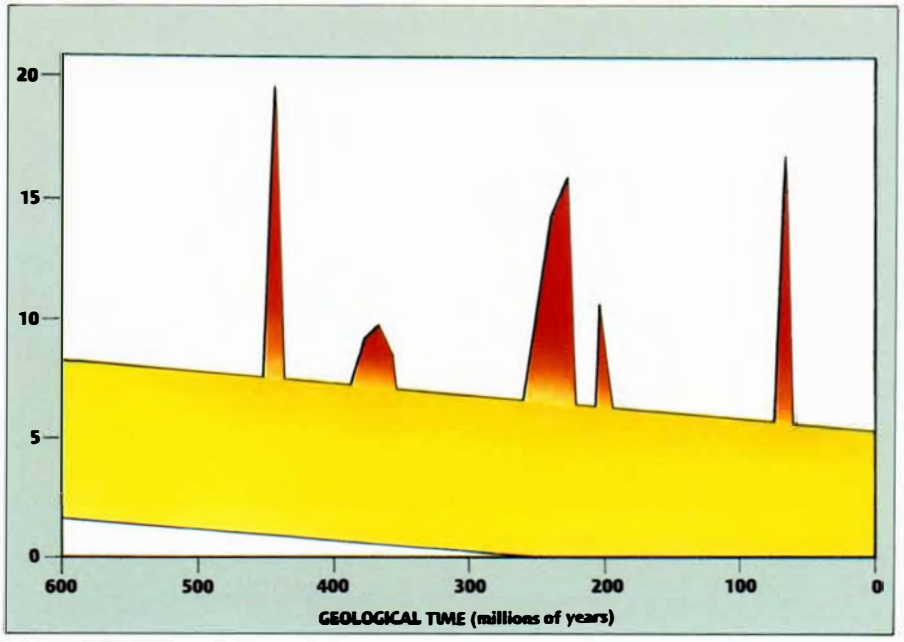
[1] Spherules and micro-spherules are solidified globules of once molten rock. Because they solidified in globular form, they are believed to have solidified after being ejected by an explosion or impact.
[2] 'Sorting' is used here to denote the segregation into separate communities of plant species previously living together in the same community.

—R.E. Molnar

major vertebrate extinctions were concentrated in the tropics. These areas, he suggested, became a 'refrigerated trap' when they cooled below the tolerance levels of the creatures that had migrated there from increasingly colder higher latitudes.

As for biotic explanations like competition and predation, Jennifer Kitchell and Daniel Pena, of the University of Wisconsin, felt there was no need to exclude them, believing that it may be incorrect to seek some overriding cause that explains all extinctions. Earlier this century, biological explanations alone were in vogue. For example, competition, as when 'more advanced' forms replaced 'less progressive' forms, was popular, as was 'racial senility' or 'genomic senescence'. It is currently thought that mammals replaced dinosaurs because the dinosaurs first became extinct, not because the mammals were 'more progressive'. And 'racial senility' fell from favour when no-one could invent a mechanism to account for it. Although no-one today seriously contends that any single biotic factor explains all extinctions, biological factors within and between species are extremely complex and may well be at the heart of the extinction story.

A spectacular hypothesis for the extinction of dinosaurs implicates an asteroid impact. There is good evidence for large impacts at the end of the Cretaceous, when dinosaurs became extinct. But why did these impacts cause a mass extinction when comparable earlier and later impacts did not? (The dinosaur and landscape are not intended to be specific.)



Artefactual explanations are based on the idea that the cyclic nature of extinctions, as claimed by Raup and Sepkoski, is only apparent and not real: it is an artefact of the patchiness of the fossil record. A. Hoffman and J. Ghiold, working at Columbia University, New York, and Louisiana State University respectively, showed that the 26-million-year cycles also correspond to a model that involves independently and randomly varying rates of extinction and origin of species. All the data for Raup and Sepkoski's number-crunching' comes from marine records, despite the popular prominence of dinosaurs. Raup and Sepkoski's 'culling' method has been criticised, although some kind of 'culling' accompanies most 'number-crunching', as they excluded (that is, culled) at the family level all groups with still living members. Their extinction percentages for each time period are percentages of total extinctions, not percentages of all the organisms living in that era. This exaggerates the apparent extent of the extinctions. And the logarithmic scale used on their graph visually overemphasises the minor extinctions.

Other qualified commentators claim that the time resolution of geological events, and the determination of their synchroneity over wide distances of the Earth's surface, are not precise enough to reveal any sudden or transient evolutionary event. The controversy over the Montana 'Paleocene dinosaurs' illustrates this. Dinosaur teeth were found mixed with mammal bones above the K–T iridium anomaly, indicating that Montana dinosaurs survived the im-

MASS EXTINCTIONS

Extinctions occurred throughout geological history, but certain extinctions seem clearly more severe: these are the so-called mass extinctions. The yellow band represents the range of background extinction rates (number of marine animal families becoming extinct every million years), while the red spikes represent the more severe mass extinctions. These do not suggest a 26-million-year cycle of extinctions. Note that the rate of background extinctions seems to be decreasing.

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Fallacious Reasoning

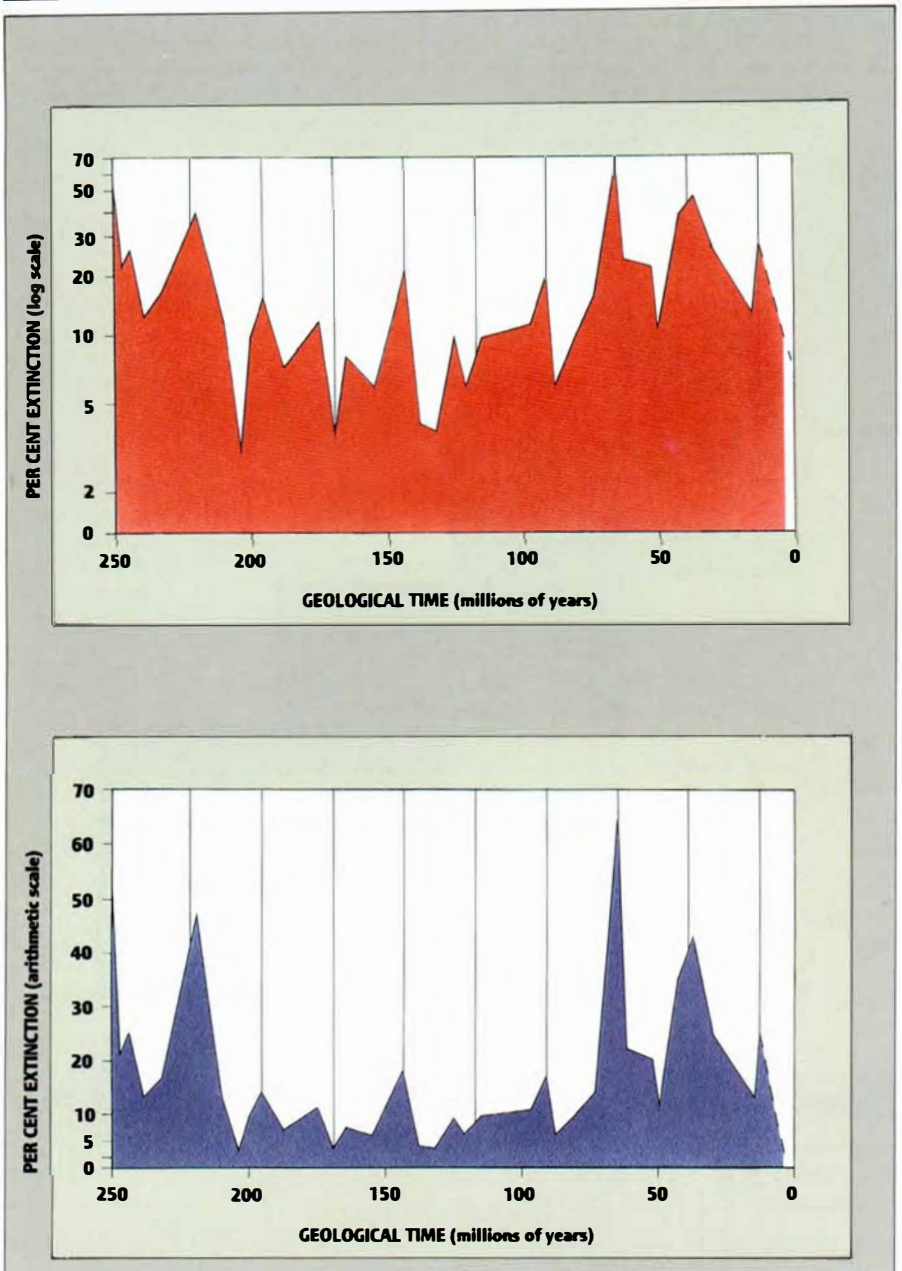
The use of a logarithmic vertical scale (ordinate) in Raup and Sepkoski's graph exaggerates the less important extinctions. A quick glance seems to show ten major extinctions. However, only two of these are extinctions of more than 50 per cent of the organisms alive at that time. Of the remaining eight, seven represent extinctions of less than 30 per cent. The proposal of a 26-million-year cycle of extinctions links together extinctions involving as much as 90 per cent of the organisms with those involving less than ten per cent. Such great differences in extent may not reflect the same cause in each case.

The difficulties in understanding what happened at the end of the Cretaceous are exemplified in two 1987 papers that estimate the number of dinosaur species at the end of that period. This estimate is part of an attempt to determine whether dinosaurs were already in decline at the time the extinctions occurred. One author asserted there were 39 species at the time of the extinctions in North America alone, while the other maintained there were no more than 14 in all. This discrepancy arises in part from different criteria used to determine different species of dinosaurs. For example, the second author concluded that the sauropod dinosaur *Alamosaurus* became extinct before the end of the Cretaceous even though fossils of this animal have been found in two American States in rocks laid down at the very end of the Cretaceous. The only reason given for this conclusion was that a few fragmentary bones attributed to *Alamosaurus* from the late Cretaceous sites were impossible to identify certainly—as fragmentary bones often are. Other dinosaur species present at the end of the Cretaceous were considered to have become extinct before the end of the Cretaceous for similar 'reasons'.

Beverly Halstead of Reading made some relevant points at the 'Table Ronde: les Extinctions dans l' Histoire des Vertebres' in Paris (1985). Firstly, last occurrences are often known only from fragments, so an intimate knowledge of the organisms is required to recognise these. Secondly, a decrease in diversity and abundance of organisms often precedes extinctions, but not necessarily closely. So even if the dinosaurs were in decline at the end of the Cretaceous, it does not imply that they would have become extinct 'anyway'. Curt Teichert has shown that, among nautiloids, several such declines have happened with the animals slowly recovering their lost numbers after each. And finally, extinction of an entire group in one continent need not be synchronous with its extinction in other continents.

Philip Signor and Jere Lipps have shown that the fossil record is inherently misleading when it comes to extinctions. The abundance and diversity of fossils reflect the area of the rocks in which they are preserved. If for any reason this area decreases, the fossil organisms will appear to have been in decline, regardless of whether they actually were or not. Furthermore, because fossils of each generation are not found, and some species are more frequently fossilised than others, some species will appear to become extinct prior to others. And this will be true irrespective of whether or not they all became extinct simultaneously. Thus all extinctions will masquerade as gradual extinctions.

—R.E. Molnar



26-MILLION-YEAR EXTINCTION CYCLE

Raup and Sepkoski's 26-million-year extinction cycle. The alleged cyclic extinctions are indicated by the vertical lines. The upper graph is that which they published and represents the percentage of marine animal families suffering extinction at times indicated on the horizontal scale. Percentages are expressed on a log scale, which overemphasises minor extinctions. In the lower graph, redrawn using the same data but with an arithmetic scale, the evidence for a 26-million-year cycle is not so obvious. Do minor extinctions really have the same causes as major ones?

pact (or what-have-you) and only gradually became extinct. But it was eventually sorted out—routine stuff really—with the recognition that an ancient stream had dug up the dinosaur teeth and redeposited them together with later mammal bones. Then a two-metre gap above the highest (that is, youngest) dinosaur bone was found below the K–T Montana anomaly. Perhaps the dinosaurs had died out long before the end of the Cretaceous? Now it seems that the rocks making up the gap have been leached, and any dinosaur bones that might have been there dissolved away. So the fossil record, lacking unequivocal time indicators, may seemingly portray organisms as becoming extinct earlier or later than they actually did.

Another cautionary Montana anecdote has folk appeal. An astoundingly high level of iridium from one locality at the K–T boundary turned out to have been caused by a technician's gold wedding ring. Gold often contains traces of iridium. Later, however, when the offending ring was taken off during the assay the values dropped to anticipated levels.

TANTALISING AS WE FIND THE DINOSAURian extinction, the geologically recent loss of many species of giant mammals, birds and reptiles has a more immediate pathos. Its extreme recency alone makes it sad. How charming to have wombats the size of boars and South American sloths as big as (small) elephants! Although most vanished 10,000 to 20,000 years ago, some held out until only 500 years ago—the moas of New Zealand, for example. Of all the continents, Australia lost the largest percentage of its giant mammals. Drastic, abrupt climatic changes that occurred over the past several thousands of years have often been blamed, but such changes had

Modern Extinctions

Guam is an island in the western Pacific. Its springs are silent, as are its summers, winters and autumns, if tropical climates can be said to have them. Rachel Carson's nightmare has come true for Guam—only this time the culprit wasn't toxic insecticides. But it was mankind, at least as the indirect, and likely unknowing, agent. Somehow from one of the many vessels coming into the harbour, a few Australian Brown Tree Snakes ended their stowaway voyages and slithered unnoticed onto the island. Of Guam's 18 native birds and seven introduced species, seven are now extinct and four others so rare that their survival seems unlikely. This has taken a mere 20 years.

Surprising as it may seem, humans are not completely responsible for every modern extinction—some odd island communities annihilated by volcanic activity would account for a few. On the other hand it has been estimated—and some say conservatively—that 1,000 species become extinct every year for which we have no honourable excuse. The clearing of vast tracts of rainforest accounts for much of this. Because many of these communities have not been studied in detail, it is clear that many species become extinct before we even know that they had existed.

Examination of pre-European middens and subfossils in places like New Zealand, Madagascar and Hawaii shows that modern peoples are not the only exterminators. Although many foraging cultures had local taboos that effectively promoted conservation, this was not always the case. In New Zealand 30 bird species, including 13 moas and nine other flightless birds, had vanished by the time the Europeans arrived. Madagascar had a remarkable fauna that also disappeared before European arrival. It included about 14 giant lemurs, six to 12 species of giant elephant birds, two giant tortoises, a hippo, an aardvark and a large viverrid (carnivorous mammal). In Hawaii 39 birds had become extinct by the time of colonisation, and 15 more since then. Other cases of modern extinctions are well known: the Dodo, Passenger Pigeon, Steller's Sea Cow and Thylacine.

The destruction of habitat, or merely its disruption, the introduction of predators against which the native species have no defence, the blocking of migration routes, and the introduction of toxins into the food web are all ways in which we exterminate our contemporaries in the biological world. Each of these has, singly, happened before, but now they occur at unprecedented frequency and in concert. The interdependence of us all in the delicate web of life-sustaining factors is now so well known that it can be hoped that this growing awareness will halt the destruction. That is, before the planet is reduced to 'jungles' of concrete inhabited by humans, sterilised monocultured prairies and Saharan wastes of irretrievable desertification.

—M.A O'Reagan

Extinctions of the Mind

William Elgin Swinton, one of the few dinosaur specialists of the early 20th century, gave a lecture on dinosaurs entitled "Reptiles of the Mind". Certainly the extinctions at the end of the Cretaceous are 'extinctions of the mind': the reactions of many scientists to the concepts of impact-caused extinction and cyclic extinction reflect as much their philosophical preconceptions as the force of the evidence.

The reaction of some geologists to the impact hypothesis harks back to the 18th-century disbelief in the existence of meteors.

In this case disbelief is not in the existence of meteors but in the possibility of their influencing the course of Earth history. At least one prominent geologist has likened the idea of any such effect to the theatrical *deus ex machina*, apparently still accepting the concept of Aristotle that a crystalline sphere isolates the Earth from the heavens. Obviously there is no barrier preventing large astronomical bodies from striking the Earth, and known craters show that impacts do occur. We can only conclude that such a position (to be fair, now abandoned) reflected preconception, not science.

S.J. Gould, from Harvard University, has long argued against any significant role of determinism in evolution. He views mass extinctions as illustrating the role of chance in evolution. In Gould's view events such as asteroid impacts, indisputably random so far as biological evolution is concerned, prove that evolution is not deterministic. There seems no way that such events and their effects can be predetermined and it seems essentially a matter of chance that we now exist, rather than dinosaurs.

The predispositions of scientists are vividly illustrated in the debate regarding whether or not the dinosaurs were gradually declining in diversity during the last millions of years of the Cretaceous. Almost all who argue that dinosaurs were already in decline are not specialists in dinosaurian palaeontology. Judging from the publications, those who accept an abrupt extinction are largely dinosaur specialists. Yet neither school pays much attention to the fact that decline in diversity of a group does not necessarily presage their extinction. Curt Teichert, for example, has shown that cephalopods both repeatedly 'almost went extinct', and survived each near-extinction; lungfish and coelacanths also survive today, although both groups long ago underwent major declines in diversity.

Several workers on both sides have declared that the controversy about the cause of the extinctions is over, but disagree about the cause. Clearly the controversy is not over and their assertions that it is reflect their attitudes to catastrophism and uniformitarianism, rather than measured weighing of the evidence.

— R.E. Molnar

occurred previously without driving these creatures to extinction. And as there is no astronomical explanation it leaves us looking frightfully guilty! Like the Galapagos species unafraid of people, perhaps these giants were doomed by their trusting insouciance.

APART FROM THE EXCITEMENT, FUN, drama and even scandal generated by the recent focus on mass extinctions, it is quite clear that more and better evidence, including more precise time determinations, is required before any of the theories will be widely accepted. Philip Signor and Jere Lipps, from the University of California, Davis, in a largely overlooked 1982 paper published in one of the Geological Society of America's Special Papers, showed that all extinctions must appear in the fossil record as stepwise gradual extinctions. This inevitably follows from the incompleteness of the fossil record. Any acceptable theory must take such considerations into account.

On the plus side, extinctions are now being studied more carefully in order to better understand their role in the evolutionary process. With more than 90 per cent of all species that ever lived now extinct (estimates given by Michael J. Benton in *Trends in Ecology & Evolution*, June 1987) we should be under no illusion as to the importance of this process.

Out of the old uniformitarian–catastrophist rivalry comes a 'paradox'. If global catastrophes — instigated extraterrestrially or not — are a regular feature of Earth's history, they become part of the regular (that is, 'uniform') rhythm of nature and cease to be 'catastrophes'.

Kenneth Hsu of the Geological Institute in Zurich, in his most recent book *The Great Dying: Cosmic Catastrophe, Dinosaurs, and the Theory of Evolution* (1987), thinks that Neo-Darwinism itself is challenged. If at any moment an entire species can be abolished by extraordinary events, then its adaptation and fitness no longer guarantee its success. And had dinosaurs not become extinct, allowing some cute, furry, little mammals lebensraum, would we ever have arisen? Hsu's thinking seems contaminated by 'finalism', the idea that evolution proceeds toward some predestined 'higher' goal. Such ideas do not represent the mainstream of evolutionary thought. If catastrophes occur they obviously rearrange both the stage and the cast, but the evolutionary drama proceeds as it always has. Species are selected, by the favoured survival of their offspring, to fit any niche in which they can survive. Neo-Darwinism is not challenged.

Although many scientists now agree that extraordinary events marked the end of the Cretaceous, few are willing to say that it was a bolide impact that single-handedly vanquished the dinosaurs. And so their demise must yet remain—to quote Anthony Hallam (*Nature*, 19 April 1984)—"a contentious issue of enduring fascination". ■

KATHIE ATKINSON

Newly discovered Australian species of these odd, velvety creatures mate with their heads!

PERIPATUS: UP HERE FOR THINKING?

BY NOEL TAIT & DAVID BRISCOE
SCHOOL OF BIOLOGICAL SCIENCES
MACQUARIE UNIVERSITY

AUSTRALIA IS WELL KNOWN FOR ITS curious and often unique animals and plants, which have evolved during a long period of isolation from other landmasses. Best known, of course, are the monotremes and marsupials; less well known, even to keen naturalists, are some equally exciting invertebrates. Why exciting? These days it is rare to discover previously undescribed species of mammals or birds. However, new species of the elegant little animals we describe in this article can be found from the suburban backyards that fringe our cities to the jarrah forests of south-western Western Australia and the wildernesses of Cape York and Tasmania. Closer examination reveals that they have evolved lifestyles just as bizarre as those of the Australian mammals that so excited our pioneer naturalists.

A mole cricket is immobilised by sticky, ensnaring threads shot out by a peripatus.

The graceful, flowing locomotion of peripatus results from cyclic alteration of the fluid pressure in the limbs.

Commonly called peripatus or 'velvet worms', these caterpillar-like animals belong to an elite club of organisms known as 'missing links', which display characteristics intermediate between those of two major animal groups. Most zoologists agree that one group of soft-bodied segmented worms gave rise to the many-legged crawling forms, which later diversified to become the hard-bodied millipedes, centipedes and insects. Peripatus provide us with living representatives close, in many respects, to these intermediate forms. Considering that insects make up more than three quarters of all animal species, peripatus have indeed yielded a noble line. Fossil evidence indicates that the ancestors of peripatus moved from the sea to the land more than 400 million years ago. Peripatus are still found on most of the landmasses derived from the southern supercontinent Gondwana: in South America, Africa, parts of South-East Asia, Papua New Guinea, New Zealand and Australia.

There are fewer than 100 described species of peripatus, which on casual inspection look remarkably similar. All are cylindrical animals with 14 to 43 pairs of stumpy legs along the body. Their heads are equipped with two extensible sensory antennae, a pair of bright beady eyes and a ventral mouth containing sharp slashing jaws. Like worms, peripatus are soft-bodied, and maintain and alter their body shape by muscles acting against a fluid-filled body cavity. They are also susceptible to desiccation (they have no wax covering) and hence are found in moist places, such as in narrow crevices inside and under rotting logs, beneath stones and in leaf litter and soil. Unlike worms, however, movement is brought about by the paired legs, each supplied with a flat sole and a terminal pair of claws. The limbs are extended and withdrawn by fluid pressure in a wonderfully coordinated rhythm. Their motion has given rise to their name, which is derived from the word 'peripatetic' meaning a wanderer or itinerant—a word, however, originally used to describe the teaching style of Aristotle who discoursed with his students while strolling through the Lyceum of ancient Athens.

The skin of peripatus has a velvety texture and, in many species, resembles a Persian carpet with rich combinations of black, deep blue, mauve, brown, orange, pale green and white. Many of the microscopic papillae, which give the skin its velvet appearance, bear a sensory spine to provide information on the outside world additional to that derived from the antennae and eyes. Even though the skin is soft and expandable, the outer protective layer, or cuticle, is shed periodically to allow for growth. Moulting, together with their possession of paired jaws, antennae and legs, is taken as evidence that peripatus are allied to arthropods.

PERIPATUS ALSO POSSESS HIGHLY DEVELoped and unusual attributes that have no doubt contributed to their survival for hundreds of millions of years. In particular, they have adopted novel approaches to the most vital activities of life—feeding and sex!

Peripatus are voracious little carnivores whose marksmanship would do credit to any hero of a Western movie. Upon encountering an unwary cricket, beetle or succulent termite, peripatus eject, with deadly accuracy, jets of slime from blunt, pistol-like papillae on either side of the head. The slime hardens upon contact to pin down and enmesh the prey. Immobilised, the prey is easy meat for the slashing jaws and powerful digestive saliva, which reduce the soft parts to a soup suitable for the killer's sucking mouth. The slime glands can also be used in defence when peripatus find themselves on the losing end of an encounter with another animal. The potential predator receives only a face full of glue as reward for its advances. Nonetheless, many peripatus end their lives as morsels in the diet of small mammals and birds, such as lyrebirds, which pick through rotting logs and leaf litter.

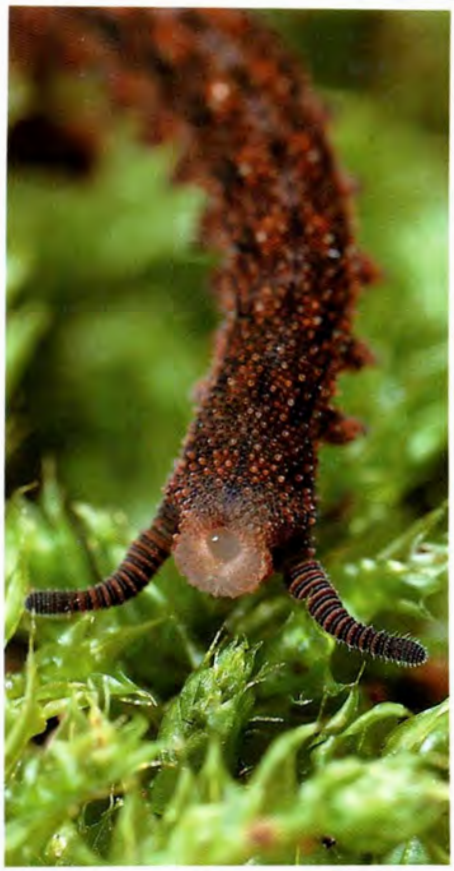
The sexual etiquette of peripatus is as unusual as their table manners, and has

KATHIE ATKINSON

been observed only in a few South African species. During these intimate encounters, the male deposits small parcels of sperm (spermatophores) on any part of the female's skin. Blood cells from the female then digest a tiny hole through the skin and the spermatophore envelope, allowing sperm to enter her body cavity where they migrate to the ovaries for later fertilisation of the eggs. As we shall see, some newly discovered Australian species take a head-on approach during their sexual encounters.

Equally extraordinary is the diversity of female reproductive strategies found among peripatus species. Many species retain the fertilised yolky eggs within the reproductive tract and give birth to fully developed, unpigmented young. This is not in itself so unusual. However, central and South American species have evolved a placental attachment between the mother and growing embryo, through which nutrients are passed. Such a development parallels the evolution of reproduction in placental mammals, a remarkable achievement for an invertebrate animal. This parallel also extends to peripatus in our region.

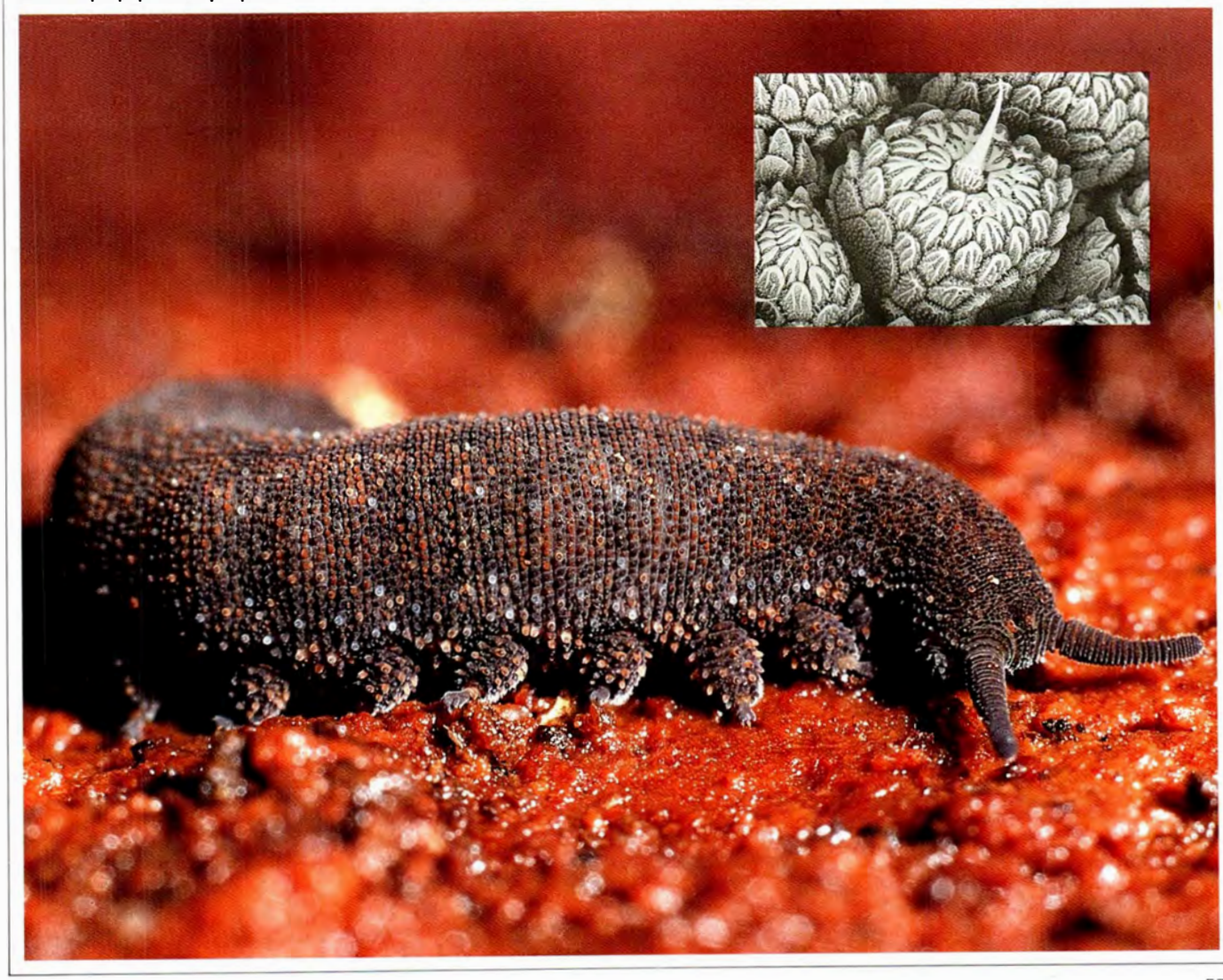
Just as Australasia supports the only



The glistening spermatophore, held by fine threads, is presented by the male peripatus' everted dimple. Such behaviour has led us to conclude that these peripatus must mate with their heads.

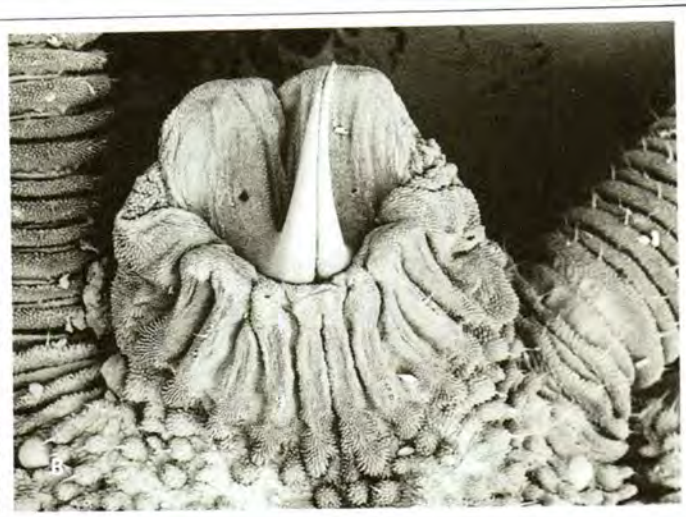
KATHIE ATKINSON

Like an intricate Persian carpet, the pattern and rich velvety texture are created by numerous microscopic papillae on peripatus' skin.



SUE DOYLE

KATHIE ATKINSON



SUE DOYLE

Male of the species from Tinderry Mountains near Canberra, showing the head cavity uneverted (A) and everted, carrying a pair of hard-curved hooks (B). The function of the hooks is still unclear.

egg-laying mammals—the Platypus and echidnas—so too the only egg-laying peripatus occur in eastern Australia and New Zealand. Initial reports of egg-laying peripatus were greeted with the same scepticism as the first accounts of the existence of the Platypus. The scepticism was finally dispelled by Arthur Dendy, a lecturer at the University of Melbourne, who described the hatching, on 3 January 1893, of a peripatus egg he had patiently observed since it was laid on 31 July 1891. Perhaps a leisurely 17-month developmental period is not unreasonable in an animal that has quietly persisted since before the age of the dinosaurs.

The first Australian peripatus, coming from "... New Holland, northwest of Sydney", was reported in 1862. Over the next 30 years, specimens from all eastern States and from Western Australia were discovered and much controversy arose over the exact number of species represented. Variation in colour, pattern, number of legs and method of reproduction led Arthur Dendy to propose at least three species. To others, such as Joseph James Fletcher, then Director of the Linnaean Society of New South Wales, these variations were no more than individual differences within a species. In 1895 he wrote in the Society's *Proceedings*: "... at present Australia would, I think, be oversupplied with as many as four species". Fletcher's conservative view, however, has not generally been accepted and today eight species are formally recognised in the scientific literature.

IN 1985 A CASUAL OBSERVATION LED US TO commence three years of field and laboratory work, which has extended our knowledge of Australian peripatus. While demonstrating a few specimens from the Blue Mountains to biology students at Macquarie University, it became clear that there were two types. Some were dark blue with a paler underside, while others were brown, more ornately patterned and possessed a distinct dimple on the head, behind the antennae. Were these simply variations among individuals of the same species? Differences between males and females? Or had we encountered a previously unknown species?

To answer these questions we electrophoretically compared the proteins (see box) of the two sorts of peripatus. The differences were dramatic—we had discovered a new species. The dark blue form fitted the morphological description of the original peripatus found in Australia "...northwest of Sydney"; the brown species was unknown to science.

Our curiosity was aroused. If unknown species could be found in an area as well known as the Blue Mountains, what awaited discovery in more remote parts? The search has taken us from Cape York to the wilderness of Tasmania on the east coast, and from Perth to Albany through the majestic forests of Western Australia. In some areas these animals are surprisingly abundant, in other places we were lucky to find a single specimen in a day. Despite long hours, rain and leeches, this work has spiritual rewards. Peripatus exhibit exquisite taste in their choice of habitat—some of the most beautiful places on Earth.

Back in the laboratory our analysis has been equally rewarding. We have found more than 40 previously unknown peripatus species, raising the total number from eight to 48 on our continent.

Our results held further surprises. We

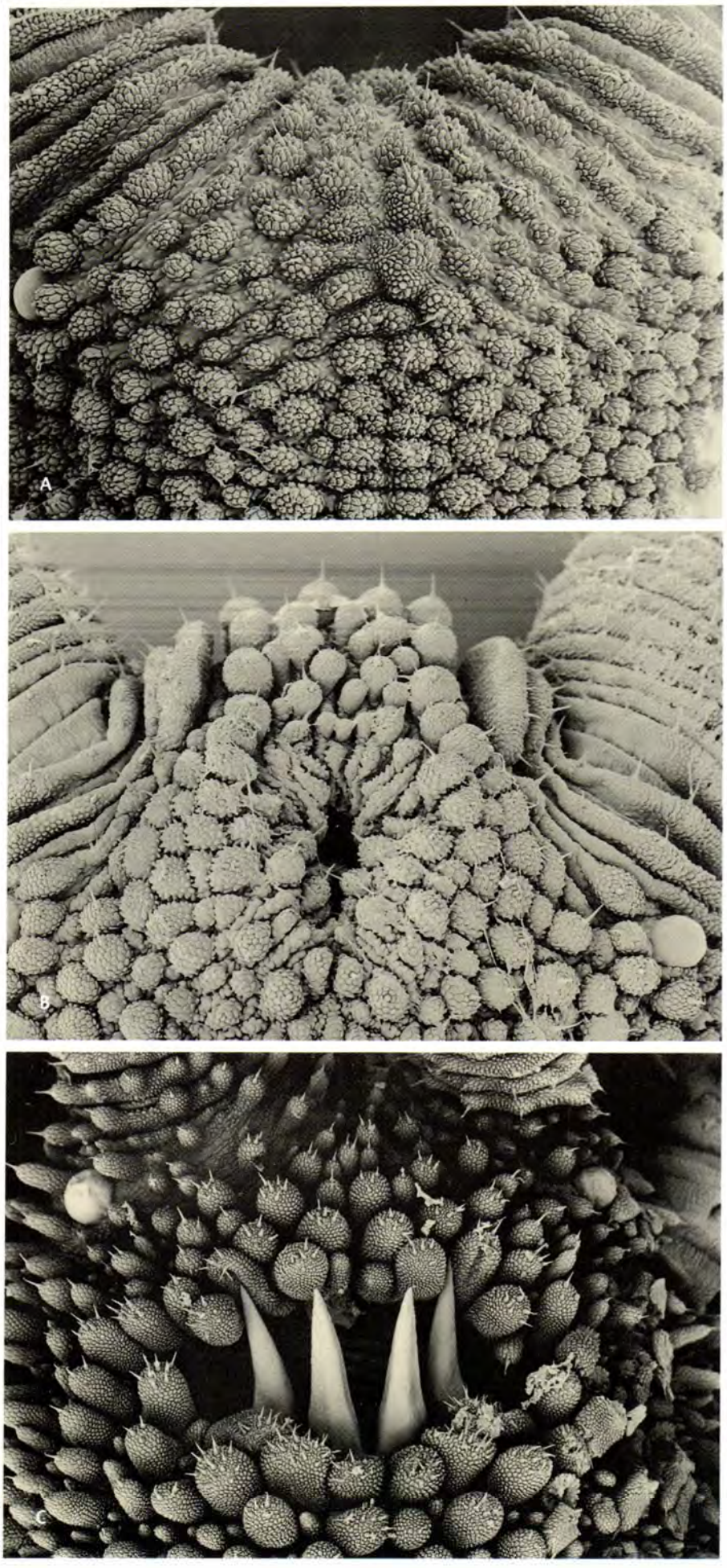
In most species of peripatus, the young are born live. While a newborn peripatus may accompany its parent for a while, it is quite capable of feeding itself from the moment it is born.

KATHIE ATKINSON

Early reports of egg-laying peripatus in eastern Australia were treated with scepticism. This female peripatus was photographed soon after it laid a large, shelled egg. If the observations made by Dr Arthur Dendy last century are correct, it will take 17 months to hatch. Inset: the only SEM of a peripatus egg, showing the intricate pattern on the surface of the shell.

KATHIE ATKINSON

SUE DOYLE



SUE DOYLE

have found that the protein differences among the species are far greater than anyone would have imagined. Despite superficial similarity, many of the species are only very distantly related, suggesting that they have been evolving independently for many millions of years, even before Gondwana began to break up. Australia may be the ancient centre of the peripatus world.

While protein analysis is valuable in revealing the existence of new species, only distinctive physical characteristics aid in quick identification of specimens found in the bush. Our attention had already been drawn to the dimple on the head of the brown species from the Blue Mountains. We therefore carried out a microscopical examination of the heads of all the species. Again peripatus held surprises. Males of many of the species possess unique species-diagnostic modifications of the skin of their heads. These may be in the form of enlargement and elaboration of the papillae

Electrophoresis

Electrophoresis, a method of protein analysis, is increasingly used to distinguish species and to determine the evolutionary relationships among them. The principle behind this analysis is very simple and, in an odd way, familiar to us all.

The bodies of all animals are made up basically of the same protein molecules. However, the members of any one species share subtle variations of these molecules and these distinguish them from members of any other species. For example, the texture and flavour of any one Rainbow Trout are very similar to those of any other Rainbow Trout, because they share the same subtle protein variants. In contrast, trout tastes quite different from tuna fish as tuna have their own distinctive variants. This principle can be taken one step further. The more closely related two or more species are, then the more similar their proteins will be. Thus, Rainbow Trout and Salmon, although distinguishable from each other, are far more similar in taste than either is to tuna fish. In the laboratory we measure the amount of protein similarity and difference among samples of animal protein extracts using biochemical techniques (not taste!). ■

Variation in peripatus species' head structure. The blue species has no head structure (A), the brown species from Mt Tomah has a large cavity (B) and a species from Brown Mt. has four spikes (C). All specimens are male.

between or behind the antennae. In other species, sexual ornamentation of the male head has been taken to an extreme. In the brown species from the Blue Mountains, the dimple of the males is in fact the opening of a deep sac-like intucking of the skin. In other species this cavity is equipped with massive spikes, hooks or syringe-like stylets. Why should male peripatus have evolved such strange ornaments? Our imaginations ran riot.

Obviously their function must be sexual as they are found only in males. Are they used in some macho display to entice a female? Are they used in combat between rival males? Or could they be used directly to perform some sexual act? Peripatus are shy creatures that do not easily reveal their intimate moments. However, they have given clues. During spring, we have seen males of two species carrying a glistening package of sperm within their head cavities—these peripatus must mate with their heads! Perhaps the hard hooks, spikes and stylets directly puncture the female's skin to allow easy access of sperm into her body cavity. Such a technique would be highly effective for animals that live in confined spaces where more conventional mating positions are difficult to attain.

Conservationists have long been concerned for the fate of our special mammals, birds and plants. Peripatus make us aware that there are many other small creatures equally unusual and deserving of preservation as part of our natural heritage. ■

A Paler Peripatus

In February 1986 the Tasmanian National Parks and Wildlife Service provided funds for a team (Robyn Stutchbury, Kathie Atkinson and ourselves) to survey the peripatus of that State. During our field work in the north-east we were accompanied by Dr Bob Mesibov who has extensive first-hand knowledge of the forests of Tasmania, especially the creatures that live in logs and leaf litter on the forest floor. Bob led us to sites where he had previously recorded peripatus. An area called Elephant Pass near St Mary's yielded several specimens of a very interesting peripatus—a pure white species lacking eyes. Usually these features are characteristic of cave-dwelling animals. Indeed the only other white eyeless species of peripatus is restricted to a single cave on Table Mountain in South Africa. Interestingly, the Tasmanian white species was found in the soil under rotting logs and not in caves. There are, however, caves in the area and it is possible that this amazing species evolved deep underground and has since spread its range to include the soil surface habitat. Bob is continuing to research its distribution, habitat and abundance as background knowledge required for its conservation.

—N. Tait and D. Briscoe

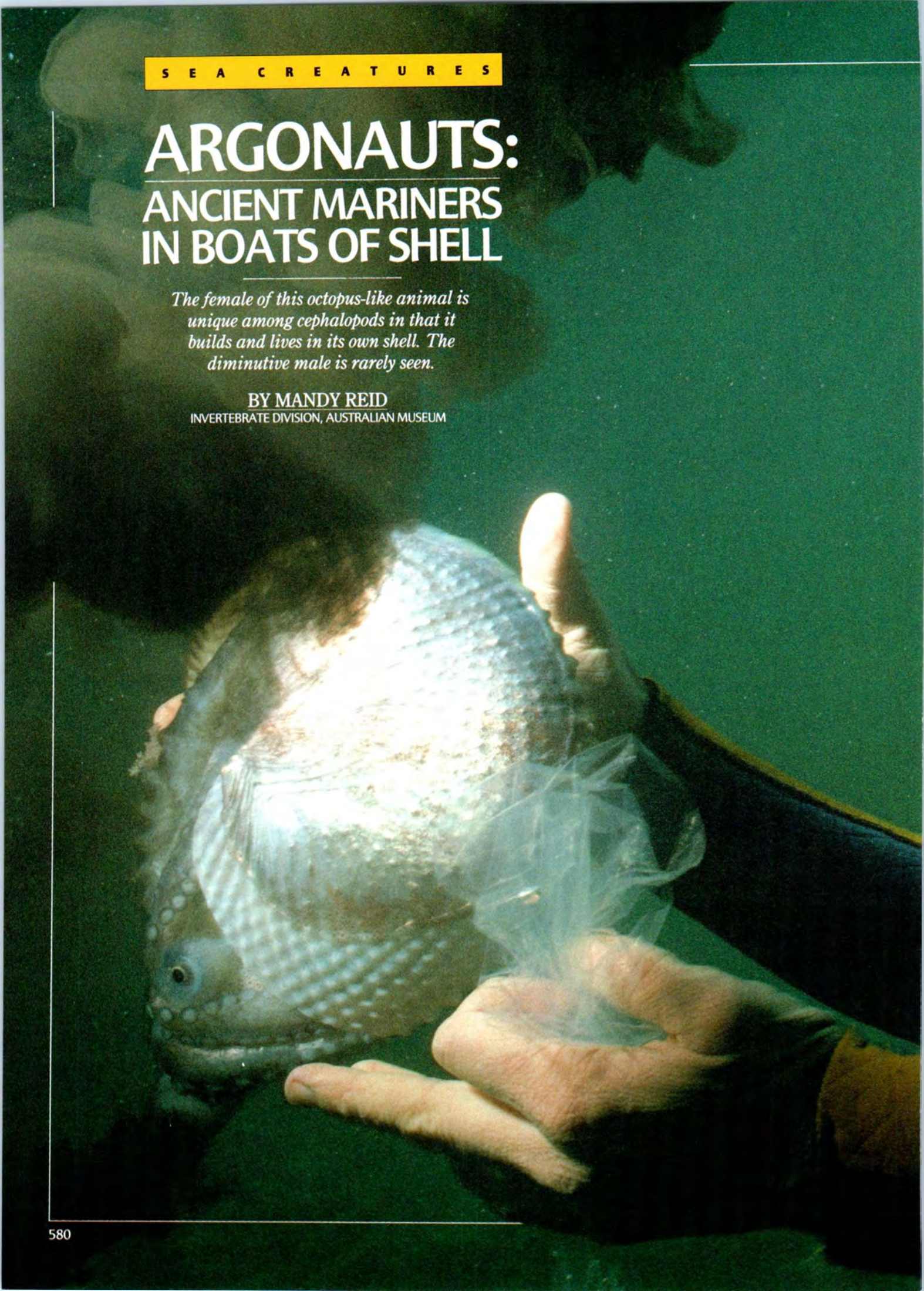
White peripatus: a new species?

KATHIE ATKINSON

ARGONAUTS: ANCIENT MARINERS IN BOATS OF SHELL

The female of this octopus-like animal is unique among cephalopods in that it builds and lives in its own shell. The diminutive male is rarely seen.

BY MANDY REID
INVERTEBRATE DIVISION, AUSTRALIAN MUSEUM

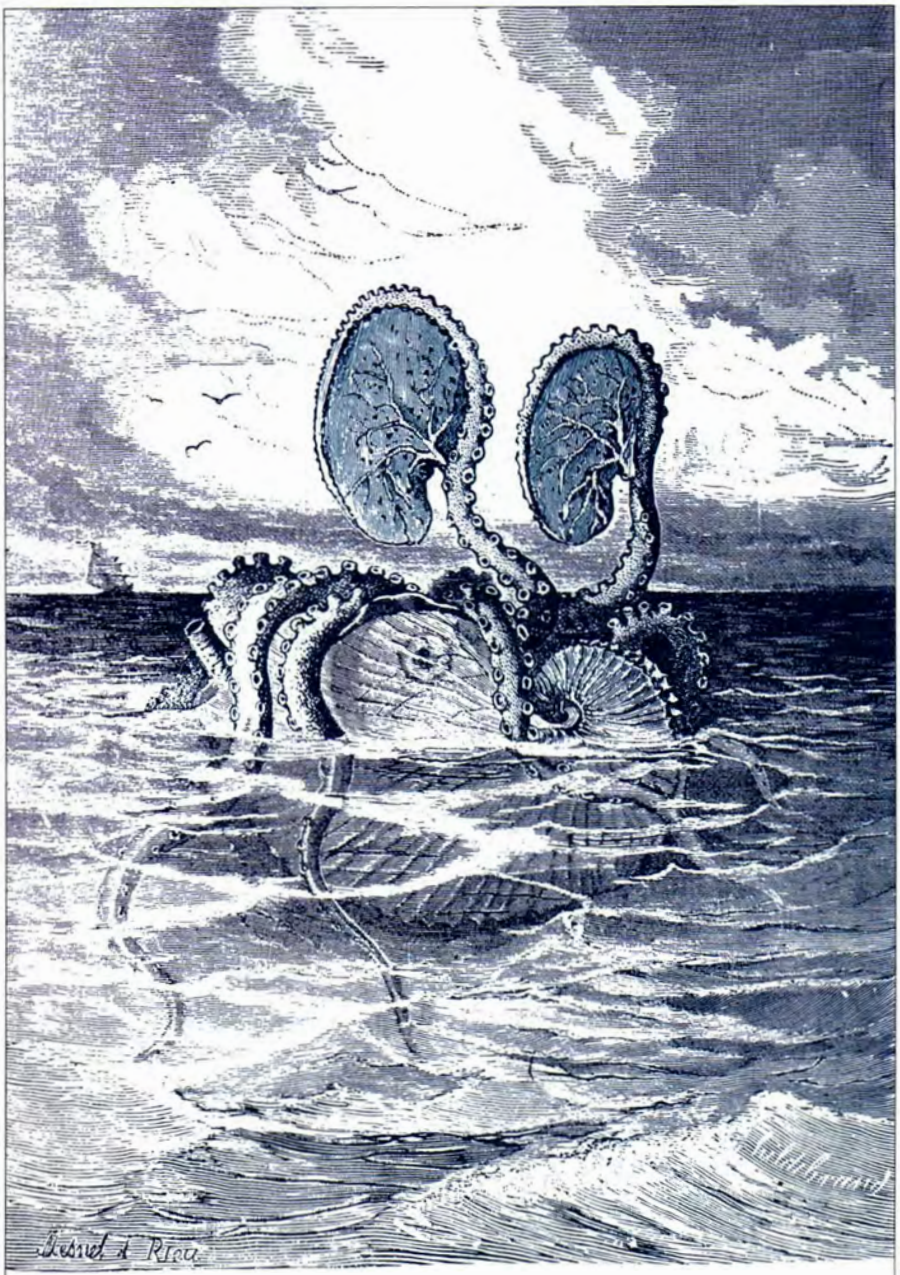


"HAVING SHOT OUT ITS WASTE waste water and thus disburdening itself, it sails, lying face up on the tops of the waves. It spreads out a membrane of amazing delicacy and, twisting back two of its tentacles and rowing underwater with the others, it makes a sail. Then after swallowing, it sinks into the water".

(Translated from Linnaeus *Systema Naturae*, 1758.)

D. PARER & E. PARER-COOK/AUSCAPE

Feeling threatened, this argonaut discharges a mass of black ink. Traditionally thought to serve as a visual screen to cover retreat, cephalopod ink also has olfactory properties. The smell of the ink provides an effective decoy against predators.



SEA MONSTER NOW KNOWN AS THE ARGONAUT.

The argonaut, seen by some early sailors as a sea monster, was poetically described by others as a graceful sailor in a boat of shell.

Famed for over 2,000 years as graceful sailors in boats of shell, argonauts or paper nautiluses are among the most spectacular inhabitants of the pelagic realm. Although rarely seen, periodically these animals are found washed up on beaches in large numbers. Recently large numbers were reported from Bass Strait, along parts of the Victorian coastline and Tasmania.

Unlike the true *Nautilus*, otherwise known as pearly or chambered nautiluses, argonauts are a type of octopus belonging to the genus *Argonauta*. Six species are currently recognised, four of which have been collected from Australian waters. All live in the open ocean near the surface. Those photographed here are *Argonauta nodosa*, an Indo-west Pacific species most common in the Australian and New Zealand region.

The female argonaut is unique among modern cephalopods (squids, cuttlefish, octopus and *Nautilus*) in producing a shell that serves as a brood chamber. She lives unattached within the shell, gripping onto it by holding her arms in a reflexed position with suckers adhering to the inside of the shell opening. The shell is also held in place by broad webs extending from the dorsal (uppermost) pair of arms. These highly extensible webs, which may cover the entire shell, secrete the calcium carbonate and organic material from which the shell is made. Although able to patch damaged parts, it is not known whether argonauts can build an entire new shell.

Besides functioning as a shell support, the web appears to play a primary role in detection of prey. Feeding behaviour in captive *Argonauta argo* was studied in 1960 by Dr J.Z. Young, now at the Wellcome Institute for the History of Medicine in London. He noticed that by touching the web with small pieces of food, such as shrimp and small fish, a fixed response was elicited: the animal would sweep one of its ventral arms up over the web to collect the food, which was then transferred to the mouth. The animals showed no eye movements or variation in pupil size when food was presented, suggesting that there is little active pursuit of prey.

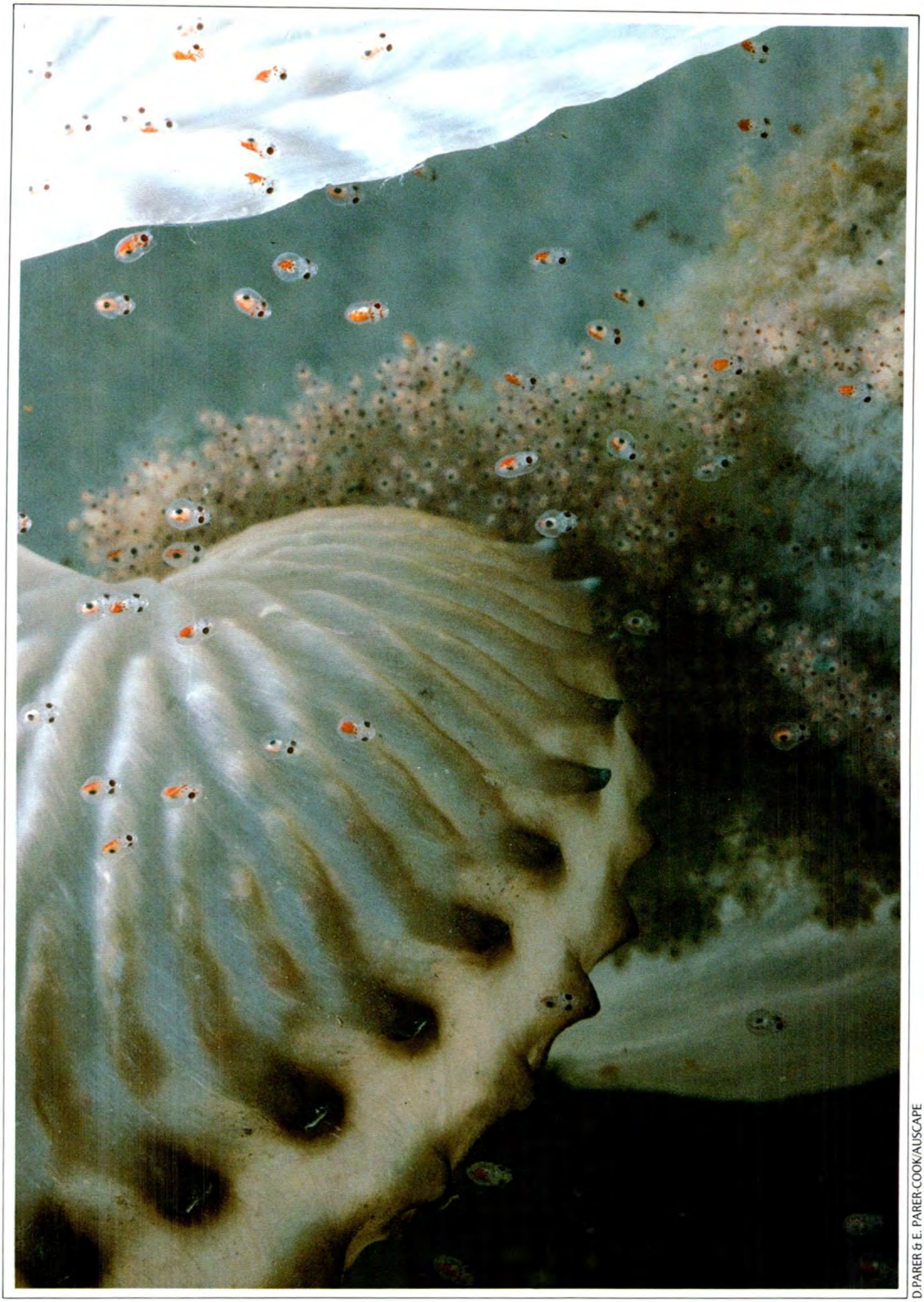
Sexual dimorphism is marked in these animals. Adult females can be 10–15 times larger than adult males, which rarely exceed two centimetres in total length. The dwarf male lacks the webbed modification of the dorsal arms; instead, one of the arms is modified for reproductive purposes. Called the hectocotylus, this arm is long and enrolled in a sac, and loaded with sperm prior to mating. The hectocotylus is autotomous (self-amputating), and is cast off when mating takes place, remaining in the mantle or body cavity of the female.

To date, no author has any certain views as to the habits of the argonaut male, or the course of events that precede deposition of the hectocotylus within the mantle cavity of the female. Occasionally mature males

RUDIE H. KUITER

Four stages of development of *Argonauta nodosa* embryos can be seen here. The least developed (top) appear milky white. As the tiny nautiluses take shape, apricot eyespots appear (right). The eyespots soon darken and chromatophores can be detected; then another dark spot appears: the tiny ink sac.

Newly hatched young, about 1.5 millimetres long, leave the confines of the shell. The egg mass attached to the inner whorl of the shell consists of clusters of eggs strung together in loops.



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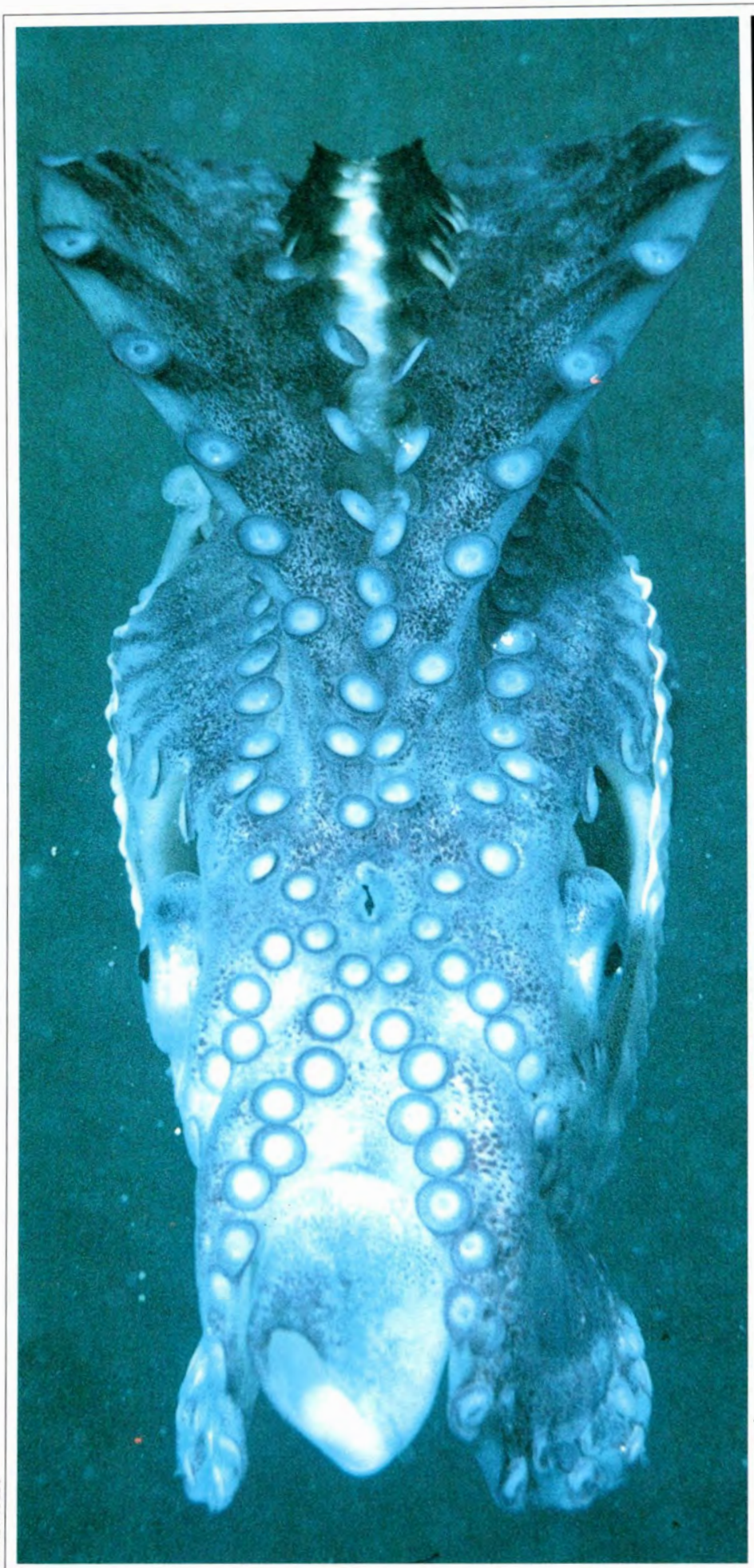


have been found in the shell of the female, but how long they are carried in this way is unknown.

The eggs, when fertilised, are laid and incubated within the shell, where the female can conveniently oxygenate and clean them. Large numbers of eggs are laid in branching strings, probably over several nights. A single egg mass carried by a female thus contains eggs at various stages of development. Upon hatching, argonaut young, as with other cephalopods, are extremely precocious and almost immediately begin jet-swimming and hunting small crustaceans.

Front view showing large muscular funnel projecting between the two ventral arms. Direction is determined by the angle of the funnel and also aided by spreading and flattening the upper and lower pair of arms.

LEW REYNOLDS

D. PARER & E. PARER-COOK/AUSCAPE

MASS STRANDINGS OF ARGONAUT FEmales have been reported from a number of Australian coastal localities such as Port Phillip Bay and Corner Inlet in Victoria, Thistle Island in Spencer Gulf, South Australia, and Montague Island and Narooma in New South Wales. The delicate shells are highly prized and are often sought after by collectors. During the last week of April in 1988, large numbers of *A. nodosa* were reported washed up on beaches on King Island in Bass Strait. In late June the same species appeared further east on beaches on the western side of Flinders Island and south-eastern Victoria. Over the following week, animals appeared on other parts of the Victorian coastline. Three factors may explain this occurrence. The first is the winter West Wind Drift current, which moves from the south-western corner of Bass Strait, through the strait, following the northern coast of Tasmania to the Furneaux Group of Islands and around the southern Victorian coast. The second is the prevailing westerly winds, which create wind stress currents at the surface. The third is the stronger-than-normal tide flows that can occur when wind stress currents work together with tidal currents on a local scale for limited periods. This can result in extra high or low tides.

At Portsea, calm conditions and clear water enabled underwater photographers

A male argonaut viewed from above with hectocotylus partially released. Males do not produce shells and are much smaller than females. This male is only about two centimetres in total length.

An argonaut peeping out from its shell. The black parrot-like beak can be seen in the centre at the base of the sucker-lined arms.

B. REID

D. PARER & E. PARER-COOK/AUSCAPE

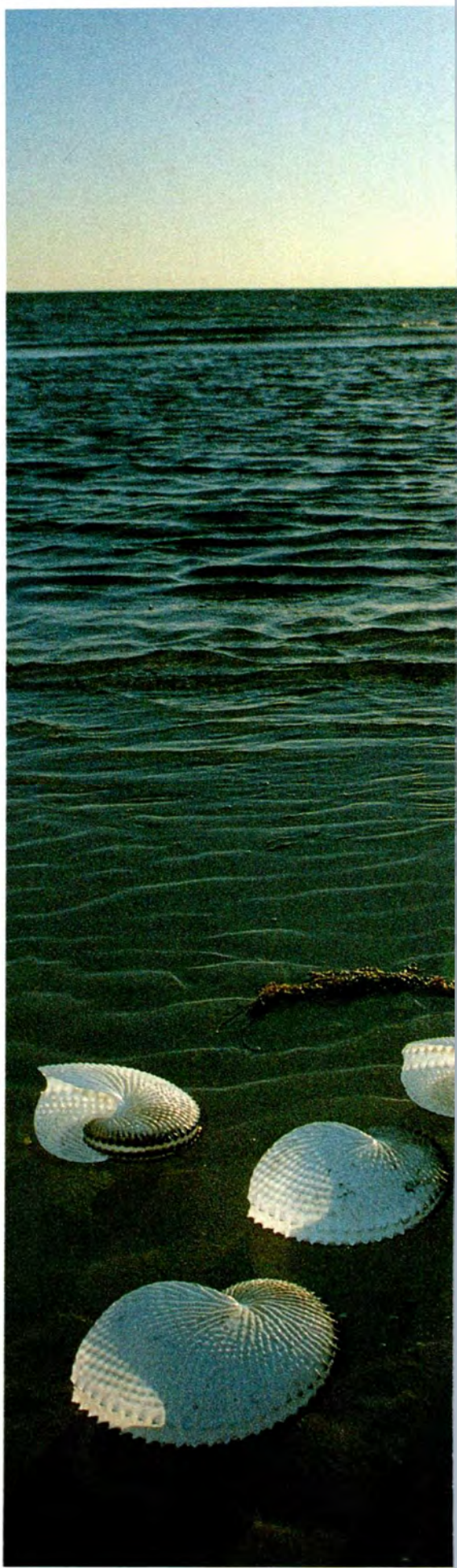
Washed into the shallows, argonauts easily fall prey to seabirds such as this Pacific Gull (*Larus pacificus*).

Rudie and Alison Kuiter to observe live argonauts in the water. Over several consecutive days at the slack of the afternoon high tide, argonauts were seen swimming from a nearby channel into shallow water where some settled on the bottom and were seen to release freshly hatched young. Although some of the adults died after spawning, or as a result of being washed up into the shallows, others appeared to be quite vigorous and some were seen swimming back into deeper water of the channel. They appeared to be relatively strong swimmers, large specimens easily outswimming a diver holding a camera. They used their muscular funnel for rapid jet-propulsion and were capable of swiftly changing direction by positioning the funnel and using the dorsal and ventral-most pairs of arms held outside the shell as stabilisers.

The reproductive activity of argonauts seems to be dependent on the currents for movement to places that are favourable for release of young. Observations at Portsea suggest the time of spawning would enable young to be dispersed with the falling tide.

Much still remains to be learnt about the ecology and general biology of argonauts. The nature of the beast makes studies difficult. They are rarely caught, especially the tiny males, although in some areas they are presumably quite common, constituting an important food for fishes. Being pelagic they are difficult to keep in aquaria. The recent sightings in Bass Strait provide us with a few more clues, but are also a tantalising reminder of what we still have to learn of their secrets. ■

The author wishes to thank Rudie Kuiter for his help and encouragement in the preparation of this article.



Empty argonaut shells washed up on Portsea Pier beach (Victoria).

D. PARER & E. PARER-COOK/AUSCAPE

Why is it, when commercial honey and jams are readily available, do Aborigines still go to so much trouble to collect honeyants?

HONEYANTS: A DESERT DELICACY

BY JEANNIE DEVITT
NORTHERN LAND COUNCIL

THE ABORIGINAL PEOPLE FROM ANGKWELE, an outstation in eastern central Australia, speak the Anmatyerre language and are often described by other Aborigines in the area as *artitye arinye*, that is, 'people from the mulga country'. Extensive belts of mulga woodland cover the area over which these families travel in search of food. The Angkwele people are regarded as being particularly skilled at finding honeyants (*Camponotus* spp.), one of the most highly prized foods of Aboriginal people living in arid Australia. The species collected by Aborigines from Angkwele is the Black Honeyant (*C. inflatus*).

Children sit expectantly on the edge of a honeyant excavation, waiting for the honey-laden ants to be brought to the surface.

The underground nests of these insects are found within dense groves of mulga. The nest entrance, hidden under leaf litter, may be either a series of small ruptures in the soil surface or a single hole. Considerable skill is required to locate a nest, excavate it and successfully retrieve the honey-engorged ants lying in a number of small, separate chambers well below the surface.

Once inside a mulga grove, a woman (or less frequently, a man) carefully scans the ground around the base of each tree. Occasionally she moves aside the leaf litter with either a metal crowbar or a stick, searching for indicators of a nest. These may be either the opening of the nest, 'worker' ants moving about, or other types of ants that are known to be associated with honeyants. Women work quietly because, they say, honeyants are timid creatures.

Having located a site, the searcher clears away all surface debris. She

LEO MEIER/WELDON TRANNIES

The Black Honeyant is the main species collected by Angkwele Aborigines. The ants are placed on freshly turned earth at the edge of the pit.

D PARER & E. PARER-COOK/AUSCAPE

JEANNIE DEVITT

The results of about 16 minutes of digging: 150 ants. These would yield about 100 grams of honey.

begins the excavation at a point up to a metre away from the actual nest entrance. Sitting at the edge of the cleared area and working in the direction of the entrance, she excavates a shallow profile six to ten centimetres deep. The freshly exposed soil is closely examined for clues to the direction of the underground chambers that house the honey-laden ants; she feels the soil texture, occasionally smells it and notes any occurrence of the distinctive red seams of earth that indicate honeyant activity. Choosing a direction, the searcher extends the profile depth and width using a crowbar and shovel. When she suspects a chamber is near, she uses the crowbar blade to delicately scrape successive layers of earth from the profile until the cavity of the chamber appears, exposing the honeyants, immobilised by their burden of honey.

At this point the woman gets a slightly curved twig, about ten centimetres long, and moistens the end of it with saliva. She then dusts it with fresh soil and uses it to reach in behind the ants, gently rolling them together, out of the chamber and onto the soft earth below. The membrane containing the honey is thin and easily ruptured, so she gathers the ants in a protective covering of earth in one hand and places them on freshly turned earth at the edge of the excavation pit. Because of this careful handling, only a few honey sacs are damaged during the excavation. If alone, a woman will eat two or three ants from each chamber she discovers and save the rest for others. If children are present, they play about on the excavated earth pile or sit expectantly at the edge of the pit, leaping excitedly as each handful of ants is brought to the surface.

Small children are fascinated by the ants—carrying five or six around in their hands, placing them carefully back on the turned earth, watching and discussing them with each other. Periodically they select one to eat. The grape-sized honey sac is put in the mouth and the rest of the body broken off and discarded. Great care must be taken when placing the ant in the mouth as it may grab onto the lip, or worse, somewhere in the throat, in an effort to save itself.

Sometimes women dig down at least a metre until all that is visible from the surface is a moving crowbar. They perform a complex excavation—enlarging the pit, back-filling, changing direction or going deeper. Eventually the nest entrance is itself engulfed, although that does not

Honeyant Art

The artist, Lily Panangka Napanangka, a member of the Anmatyerre people, has painted a Honeyant Dreaming at Yuelama (Mt Allan, Northern Territory). The painting shows Black Honeyants moving along their underground labyrinths. Black Honeyants usually feed on the nectar from the native fuschia bush *Eremophilia latrobei*. U-shapes at the entrances to the tunnels are women with their digging sticks hunting the ants and collecting them in their wooden dishes or *parrajas*. At each corner of the painting, older women are shown eating honeyants from wooden dishes. Their digging sticks are lying beside them. The painting was purchased for the Australian Museum at the Yuelama Museum in June 1988.

—Kate Khan
Australian Museum

JEANNIE DEVITT

Honeyants in a bark dish—this particular collection was the result of one-and-a-half hours work.

necessarily mean the nest is exhausted. Excavating from one side in towards the nest entrance seems to increase the possibility of striking the small chambers from the side rather than directly above. If a chamber is accidentally entered from above it tends to collapse, destroying the ants or making them difficult to retrieve. The excavation process at Angkwele did not indicate the presence of a central cavern containing a large number of honeyants; individual chambers produce anywhere between one and 27 ants.

I WAS UNABLE TO DISCOVER WHETHER THE availability of honeyants varied with seasonal conditions. Although I observed people searching for them during most months of the year, the local people believe that the honey is superior (that is, sweeter) shortly after rain. The Aborigines believe that ants produce the honey from a substance called *alwetantyiye* that coats the leaves of the mulga tree. The honey produced may be either dark (preferred) or light in colour, and both types can be found in the same nest.

In the Anmatyerre view one cannot come to the 'end' of a honeyant nest because they extend to the very heart of the Earth, but when the supply at one location dwindles a woman will leave that site in search of another. The pit is not back-filled. The searcher simply takes her gathered ants and tools, and moves on.

Honeyants, together with nectar, lerps and the honey of native bees, were one of the few sources of concentrated sweetness available in the traditional Aboriginal diet. Today there are a number of other readily available sources such as treacle, jam, sugar and commercial honey. Nevertheless people continue to put much time and effort into procuring small quantities of honeyants. On one occasion I watched two women and two men excavate one site for almost three hours. Although such marathon excavations were unusual, they drew my attention to the value people place on honeyants. The greatest quantity of honey I saw retrieved from an ant nest was 250 grams (358 ants) but the majority of sites

The pit can be more than a metre deep; sometimes all that is visible from the surface is a moving crowbar.

'Honey' From an Ant

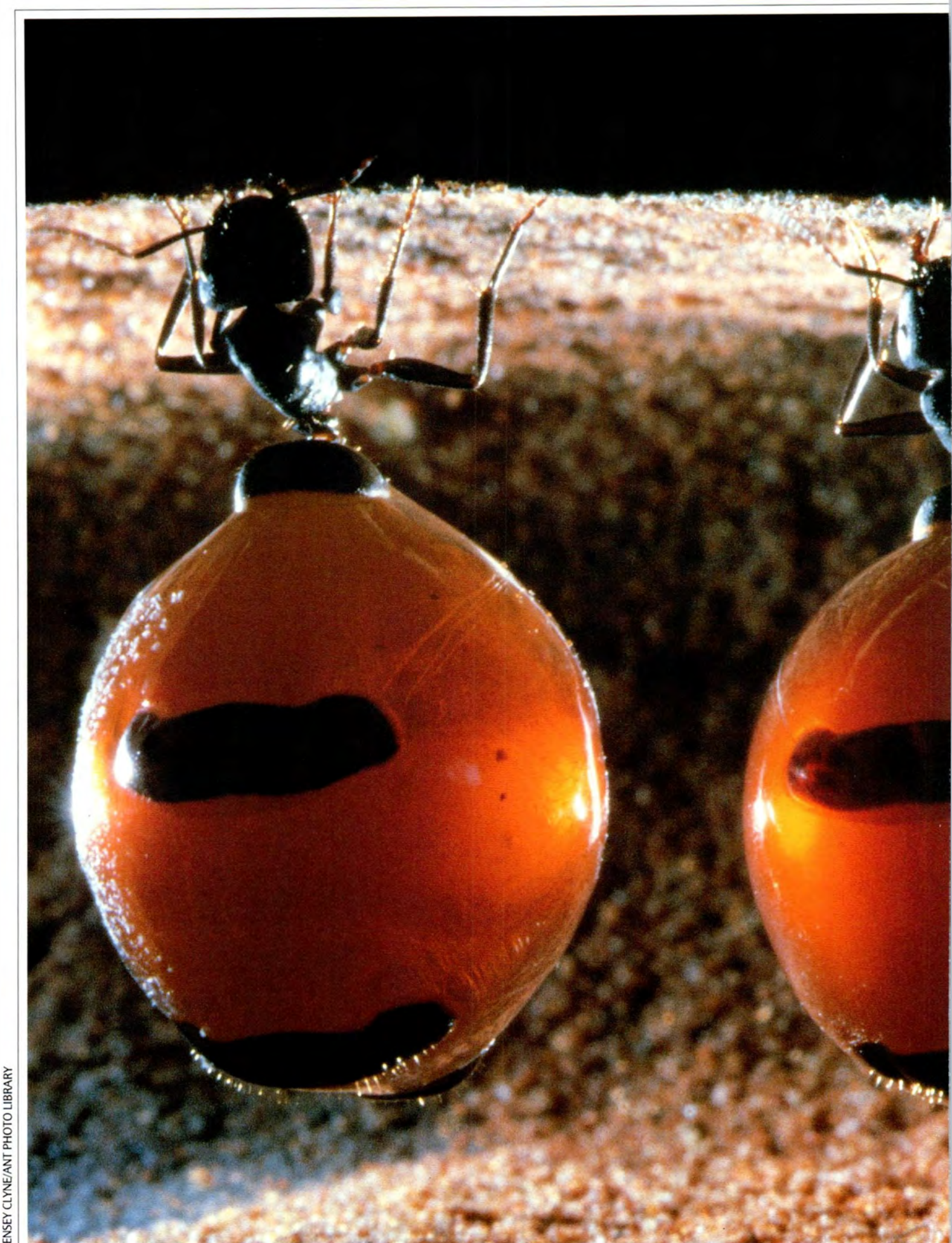
A number of species of ants belonging to the subfamily Formicinae carry honeydew and nectar in the large distended crops of specialised workers called repletes. *Melophorus bagoti* is the principle honeyant but several species of *Camponotus* also store sugars in this way.

Although little is known of the habits of these ants, the mechanism is one of food storage to enable the ants to survive drought in arid areas. Some workers gather honeydew from scale insects and feed it to the repletes, which become mere storage vessels. The repletes spend their lives hanging from the ceilings of chambers deep within the nest. When solicited by other workers, the repletes regurgitate part of their crop contents.

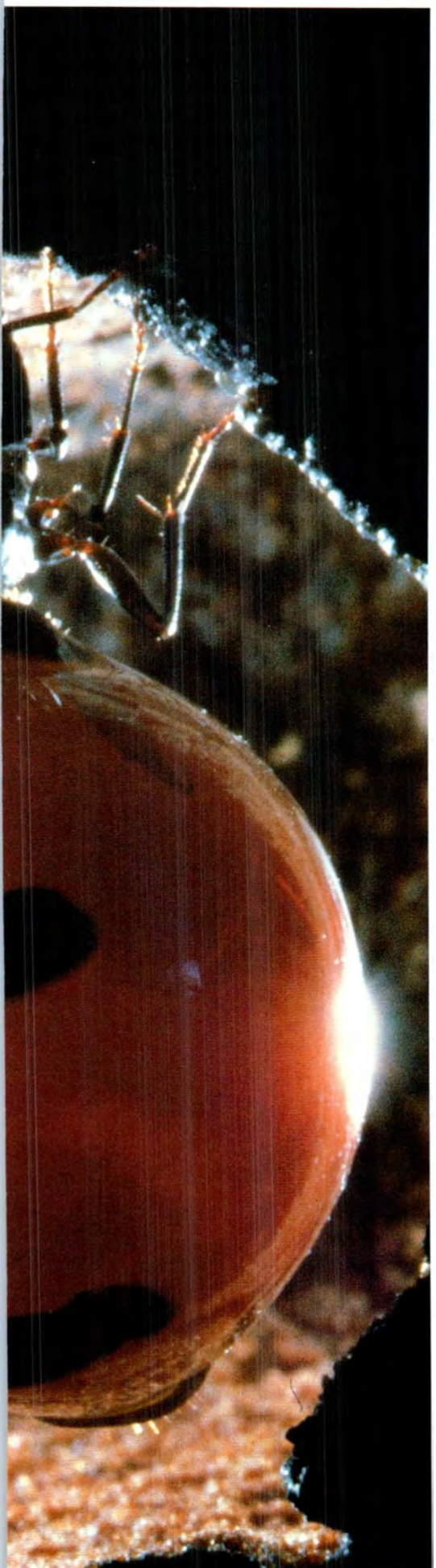
Honeydew is a highly prized plant product produced by scale insects and other homopterans that feed on plants. The piercing, sucking mouthparts of these bugs tap the main food stream of the plant, and their resultant rich excretions—the honeydew—contain many amino acids, carbohydrates and some lipids. It is not surprising that ants feed on honeydew, with many ant species being dependent on specific scale insects.

—Geoff Holloway
Australian Museum

JEANNIE DEVITT



DENSEY CLYNE/ANT PHOTO LIBRARY



Nutritional Value

An analysis of honey obtained from ants indicated that it is not essentially different in composition to either bush or commercial honies. It is less viscous though, and has a considerably different taste. Below is a comparison of the nutrients found in the honey obtained from Black Honeyants, that from central Australian native bees (probably a species of *Trigona*) and commercially produced honey.

	Black Honeyants	Native Bees	Commercial Honey
% Edible Portion	100	100	100
Energy (kJ)	992	1407	1348
Water (g)	37.1	3.7	19.3
Protein (g)	1.1	0	0.9
Fat (g)	0	0	
Carbohydrate (g)	60.8	87.1	80.0

Honeydew is fed to special worker ants. Their swollen abdomens contain the honey. These 'storage' ants hang upside-down in underground chambers.

excavated produced less than 100 grams. Perhaps the actual quantity of honey retrieved is not the aspect of greatest significance. Aboriginal women do not consider digging with a crowbar in that context as tedious drudgery. The procedure is slow but without hazards since the ants do not bite. It is an activity ideally suited to the participation of family groups, particularly those including children. In contrast to hunting, it is a leisurely pastime.

Honeyant collection, and all activities involved with obtaining bush foods (including hunting), entail constant, careful observation of the environment. This is part of the gradual process of learning about the country and an important aspect of what Aborigines describe as 'looking after country'.

The honeyant and its habits are not only a highly valued food item wherever they occur in central Australia, they are also the focus of mythological accounts and elaborate ceremonial activity. This shared mythology links together many different groups of Aboriginal people, despite the large distances that may separate them. The continuing use of honeyants is, I believe, an affirmation of deeply held cultural values. ■

I thank the families of Angkwele for their patient teaching; the Australian Institute of Aboriginal Studies for funding the research; and the Human Nutrition Unit at the University of Sydney for the analysis of bushfood specimens.

This young Penguin has moulted and grown its first set of true feathers. Some down remains around its neck.

ROD MORRIS

Unlike its Antarctic relatives, New Zealand's Yellow-eyed Penguin lives in the scrub, not the ice and snow. Long ignored by scientists, its numbers are dwindling through habitat destruction.

THE WORLD'S

RAREST PENGUIN

BY PHILIP SEDDON
& YOLANDA VAN HEEZIK
ZOOLOGY DEPARTMENT
UNIVERSITY OF OTAGO, DUNEDIN, NEW ZEALAND

THE VAN SKIDDED TO A HALT ON THE DRY gravel road. Fifteen minutes drive from the city of Dunedin in New Zealand we were already surrounded by the lush green paddocks of coastal farms. Climbing over a fence we set off across the fields, past flocks of sheep grazing in the sunshine. Ten minutes of easy walking and two

Only the Yellow-eyed Penguin has yellow eyes: most other penguins have dark brown eyes. Adults also have a band of gold feathers around the eye.

ROD MORRIS

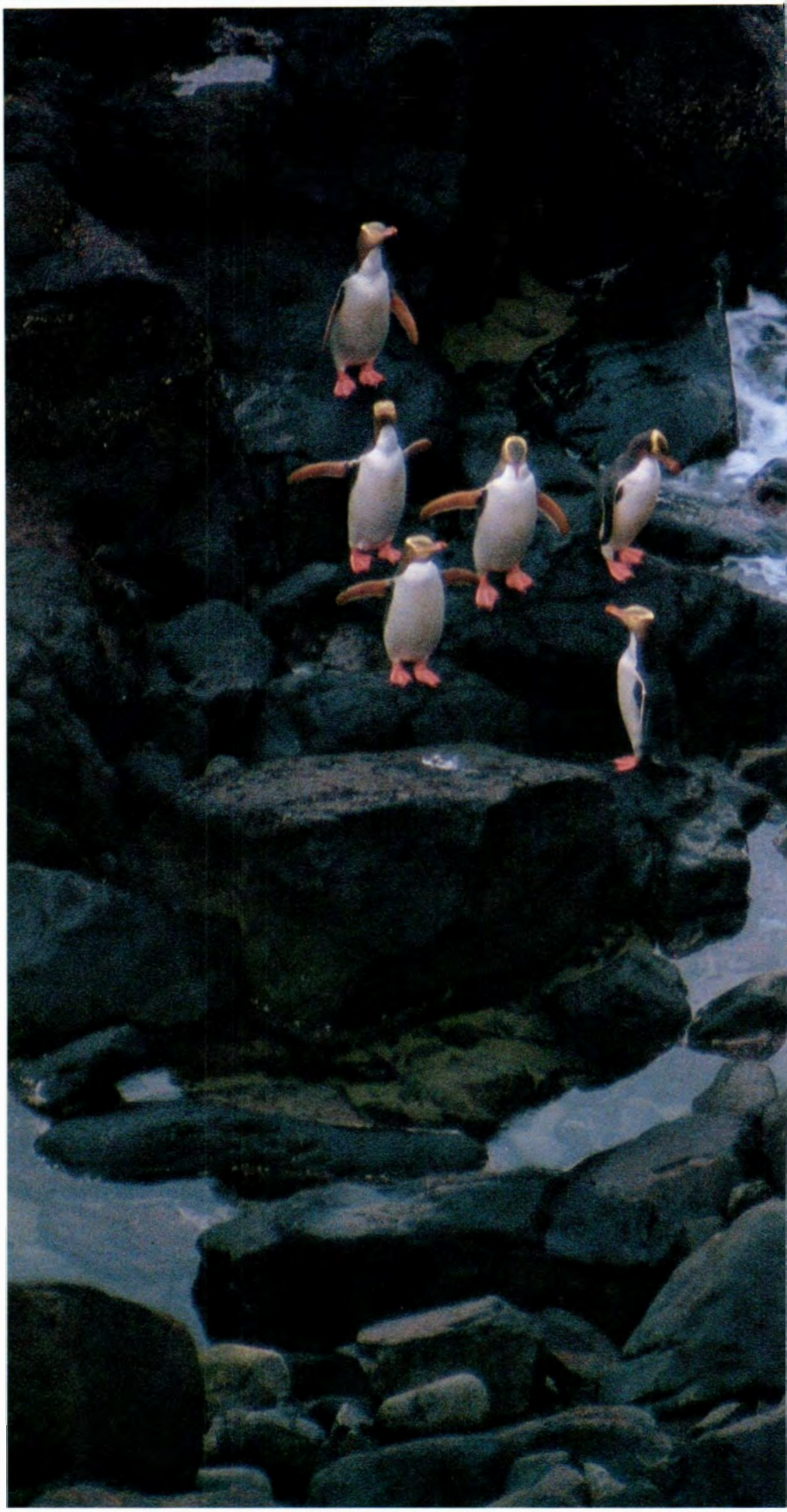
fences later we could see ahead an expanse of white sand beach, typical of the South Island's Otago coastline. Clumps of scrub were scattered along the line of low cliffs above the beach. As we approached the scrub we spied a narrow trail of flattened grass entering a large stand of flax. Peering into the dark tunnel formed by overhanging flax, we saw what we had been searching for: a solid-looking bird with a white front, dark blue back and bright band of gold feathers encircling its head sat on a nest of grass and twigs. We had found a nest occupied by the rarest penguin in the world—the Yellow-eyed Penguin.

Megadyptes antipodes, meaning 'big diver from the south', is the scientific name for the Yellow-eyed Penguin. Studying the bird kept us occupied six to seven days a week throughout the long breeding season, from egg laying in September until the chicks first enter the sea in February. Our study of nesting behaviour of the adults and the growth of the chicks required frequent visits to a number of the small, scattered breeding areas found hidden in the scrub along the Otago coastline. Although a seemingly idyllic pastime, the behaviour of this particular penguin made our summertime collection of data far from leisurely.

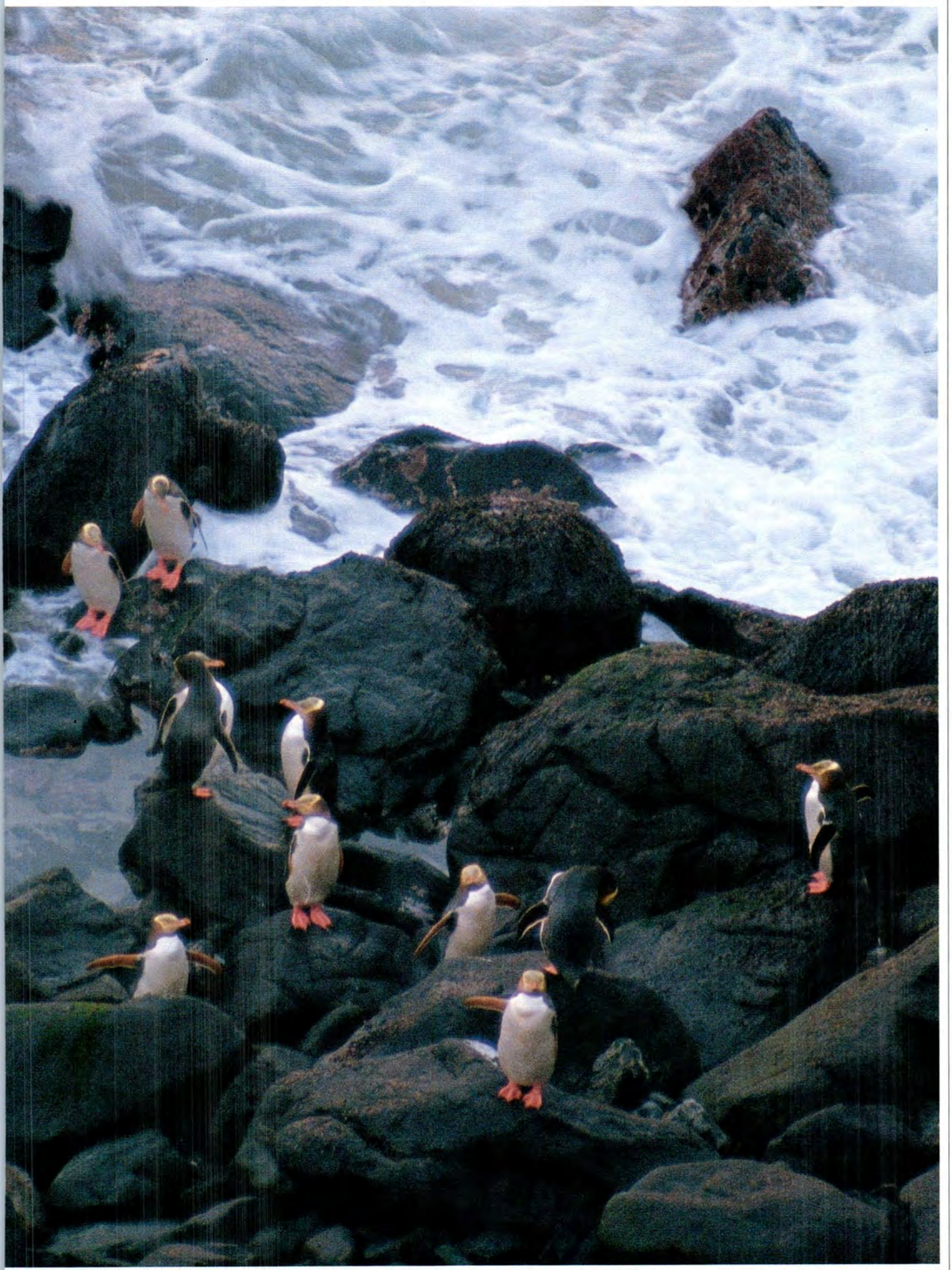
Standing about 70 centimetres tall and weighing up to eight kilograms, the Yellow-eyed Penguin is not to be taken lightly. Its beak, sharp-edged and with a curved tip, is ideally suited to grasping fish and squid, and quite capable of doing the same to human flesh—as the scars on our hands will testify. But the flippers are the more formidable weapons. A Yellow-eyed Penguin will strike unwelcome visitors with the leading bony edge of a flipper. Driven with all the force of the huge swimming muscles in the chest, and delivered at a machine-gun pace of five blows per second, a direct hit will result in severe bruising.

Despite its defensive capabilities, the Yellow-eyed Penguin is somewhat of a recluse, with a lifestyle at odds with most people's idea of penguins. It never ventures near the icebergs and snow of the Antarctic, preferring instead to remain in the temperate climate of the south-eastern coast of New Zealand's South Island. No crowded colonies either since the Yellow-eyed Penguin has numerous bays and beaches in which to nest. It seeks out sites beneath dense vegetation, often hidden from view of its neighbours. Some pairs may travel over a kilometre inland in search of a suitable location—no mean feat on stumpy legs.

For us, locating all the penguin nests in any one breeding area was no mean feat either. The main access pathways, worn by generations of penguin feet, were easy to follow. Once inside the scrub, however, the only effective searching method was to drop on all fours and crawl forward through tangled vegetation, sometimes rounding a tree stump to come face-to-face with a bel-



Yellow-eyed Penguins are more likely to be seen in groups during winter, after breeding.



ROD MORRIS

ROD MORRIS

Yellow-eyed Penguins prefer to nest in secluded dense vegetation. Few suitable nesting sites remain due to the clearance of land for farming.

ligerent penguin. Often the smell of a well-used nest, a strong fishy odour, is the best guide to its location.

The need for dense vegetation and secluded sites has made the Yellow-eyed Penguin particularly vulnerable to changes in its breeding habitat. Up until about 200 years ago, the penguins had virtually unlimited, predator-free coastal forest, which provided a cool, shaded environment on land for a penguin insulated against the cold of the sea. With the clearance of much of this forest for farming, the penguins have been forced to find nest sites in the few remaining scattered patches of low coastal scrub. This much-modified habitat seldom provides adequate shade for nesting penguins, with both adults and the downy chicks becoming dangerously overheated on sunny days.

Possibly as a result of their solitary nesting, Yellow-eyed Penguins are extremely wary of people, and have been known to launch themselves off cliffs rather than be approached by humans. Whereas Fairy Penguins will come ashore via a concrete ramp under the gaze of crowds, Yellow-eyed Penguins will not land if even one person is visible on the beach. Even if hungry chicks are waiting at the nest, adult penguins will remain beyond the line of breakers until a beach is empty. Such intolerance of humans may cause problems where breeding areas are next to popular beaches.

WITH THE BUSH-FELLING OF LAST CENtury also came the introduction of wild cats, ferrets and stoats. Adult Yellow-eyed Penguins can defend themselves against all but dogs, but the chicks are an easy meal for most predators. In some breeding areas where ferrets are present, all the chicks will be eaten before they are six weeks old. If a chick can survive this long it is then big enough to be able to defend itself.

Up until the sixth week after hatching, chicks are accompanied at the nest by one parent. After this time the chicks' demands for food become so great that both parents must spend the day at sea fishing, returning in the evening to deliver the daily feed of small fish and squid. The growth of the chicks is a leisurely affair relative to that of the Antarctic penguins—such as the Adelie, which must compress all of its breeding activities into the short austral summer.

Also unlike many other penguin species, Yellow-eyed Penguins almost always lay two eggs of equal size and raise two equally sized chicks to fledgling. In fact, a pair of Yellow-eyed Penguins probably raises more total chick mass each season—some ten to 14 kilograms worth—than does a pair of any other penguin species.

Loss of nesting habitat has reduced the numbers of penguins able to nest in once important breeding areas. Of those that do

It is necessary to approach these wary penguins cautiously when attempting to read flipper bands. The sharp-edged beak is ideally suited to grasping fish, squid and human hands!

YOLANDA VAN HEEZIK

Yellow-eyed Penguins can be found in scattered patches of low coastal scrub in the south-east of New Zealand's South Island. This bird has been moulting, as evidenced by the ring of feathers around its nest.

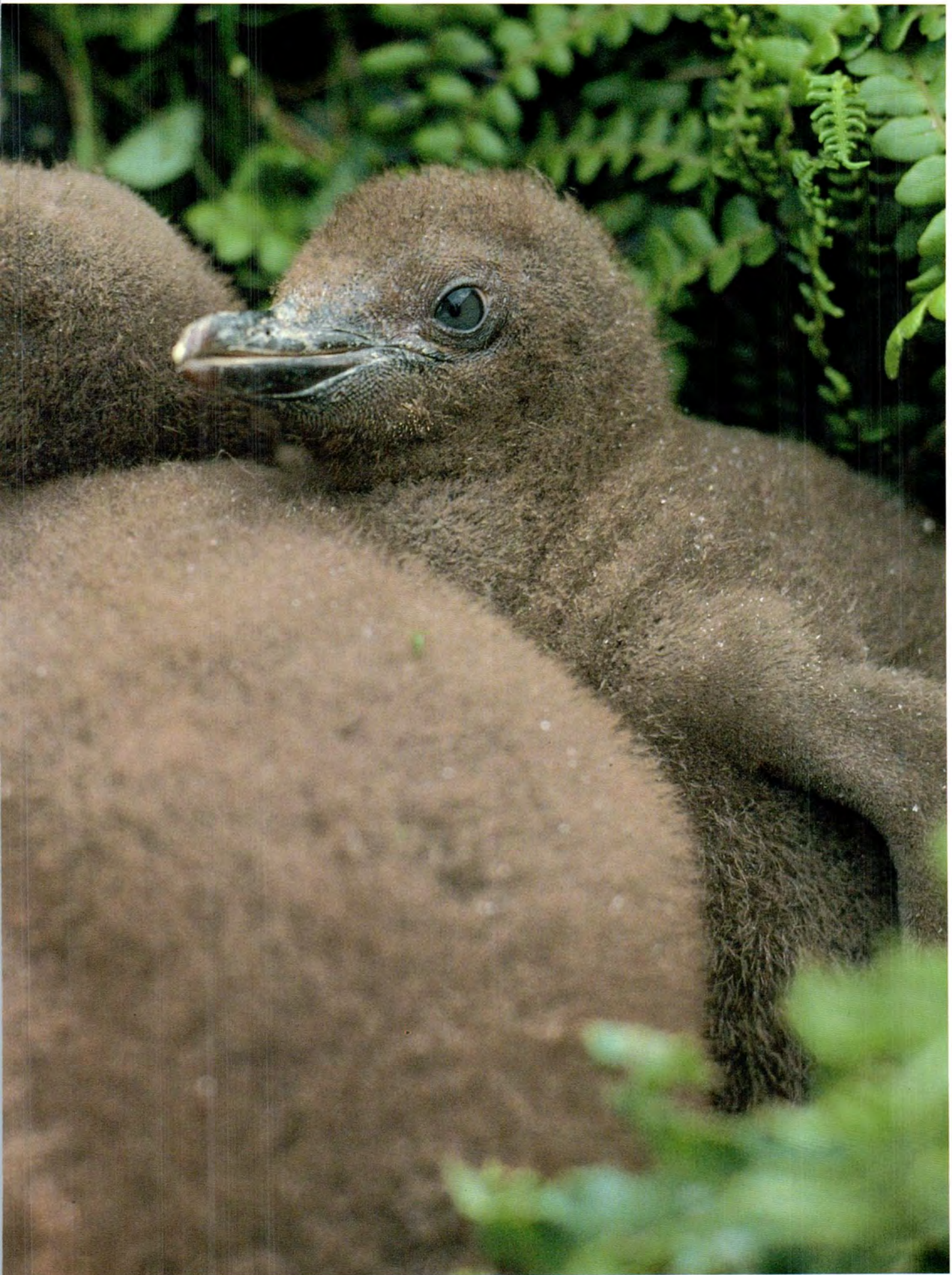
breed, many will be unsuccessful, losing their chicks to predators. Never numerous, the total population of Yellow-eyed Penguins may now be less than 6,000 individuals. But all is not doom and gloom. New Zealanders are realising they have a unique penguin at their doorstep, and moves are being made to ensure a future for it.

The high public profile of the Yellow-eyed Penguin, and the great appeal of penguins generally, means that volunteer labour is always available for annual penguin banding and beach counts—both of which are essential if we are to monitor the recovery or decline of the species. Concerned members of the public have formed the Yellow-eyed Penguin Trust, which aims to raise both public awareness and funds to purchase and revegetate breeding areas in urgent need of protection. Important breeding areas, for example, are being fenced to exclude stock. Sheep and cattle browse on the vegetative cover essential for successful nests and graze grass low enough to allow rabbits to move in. The rabbits, being the main prey of ferrets, thus maintain predator numbers for the nine months of the year during which penguin chicks are not available as easy pickings. Trapping programs remove predators and ensure the survival of the chicks.

Rather than waiting until penguin numbers drop even further, if enough effort is invested now to protect and restore the Yellow-eyed Penguins' breeding habitat we can realistically aim to help these penguins help themselves. ■

Month-old Yellow-eyed Penguin chicks. They will lose their down after about five weeks. Chicks are not safe from predators until they are about six weeks old, when they are able to defend themselves.

ROD MORRIS



ROD MORRIS

The author, Gary Dodson, with a Forest Service Officer observing flies on a trunk of a downed *Dysoxylum gaudichaudianum* tree in Papua New Guinea.

THE HORNY ANTICS OF ANTLERED FLIES

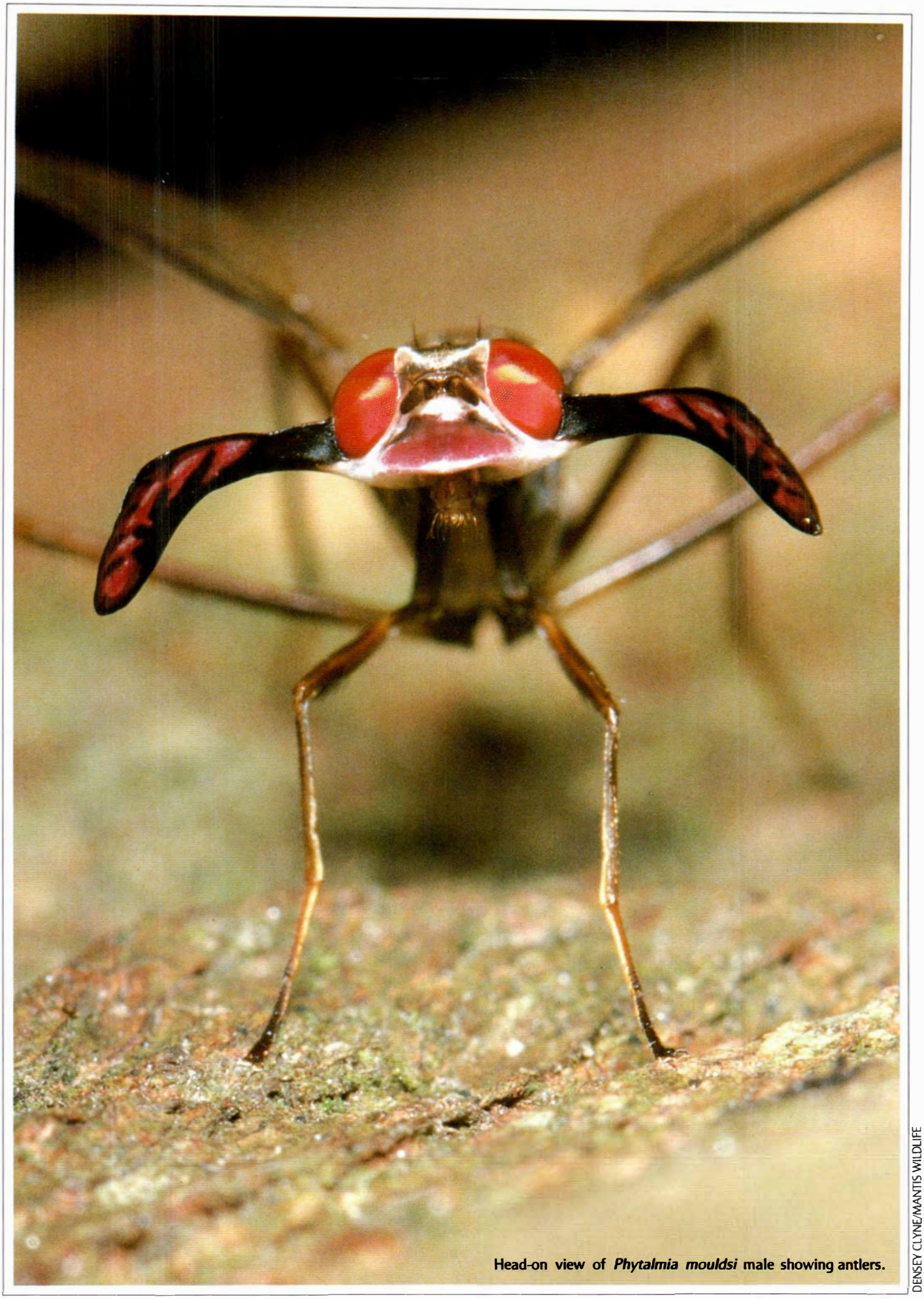
BY GARY DODSON
DEPARTMENT OF ENTOMOLOGY
UNIVERSITY OF FLORIDA

THERE ARE NATIVE ANIMALS WITH antlers in the forests of Queensland and Papua New Guinea—not the deer or elk of the Northern Hemisphere, but flies of the genus *Phytalmia*. Although only 1–1.5 centimetres long, they are nonetheless spectacular, both morphologically and behaviourally. The family of true fruit flies (Tephritidae), counts among its members some of the most notorious insect pests in the world—the Mediterranean Fruit Fly (*Ceratitis capitata*), the Oriental Fruit Fly (*Dacus dorsalis*) and the Queensland Fruit Fly (*D. tryoni*) are among the best known. Although the *Phytalmia* belong to this infamous family, their unusual morphology and habits set them apart as a distinct group.

Only the males possess the antler-like structures, which have a unique shape within each species and vary from spatulate to finely branched. Unlike the true antlers of mammals, which are derived from hair and shed each year, these structures are permanent outgrowths of the body covering (cuticle) and project from the outer edges of the eyes. There has been much speculation regarding the function of these structures, but little formal study. Recent work has aimed at exploring their role in *Phytalmia* behaviour.

Naturalists have long been fascinated by these flies. Alfred Russell Wallace, a contemporary of Darwin who independently

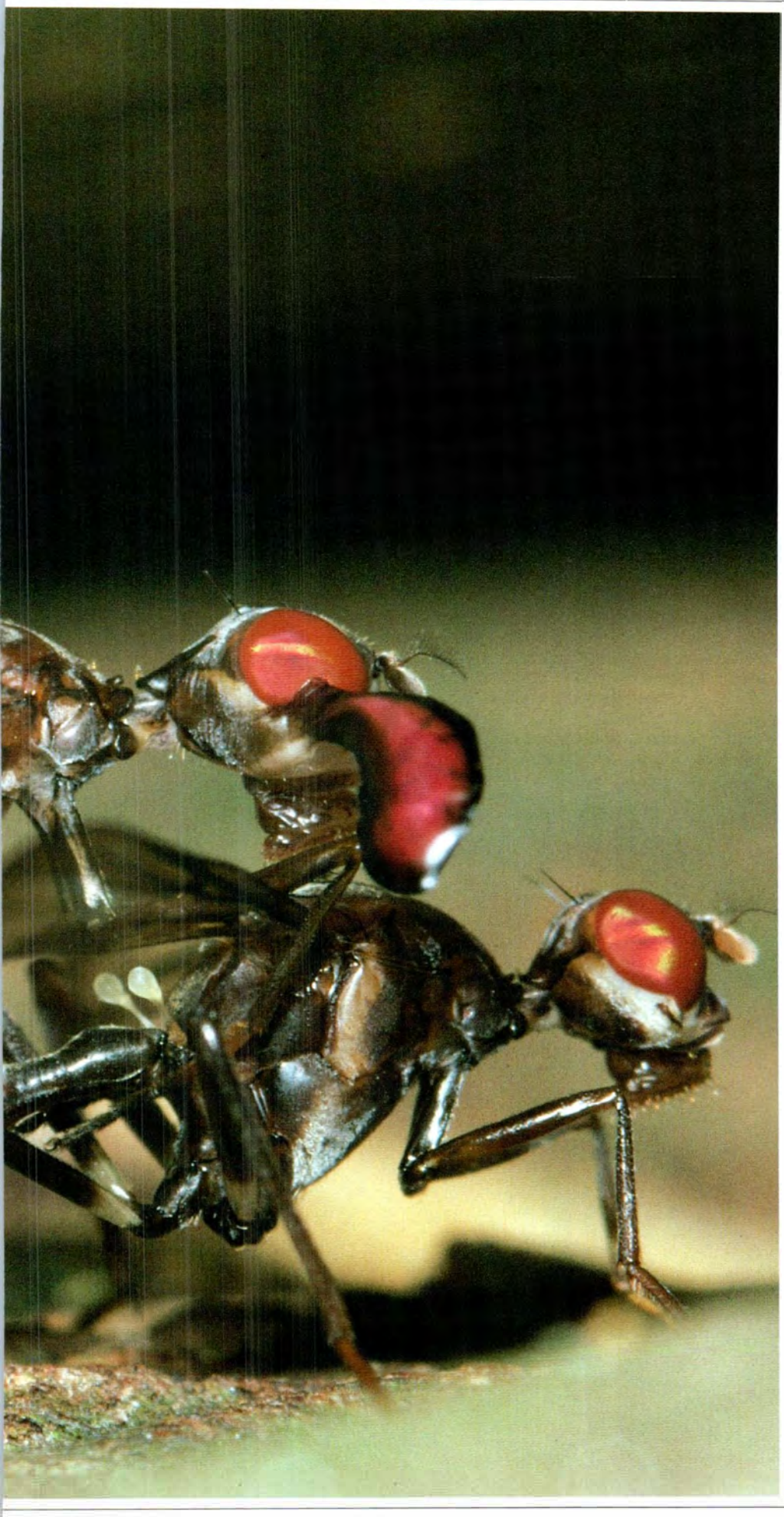
The battles between male antlered flies more than superficially resemble the rutting of deer and elk; their antlers are used to compete sexually for females.



Head-on view of *Phytalmia mouldsi* male showing antlers.

DENSEY CLYNE/MANTIS WILDLIFE

DENSEY CLYNE/MANTIS WILDLIFE



developed a similar theory of natural selection, encountered them during his 1858 visit to New Guinea and included a drawing of several specimens in his subsequent book *The Malay Archipelago* (1869). Of the six described species of *Phytalmia*, one occurs in a remote area of far northern Queensland; the remainder is known only from Papua New Guinea and Irian Jaya. Research on these flies is hindered by difficult access to their habitat. The one Australian species (*P. mouldsi*) occurs in patches of rainforest in the Iron Range area of Cape York Peninsula. It is just one of many insect species restricted to this area that have affinities closer to the New Guinea fauna than to the Australian fauna.

THE LIFE HISTORIES OF *PHYTALMIA* species are almost as unusual as their appearance. Females deposit eggs under the bark of fallen tree trunks or limbs, and the larvae feed within the decaying sapwood. Pupation occurs in less than three weeks and adults begin to emerge after another two weeks. Considerable evidence indicates that each fly species is restricted to one or very few tree species as hosts, most of which are in the mahogany family Meliaceae. The only known host for *P. mouldsi* is *Dysoxylum gaudichaudianum*.

Within a few days of a tree fall, flies begin to appear at the resource. Males are able to identify spots along the tree that are attractive to females as a site for egg laying (oviposition). Individual males take up residence at such sites and await the arrival of females. Other males are also attracted to the sites and attempt to displace the resident. Which male will ultimately remain at the site is determined by pushing contests between them. In *P. mouldsi* these contests can be divided into categories of escalating levels of intensity, which are dependent on the size of the two males involved. If one of the males is much smaller than the other, the interaction is not likely to proceed beyond a non-contact face-off before the smaller of the two retreats. Males that are closer in size usually advance towards each other until they make contact with their antlers and heads, but the interaction can still end quickly if one is definitely larger. The real battles royal occur between males that are the same or nearly the same size. As they push against each other they rise up off the substrate, stilting up on their middle and hind legs, always maintaining contact with their heads. Such fights can last several seconds before one male is finally forced backwards and retreats. Occasionally two evenly matched opponents will engage in a series of these contests before a winner is decided.

During these set-tos the antlers do not appear to play a major role in the actual transmission of force from one fly to the other. Indeed, following initial contact between the flies while they are still parallel to the substrate, the antlers are generally crisscrossed with only their bases touching.

***Phytalmia mouldsi* flies mating. The male is on top.**

GARY DODSON

A mass of *P. mouldsi* flies (mostly males) on *Dysoxylum gaudichaudianum* at Iron Range, northern Queensland, shows the attractiveness of limited oviposition sites.

The real pushing surface is the leading edge of the face (the epistomal margin), which in this species is produced well forward like a prominent upper lip.

But does it pay to have bigger antlers? This question is not easily answered. Antler size is related to overall body size—the smaller the male, the smaller his antlers. The smallest males in the population have no antlers at all. They lose encounters because they are small. But what if a large male did not have antlers? Experimental manipulations reveal that with similarly sized males of *P. mouldsi*, decreasing the size of the antlers decreases their chances of winning a fight, while artificially increasing antler size increases their chances of winning. However, even with their antlers removed, large males still defeat small males.

Phytalmia mouldsi males engaged in the most extreme category of their aggressive interactions. After making contact horizontally on the substrate, they raise each other until the full extent of their middle and hind legs is reached, and push against each other with the epistomal margin of the face until one falls over and retreats.

These interactions more than just superficially resemble the rutting of their mammalian analogues. Just as with elk and other deer, success in these male intrasexual interactions has a significant effect on subsequent mating success. Through territorial ownership, males are in a position to encounter females that arrive in search of oviposition sites. Females attracted to these locations are prevented from ovipositing until after mating with the resident male. The male then remains in contact with the female, standing above and holding the bases of her wings as she oviposits. Observations thus far suggest that this female-guarding behaviour prevents other males from mating with her; it does not necessarily benefit the female.

ONE IMPORTANT QUESTION IN THIS RESEARCH concerns the value to females of the male-controlled sites. Observations of females ovipositing for long periods at locations on logs where males are not present suggest that females are capable of finding and utilising appropriate locations on their own. However, the sex ratio at the tree is normally always strongly biased towards males, and it could be that suitable oviposition sites without resident males are scarce.

This resource–defence mating system fits well with the predictions of behavioural ecologists regarding the influence of resource distribution on animal mating systems. When resources required by females are distributed in such a way that individual males are able to control access to them, males are expected to defend a position at the resource. Localised or patchy distributions of a limited resource lend them-

GARY DODSON

Phytalmia mouldsi males in head-on combat.

DENSEY CLYNE/MANTIS WILDLIFE

GARY DODSON

On the Level

The fights of one of the Papua New Guinea species differ from those of the Australian species in ways that seem to be correlated with their different antler morphology. *Phytalmia alcicornis* has the most massive antlers within the genus. Here, as might be expected, the antlers are more involved in the actual pushing action. The large, broad lobes of the opponents' antlers come together while the narrow lower arms hook underneath. The much less prominent epistomal margin does not appear to be important in transmitting force. Perhaps as a consequence of this structurally based difference in the fights, closely matched *P. alcicornis* males do not stilt up on their rear legs like *P. mouldsi*. Extended interactions in *P. alcicornis* result in a series of consecutive short bursts of mostly horizontal pushes. The ultimate result is the same, with one male being knocked onto his backside, then retreating.

selves readily to monopolisation, and so a resident male should experience a high encounter rate with potentially receptive females. The cost to a male as a result of his defensive behaviour must be outweighed by the benefit of acquiring more matings than non-resident males. In other words, defence of the resource must be 'economically feasible' in an evolutionary sense.

The *Phytalmia* system appears to meet these expectations. All indications are that suitable larval substrate is a somewhat restricted resource. In any given patch of rainforest, falling trees are something of a rarity. While this fact may provide comfort to bushwalkers, it probably has been a significant force in the evolution of behaviour in these flies. When a fallen tree or limb does become available, the decaying process apparently proceeds in such a way that suitable locations for depositing eggs, at least initially, remain scarce and males are able to monopolise sites.

Many important evolutionary questions can be addressed with studies such as this one. It is hoped that research on *Phytalmia* will aid in our understanding of the role of ecological factors in the structure of insect mating systems. Additionally, the evolutionary history of extreme secondary sexual characteristics, such as the antlers of these flies, remains an important and controversial topic among evolutionary biologists. Studies aimed at determining the present function, if any, of these structures may help unravel such mysteries. ■

***Phytalmia alcicornis* males facing off before engaging in their (mostly) horizontal pushing contest over control of territory on the tree trunk. Positioning of the lower 'arm' of the 'antler' under that of the opponent's seems to give a leverage advantage.**

Not all fungi have the classic shape depicted in fairytales; yet their unusual shapes and forms are indeed magical!

BY BRETT GREGORY

This ghost fungus, a species of *Pleurotus*, haunts the Royal National Park.

A *Collybia* species forms a miniature forest in the Royal National Park.

A fairytale-like clump of *Hygrophorus* species, Royal National Park.

P H O T O A R T

A tiny insect explores the 'branches' of this Coral Fungus, *Clavulina rugosa*, Royal National Park.

The Royal National Park on Sydney's outskirts is host to many species of fungi, such as this wax-like *Clavulinopsis amoena*.

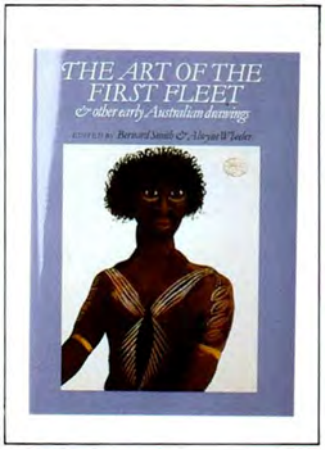
The Flame Fungus, *Clavulinopsis miniata*, leaps from the leaf litter in the Royal National Park.

PHOTOART

The delicate stalks of *Mycena sanguinolenta* sprout from a log in the Royal National Park.

Ruby Bracket, *Tyromyces pulcherrimus*, has a downy appearance. This specimen was found in the cooler areas of the Barrington Tops, New South Wales.

REVIEWS



The Artwork of the First Fleet, and Other Early Australian Drawings
Ed. by Bernard Smith and Alwyne Wheeler. Oxford University Press, Melbourne, 1988, 255 pp. $195.00.

Baudin in Australian Waters, The Artwork of the French Voyage of Discovery to the Southern Lands, 1800–1804
Ed. by Jacqueline Bonnemains, Elliott Forsyth and Bernard Smith. Oxford University Press, Melbourne, 1988, 347 pp. $250.00.

The Aboriginal people are the most surprising feature of these outstanding volumes. Fresh visions of their culture, their artefacts and their daily lives 200 years ago leap off the pages.

I had long held the impression that little accurate or useful visual recording of the Sydney Aborigines had taken place before the tribes succumbed to the combined assaults of smallpox and the gun. But as I turned the pages it became clear that this impression was born of the fact that so much of the artwork is held overseas.

Here were the people of the Sydney region and Tasmanians as I had never seen them before: painted for a funeral, curing sick children, dancing. From these drawings can be gleaned minute details of body ornamentation, elaborate tombs, personal equipment, dance sequences and of how mothers carried their children. There are even drawings of their characteristic copulation positions. Perhaps most fascinating are the sensitively drawn portraits of men, women and children from which individual personalities emerge.

These volumes are a continuation of a series that began with *The Art of Captain Cook's Voyages*. It provides, for the first time outside of restricted academic circles, a comprehensive selection of early European visual recording of Australia. This is state-of-the-art publishing at an unavoidably high price—no other format could have done justice to the subject. After all, the zoologists, anthropologists and historians, not to mention the Aboriginal dance choreographers and the artists, novelists, film makers and poets who will use this material in countless ways, could never, realistically, have access to the originals.

Magnificent standards of reproduction have been backed up by authoritative chapters from a cast of eminent and readable scholars. The authors have provided researchers with copious references, appendices, annotations and bibliographies.

The Artwork of the First Fleet draws mainly on the enormous wealth of material relevant to the early European exploration of Australia held by the British Museum (Natural History). The paintings and drawings of this unlikely collection of Englishmen (one was a midshipman and two were convicts) appear at first glance to be charmingly naive, but their main quality emerges as a striving for accuracy of detail. This detail is particularly evident in the drawings of birds, mammals and reptiles on which many of the original scientific descriptions of our fauna were based. Yet it was a vernacular stylistic tradition that met the needs of the time, a fact well illustrated by the beautiful charts and views selected for publication. After all, profiles of coastline were particularly important to seamanship. The growth of European settlement at Sydney Cove, Norfolk Island and Parramatta is also portrayed.

The two artists of the Baudin Expedition, like those of the First Fleet, did not set out expecting to chronicle the natural history and the indigenous peoples of Australia. Nicholas-Martin Petit and Charles-Alexandre Lesueur had both signed on as 'gunner, 4th class' and were pressed into service as scientific illustrators after the Expedition's three official artists deserted at the first port of call.

Baudin in Australian Waters should do much to restore the Expedition to the place of honour it deserves in the annals of scientific endeavour. Almost unremembered today, it accomplished perhaps more than any 19th-century expedition to the region. Eighteen thousand biological specimens representing over 2,500 new species were obtained. Seventy-two live specimens were brought home to France and much priceless ethnographic data was collected. All this was achieved in the face of dissention, desertions, disease and death. When Baudin's ship entered Port Jackson there were only six men well enough to handle the sails! In addition, the Expedition had incorporated all the tensions facing France at a time when the Republican phase of the Revolution was giving way to Bonapartist reaction. During the Expedition's absence, Ministers and institutions under whose auspices it had been launched fell from favour. It returned without Baudin, who died of TB on the voyage home, and Napoleon is said to have remarked "Captain Baudin did well to die; if he had returned I would have hanged him".

Not least among the charac-

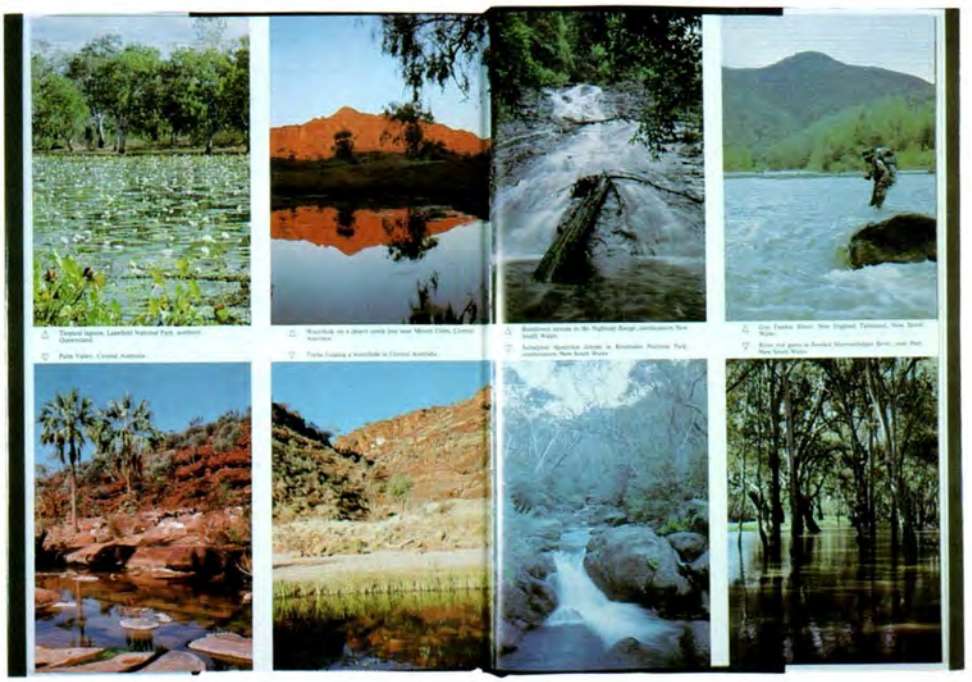
ters of the Expedition was Francoise Peron, a young scientist of mercurial temperament whose responsibilities included anthropology and ethnography. In fact it was Peron who coined the term 'Anthropologist' for himself a few weeks before the voyage departed—a calling he envisaged as part of medical science. Alas, Peron's personality made him perhaps not the best chosen person to pioneer the profession he had named. His enthusiasm for 'natural man' quickly turned to contempt when a French sailor was wounded following a misunderstanding with the Bruny Island Aborigines.

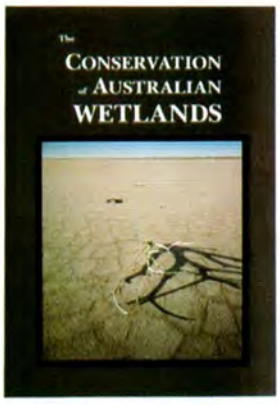
Fortunately Peron's growing venom towards the Aborigines was counter-balanced by Baudin who enforced a vigorous code of non-violence on the members of the Expedition and whose writings about the Aborigines "tended to be cool, factual ... without any particular theoretical posture nor speculating about the human condition". In any case, zoological duties began to consume more and more of Peron's time (the appointed zoologist having died early in the voyage) and today he is remembered better as a zoologist.

In spite of the Expedition's disenchantment with 'natural man', the drawings of Petit and Lesueur and the accounts of Baudin and Peron are undoubtedly the most valuable ethnographic material on the Tasmanians ever assembled. The bulk of the Expedition's work, however, was spent collecting zoological specimens, and Charles Lesueur's meticulous drawings and watercolours, covering the range from sponges to mammals, make up the greater part of the volume. The massive collections kept the professors of the Museum d'Histoire Naturelle in Paris busy for many years, although, ironically, the majority of organisms collected at such enormous human cost were later recollected and first described by others.

In summary, the two volumes bring some of the most important and fascinating visual records of Australia to a wide audience and while they are, inevitably, priced beyond the resources of many private collections, they deserve to be found in all libraries.

—Gavin Gatenby
Australian Museum





The Conservation of Australian Wetlands

Ed. by A.J. McComb and P.S. Lake. Surrey Beatty & Sons, Sydney and World Wildlife Fund Australia, 1988, 196 pp. $50.00.

Australia has an enormous range of wetlands, which, for a long time, enjoyed poor public relations. Apart from a few dedicated conservationists, wetlands were perceived as wastelands and a danger to human health while reclamation (in most cases a euphemism for destruction) was a public spirited act. This view has begun to change and, at least for coastal wetland, there is now wide community recognition that protecting the habitat brings many benefits, not least the maintenance of fisheries. However, even in the coastal zone the pressures leading to wetland degradation are still great; inland wetland types are poorly known and understood.

This handsome volume provides the first comprehensive overview of Australian wetlands, from the well-'truttified' (trout-released) waterbodies of Tasmania to the great tropical wetlands of the Northern Territory and northern Queensland; from the coastal mangroves to the mound springs of central Australia.

The bulk of the book is a State-by-State survey of wetlands. For each State there is a description of the major wetland types and their distribution; identification of their various threats; and an assessment of the conservation status of the State's wetlands. It is clear from these accounts that, unless major land management changes occur, the future of most wetlands is bleak and the conservation status of many wetland types poor.

The book concludes with a brief review of conservation and management problems. This chapter reinforces the urgency of the problem of achieving wetland conservation. The threats to wetlands are multitudinous. What are we to do about it? The failure to come to grips with the question is, to my mind, the most disappointing feature of the book. The nature of the problem is identified, but there is little evidence that practical management techniques are being developed. The management of wetlands is intimately tied up with the management of water. The conservation of wetlands will, in many cases, require modification and manipulation of water regimes. For most wetland types, we have little idea as to appropriate management regimes—developing management strategies will require greater understanding of the ecology of wetlands but will also require bold, large-scale experiments. This book provides ample evidence for the need to conserve the diversity of Australia's wetlands and to take action sooner rather than later. The challenge now is to develop and implement management strategies—who will take the initiative?

—Paul Adam
University of NSW

Care of Australian Reptiles in Captivity

By John Weigel. Reptile Keepers Association, Gosford, NSW, 1988, 144 pp. $12.00.

This booklet was produced in

an effort to bring about a rational approach to the keeping of reptiles in captivity in New South Wales. After a brief preface and introduction, which includes a list of amateur Australian herpetological associations, proceeding chapters cover legal requirements, housing in general, housing venomous snakes (including treatment for snake bite), feeding (including the production of food insects), skin sloughing, diseases and captive breeding. The suggestions for overcoming feeding difficulties, I would think, will be particularly beneficial.

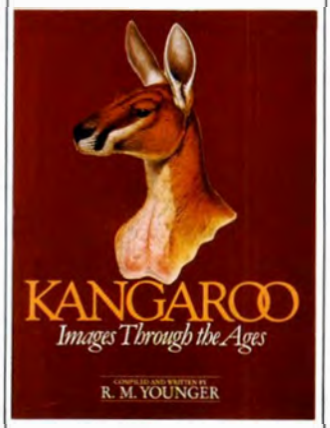
A feature of the book is the 'Care Sheets', in which the maintenance requirements of 50 species are outlined. Each has details of habits, housing, feeding, captive behaviour and breeding. An additional cautionary paragraph is also presented for each venomous snake species. The wealth of practical helpful knowledge is complemented by numerous sketches and 21 of the author's excellent colour photographs. There is a list of selected references; and no index.

Typographically, this is a clean production with few blemishes. I could find only two instances of editorial inconsistency: *Dendrelaphis punctulatus* is referred to as the Green Tree Snake and Common Tree Snake; and children's pythons are allocated to the genus *Liasis* on the relevant Care Sheet, but a photograph of the Dwarf Children's Python is captioned wih *Bothrochilus*. I also wondered if it would have been worthwhile to include details of the drugs mentioned in a 'Products Mentioned' section.

However, these are relatively minor points and do not detract from the book's presentation and value. The author urges a particularly responsible and pleasing approach throughout: do not destroy the environment in your search for species; check your cage temperatures; adopt a careful approach to venomous snakes; and keep records for future publication.

On a personal note, I particularly welcome this book. My publication of similar material has been out of print for over three years and I have been well aware of the need for a replacement. This book is a must for anyone involved with the captive maintenance of Australian reptiles and probably many other people as well. I highly recommend it.

—Chris B. Banks
Royal Melbourne Zoo



Kangaroo. Images Through the Ages

By Ronald M. Younger. Century Hutchison, Melbourne, 1988, 247pp. $39.95.

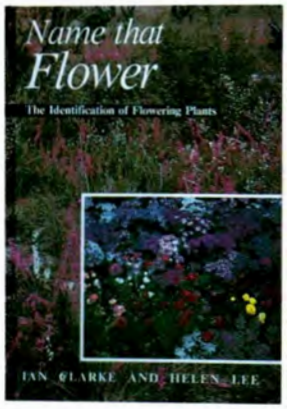
When I first received this book I found it difficult to categorise. I eventually decided to take the title at face value and flipped through it, enjoying the many diverse illustrations. This turned out to be a worthwhile exercise, for the illustrations alone tell the story of the kangaroo–human interactions that are the focus of the book. They range from magnificent 19th-century watercolours, through to some hilarious and rather ghastly cartoons. The latter have much more to say about Australian history than about kangaroos. The cartoon on page 172, for example, depicts the British lion and Australian kangaroo at the end of the Boer War. It shows what a sycophantic load of anglophiles we all were at the turn of the century. The only thing that marred my enjoyment of the illustrations was the occasional lack of referencing, such as the date and place of previous publication.

On settling down to read the text, I must admit to being initially disappointed. The first chapter is undoubtedly the worst, and one feels that the author is out of his depth when dealing with prehistory. He reports, quite erroneously, that when the Aborigines first arrived there were no ferocious animals in Australia except crocodiles, thus consigning to oblivion our wonderful extinct marsupial lions, and giant goannas and snakes. He also reports that all the animals that give Australia its unique flavour are from Gondwana, conveniently forgetting our characteristic goannas, poisonous snakes, rodents, brolgas and many other birds, all of which are of Asian origin. Finally, we get a rather eccentric account of the Aboriginal occupation of Australia.

Having got through this mire, however, I found that in later chapters the information takes a quantum leap in quality. The author is clearly an excellent historian and the book is generally authoritative, lucid and fascinating. Although I have studied kangaroos throughout my professional life, I learned some new facts and was shown familiar events in a new light.

Even when I had finished this largely enjoyable read, I still could not categorise the book, nor decide who might buy it. It is certainly not aimed squarely at the professional natural history market, although I suspect that many academics will profit from purchasing it. Likewise, it is not a coffee-table book—there is too much detailed information that would be missed by the casual reader. Perhaps it has much to offer well-informed and curious Australians, for it has much to teach us of our national symbol, and indeed of ourselves.

—Tim Flannery
Australian Museum



Name That Flower: The Identification of Flowering Plants

By Ian Clarke & Helen Lee. Melbourne University Press, Melbourne, 1987, 260 pp. $29.95.

For anyone interested in identifying flowering plants and understanding more about their structure, this book is one of the best of its kind. It includes several introductory chapters, the

following of which are most useful for identification: the structure of a typical flower, the arrangement of flowers on the plant (the inflorescence), and the methodology of identification. These chapters are clearly written and well illustrated.

Despite its usefulness, the book has some shortcomings. The introductory chapter on classification and nomenclature is too brief and, for anyone without a taxonomic background, it would be difficult to understand. A discussion of the major classification schemes currently used in various Floras would have been useful. The chapter on plant structure and function explains several descriptive terms, particularly those referring to shape and arrangement. However, the paragraphs on cells, the vascular system and plant growth are too general and do not provide any information that would assist in the identification of plants. The other introductory chapter, discussing reproduction, only provides general information with some descriptive terms relating to fruit structure.

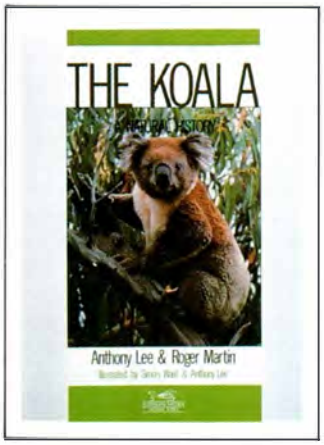
The largest chapter provides a well-illustrated discusssion of common plant families that are widespread in Australia. The notes are concise, useful and summarise the diagnostic features of each family. A list of 'spotting characters' has been provided for most families. Some of the families whose floral structures are highly modified, however, are not adequately covered, and some are not dealt with at all. A glossary of terms is also provided, although several commonly used terms have been omitted, and a selective bibliography is included.

—Barry Conn
National Herbarium of NSW

The Koala: A Natural History

By Anthony Lee and Roger Martin. Illustrated by Simon Ward and Anthony Lee. New South Wales University Press, Sydney, 1988, 102 pp. $12.95.

The year of the Koala must be 1988. We seem to have been overrun with Koala symposia, books, news items and foundations. And I must admit that, had I not personally known the authors of this work, I would have opened it with some dread, suspecting yet another populist account of this cute animal. Instead, I approached the book with enthusiasm and found that it lived up to my expectations, for it is clearly *the* authoritative work on the subject. It is full of previously unpublished information stemming from careful and detailed studies, and it dispels many misconceptions regarding Koalas that have arisen in recent years. For anyone interested in the management and conservation of Koalas, this book really is a must.



The key chapters are the last two, which deal with prehistory and history, and management. The authors make a very convincing case that Aboriginal predation on Koalas was intense, and had a severe effect on Koala numbers, keeping densities low. Without this crucial piece of information the Koala dilemma facing us at present would be largely uninterpretable for, as the authors go on to say, the real management problems lie in the Koala populations that are increasing too quickly, and destroying their resource base. They also address the question of *Chlamydia*, which has been so widely proclaimed as a threat to Koalas. They show that chlamydial infections in Koalas is *not* a threat; instead they write "the almost universal presence of *Chlamydia* in Koalas may be a blessing". Again the major management problems concern those *Chlamydia*-free Koala populations that are increasing too rapidly. Having canvassed all options as to how to deal with this problem, and having found that all but culling is unsatisfactory in the long term, they end this excellent little work with a most difficult question: "What do we do when we have too many Koalas?"

—Tim Flannery
Australian Museum

Why isn't scientific knowledge translated more effectively into environmental policy and practice?

SCIENCE IN ENVIRONMENTAL POLICY

BY CORALIE CREEVEY

AS AUSTRALIA TURNS TO SCIENCE and technology to help solve its economic problems, it's often forgotten that economic crisis first turned the nation to science.

The predecessor of today's CSIRO was set up in 1926 when Australia faced environmental ruin—and therefore ruined farms and farmers, and ruined exports and economy. Prickly pear, rabbits, blowfly strike and soil erosion were major problems.

Despite significant scientific successes, such as *Cactoblastis* beetles to control the prickly pear, some of these problems are little better today; some are worse. And some new problems have emerged.

Yet causes and cures are often known. Soil conservationists, for example, promote no-till farming to minimise disturbance of the soil during cropping, and thus erosion risk.

Why, then, isn't scientific knowledge more often translated into environmental policy and practice?

A session at the ANZAAS Congress in Sydney in May 1988 asked this question. Speakers included Professor Ron Johnston of Wollongong University, Professor Adrienne Clarke of Melbourne University, and Dr Peter Crawford, Managing Director of the Sydney Water Board 1983–1987.

Scientists have long been concerned about their impact on policy: delegates at an ANZAAS Congress, as long ago as 1914, said it was time that "happy-go-lucky practices gave way to knowledge-based decisions." Yet popping Customs, Science and Small Business into the one federal portfolio suggests the still-low political status of science. This may be because the scientists' insistence on research autonomy has often led to research of low national priority. Scientists so engaged can't have much to contribute to policy-making.

Scientists wanting to contribute must understand how policy is made. First, an issue is identified at the scientific or community level, and the scientist initiates action. This may mean stirring public opinion through the media. Next comes the political response when government may seek the advice of other scientists, bureaucrats, industry and the community. A formal inquiry may be held. Scientists should be prepared to advise at short notice during this messy, sometimes lengthy phase. They must realise that decisions often can't await more research, and that if they sound too ambiguous they will be ignored. Their information need not be perfect; it must be comprehensible to non-scientists. Finally, the government formulates new regulations. Again, the scientist must be ready to comment at short notice.

Control of Prickly Pear by *Cactoblastis cactorum* has been one of Australia's most significant scientific successes.

KATHIE ATKINSON

The process is slow and often controversial. Quisling scientists lose their peers' esteem, and many scientists of integrity may fear this, especially if media disputes develop.

Yet if scientists understand the policy process and *want* science to be as important to policy as economics, they will brave the public arena. Certainly, they are well qualified to do so: they are practised in hypothesising, in predicting a range of results from the range of uncertainties in present knowledge, in developing models and establishing methods to test them, and in discovering holes in the models.

After ANZAAS, I asked some New South Wales government scientists and policy-makers to comment. Peter Haskins, a geologist now in the Soil Conservation Service's marketing branch, agreed with me that soil erosion is our greatest problem. He said that 85 per cent of Australians live within 20 kilometres of the coast and therefore most don't see soil problems and so don't lobby politicians to solve them.

Scientific values are easily trivialised. This is why Peter Hitchcock, the dissenting Helsham commissioner into Tasmania's Lemonthyme and southern forests, emphasises the importance of public appeal—you need to promote an area's beauty, the wilderness experience and recreational value rather than its rare plants or insects. If politicians, for example, had been told only about the Tisphone Joanna Butterfly (*Aboena joanna*) that lives at Point Plummer, a headland near Port Macquarie, they would probably not have protected the area. Scientific facts are part of conservation planning but are not always enough to achieve conservation.

Dr John Turner, a research scientist with the Forestry Commission, is also positive about scientific input into policy, but said much depended on public—and therefore political—appeal. Rainforests have it, diminishing yellowbox plant associations west of the Great Dividing Range don't.

Twenty years with the Commission have shown Dr Turner two levels of policy: the political, where science makes little or no impact; and the departmental, where study results are constantly incorporated into policy. He considers the Terania Creek rainforest's inclusion in a national park a political decision.

Science-based departmental policies include ending clear-fell logging in the Eden forests in the early 1970s, and the requirement that buffer strips be left along watercourses. Commission scientists also found that 70 per cent of arboreal animals lived in just nine per cent of some forest areas; these were protected while logging was allowed elsewhere.

Dr Turner sees a major problem for scientists in legislation: science is quantitative—it measures precisely—whereas legislative acts often speak of "a significant environmental effect".

Overall, these government scientists believe that scientific facts have been important in most decisions for many years, especially in areas of public interest. But mallee and yellowbox, and salinised and eroded land lack the public appeal of cute mammals and spectacular rivers.

So, whatever the scientists know and do, it seems that their impact will be slight so long as Australians lack the political and social will to confront their major environmental—and possibly economic—problems. ■

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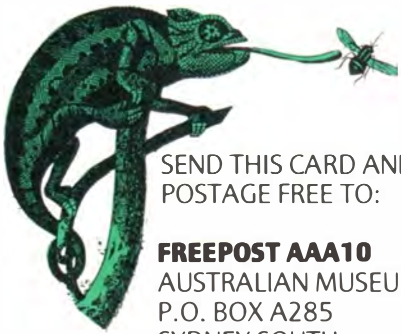

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