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Up Front

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NAT

It's springtime. Such a lovely time of year. The bulbs are blooming, the birds are nesting and some male Magpies are doing such good impersonations of scud missile attacks that they have people running for cover or the local hospital, depending on the ferocity of the attack. Every spring, the newspapers carry stories about problem Magpies and the wounds they have inflicted on innocent passers-by. When I was younger, I remember clearly the days when my father would come home in quite a state because he had been monstered most of the way home by a persistant Magpie. And more than once he bore the wounds to prove it. Not such an endearing behaviour from a bird that holds a special place in most Australians' hearts. So why do these birds do it and how do they pick their victims? And why doesn't every Magpie engage in this warfare with the human race? All good questions and starting on page 32 you can find out the answers from a scientist who has spent the last few years voluntarily placing himself in the line of Magpie fire.

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

BILL BELSON/LOCHMAN TRANSPARENCIES

I think I would have to say that the most popular animals we have ever featured in *Nature Australia* are frogs. They just never seem to fail to fascinate anyone who sees them. At the Australian Museum's Open Day this year, one of the most frequently visited displays was the one on frogs. Both adults and children alike are enthralled by these beautiful amphibians. Well, I'm no different and I just love it when we get the opportunity to feature them. The photos we selected for our Photoart section were just so spectacular we knew we had to use them on the cover and poster as well. So, to all you fellow frog lovers out there—sit back and enjoy one of the most beautiful selections of frog photos you are ever likely to see. And don't forget that you can buy a flat version of the poster— the details are on the back of your address sheet.

—Jennifer Saunders

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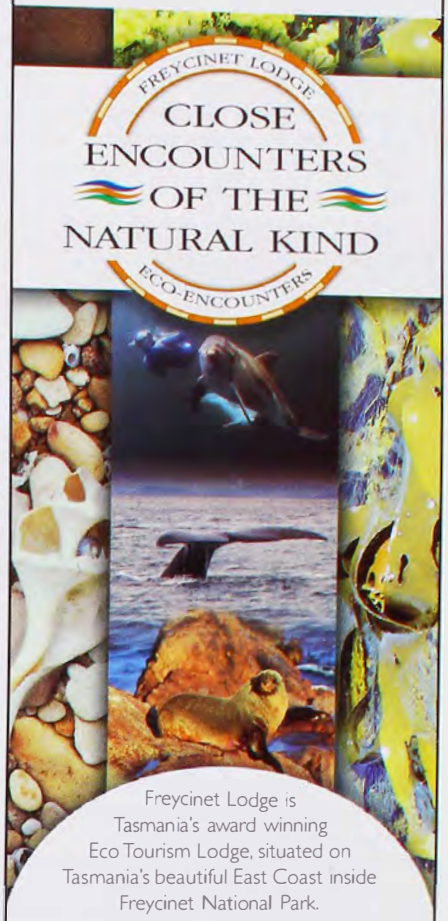

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Front Cover

A pair of Northern Orange-eyed Tree Frogs (*Litoria xanthomera*) in amplexus. The male is on top. Photo by Mike Trenerry/Nature Focus.

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Articles

LETTERS

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

Faithful Bobtails

Having studied the Bobtail (*Tiliqua rugosa*) some years ago, I was delighted to see the species receiving deserved publicity in Mike Bull's article (*Nature Aust.* Spring 1996). Like him I noticed the formation and persistence of pairs in spring, but the idea that they reform in successive years is intriguing. One thing he did not comment upon, however, is the formation of Bobtail (I hope you don't mind the western vernacular) trains, where two to three males follow a single female. Do South Australian Bobtails, a different race from those I am familiar with, not do this?

At the time, my assumption about the devotion of the males was that they were waiting for the female to ovulate. But why wait? Why not rush around (if a Bobtail can ever be said to rush) sowing the Bobtail equivalent of wild oats? In the Perth population I studied, the average brood size was a mere 1.3. With such a small number of young each year, perhaps it is advantageous to the male to stick with one female and be sure of fathering her young. If the female is sexually receptive for only a short time, then there would be all the more reason for the male to be there at that time, not chasing after another female. I wonder if anyone has investigated the reproductive cycle of the female Bobtail to see if they do offer males only a brief window of opportunity?

When I first heard the suggestion that Bobtails were monogamous, I felt that it probably resulted because Bobtails (at least those I know) are sedentary and, therefore, males would be likely to latch onto the same female a few years in a row. But 14 years? That does suggest that the males, and the females, recognise and prefer a partner they know. This could be advantageous to both, especially in such a long-lived species where older animals have proven their genetic fitness. Does Bull know of any studies done on mating systems among lizards in the genus *Egernia*? At least some species live in colonies, which might be an ideal situation for sexual shenanigans.

Incidentally, I was also interested in the Nature Strips article on the slit spider *Fissarena etyabuka*, as I have often seen such burrows in the Great Sandy Desert in northern Western Australia and have wondered what made them. Congratulations on a very worthwhile publication.

—Mike Bamford
Kingsley, WA

From daily observations of Sleepy Lizards (or Bobtails) over many spring seasons we have never seen 'trains' of males following females in our South Australian population. It is quite possible, however, that geographically separated populations have distinct mating systems.

It is quite true that the females are only receptive for a short period at the end of the spring. Thus the partnership between male and female during the preceding eight weeks provides no mating opportunities for the males.

We also explored the 'slothful lizard' hypothesis to explain long-term pair fidelity. However, since each male overlaps with the home ranges of at least four females, there is only a one-in-four chance of choosing the same female next year by random encounter, and a one-in-sixteen chance of choosing the same partner in three successive years. The actual frequencies of partner retention are much higher than this. By 14 years the probability of having the same partner by chance would be vanishingly small.

We are, in fact, currently exploring the mating system in the Gidgee Skink (Egernia stokesii) *to see if the sort of patterns that Bamford predicts do develop.*

—Michael Bull
Flinders University, SA

Fox Trots

I read with great delight the Nature Strips article in the Autumn 1996 issue of *Nature Australia* and the Letter by Tim Low in the Summer 1996–97 issue about plant laxatives, and I would like to make a contribution to the discussion. In 1992 I was indulging myself in one of my favourite pastimes, collecting fox scats, when I noticed a scat full of Bitou Bush (*Chrysanthemoides monilifera*) seeds and berries. Bitou Bush is an

PAUL MEEK

A fox scat containing Bitou Bush berries. A plant with some green maturing berries can be seen in the background.

introduced species that has successfully invaded vast areas of coastal Victoria, New South Wales and Queensland. This finding prompted me to conduct a study on more scats to see if the seeds were able to pass through the foxes' digestive system and still remain viable. Nearly 70 per cent of the seeds recovered from scats germinated on well-drained sandy soils. In most of the scats I looked at, the berries remained completely intact. I began to wonder why the fox would fill its belly with berries and then defecate them whole. Then it dawned on me. Perhaps the berries give the fox diarrhoea, thus ensuring that the seeds are scattered soon after the fox has eaten them? Perhaps there's a secret laxative ingredient in Bitou Bush that may have evolved for this purpose?

—Paul Meek
Parks Australia
Christmas Island

Thin Hides?

I refer to the Nature Strips article "The Cost of Being Fat" (*Nature Aust.* Summer 1996–97). It is indeed interesting that there is a correlation between the abundance of predators and the average body mass of birds, as demonstrated in the British population of the Great Tit over the past half-century.

However, to suggest that "individual birds can adjust their fat levels according to a trade-off between risks of starvation and predation" is to attribute to our feathered friends a greater degree of self-control than many humans display! Further, the claim is made that "the cost of being fat is reduced manoeuvrability", yet it remains to be demonstrated that the heavier birds are less able to escape predators than are the lighter (or leaner) individuals. At the same time, we can imagine that the predatory Sparrowhawks display a preference for bigger meals, and this may well be one factor in the mechanism.

Surely, however, the major factor is that, when individual Great Tits are aware of Sparrowhawks overhead, they remain concealed in the hedgerows and spend both time and energy avoiding detection. Because of these behaviours, they eat less, "even when there [is] plenty of food around". As a consequence, average body mass across the whole population declines when predator abundance increases.

Consider an analogy from the sad but real world of human life. In the recent Zaire warfare, I have heard from personal testimony that when there are soldiers around, local villagers choose to stay concealed, rather than go to the markets to buy and sell food. As a consequence, they eat less. It is not that people choose to eat less so that they can be smaller targets or out-run the soldiers.

—Andrew Dircks
Carlingford, NSW

Censoring CALM

One of the essential characteristics of sound science is accuracy, careful checking and separation of fact from fancy. Unfortunately, Ian Lowe (The Last Word, *Nature Aust.* Summer 1996–97) does none of these when he repeats an allegation that was disproved in 1993.

Lowe asserts that the Western Australian Department of Conservation and Land Management (CALM) censored scientific papers. This claim is false and was repudiated when environmental activists made it, nearly four years ago!

In March 1993, the Minister for the Environment in Western Australia set up an independent review to consider and adjudicate between the allegation and CALM's detailed response. He interviewed seven CALM scientists as well as those who made the allegations. The scientists were offered Ministerial protection prior to being interviewed. The Minister subsequently found that CALM had no case to answer and dismissed the claim.

CALM's Director of Science and Information Division published a detailed rebuttal of the allegation in the science magazine *Search* (24: 96–100; 1993).

Later in 1993, environmental activists repeated the allegation in legal action. However, Justice White of the Western Australian Supreme Court in his judgment wrote "While the applicant submits that there is something sinister in these omissions, with connotations of the deliberate concealment of important information, there is nothing to support such a submission and I am not prepared to find that the difference between the draft and the final article is evidence of bad faith on the part of CALM".

One wonders how sound Lowe's thesis is, if he has to rehash yet again an untrue allegation to support it.

Lowe also sees "self-censorship" as undermining the scientific process. Scientists write their papers after marshalling the evidence they have collected for and against the hypothesis being tested. This is an intense period of self-reflection because scientists expect that their competitors (that is, other scientists) will find fault with their work. This peer review process helps to winnow out the subjective parts (opinions, beliefs etc.) from that which is objective (factual data, conclusions substantiated by evidence). It does not help at all to label this normal mulling over of data collected with the emotive term "self-censorship".

—I. Abbott
Science and Information Division
CALM

As Abbott says, sound science separates fact from fancy. He should follow that principle. I examined the evidence in 1993 and concluded that CALM had censored scientific papers to suppress important findings. Other scientists came to the same conclusion. Abbott's assertion that this view "was disproved in 1993" is pure fancy. While the journal Search *did publish an article from CALM's then Director of Science and Information Division, James Armstrong, who tried to counter the charges, the next edition of the journal contained a detailed refutation of Armstrong's claims!*

It is also fancy to say that the Western Australian Minister for Environment "set up an independent review". The Minister, accompanied by a consultant he chose and a member of his own staff, interviewed some scientists in his own office and then met four representatives of the Conservation Council of Western Australia, but refused to go through the evidence with them. The Minister then simply issued a media statement, saying he was satisfied! It was classic damage control, Jim Hacker style.

The Supreme Court's findings provide little support for Abbott's case. The appeal to the Full Court asked it to quash an amended forest plan on the grounds that scientific evidence had been ignored. Those who challenged CALM claimed that it had failed to comply with its duty to act openly and have regard to all relevant material in preparing its management plan. The Full Court felt that "a mere failure to take account of relevant scientific data will not, of itself, amount to an improper exercise of power" and dismissed the appeal. It may not amount to an improper exercise of power, but it does amount to a failure to take account of relevant scientific data—as I concluded myself.

I do understand the difference between reflection and self-censorship. I reflect on my own draft papers, looking for weak links in the argument or flaws in the analysis. I do not, however, feel a need to reflect on whether the conclusions will match the prejudices of my employer; as a university employee, I can publish without fear of victimisation. The independent review of CALM's forest management policy late in 1992 by retired judge Tos Barnett led him to report "a climate of fear" among the scientists. I see no evidence that this has changed.

—Ian Lowe
School of Science
Griffith University

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Nature Strips

COMPILED BY
GEORGINA HICKEY

Skimming the Fat

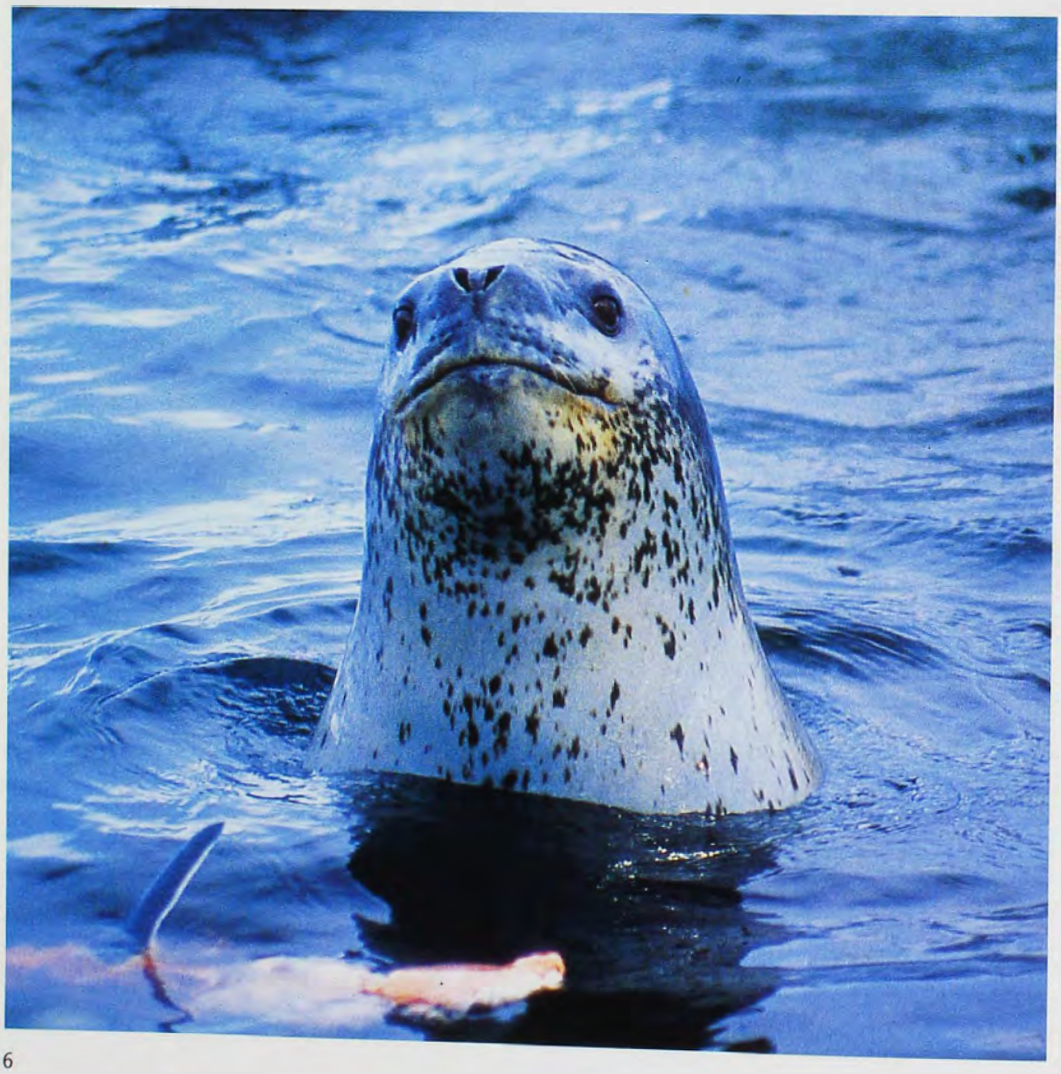
Early reports of Leopard Seals (*Hydrurga leptonyx*) hunting Adelie Penguins (*Pygoscelis adeliae*) in Antarctica often cite them stripping the penguin of its skin and then swallowing the carcass whole. However, recent observations by Gordon S. Court (Department of Environmental Protection, Alberta), while at an Adelie Penguin rookery on Cape Bird, Ross Island, are quite contrary. Yes, Leopard Seals do strip the penguins of their skin, but slow-motion replays of video recordings revealed that, rather than discarding them, the seals quickly bolted them down. More often than not it was the rest of the penguin's carcass that was discarded.

But why would Leopard Seals be more interested in the penguin's skin than what was inside it? What is the reasoning behind such an apparent wasteful use of meat?

According to Court, this hunting method is in response to a superabundant food supply when predators can afford, quite literally, to 'skim the fat'. During the breeding season Adelie Penguins gorge on krill, whacking on an enormous amount of weight to prepare themselves for their time of fasting while incubating the eggs. This extra weight is stored as a layer of fat just below the skin, and it is this part that is sought after by Leopard Seals. By harvesting the most energy-rich part of their prey, the seals are able to get the most out of their foraging efforts. Alaskan Brown Bears use a similar hunting strategy when they harvest just the roe (eggs) from spawning salmon.

When Adelie Penguins are not on the menu, however, Leopard Seals are content with krill, fish, squid and occasionally other seals. Or they may even pick up what's left of the penguin carcasses they let drop to the sea floor.

—G.H.



COURTESY GORDON COURT

Leopard Seals peel their Adelie Penguin prey.

Meat-eating Slugs?

Worldwide, slugs are typically thought to be herbivorous. But for part of the year, on a hillside in southern Spain, one species resorts to raiding the larders of local carnivorous plants in its search for scarce nutrients.

Regino Zamora and José Gómez from the University of Granada investigated the kleptoparasitic (food-stealing) behaviour of the slug *Deroceras hilbrandi*. Insects are trapped by the carnivorous plant *Pinguicula vallisneriifolia* with the help of stalked glands on its leaves that secrete a sticky mucilage, and which might be expected to hamper the slug's progress. But when tested, the researchers found that, although moving across the tacky surface is hard work, the reward is worth it.

Prey size is no barrier, although the majority of prey taken were small flying insects caught between the stalked glands on the leaf surface. And while it can take up to 90 minutes to devour a large insect, the slugs merely consume the smaller animals as they pass over, leaving legs and wings in their wake.

When *P. vallisneriifolia* loses its leaves in winter the slugs revert to herbivory, dining on leaf buds. As leaves grow in spring, the slugs gradually increase their carnivorous habit, sporadically eating both leaves and insects, and become exclusively carnivorous again in summer.

Zamora and Gómez found that, given the option, these slugs feed almost exclusively on insects. The researchers conclude it must be hunger for essential nutrients that drives this slug–carnivorous

F. GOHIER/ACANA/AUSCAPE

Tyrannosaurus rex: predator or scavenger?

plant interaction, which fits in nicely with a recent hypothesis on nutrient limitation being a major factor in determining the ecology of organisms.

—R.S.

Could the King Kill?

Was *Tyrannosaurus rex* a predator or a scavenger? While the evidence for *T. rex*'s meat-eating nature has been around for some time, support for the beast being a killer has been in short supply. Some scientists even argue *T. rex*'s teeth and jaws weren't strong enough to attack and restrain a struggling animal, and only capable of gnawing the remains of another creature's kill.

One reason why the question remains open is that few researchers have bothered to closely examine partial skeletons. Whole skeletons are more interesting, but are unlikely to be the remains of a carnivore's lunch.

However, a team of American researchers led by Gregory Erickson from the University of California came across a *Triceratops* pelvis pocked with bite marks from *T. rex*, the deepest of which was 11.5 millimetres. Using artificial *T. rex* teeth made from bronze–aluminium (which is approximately as strong as tooth enamel) and the nearest modern thing to a *Triceratops* pelvis—the pelvis of a cow—the researchers were able to simulate the ancient bite marks and estimate how much bone-crunching force the King had at his disposal. The results indicate that *T. rex* would have exerted 6,410 Newtons behind its front teeth, and over twice that behind its back teeth. Humans, by comparison, exert a maximum force of 749 Newtons with their back teeth, while African Lions exert about 4,168 Newtons. In fact, the forces demonstrated for *T. rex* are greater than any known creature (although American Alligators come close) and would certainly have been strong enough to attack and kill prey.

Now that scientists realise there's something to be learned from *T. rex*'s table scraps, more partial skeletons should be re-examined for tooth marks. Proving that *T. rex* was mainly a predator, however, could take some time.

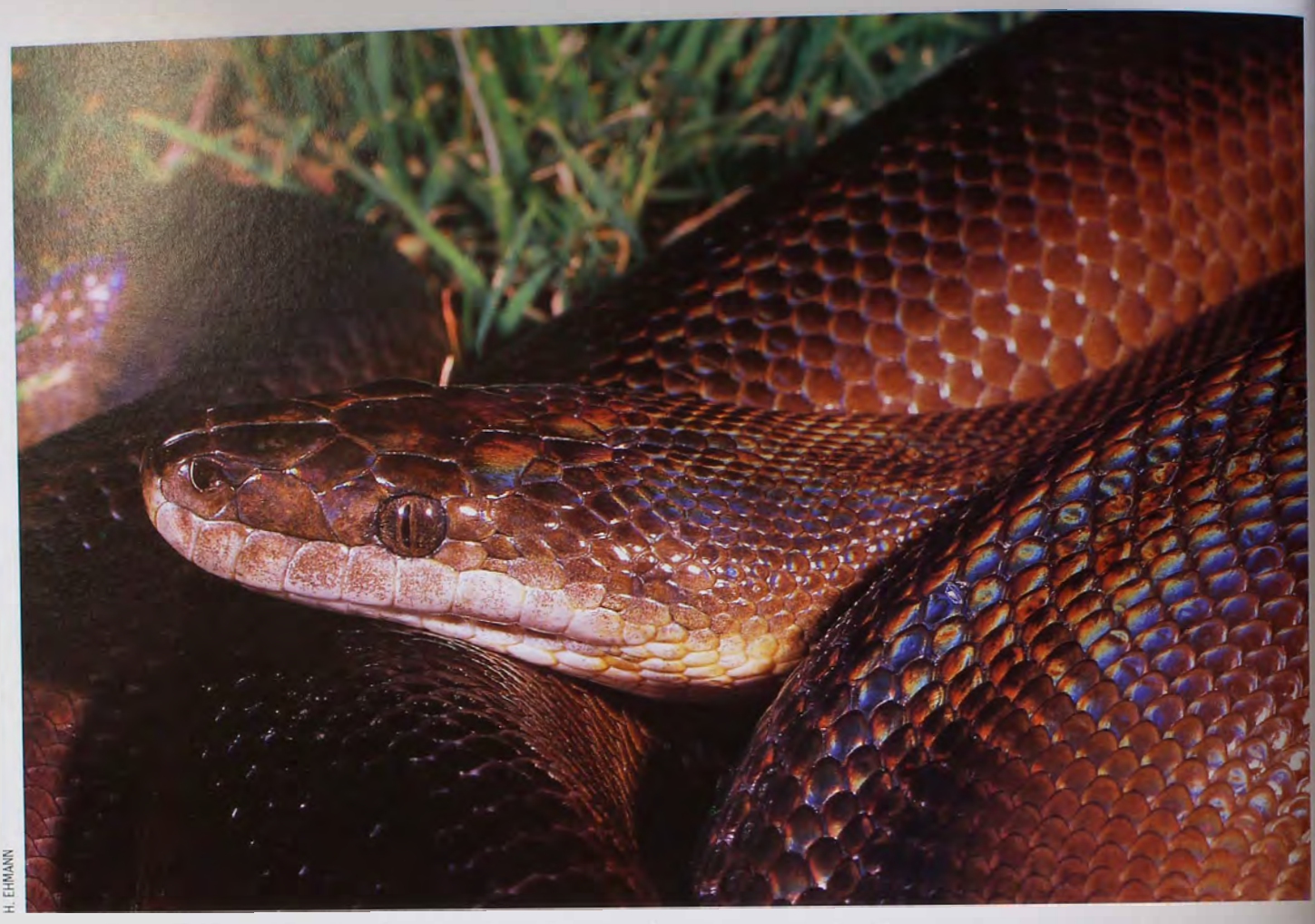
—G.McN.

Raven Roosts

Like extras from Alfred Hitchcock's "The Birds", Common Ravens (*Corvus corax*) get together each night to form communal roosts that, in some places, may contain thousands of birds. But roosting in groups isn't just a good way for ravens to look creepy, it also allows them to share information about the best places to eat.

John Marzluff, Bernd Heinrich and Colleen Marzluff of the University of Vermont spent many cold hours sitting in pine trees themselves in order to observe the behaviour of roosting ravens. Their study area was in western Maine, and the ravens there formed temporary and relatively small roosts (up to 80 birds). The birds usually arrived at their nocturnal roosts singly or in small groups over a period of up to an hour, but left as highly synchronised groups at dawn, generally all heading off in the same direction. Sometimes though, the ravens would form large groups on arrival, flying in wide circles around the roost, before either settling as a group or flying away to a distant roost site. This social soaring behaviour apparently alerted other birds to the shifting of a roost site so that it was closer to a food source such as the carcass of a deer.

The researchers also used captive birds to determine whether or not information sharing was taking place. They isolated birds by keeping them in an aviary for several months and then released some near a roost and others far away. The next day most of the birds released at the roost followed their new companions to food. Birds released away from the roost, however, were rarely able to find the local food sources. Other captives were released next to fresh carcasses just before dusk. One of the birds that joined a communal group



H. EHMANN

Water Pythons in the Top End have been shown to make regular seasonal migrations in search of their prey.

that night returned the next morning followed by 30 of its roost mates!

Whether the birds use vocal signals to communicate a food source or are simply followed as they leave the roost is unknown. Either way, the birds benefit from the information sharing because not only is their food source unpredictable and patchily distributed, but it lasts only for a short period of time, with heavy snowfall and mammalian scavengers usually exhausting it before the ravens can.

—G.T.

Pythons on the Move

When we think of seasonal migrations we tend to imagine flocks of birds heading somewhere warm for the winter or perhaps the massive herds of Wildebeest doing their annual circuits of the Serengeti. But each year in northern Australia there is a little-known migration taking place, albeit on a slightly smaller scale.

For over ten years, Thomas Madsen and Richard Shine, zoologists from the University of Sydney, have been studying Water Pythons (*Liasis fuscus*) at Fogg Dam, a 2.6-square-kilometre water body 60 kilometres south-east of Darwin. At night they walked or drove along the man-made dam wall, catching and marking any pythons they encountered. They found that their capture rates were highly seasonal, with a low during the wet season (February to May), rising to a peak in November/December, just before the onset of the monsoon.

Curious about where the pythons went, they placed radio-transmitters inside a number of snakes and then followed them throughout the year. During the dry season the snakes were usually found around Fogg Dam, often living in the deep soil cracks. Just before the first heavy rains of the wet season though, most of the snakes moved to higher ground. A few travelled up into the surrounding woodland but most migrated out onto the flood plain where they spent their time around raised levee banks, up to 12 kilometres from their dry-season haunts.

While they were studying the pythons, Madsen and Shine were also trapping the snakes' favourite prey—the Dusky Rat (*Rattus colletti*). During the dry season, the rats, like the pythons, live in the soil cracks on the flood plain, but when the rains come, they are forced to move to higher ground. Some of the rats move into the woodland, but the majority migrate out to the raised levee banks on the flood plain.

So each year the pythons migrate from the dam to the flood plain or, in some cases, into the woodland, following their prey—the only terrestrial reptile species so far known to make such a journey. However, the numbers of rats out on the flood plain stay fairly high throughout the year, so why do the snakes bother to return to the area around Fogg Dam? Madsen and Shine suggest that the snakes migrate back to the dam to follow the larger male rats, which are far more common around the dam during the dry season than out on the flood plain, presumably because of the increased soil moisture there, and the associated increase in quality and availability of food.

—G.T.

Bioluminescent Burglar Alarms

Have you ever noticed how a thousand little lights often turn on when you run your hands through sea water at night? The light is given off by single-celled plants called dinoflagellates whenever they are disturbed. Even the swimming movements of shrimp, which graze on dinoflagellates, are enough to trigger luminescence. But how could drawing attention to themselves in such a dramatic way possibly benefit the dinoflagellates? Surely it only attracts the attention of other hungry mouths to the scene.

Recently Kellie Fleisher and James Case from the Marine Science Institute at

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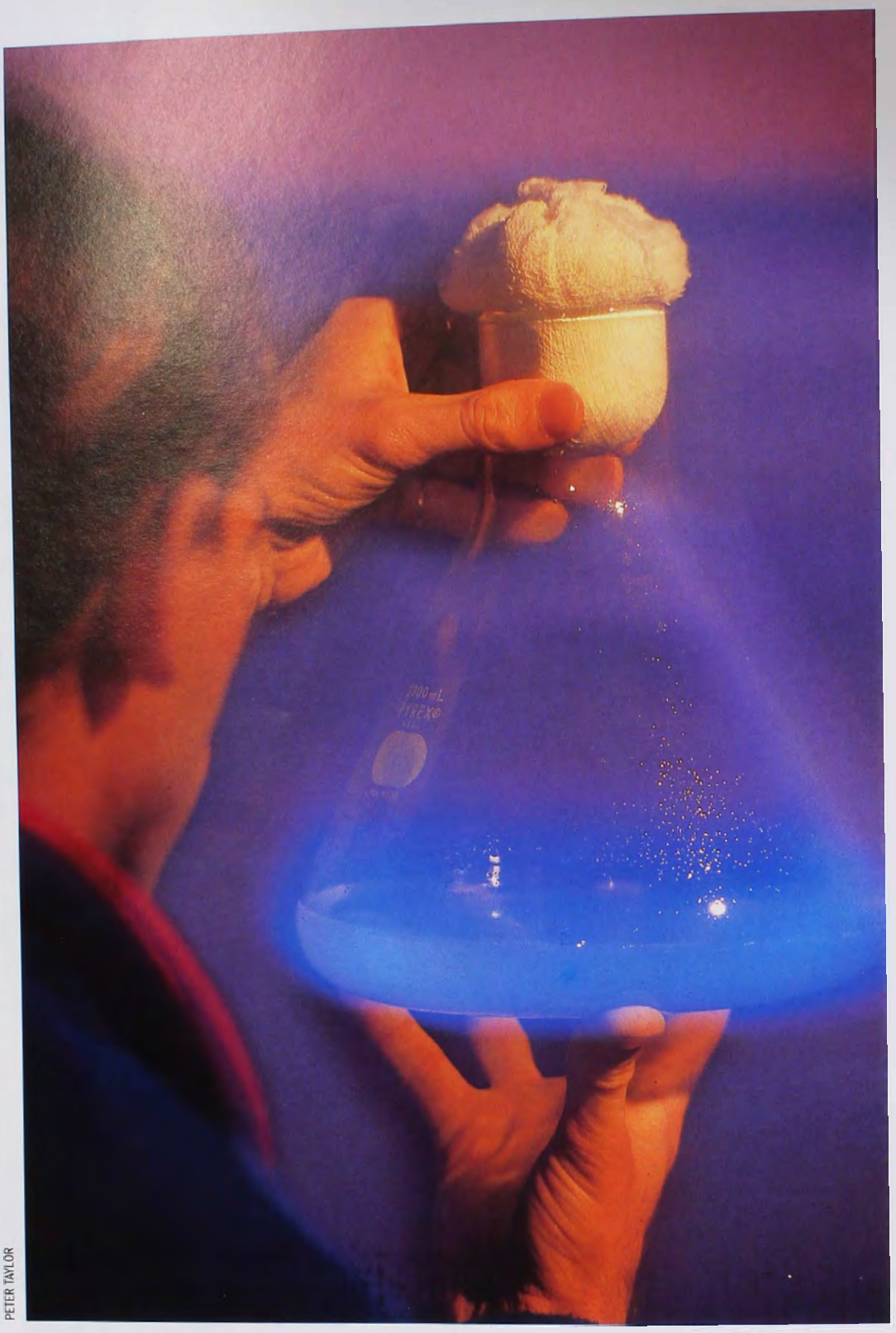


PETER TAYLOR

Bioluminescent dinoflagellates do their thing.

the University of California at Santa Barbara found that this is exactly what happens, except the light is really acting as a burglar alarm, attracting the attackers' own predators.

In the laboratory, the researchers studied the predation efficiencies of two cephalopods (a cuttlefish and a squid) on shrimp and mosquito fish, which in turn dine on bioluminescent dinoflagellates (*Pyrocystis fusiformis*). The squid and cuttlefish caught more prey when dinoflagellates were present, and their success rate increased with the concentration of luminsecent microorganisms. In total darkness, few prey were attacked.

The researchers believe that the cephalopods were using the light produced by the dinoflagellates to help locate their non-luminescent prey. While the top predators benefit by getting a meal and the dinoflagellates escape being eaten, only the middle man—in this case the shrimp and fish—dip out in the deal.

—R.S.

The Testicle Conundrum

It's a fairly safe bet that all men will, at some point in their lives, question the sense of having external testicles. And it's a reasonable question. Why place such a sensitive and precious pair of organs out where they could so easily be damaged? That the factories responsible for the production of the next generation are placed in such a precarious position does seem somewhat paradoxical.

Given that this question is posed with such regularity, it's not surprising that there is a number of explanations available. The most popular has grown from the observation that testes function at their best at a temperature below that of the human body, implying that external testes are just out there to keep cool.

However, Michael Chance of the Social Systems Institute in Birmingham suspects that this improved testicular function at lower temperatures is a secondary adaptation, brought about by the externalisation of the testes rather than responsible for it. It was a newspaper article about English rowing crews that prompted Chance to develop his novel theory. Urine samples taken from the rowers at the end of a race were found to contain fluid from the prostate that wasn't there before the start of the race. Unlike the bladder, the male reproductive tract doesn't have any sphincters to hold in the various products, so the sudden changes in abdominal pressure involved in activity such as rowing can cause these precious fluids to be expelled.

Chance reasons that galloping, leaping or jumping mammals, whose methods of locomotion cause sudden changes in pressure in the abdominal cavity, have external testes so that their sperm contents do not leak. By contrast, mammals whose lifestyles do not involve gut-jarring movements, such as ground-scuttling creatures, fully aquatic cetaceans and sirenians, and elephants, tend to have internal testes.

—G.T.

Cock-a-dolittle

It's that indecent hour of the morning, and the proverbial rooster is crowing. He is reiterating his dominant status among the group, advertising his potential as a mate—a good honest signal

What does it cost for a cock to crow?

of his quality. He may crow up to 250 times before you get back to sleep.

As animal calls are often costly to produce, such raucous enthusiasm from the rooster would seem a strenuous task. Measurements of oxygen consumption taken from insects and frogs show that the maximum sustainable level of metabolic rate is often exceeded while calling. Therefore, only males in top condition can afford to call frequently. So it was to the surprise of Andrew Horn and colleagues (while at the Centre for Food and Animal Research in Ottawa, Canada) to discover that the energetic cost of crowing in roosters (*Gallus gallus*) is only 15 per cent above resting, which makes it cheaper than basic low-level activities such as feeding, drinking and preening.

If crowing is such cheap talk, why don't all males do it? The researchers suggest that, although it is within the

BRIAN CHUDLEIGH

energetic capacity of all males, there are other costs that maintain crowing as an honest signal of status and condition. Wasting foraging time, attracting predators and being 'hen-pecked' by other males would deter those of lower status from crowing. Therefore, the hierarchy is still maintained without the rooster running up a huge bill.

—K.B.

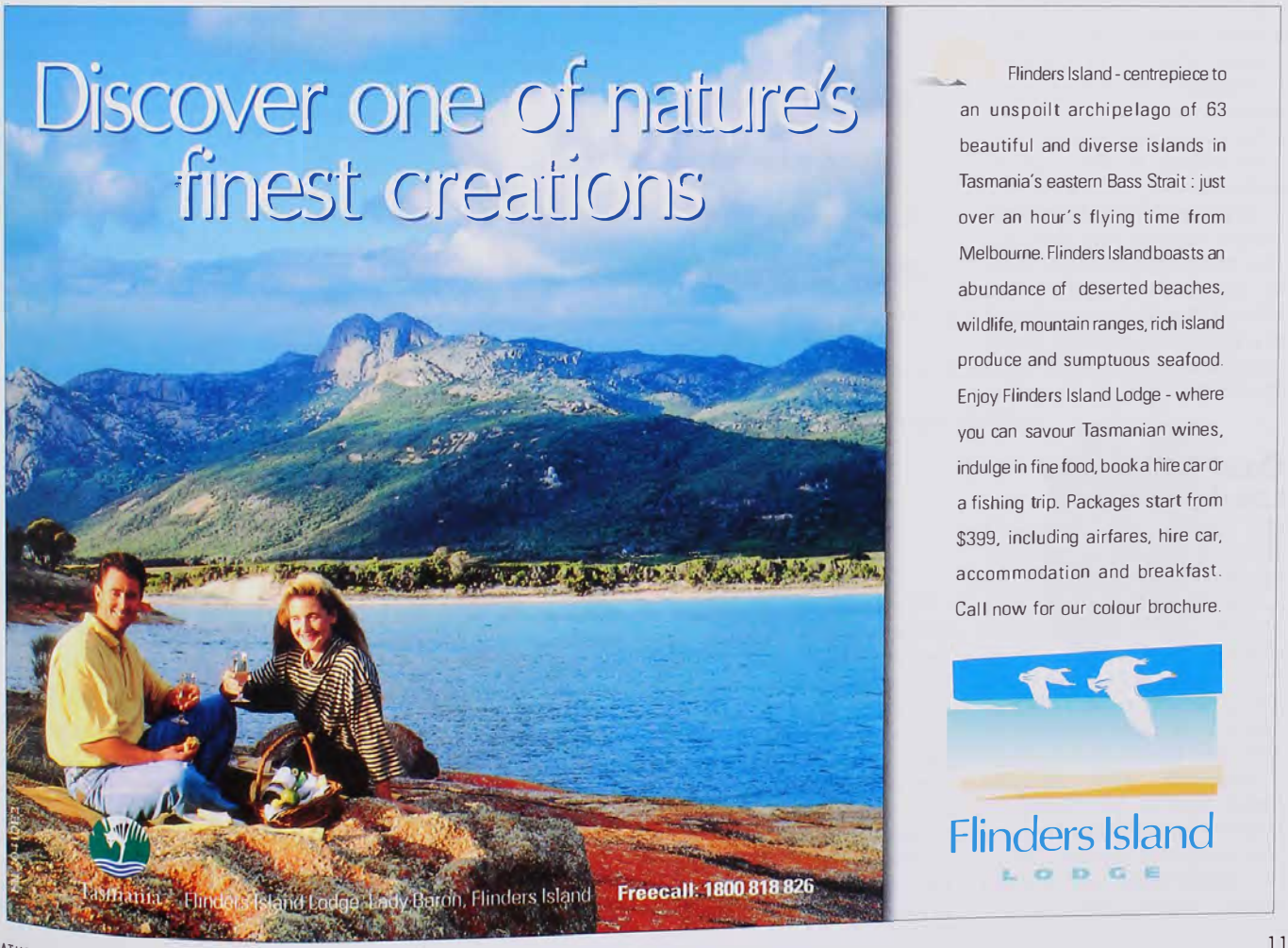
Flying by Numbers

Why don't bees fly in formation? Why don't geese swarm? It's all to do with some clever maths recently revealed by a group of Japanese researchers.

The collective motions of birds, insects, fish and bacteria are diverse and have been the subject of extensive study. But scientists have generally believed such motion is unpredictable, with external factors creating too much 'noise'. However, Naohiko Shimoyama and colleagues from the Research Institute of Electrical Communication in Sendai, Japan, have predicted the movement of flying groups of animals using a mathematical model and computer simulations.

The researchers related the animals' body length (L), the time it takes for one wing beat (t) and the average flying velocity (V) to calculate a parameter they call 'G' ($G = L/Vt$). The simple equation seems to be all that is needed to predict whether a group of flying animals will wander, swarm or form a flock.

They discovered that if G is generally greater than one, the animals' flying behaviour tends to be swarm-like. The



DAVE WATTS/NATURE FOCUS

Mathematics predicts that Brolgas (*Grus rubicunda*) fly in ordered flocks.

swarm clusters as one group but the movements of individuals within it are chaotic. The researchers found that mosquitoes have a G value of about 100, consistent with observations of their swarming behaviour.

If G is less than one, flying is more ordered, like a flock. Cranes, which in real life fly in regular formation and at constant velocity, were found to have a G value of about 0.1.

According to the mathematical model, animals with a G of about 1, like sparrows, should wander. And they do. The centre of a sparrow cluster meanders irregularly but within it the birds are ordered in a lattice-like position, which occasionally rearranges when the cluster changes direction.

—C.B.

Ötzi's Mossy Underwear?

In 1991, a 5,300-year-old hunter known as Ötzi was discovered melting out of the ice in the Ötztaler Alps that border Austria and Italy. His clothes and tools were remarkably well preserved, giving scientists and archaeologists a rare glimpse of Neolithic life.

Although DNA analysis found Ötzi to be related to modern inhabitants of central and northern Europe, there is considerable speculation about where the iceman lived. Some scientists suggest he came from the north (modern Austria), because of the pollen found on his clothes. Others say his personal effects most closely resemble those found in Neolithic settlements to the south (modern Italy).

Because he was found with so much moss, it is likely he brought it with him, possibly for insulation in his clothes.

Mosses found on Ötzi's clothes add weight to the southern origin theory. When James Dickson from the University of Glasgow and colleagues examined the 30-plus species of mosses and liverworts found on the body, they found a large clump of *Neckera complanata* and smaller amounts of *N. crispa*, two species presently found growing together at low altitudes on shaded rock faces and tree trunks.

Today, the nearest these mosses grow is 15 kilometres south-east of where Ötzi was found, only a few hours walk for a fit man. To the north, the closest the mosses are found growing together is more than twice that distance away. Dickson says the distribution is unlikely to have changed since Ötzi walked the valleys.

Because he was found with so much moss, it is likely he brought it with him, possibly for insulation in his clothes. Another suggestion is the moss was intended as toilet paper, agreeing with considerable evidence that moss was the hygienic wipe of choice in Neolithic times.

—R.S.

Rock-rats Alive!

Isn't it typical? You drive hundreds of kilometres, climb up and down dozens of cliffs to set thousands of thoughtfully placed traps, and for what? Nothing! Then others come along, put out a few traps ("just for fun", they say) and, bingo, they catch a rock-rat. Not just any old rock-rat—the Central Rock-rat (*Zyzomys pedunculatus*), last seen 37 years ago (see *Nature Aust.** Autumn 1995).

In August 1996, while help-

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The freedom to see.

ing to construct the Larapinta Trail in the West MacDonnell National Park, Australian Trust for Conservation Volunteers trapped a rodent they found difficult to identify. So they took a few photographs of the animal to show to staff of the Parks and Wildlife Commission of the Northern Territory (PWCNT). The word 'excited' falls rather short of describing our feelings at seeing the first photographs of a live Central Rock-rat.

Although we now have proof of the species' existence and have several live specimens at the Alice Springs Desert Park, the next step is to determine the animal's distribution and relative abundance. A preliminary habitat survey of two locations at which the rock-rats have been caught has been conducted. This information will be used in conjunction with an existing Geographic Information System (GIS) to map other areas of potential rock-rat habitat in the West MacDonnell Ranges.

**Previously ANH*

The captive animals have settled in to their new homes quite well and will be closely monitored. Currently there is no information at all on the biology of the Central Rock-rat, so everything we learn from these animals will be new and will provide vital data to guide field research and management of the species. The most obvious questions to pose now are, how have these small mammals survived when so many others in central Australia have become extinct, and what other species are still out there avoiding detection?

—David Wurst
Parks and Wildlife Commission of the Northern Territory

COURTESY JENNIFER JARVIS

Although these Naked Mole-rats are from the same litter, the big one is programmed to disperse.

Fat and Lazy Mole-rats

Being fat and lazy will generally qualify you to be society's pariah, but not for Naked Mole-rats (*Heterocephalus glaber*). Like ants and termites, mole-rats are eusocial. The majority of the colony members are 'workers', performing all of the laborious tasks such as gathering food and maintaining the tunnels. The 'breeders', meanwhile, get to do all the fun stuff like mating and harassing the workers.

But by restricting breeding to a chosen few and keeping all of their breeding 'in-house', mole-rat colonies risk damage from inbreeding. The social insects have come up with various strategies to reduce inbreeding (think of 'flying ants—the winged phase of termites), but it wasn't until recently that a method was discovered for mole-rats.

Justin O'Riain, from the University of Cape Town, and colleagues searched 48 captive mole-rat colonies for outbreeders by opening up an exit from each colony and waiting to see if any members

MIKE GILLAM/AUSCAPE

A male Central Rock-rat—the first of its species ever to be photographed live.

persistently emerged. Only six of the colonies were found to harbour individuals infected by the travel bug and most of these were males. What was unusual was that these travellers were overweight (around 20 per cent fatter than the colony norm) and allergic to work, being much more interested in eating than in mundane tasks such as burrow maintenance and defence.

You might assume that this selfish behaviour was getting them thrown out of their burrows but the researchers found that, despite their lazy behaviour, they were not being attacked nor harassed. They were simply succumbing to their own internal urge to leave.

Experiments carried out by the researchers also showed that, unlike their burrow mates, the dispersers had a healthy attitude towards 'foreigners'. When given a choice between workers from their own colony and those from a foreign colony, dispersers ignored the relatives and attempted to copulate with the unrelated mole-rats of either sex. By contrast non-dispersers always chose their relatives and acted aggressively towards outsiders. (Mole-rats are, however, occasionally accepted into foreign colonies...just enough, it seems.)

The researchers speculate that the large fat reserves of the dispersers probably act as a sort of picnic hamper to ward off starvation on the dangerous overland journey in search of other colony members. And although successful dispersers were apparently quite rare, it only takes the input of new genetic material every now and then to reduce the effect of inbreeding.

—G.T.

Lemon-scented Monkeys

Records of apes and monkeys apparently gaining medicinal benefits from the use of plant and animal material are certainly not isolated. One of the latest reports comes from primatologist Mary Baker, of the University of California at Riverside, who has observed wild Capuchins (*Cebus capucinus*) in Costa Rica purposefully rubbing themselves with material from at least four plant genera—*Citrus, Clematis, Piper* and *Sloanea*.

She is aware of at least one captive monkey that enjoys rubbing its fur with anything lemon-scented, including lemon-flavoured Gummi Bear lollies.

Capuchins (the monkey species once favoured as companions by organ grinders) don't just casually dab this material onto their fur. They apply it with great gusto. Baker reports: "The application of plant material was highly energetic, almost frenzied in appearance. The monkeys moved rapidly, drooling, biting into the plant and rolling it between their hands. Then, using their hands, feet and tails, they applied the plant material over various body parts or over their entire bodies."

Baker observed that material from *Citrus* species appeared to be particularly favoured, the monkeys often saturating their bodies with the juice of lemons, limes and oranges. She is aware of at least one captive monkey that enjoys rubbing its fur with anything lemon-scented, including lemon-flavoured Gummi Bear lollies.

Most of the plants used for fur rubbing by Capuchins are known to contain compounds that repel insects or have medicinal effects and which have, for these reasons, also been long used by indigenous people of Central America. Baker's work is now focusing on determining the extent to which the monkeys understand the benefits of the plants they use in fur rubbing. Do they simply do it because it feels good, or do they do it because they know it's good for them?

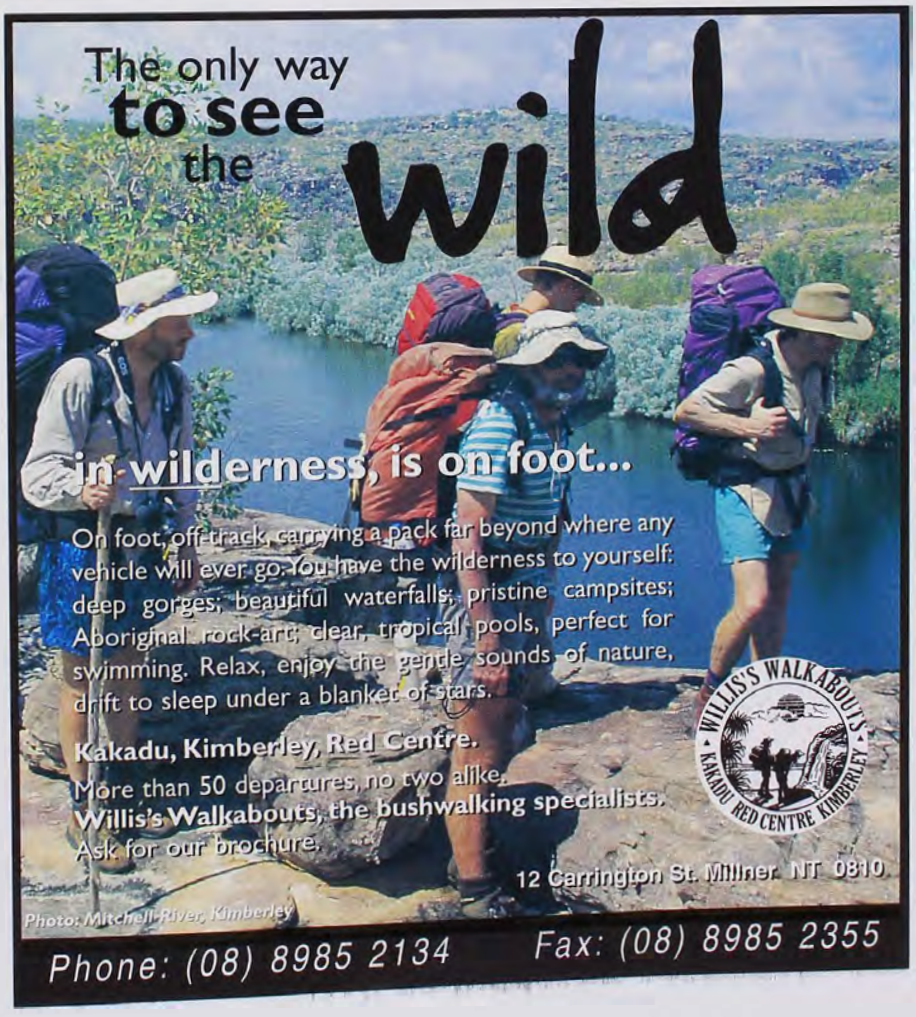
—K.McG.

Feathered Dinosaur

Archaeopteryx may have a rival for the title of 'missing link' between birds and reptiles. Known from late Jurassic (145-million-year-old) rocks from southern Germany, *Archaeopteryx* specimens combine the skeleton of a small meat-eating dinosaur with the uniquely bird-like feature of feathers. However, because the structure of the feathers and the patterns in which they are arranged suggest the animal was capable of flight, *Archaeopteryx* is recognised as the first bird.

Palaeontologists have speculated that the group of dinosaurian ancestors to *Archaeopteryx* must have had a covering of small feathers. Recent finds from China have lended support for this speculation.

While on a recent visit to China, Philip Currie of the Royal Tyrrell Museum of



Palaeontology in Canada reviewed a number of specimens collected from a late Jurassic or early Cretaceous (130-million-year-old) deposit in Liaoning Province, northeastern China. One specimen in particular, originally collected by a local farmer who thought it was a small dragon, made the hairs on Currie's neck stand up. The small (three-quarters of a metre long) skeleton of a typical meat-eating dinosaur (a compsognathid) was covered with clear impressions of what looked like small, downy feathers along its back, around its neck and along both the top and bottom of the tail. If these are, in fact, feathers (some palaeontologists doubt they are, believing them to be some sort of 'protofeather' or even skin structure), then this is the first specimen of a feathered dinosaur, and Ji Qiang (Chinese Geology Museum in Beijing) and Ji Shuan thus named it *Sinosauropteryx prima* (meaning first Chinese feathered lizard). Although described as a new genus in a new family and order, *Sinosauropteryx* is so similar to the small dinosaur *Compsognathus* that some palaeontologists are suggesting it is a new species of the same genus. Reports of another two or three specimens, one of which is over a metre long, also show the combination of a small dinosaur skeleton with a covering of small downy 'feathers'.

Feathers are relatively soft items and only fossilise in sites of exceptional preservation, such as the *Archaeopteryx* sites in Germany and the new Chinese site. It is quite possible that a number of other, closely related, known dinosaurs were similarly 'feathered' but no evidence of their outer covering has been preserved as fossils. Because downy feathers are useful in modern birds for heat retention, their apparent appearance in *Sinosauropteryx* provides tentative support for the still-controversial theory that some dinosaurs may have been warm-blooded.

—Paul Willis

***Sinosauropteryx prima*: China's first feathered dinosaur?**

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We know that stars shine during the day, even though we can't see them, but what about aurorae?

Daylight Aurorae

Aurorae are one of nature's most spectacular nocturnal events. These glowing curtains in the polar skies are a result of the interaction between the solar wind—a stream of charged particles flowing constantly from the Sun—and the Earth's magnetic field. When the solar wind reaches Earth's environment it drives an electrical current between space and the Earth's ionosphere (upper atmosphere). One idea is that, whenever the conductivity of the ionosphere is reduced, it's like a downed electricity cable, resulting in a violent electrical discharge which produces the aurorae.

During the daytime, however, ultraviolet radiation from the Sun improves the ionosphere's electrical conductivity, allowing the electrical current to flow uninterrupted. This fact prompted the question: if an aurora occurs during the daytime when no-one can see it, has an aurora really occurred? Even researchers who study them assumed aurorae performed their luminous dance around the sky around the clock. Surely they are invisible during the day only because the bright, sunlit sky overwhelms their delicate glow. Recent studies by Pat Newell and colleagues

PETER VISSCHER

from Johns Hopkins University suggest, however, that aurorae switch off when the Sun is up.

Using data collected from five US Air Force weather satellites from 1983 to 1992, the scientists studied more than 150 million measurements of the discharges that produce aurorae. They found that the electrical discharge is strongest—and hence aurorae are most active—between sunset and midnight, and least active during the summer months when the nights are shorter. Rarely did they occur when the Sun was up.

—G.McN.

Silky Lures

Have you ever wondered what the 'cross' in the web of a St Andrews Cross Spider (*Argiope keyserlingii*) is for? These so-called stabilimenta can be found on the webs of a variety of orb-weaving spiders and their function has perplexed arachnologists for over a century. Apart from diagonal crosses, stabilimenta can take a variety of other forms including linear zigzags and disks that surround the web's hub. The explanations for their function are just as varied, including web stabilisation (hence the name), adjustment of web tension, moulting platforms, advertisement of the web's presence, protection from predators, and an aid to thermoregulation. It has also been suggested that stabilimenta reflect UV light and thus may help catch flying insects that are attracted to UV.

To test this last hypothesis, Taiwanese zoologist I-Min Tso, while at the University of Michigan, compared the numbers of prey caught in decorated and undecorated webs of the Banded Garden Spider (*Argiope trifasciata*), a North American orb-weaving spider that forms linear zigzag stabilimenta. He found that webs decorated with stabilimenta did indeed catch more flying insects, almost twice as many as undecorated webs, regardless of where the webs were placed, the area and mesh size of the webs, and the length of the stabilimentum. (In a more recent study by Mark Elgar and colleagues from the University of Melbourne, St Andrews Cross Spiders were shown to increase the amount of silk decoration when their webs were located in dim light, lending further support to the idea that stabilimenta do indeed function to attract insect prey.)

For non-stabilimentum builders to achieve the same increase in foraging success rate, I-Min Tso argues they would have to build considerably larger webs. And, considering it takes less than five minutes and only a little silk to add a stabilimentum to an existing orb web (compared to 30–60 minutes and a good 20 metres of silk to spin the web), it makes sense, for *Argiope* spiders at least, to 'decorate the parlour', rather than add on major extensions.

—G.T.

C.A. HENLEY

The cross in a St Andrews Cross Spider's web attracts flying insects.

QUICK QUIZ

1. What is the most common gaseous element in the atmosphere?
2. Do Numbats feed by day or night?
3. Which direction do surface water currents circle in the Southern Hemisphere?
4. What is the longest living mammal?
5. Where would you find the inactive volcano 'Olympus Mons'?
6. What does ANZAAS stand for?
7. How many horns does a White Rhinoceros have?
8. What is Jacobson's organ, present in many vertebrates, used to detect?
9. Which animal is the symbol of the World Wide Fund for Nature?
10. What is another common name for Killer Whale?

(Answers in Q & A)

Carrie Bengston, Karina Bull, Karen McGhee, Geoff McNamara, Rachel Sullivan and Geordie Torr are regular contributors to Nature Strips.

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It has taken ten years for me to discover how, with every window and door shut, the bowl always manages to hold a full green complement by our next visit.

RAISING A GLASS TO THE LOO LORD

BY STEVE VAN DYCK

FOR ME THE SUBJECT OF GREEN Tree Frogs (*Litoria caerulea*) has become so personally challenging that I have to begin with a confession of bias. I like them all right, and enjoy juggling them from the kitchen cupboard to the rainwater tank, but that's part of the problem...I find them much more fascinating in a downpipe than sliding among my breakfast dishes. The real worry is that someone inside the house has an inherited attitude toward Green Tree Frogs that can be traced as plainly as a Hapsburg lip back to my mother-in-law. A big green bullroarer can evoke anything from maternal clucking to palpitations of rapture. Like fainting for the Beatles, the problem is animal-adoration-overload. My pro-frog spouse, who'd have a house full of them if she had her way, sees a Green Tree Frog and starts swooning...I see more slime and spawning.

There really are dozens of plumbing-type things that leak and weep around our house, but for some reason the Green Tree Frogs always end up pressed inside the wine glasses, gravy jugs and salad bowls in our Nullarbor-dry kitchen pantry. The skid marks and sloughed Glad-Wrap-skins certainly break the ice at our poorly attended cocktail parties, but it's the semi-liquid end products of their cockroach recycling program that really cause a sensation...mostly to the olfactory apparatus when you fling open the pantry doors to the Nutri-Grain and have your morning's wolverine-breath eclipsed by the miasma of frog-processed cockies.

To demonstrate the already-mentioned genetic link, at my in-law's holiday place on Lake Cootharaba, two hours north of Brisbane where we often spend a 'relaxing' weekend, there is a protective sign my mother-in-law has written on the toilet seat that says "Please close lid after use or all the green frogs will dehydrate in the house". To the uninitiated, the expectation of what might occur if they actually decide to lift the lid is itself enough to dry up any urge they may have approached the throne with. I'm used to it now, but it has taken ten years of hesitant lid-opening, mega-flushing, fishing-out and frog relocation for me to discover how, with every window and door shut, the bowl always manages to hold a full green complement by our next visit.

After eviction, the super-homing Green Tree Frogs wait until dark, then crawl up the weatherboards, around the guttering and all the way up to the top of the stink-pipe that towers above the ridge of the tin roof. There, because the protective flywire long ago rusted away, they can slip into the pipe and slide down to where the stink-pipe merges with the outrushing flash-flood from the WC. With the commitment of Lloyd Bridges they must hold their noses, negotiate the watery S-bend and reach the familiar atmosphere of the cavernous Caroma pedestal. But, like spawning sockeyes, the urge is to go higher upstream. So they work their way to the back of the dunny rim and squeeze themselves up through the flusher hole and into that pipe that delivers raging white-water from the cistern. (Only a mirror and torch will convince you that this is possible.) The only problem is that the pipe is opaque so you can't really tell if what is about to happen next is going to happen, because you can't see the frogs crushed inside it. Anyway, after a good, long, relaxing read of the magazines, and oblivious to the dozens of glutinous green digits pressing the insides of the plumbing behind, you push the flusher button expecting Barron Falls to sweep all before it, but all you get are two or three perfunctory dribbles that slosh and splutter for ten minutes like the convulsions of a dying Foster's tap. A couple of slimy green sandbags might succumb to the back-pressure and get spat out in a horrible churning maelstrom, but the end result is a totally dysfunctional flush. My relaxation on these breaks consists mainly of walking...either to the public phone to engage a plumber at time-and-a-half, or

PETER MARSACK/LOCHMAN TRANSPARENCIES

A face that can sometimes be hard to ignore—especially when it is staring up at you from inside the toilet bowl!

BILL BELSON/OCHRAN TRANSPARENCIES

Green Tree Frogs are always on the lookout for potentially watery places to replace their once-loved but now filled-in ponds.

GREEN TREE FROG

Litoria caerulea

Classification
Family Hylidae (tree frogs)

Identification
Lime to olive green above, white below, often with white spots or a variable white line from the corner of the mouth to the shoulder. Fingers and toes long, partly webbed with large terminal discs. Males grow to 7.5 cm, females to 10 cm.

Distribution
Common from coastal to arid habitats in north-eastern SA, throughout NSW and Qld, most of the NT and northern WA. Also in southern Papua New Guinea.

Food
Opportunistic predators of arthropods, mainly insects, but just about anything else living that can be swallowed, including small birds, rodents, bats, and human fingers to almost the third knuckle of a food-bearing finger. Not too proud to use hands to push food into mouth.

Breeding
Males call with a deep, booming, repetitive 'gar-ork gar-ork...'. Northern wet-season breeders. Spawn laid in clumps of 200–2,000 eggs in still water from Nov. to Feb.–Mar. Very large brown-greenish tadpoles up to 10 cm long. Adults have lived to 23 years in captivity.

around the backyard looking for vacant places to dig holes on the double.

But how can you blame them? A council-wide obsession with filling in all pools not attached to the umbilicus of a Kreepy Krauly, and the demise of humid backyard dunnies and dripping domestic water tanks with all their galvanised clutter, has left countless city suburbs permanently croakless. Not because Green Tree Frogs need to go swimming every night, but because they need to lay their eggs in water deep enough to be around long enough (six weeks) to give the tadpoles time to turn and ultimately replace those that spawned them.

Like their preoccupation with our dry pantry, when not breeding, their day-to-day existence is really not dictated by large bodies of water. They, like other frogs, don't drink, but absorb water through the skin, and as the soft belly near the groin gives the quickest uptake, a moist kitchen sink is a perfect spot to splot the body on, and top up what might have evaporated on a hot day. But even evaporative water loss is countered by a Driza-Bone back, whose skin loses water at a far slower rate than it would evaporate from, say, an open saucer under the same conditions. And that typical hard-pressed, legs-in huddle against an impermeable surface like the inside of a wine glass reduces water loss from the belly to almost nothing. And just to rub it in, the selection of a narrow glass over an open one increases the humidity surrounding the frog, thereby further reducing the rate of water loss.

For people who become hypertensive at the thought of treading barefoot on such clammy green skin, it is an ironic twist of homoeopathic proportions that the high blood pressure generated by these loo-lurking detonators was later to be medically controlled by a substance called caerulein, which was isolated from the protective slime on the Green Tree Frog's back. However, anything other than small, medically supervised doses of caerulein can do such horrendously unspeakable things to the human gut wall and gall bladder that frog skin is a definite no-no in Aussie campfire cuisine and is side-stepped by all bush cooks happy to be pink, not green, around the gills.

On a healthier note, great leaps are being made by concerned individuals and clubs committed to redress the bleak-looking future faced by Green Tree Frogs on the domestic front. You can't please everyone, and a dreary frog prognosis may actually please the faint-hearted whose appreciation of green skin and webbed feet begins and ends with the Muppets. But to others who, as youngsters, fell asleep to a frog going 'gar-ork gar-ork' outside in the meter-box (or, in other cases, from inside the parfait glasses), no amount of felt puppets or cable television will ever replace a quality of life that seems to be slipping through our fingers quicker than a handful of tadpoles.■

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

While we were installing pitfall traps, a tiny worm-like lizard fell from a handful of sand, protesting loudly with high-pitched squeaks.

MALLEE WORM-LIZARD

BY PETER ROBERTSON

THE FIRST RECORD OF THE Mallee Worm-lizard (*Aprasia aurita*) was a specimen donated to the National Museum of Victoria in 1902, collected from Woomelang, north-western Victoria. In 1911, a further 16 individuals were donated, from the nearby Ouyen area. Despite intensive searching, no further specimens came to light, and it was feared that the species may have become extinct. A not unreasonable assumption, as most of the mallee vegetation in the vicinity of Woomelang and Ouyen had been converted to wheat paddocks during initial settlement. Presumably the original specimens were found during that land clearing.

As part of a major review of the use of public land in the Victorian mallee region, an extensive flora and fauna survey was undertaken between 1985 and 1987. All major habitat types were sampled seasonally over the three-year period.

One of the first areas to be surveyed was Wathe Flora and Fauna Reserve, a small (6,000-hectare) remnant of mallee, surrounded by cleared land, on the eastern edge of the Big Desert—coincidentally, roughly halfway between Ouyen and Woomelang. While we were installing the pitfall traps and carefully filling the sand around the buried buckets, a tiny worm-like lizard fell from a handful of sand, protesting loudly with high-pitched squeaks. With mounting excitement we quickly identified the animal as *A. aurita*, the first specimen to be uncovered for 74 years. Only six more individuals were to be found during the following two years of the survey, all from the Wathe Reserve.

The Mallee Worm-lizard is one of the smallest (up to 18 centimetres long) members of the legless lizard family (Pygopodidae) and the only species to possess an external ear opening, although this is hidden beneath a slightly notched temporal scale. The ten species in the genus *Aprasia* are scattered across the drier parts of southern Australia. They are all fossorial, burrowing in loose sand and soil, and are often found in association with small ants. It is thought that all species eat only ants, probably taking them directly from the ant galleries. The degree of specialisation, whether on particular life stages or particular species of ant, varies between species. (Analysis of the Mallee Worm-lizard's diet is yet to be carried out.)

This specialisation on ants as food is seen in comparatively few reptiles. But for those that can tolerate the pungent taste, the harvest can be bountiful indeed.

This specialisation on ants as food is seen in comparatively few reptiles. But for those that can tolerate the pungent taste, the harvest can be bountiful indeed, with over 86 species of ants recorded in just one quarter-hectare area of mallee in Victoria.

Legless lizards, like their close relatives the geckos, all appear to lay only two eggs per clutch, with those in southern Australia probably producing a maximum of one clutch per year. It can be quite difficult to tell the sexes apart on external features, but male *Aprasia* have small projections or 'spurs' under each of the small hind-limb flaps either side of the vent. These are probably used in some manner during mating. Male *Aprasia* also have upper teeth, unlike females, and these may help them get a firm grip on the female during mating. In common with the geckos, legless lizards are able to vocalise, producing high-pitched squeaks when alarmed or threatened, and possibly during social interactions.

Very little detail is known of the ecology of any *Aprasia* species, although the Pink-tailed Worm-lizard (*A. parapulchel-*

PETER ROBERTSON

la), also endangered, is currently the subject of intensive research. To attempt to discover more about the ecology and conservation requirements of the Mallee Worm-lizard, the Australian Nature Conservation Agency (now called Environment Australia Biodiversity Group) funded my return to its habitat in 1993. I was particularly interested in determining its status, because in the intervening years a bushfire had burnt part of Wathe Reserve where the lizard had been found. As it had been known only from long-unburnt vegetation, and because of its dietary specialisation and the potential effects of fire on the ant community, I postulated that the species may have been particularly susceptible to fire.

Trapping in all vegetation communities with various fire histories produced 135 Mallee Worm-lizards and 72 Pink-nosed Worm-lizards (*A. inaurita*), the two species occurring together at 23 of the 58 sites. Interestingly, both species showed no preference for vegetation of any particular age after fire. The Pink-nosed Worm-lizard, which is relatively widespread across southern Australia, was restricted to floristic vegetation communities on sandy soils, while the Mallee Worm-lizard occurred in a greater range of communities, extending to those on the harder, red sandy loams. Importantly, the Mallee Worm-lizard was found at sites in the extreme east of Wyperfeld National Park, greatly extending its known range.

These findings were particularly encouraging for the future of the species, with it now known from two secure conservation reserves. Actions have been taken to revegetate a narrow corridor of habitat between the two areas in an attempt to provide for some long-term gene flow between the populations. Still, the total area of suitable habitat is probably less than 5,000 hectares, which must be managed appropriately, despite little knowledge of what really is appropriate. We cannot afford to be complacent.■

At the time of writing, Peter Robertson was a wildlife biologist with the Victorian Department of Natural Resources and Environment, managing threatened species recovery programs. He now works privately as an ecological consultant.

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South Africa is now choking under exotic vegetation and 40 per cent of their environmental weeds are Australian.

INVADING AFRICA

BY TIM LOW

IN SOUTH AFRICA, AN AUSTRALIAN invasion is under way. Hordes of wattles, hakeas, tea trees and eucalypts are marching over hills and across flats, eliminating native plants in their wake. Around Cape Town, grim locals take up weapons and join 'hakea hacks' to fight the onslaught. Under threat are South Africa's heathlands* (known as 'fynbos'), one of the richest plant habitats on Earth.

Cape Town is remarkably windy. When the first Dutch settlers disturbed the nearby heathlands, the sandy soil blew up in drifts. Roads drowned under sand. In 1845 the Government acted, stabilising dunes by sowing shrubs and trees. Although plants from around the world were trialled, Australian shrubs and trees proved best. Seeds came from, among others, Baron Ferdinand von Mueller, Australia's eminent botanist and notorious acclimatiser, and Cape Town Governor George Grey, previously an explorer in Western Australia.

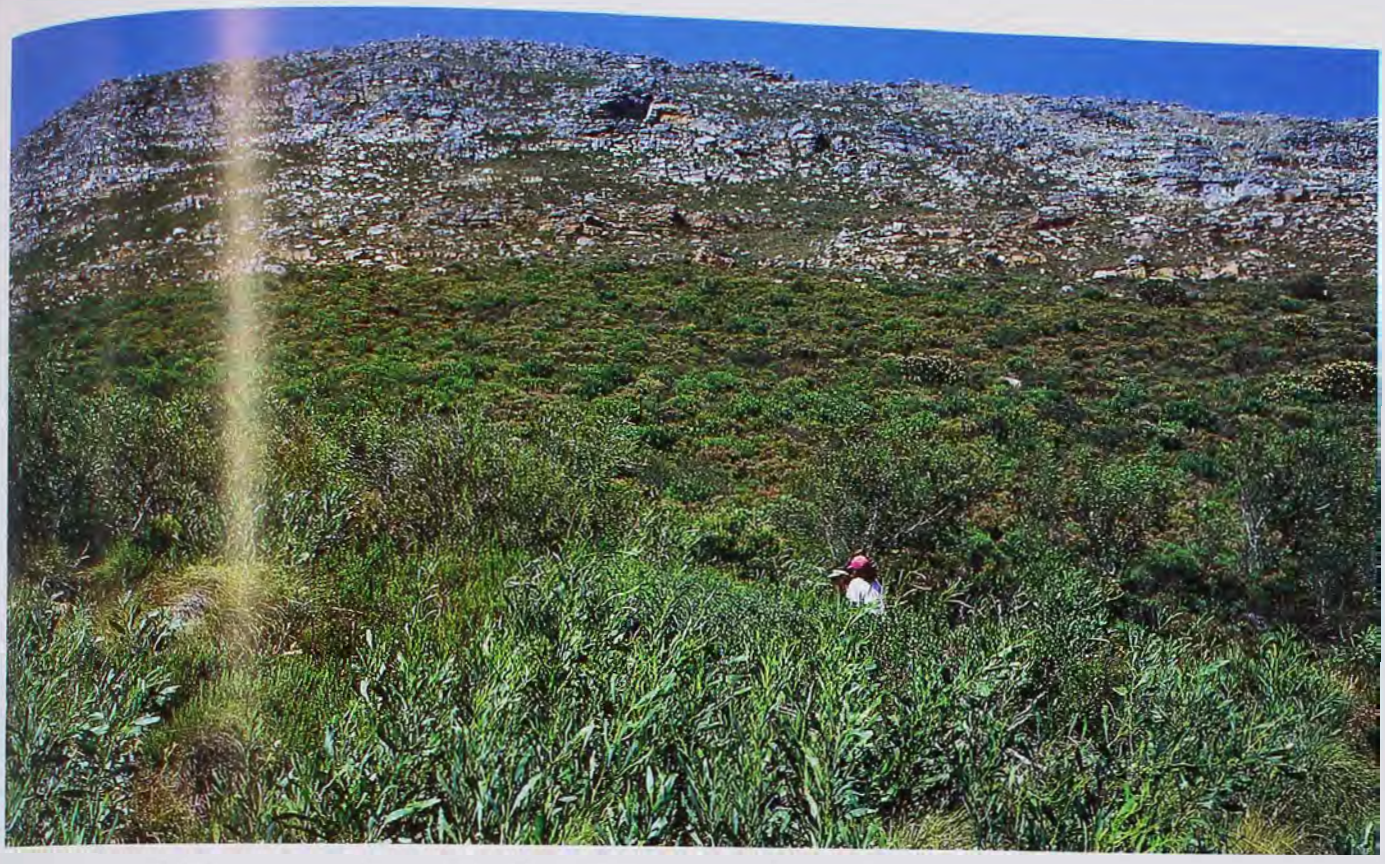
Cape Town residents took a liking to the Australian plants. There were plantings of hakea hedges, of shrubs and trees in gardens and parks, and later of wattle plantations for tannin production. One resident talked of "the green tresses of the casuarina floating over our gardens, and the lofty plumes of the eucalyptus over everything else". Extraordinary numbers of seeds were distributed. The Forestry Department, from 1882 to 1893, traded 14 million seeds of Coastal Wattle (*Acacia cyclops*), 16 million seeds of Coast Tea Tree (*Leptospermum laevigatum*) and 300 million seeds of Golden Wreath Wattle (*A. saligna*, known by the quaint name 'Port Jackson'). One customer alone bought 1.5 million seeds of 'Port Jackson'.

South Africa is now choking under exotic vegetation and 40 per cent of their environmental (as opposed to farm or garden) weeds are Australian. In the

**The term 'heathland' is used loosely here to define an area of low-growing shrubs, growing on acidic, infertile soils..*

PHOTOS: TIM LOW

In southern Africa, Boobialla, a native of southern Australia, is widely planted in parklands near the sea, from whence it spreads into dune vegetation.



At the study site of Pat Holmes near Cape Town, Golden Wreath Wattle or 'Port Jackson' (in the foreground) is invading diverse fynbos heathlands. Spider Gums were growing nearby.

Cape Province the Australian component is much higher. The worst offenders are three wattles and three hakeas: Coastal Wattle, Golden Wreath Wattle, Sydney Golden Wattle (*Acacia longifolia*), and Silky Hakea (*Hakea sericea*), Rock Hakea (*H. gibbosa*) and Sweet Hakea (*H. drupacea*). (A fourth hakea, *H. salicifolia*, is called 'Tame Hakea' because it does not invade.) Along with three pines (*Pinus pinaster, P. radiata* and *P. halepensis*) these plants constitute a grave threat to wilderness in the Cape Province. They readily invade pristine fynbos heathlands, displacing proteas (*Protea* species), ericas (*Erica* species) and other shrubs, and threatening the survival of many rare species. They grow alongside a range of other weeds from Australia including Coast Tea Tree (called 'Australian Myrtle'), Crested Wattle (*Paraseriathes lophantha*), Black Wattle (*A. mearnsii*), Blackwood (*A. melanoxylon*), Spider Gum (*Eucalyptus lehmannii*), Boobialla (*Myoporum insulare*) and Heath Banksia (*Banksia ericifolia*).

You cannot travel in the Cape Province without encountering these plants. On a visit to Cape Town I drove past slopes smothered in hakeas and wattles. I went to the study site of Pat Holmes, an ecologist working with wattles at the University of Cape Town. She showed me thick tangles of 'Port Jackson' advancing into beautiful fynbos heaths.

Australian plants are now well integrated into some South African ecosystems. Wattle seeds are food for birds and Chacma Baboons (*Papio ursinus*). The Striped Field Mouse (*Rhabdomys pumilio*) will live in wattle thickets on a diet of 50 per cent wattle seeds. Seeds that escape mice and gerbils are dispersed by African ants and by the Black Korhaan (*Eupodotis afra*), a small bustard, thus making the problem worse. Another bird, the Acacia Pied Barbet (*Lybius leucomelas*), makes no use of the seeds, but excavates its nest holes in acacia trunks; wattle plantings have allowed it to expand its range.

Biologists in South Africa are struggling to understand why Australian plants do so well there. The similarity of climate and soils, and the lack of native predators, are only part of the answer. When wattles or Silky Hakea invade mountain fynbos, the above-ground plant biomass can double or triple. South African fynbos, a treeless habitat, seems unable to fully exploit the water within the system. Pleistocene climatic changes may have left an African flora less adapted to the environment today than the Australian and coniferous invaders.

To help fight the invasion, Australian insects and diseases have been deployed. Pat showed me Golden Wreath Wattles carrying large brown galls produced by the gall rust fungus *Uromycladium tepperianum*. To control the hakeas, a moth and two weevils were released, and one of the weevils, *Erytenna consputa*, has become established at more than 80 sites. A bud-galling wasp (*Trichilogaster acaciae-longifoliae*) was released on Sydney Golden Wattle, and both kinds of galls are now exercising major control.

The need to control these plants has become urgent with the discovery that Cape Town's water supply is at risk. Foreign trees were once planted around the city with the idea they would bring in water by attracting rain. In fact the wattles, hakeas and pines are siphoning off soil water and Cape Town's survival is under threat. Millions of rand have been allocated for weed control.

For me, South Africa was an extraordinary chance to see the shoe firmly on the other foot. I wandered around a beach in the Cape of Good Hope Nature Reserve where Bitou Bush (*Chrysanthemoides monilifera*), African Boxthorn (*Lycium ferocissimum*) and Butterfly Bush (*Polygala myrtifolia*), all very invasive weeds in Australia, were growing alongside Coastal Wattle. I found it impossible to master my prejudices, to see the Boxthorn and Bitou as 'good' plants and the wattle as the weed. Of course the real villains in this story are not the plants themselves, but the people who, today more than ever, believe it is their commercial right to spread garden and timber trees around the world, without regard to the problems sown for the future. ■

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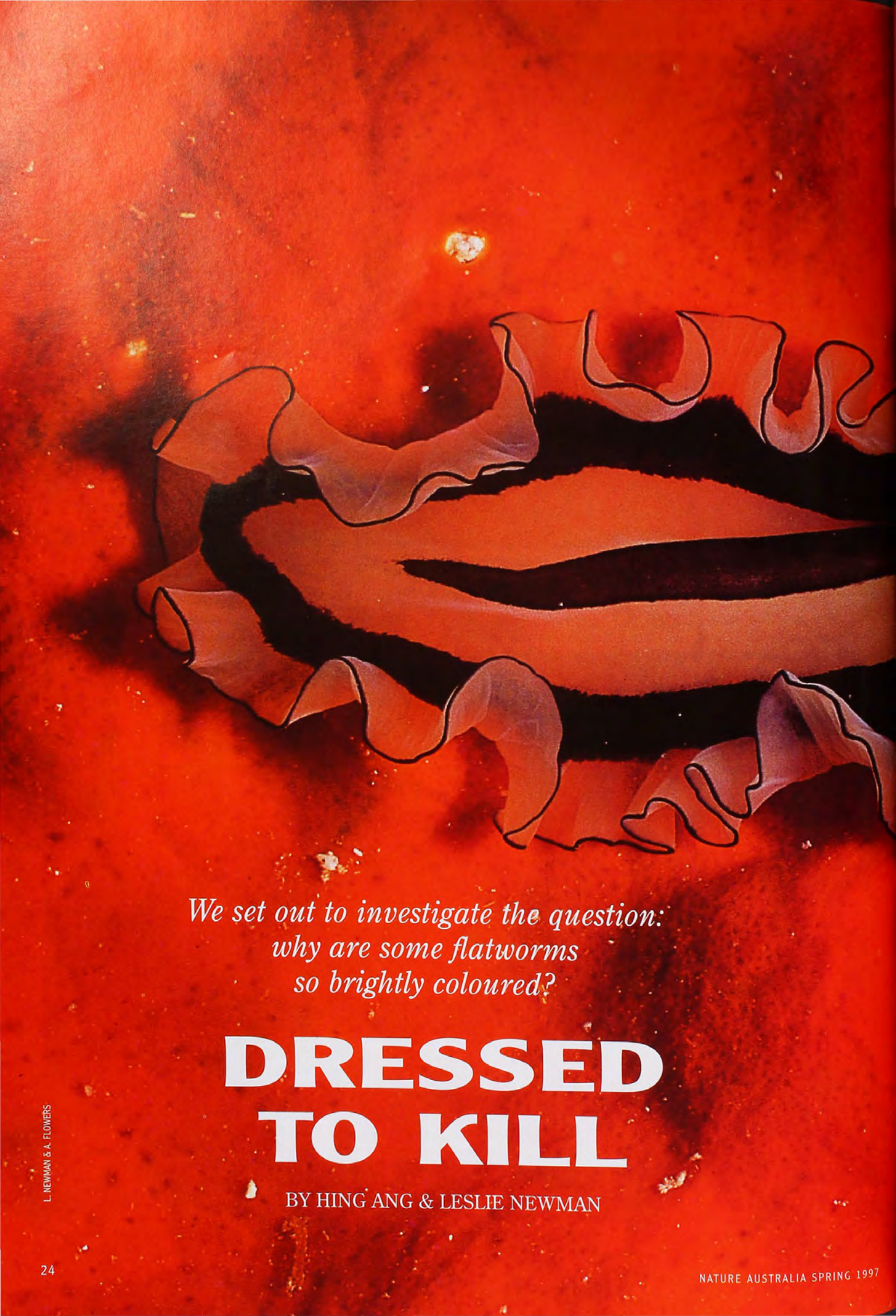
Tim Low is a consultant biologist and nature writer deeply concerned about exotic invasions. He visited Cape Town in December 1995.



We set out to investigate the question: why are some flatworms so brightly coloured?

DRESSED TO KILL

BY HING ANG & LESLIE NEWMAN

L. NEWMAN & A. FLOWERS

The largest and most gaudy of the polyclad flatworms are members of the genus *Pseudobiceros*. *Pseudobiceros gratus* is one of the most delicate species and its contrasting pattern is most certainly aposematic.

WHETHER STEALTHILY SLIDING over coral or casually cruising through the water column, marine polyclad flatworms are a spectacle to behold. These extremely delicate and flattened creatures, found commonly in oceans all over the world, include some of the most brilliantly decorated animals in the sea.

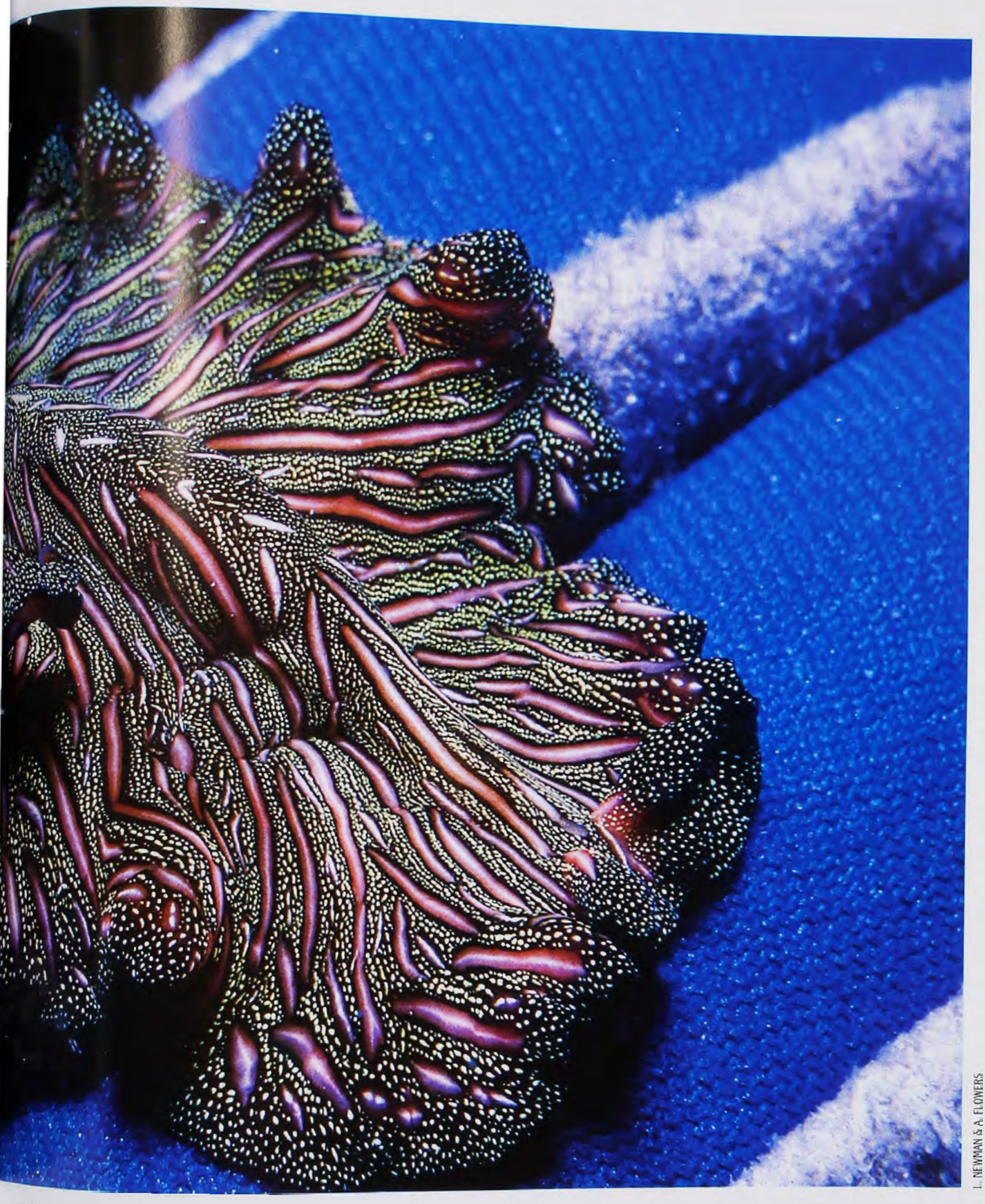
Despite possessing a virtual kaleidoscope of colour patterns, and a natural artwork that would impress even Picasso, many tropical polyclad flatworms have been overlooked in the past, mainly because they are so hard to study. These delicate animals tend to autolyse (self destruct) if stressed, disintegrating into a mucous mush. Past researchers often gave up in frustration and rarely, if ever, collected specimens. Thus, when one of us (Leslie) and Lester Cannon (Queensland Museum) first started studying flatworm biodiversity, there were few specimens in museum collections to work with—certainly very few in good condition. Through much trial and error, however, we devised a fixation technique that not only keeps the animals intact but also preserves their patterns, although they lose the brightness of their colours. A door to the life of polyclad flatworms had finally been opened.

These delicate animals tend to self destruct if stressed, disintegrating into a mucous mush. Past researchers often gave up in frustration and rarely, if ever, collected specimens.

Despite a broad general knowledge of polyclads, there is still little known about their specific biology. With continued study, however, especially underwater observations, we are learning more and more. We now know, for example, that some flatworms secrete or harbour substances that are unpalatable to predators: when we tried to feed them to fish they simply spat them out. Luckily for the flatworms they also have well-developed powers of regeneration. If damaged, these worms can replace lost parts or torn tissue within a few days. A flatworm cut straight down the middle may result in two smaller flatworms!

These extraordinary animals creep along on thousands of microscopic motile hairs or cilia. Some flatworms also swim, particularly when threatened. By undulating the margins of their bodies they are able to glide gracefully through the water column, a spectacle resembling nothing less than the flamboyant flying carpets of Arabian fairy-tales. Their behaviour is also quite intriguing in that many (especially the more brilliantly coloured species) seem to 'show off' their colours. These worms are most often seen out and about, making no attempt to hide or conceal themselves from potential predators.

While we know a lot about the significance of colour in terrestrial animals, it is still poorly understood in the marine environment. So, with the intention of solving one of science's lesser-known mysteries, we set out to investigate the question: why are some flatworms so brightly coloured?



L. NEWMAN & A. FLOWERS

The Persian Carpet Worm (*Pseudobiceros bedfordi*) is one of the most common polyclads from Indo-Pacific coral reefs. Here it is crawling over a dive glove apparently not bothered by being 'captured'.

COLOUR PATTERNS ARE THOUGHT TO serve various purposes in nature. For many animals they are used as a way of recognising each other, especially for attracting members of the opposite sex. For others they may help camouflage the animal. This is known as cryptic colouration and occurs where the colour and patterning of the animal closely resemble or complement the immediate environment, thereby breaking up the perception of form and shape. Still other animals use bold colouration as a warning to predators that they are distasteful. This is known as aposematism. The final possibility is that colours and patterns are used by animals to impersonate or mimic other, more dangerous animals (mimicry). So which theory is most appropriate for polyclads? Do flatworms use colour for species recognition, camouflage, aposematism, mimicry, or all or some of the above?

Flatworms only have simple eyes

around the margins of their bodies. These allow them to detect changes in light intensity but are quite incapable of distinguishing colour and form. Hence the theory that colour patterns are used for species and sexual recognition can be dismissed. Furthermore, although cryptic colouration has evolved in several groups of polyclads, most show 'exhibitionist' behaviour, as well as sporting conspicuous colours. It would therefore seem that these flatworms, at least, are not using colours for camouflage. This leaves only aposematism or mimicry to explain their extravagant colour and patterns.

Aposematism requires a predator to first learn to avoid prey bearing bold ('aposematic') colours. A predator must taste, reject and thus learn to associate colour or pattern with unpalatability. Since we had already observed that flatworms were often rejected by fish and that they frequently expose themselves by being out during the day, aposematism seemed to be the most tenable explanation for colouration in flatworms. The 'court room' of science, however, demands more conclusive evidence to convict. We therefore devised an experiment that would determine whether fish predators could learn to avoid flatworms on the basis of colour alone.

For our experimental predator we chose the Moon Wrasse (*Thalassoma lunare*), as this species is known to eat just about anything. These reef fish are also found within the same habitat as many of the most colourful flatworms. They are also quite easy to catch. Ashley Scivyer and Puk Petersen from 'Underwater World' at Mooloolaba in Queensland were willing to assist us by collecting both fish and flatworms.

We knew that there were flatworms off Mooloolaba, however the collectors initially mistook nudibranchs (naked sea slugs) as flatworms. Flatworms are almost invariably mistaken by the curious observer for nudibranchs, which are basically snails without shells. It is well established that, being shell-less and

It is not known whether or not all polyclads are toxic to fish. This species, *Pseudoceros imitatus*, plays it safe by mimicking the highly toxic nudibranch *Phyllidiella pustulosa* in its colour pattern and texture.

Free-living polyclad flatworms such as *Pseudoceros ferrugineus* use brilliant colour patterns to advertise their unpalatability to predators such as reef fish.

PHOTOS: L. NEWMAN & A. FLOWERS

defenceless, many of these molluscs sequester natural toxins from their prey (usually sponges) and display their distastefulness with brilliant warning colouration. Nudibranchs even rival flatworms as the most spectacular underwater exhibitionists. However, these animals characteristically possess naked gills and a distinctly molluscan foot, whereas flatworms are completely flat and lack gills. The collectors quickly learned to distinguish flatworms from nudibranchs.

In our experiment, the Moon Wrasses were offered live flatworms, edible coloured models of the flatworms, and edible uncoloured models. The models were made of agar jelly and resembled the flatworms in colour pattern, size and shape. In addition they were flavoured with ground-up, freeze-dried brine shrimp so not only were they edible, but also extremely tasty to the fish should they try to eat them.

The flatworms that we used (*Phrikoceros baibaiye, Pseudobiceros stellae* and *Pseudoceros paralaticlavus*) are noted for their bright and conspicuous colours of black, white, yellow and orange—colours that are known to be aposematic in many terrestrial animals. The fish initially tried to eat these worms but immediately spat them out whole and undamaged, clearly showing that the flatworms were unpalatable to the fish. The fish avoided the live flatworms thereafter. We observed that the fish also avoided the colour models yet were more than happy to consume the uncoloured models. This clearly showed that the fish had learned to avoid the flatworms on the basis of colour alone. So we had a verdict! Flatworm colours are aposematic and they dress to advertise their distastefulness to predators.

Unlike other turbellarians, these polyclad flatworms employ hypodermic insemination during copulation. The pointed penis and the sharp stylet at the tip are used to puncture the skin of each partner and they randomly stab each other. This behaviour might continue for hours or days resulting in considerable damage to each animal.

WE ARE THE FIRST TO BE ABLE TO show experimentally that aposematism is the reason for the bright colouration in flatworms. However, the results have had an additional spin-off. In demonstrating that fish had learned to avoid flatworms on the basis of colour and pattern, we had also demonstrated the operation of mimicry. The coloured agar models were essentially non-living mimics of the live flatworms and were protected from the fish by exploiting the features that the fish had learned to avoid—colour and pattern. Although we have yet to determine if it is unpalatable itself, we know of at least one rare flatworm (*Pseudoceros imitatus*) that mimics the pink-and-black colour pattern and knobbly texture of an extremely toxic and common nudibranch (*Phyllidiella pustulosa*). Therefore we concluded that warning colouration is clearly the most significant reason for colouration in tropical flatworms, but we acknowledge that mimicry of this condition may also play a role.■

POLYCLAD FLATWORMS

Classification
Phylum Platyhelminthes (flatworms, including parasitic flukes and tapeworms, and free-living flatworms); 'Turbellaria'; order Polycladida (free-living flatworms). Over 335 recorded spp. (90% new) from Aust. and PNG. Probably 100s, if not 1,000s, more species yet to be discovered.

Identification
Free-living, flattened, oval-shaped worms of moderate size (av. 3–50 mm in length but up to 14 cm). Branching gut with combined mouth and anus found anteriorly on the ventral side. Pair of tentacles present either on dorsal surface or anterior margin. Many species brightly coloured. Often numerous light-sensitive eyes in anterior region. Well-developed powers of regeneration.

Distribution and Habitat
Circumglobal, but more diverse in tropical and subtropical seas. Exclusively marine, usually found associated with their prey or as symbionts with other invertebrates such as molluscs and crabs.

Diet
Carnivorous, feeding on various invertebrates especially sessile ascidians (sea squirts) and commercially important bivalve molluscs, including oysters and giant clams. May engulf prey whole, or extrude their pharynx up to twice their body length and digest prey outside their body by extracellular digestion.

Reproduction
Hermaphroditic. Many species use indiscriminate reciprocal hypodermic insemination, in which penis is stabbed randomly into body wall of partner and injected sperm migrates to ovaries. Others use internal fertilisation and copulate ventral surface to ventral surface. Eggs laid in thin layers, usually on prey, and take about a week to hatch.

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PHOTOS: I. NEWMAN & A. FLOWERS

This *Acanthozoon* sp., although brightly patterned, is thought to be cryptically coloured when found on its equally brightly coloured natural habitat. These flatworms also possess dorsal pustules that contain branches of its gut that act to increase its digestive area.

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Hing P. Ang is a post-graduate from the Zoology Department, University of Queensland, and researches fish behaviour and aposematic colouration in marine animals. Dr Leslie J. Newman is a Post-doctoral Research Associate in the same department and is currently working on an Australian Biological Resource Study grant to examine the biodiversity of the Australian polyclad fauna.

They would like to thank Ashley Scivyer, Puk Petersen and the staff of 'Underwater World' at Mooloolaba, Queensland, and the Australian Biological Resource Study for all their help and support.

Surely it was not
Dr Jekyll's famed potion
that made these normally amiable birds
into scalp-fixated Kamikazes.
So why do they do it?

DR JEKYLL WITH THE PIED HYDE

BY NICK CILENTO

RIGHT. THE FEMALE IS ON THE NEST, the male is foraging 40 metres away. I note the time and my distance to the nest and I'm away. Walking casually down the path that passes under the nest tree, I don't let my gaze stray onto either of the pair, and while I give an outer appearance of casualness, I am tense. I must relax though and trust my reflexes. I am now within 50 metres of the tree and I know he is coming.

BRIAN CHUDLEIGH

Old enough to look after itself, this juvenile White-backed Magpie (*G. t. leuconota*) in New Zealand takes flight.

His behaviour is familiar to me now. I have walked with the sun behind me and I look down at my shadow. Suddenly there he is. My childhood instinct kicks in and I duck to the side. He sails past where my head was, giving a loud clap of his beak. He's keen all right! It would have been a full contact blow and that hurts. I make a mental note to record later: *it's the male again; single swoop and then to ground; distance he came to intruder, 0 metres.* I look at him foraging in the grass as if I no longer exist. I love these birds; they break all the rules.

As a child, however, I can remember my relationship with Magpies oscillating between like and loath. For most of the year they followed me around the yard, affable companions for those endless hours of mowing. But then the silly season would come and I couldn't leave the veranda without a branch from the umbrella tree to swing about my head. This change of personality I could never quite understand. Now the silly season is when I like them most.

THE AUSTRALIAN MAGPIE *(GYMNORHINA tibicen)* is one of the few native species to have benefited from urban and rural encroachment on native habitats. Well-watered lawns and grassy fields with the occasional big tree give them just what they need to forage and breed. This, along with their widespread distribution, large conspicuous appearance and bold up-front personality, has made the 'Maggie' one of the most recognised and observed of Australian species. They have also been well studied and much is known about their breeding cycle, social structure, territoriality and vocalisation.

A picture of the Australian Magpie evokes widely conflicting images in every Australian—be it the gardener's companion, the emblem of sporting legends, or the bold charismatic daily visitor who looks you in the eye when it comes for a feed. One Aboriginal legend has it that it is the carolling of Moograbah the Magpie that each morning raises the sky from the Earth to bring us the day. A great responsibility, but perhaps not too great for one with such a beautiful song. However, one common perception of this quintessential Aussie bird is that of the stealth bomber, the silent attacker from behind. It is surprising to find, therefore, that very little is known about this behaviour, one of their most recognisable traits.

The Department of Environment (DOE) in Brisbane alone receives several hundred calls of complaint each year from angry residents, many of whom want the removal or destruction of aggressive Magpies in their neighbourhood. This, country wide, easily equates to our most dramatic suburban wildlife conflict. The solution in the past was to remove the offending bird. Magpies now, however, are protected not only by law but also by community concern, and wildlife authorities are hesitant to take such unpopular steps. These factors, along with a lack of behavioural information, create a major wildlife management nightmare.

Relentless in his attack, the male Magpie that occupies this territory shows individual recognition of the author who two years earlier had climbed to the nest, a perceived hostile act.

IN 1994 I TOOK UP THE MAGPIE conundrum. Surely it was not Dr Jekyll's famed potion that made these normally amiable birds into scalp-fixated Kamikazes. So why do they do it?

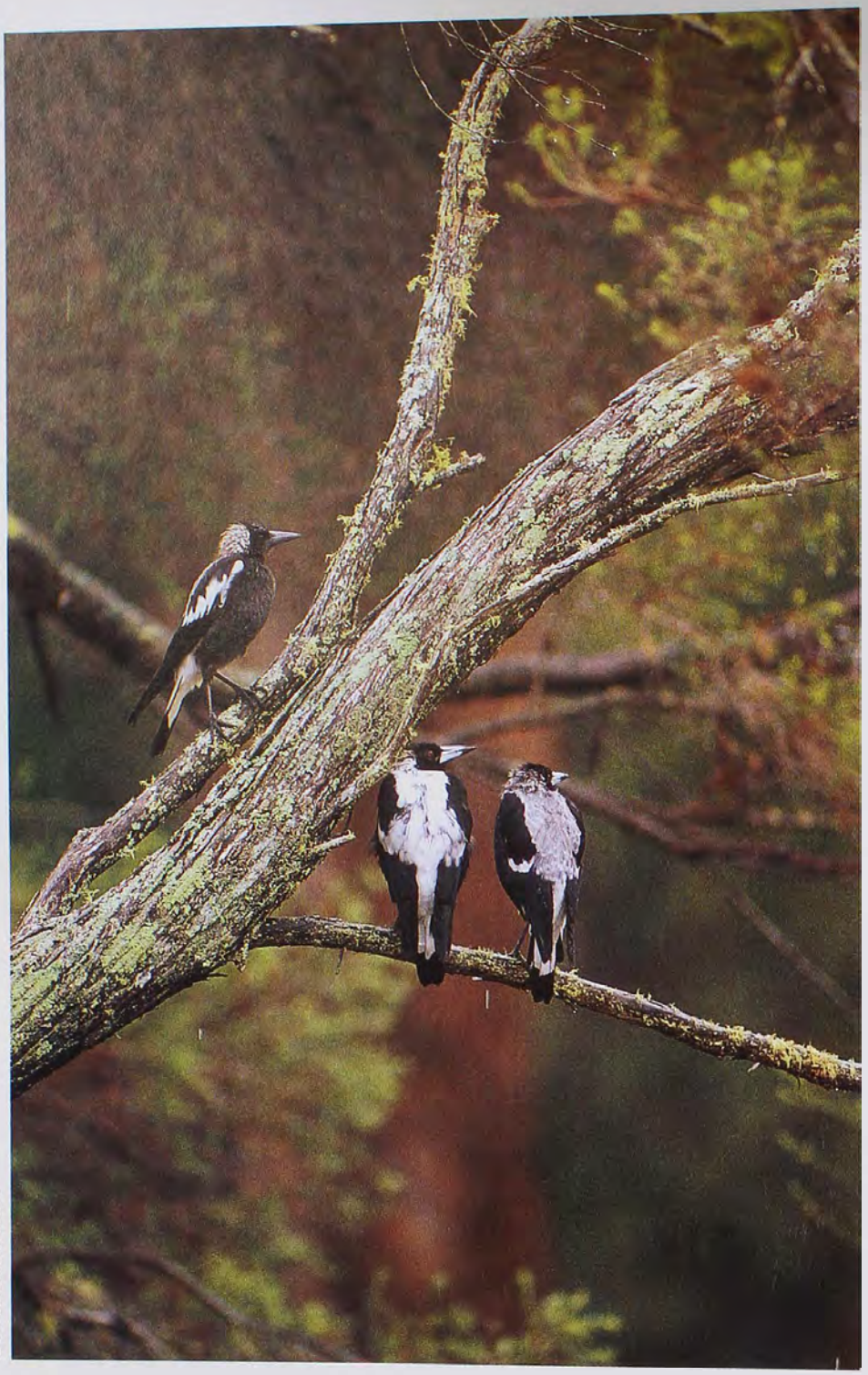
This question comes prepacked with an unbelievable amount of public myth and folklore. Everyone has a story about Magpie attacks. Generally, however, the gist of these stories tends towards it being simply the species' brood defence strategy; that is, they are only protecting their young. Since the Magpie danger period, roughly August to November, corresponds with their breeding season, this answer seemed plausible. But was it as simple as that?

The problem was that it is not a trait common to *all* Magpies. In fact, it is a behaviour almost totally confined to birds that come into frequent contact with people. But even in the most densely populated areas there is less than five per cent of birds that show aggression towards humans. Birds in native bushland areas prefer to avoid people than

STEVE HOLLAND

KATHIE ATKINSON

Magpies: you either love 'em or hate 'em. And it is this conflict of opinion that creates a very difficult situation for wildlife officers.



JEAN-PAUL FERRERO/AUSCAPE

A tight family unit—these White-backed Magpies (*G. t. leuconota*) of south-eastern Australia shelter from the rain (from left to right they are a juvenile, male and female).

attack them. This does not fit the common scientific notion of brood defence.

Brood defence is a form of parental care that involves considerable investment of time and energy, and in its most overt form (that is, defensive attacks) is also potentially dangerous to the parent birds. In every situation parents are unwittingly assessing and weighing up the costs and benefits of defending their young in terms of their own lifetime reproductive success (which they are trying to maximise). In other words, they are balancing whether they should defend their present young today, or not risk it and live to reproduce another day. Each decision is said to be an optimal response to the given situation and every individual is pre-programmed to instinctively make such decisions. This suggests that all individuals of a species should recognise and respond to a common brood predator in the same optimal fashion. That some Magpies show extreme overt responses to humans while most others show none, raises questions about either this 'optimality theory' or the nature of the behaviour, or perhaps both.

The cognitive (learning) abilities of birds and other animals are now well recognised. As it is with humans, this ability to learn allows for variation within a species' behaviour where context and experience create the individual's own decision-making rules. Explanations such as the optimality theory require a genetic control of behaviour, which seems a little simplistic and does not allow for the involvement of cognition and experience. Each time a parent encounters an enemy, the details of its response will be influenced by the parent's previous experience, and each experience will add to the next. That a relatively small number of individuals exhibit what appears to be anti-predator responses to humans, suggests that in the past humans have posed some threat to these birds or their brood. The most logical explanation for this is maltreatment, and it is certainly a factor. A male from one territory would, without fail, single me out in a busy street after I had climbed twice to its nest to photograph nestling development (an ill-advised activity, as the scars on my scalp bear witness). When I recently returned to the territory after nearly two years, his recognition of me was instantaneous, as if to prove his cognitive worth.

While maltreatment may take the form of an idiot with a camera, or more often boys with stones, a less obvious form may be that of 'chick rescue'. The rescue of a nestling that has fallen from the nest (a common occurrence with such big, clumsy young on windy days) may unexpectedly present the well-meaning saviour as a predator in the eye of the parent bird.

Individual birds will have had experiences with different types of people, and this is confirmed in many instances by a high degree of target specificity. Children are a common prey with a distinct bias towards boys. One bird I know only targets boys with caps, while other birds are seen to go for women with prams, men with bald heads and adults carrying infants, to name a few. Some Magpies will appear to be generalists, but even then they do not attack everybody and some decision-making rules appear to be at work. But does this behaviour really conform to that of brood defence?

Magpies, unlike most Australian birds, aggressively defend their territories (to the point of death) year round. They are a long-lived species (up to 20 years) and must ward off many consecutive rival groups of Magpies. They have therefore evolved a complex repertoire of 'anti-social' behaviours that are typically directed at ousting territorial competitors. This behaviour, coupled with their fortitude for confrontation, has also furnished the species with an effective means of dealing with brood predators. The sight of these gutsy birds repeatedly hitting a Wedge-tailed Eagle or a Red Fox makes one wonder at the extremes to which this aggressive trait has evolved.

So are Magpies treating humans as brood predators? To answer this, I designed an experiment whereby I set

The Magpie's often conspicuous, untidy nest of twigs may contain up to six eggs.

ROGER BROWN/AUSCAPE

myself up as a predator, intentionally provoking the Magpies by either standing beneath nest trees and staring up at the nestlings, or trying to pick the fledglings up. I used territories familiar to the Brisbane DOE staff as having menacing birds (bombers), as well as an equal number of territories in both urban and non-urban areas where birds have never been known to attack. Unlike those of the south-eastern States, Magpie territories in Brisbane rarely contain more than a single pair of birds and their young. It was therefore logistically possible to systematically record responses.

It became apparent that, while the passive majority showed no response, the behaviour of bombers, when intentionally provoked, conformed to a predicted theoretical pattern. The intensity of defence increased with the growth of the young, with both males and females peaking in aggressiveness during the first weeks after fledging (young leaving the nest). At this time the youngsters are jelly-legged, can hardly fly and are most vulnerable to ground predators.

With these results I could now confirm the long-held view that Magpies attack humans because they are caring parents. However, most people don't stand under nest trees, staring hungrily at nestlings, or try to pick up fledglings, as I did in this experiment. So is it representative of the behaviour that the everyday person experiences while out walking? From the results of another experiment, in which I behaved like a typical, harmless pedestrian, the answer is no and the difference is fascinating.

WHEREAS BOTH MALE AND FEMALE Magpies attack humans that pose a threat to their young, only males attack the average non-threatening passer-by. These 'pedestrian' attacks may start while the female is building the nest and will continue while she is incubating. After the eggs hatch the male will as

Outside of human environs Magpies are relatively shy and prefer to avoid people.

An elegant pied profile. Urban Magpies are typically wary but unafraid of human activities.

usual assist in feeding the nestlings but will at the same time increase the intensity of his attacks. These are almost always fast, silent and from behind when least expected.

It is when the young fledge and are finally accessible to us ground-dwellers that his behaviour really comes into question. He all but ceases his people-focused hostilities and goes about the business of foraging and feeding the young. Why would he suddenly stop his attacks if the purpose of them was to defend his young?

Males and females within a territory appear to share in its ownership, and females match males in their aggressiveness towards territorial competitors and brood predators. So how do females respond to pedestrians? Typically they don't. While males are off expending vast amounts of time and energy attacking a non-threatening 'pseudo-predator', females carry out their normal behaviour of tending the nest and looking out for other Magpies and true threats (which sometimes include marauding humans) to her young.

So, when people obviously pose a threat, they may elicit brood defence behaviour from aggressive birds (both male and female). But the daily attacks by male Magpies on the general non-threatening public are quite different. An earlier notion described the harassment of non-predator species as 'play', which becomes more frequent during breeding because they 'have nothing better to do' while the female is attending the nest. While this can't be ruled out, it now appears more likely that they are actually showing their partners their paternal worth, so that they will continue to mate with them in the future. Males that don't swoop humans can be seen swooping other conspicuous non-predator species such as cockatoos and rabbits.

DURING BREEDING THERE IS A 25-FOLD expansion in the size of the males' testes, caused by a massive increase in hormones. While this appears to increase mating success, it also increases the birds' levels of aggression, which is particularly useful at a time when other males are desperately trying to steal their territories so they too can breed. This expansion and subsequent decline of the testes parallels the change in intensity of male birds' attacks on people, and it is therefore highly probably that the behaviour is hormone-promoted.

Every Magpie in the vicinity of urban landscapes profits year round from food handouts. Through these constant positive interactions with people all Magpies should recognise people as harmless. Some birds appear to take this on board but have also incorporated humans into their hit list as a learned response from past maltreatment. Others (predominantly males) respond to humans as they do to a cockatoo, and form a stereotypic response to a highly conspicuous, recognisably harmless stimulus that is repeatedly intruding on their territory. It is this hormone-driven 'showing-off' that is the bane of cyclists and postal deliverers around the country. With each attack, the frightened reaction and rapid retreat of these intruders go to positively reinforce the bird's action. What we consider inappropriate behaviour thus becomes appropriate for the bird.

Few people consider being attacked by a Magpie as fascinating as I do. Of the substantial number of people who are hospitalised each year, either directly or indirectly due to their experience, many are traumatised. It is simply how we learn from our experiences that determines how we view things. Magpies don't have a problem with bombing people. The conflict is entirely a human perception. Perhaps with a better understanding of the birds' behaviour, we can change that perception and hopefully ease the conflict. ■

AUSTRALIAN MAGPIE

Gymnorhina tibicen

Classification
Family Artamidae (magpies, butcherbirds, currawongs, woodswallows); 6 currently recognised subspecies, comprising both black- and white-backed forms: Black-backed (*G. t. tibicen*), White-backed (*G. t. leuconota*), Tasmanian White-backed (*G. t. hypoleuca*), Western (*G. t. dorsalis*), Groote Eylandt (*G. t. eylandtensis*), and New Guinean (*G. t. papuana*).

Identification
Distinctively pied in colour; nape, rump and wing-flashes white; 25 cm in height; weighing 250–400 g; lower nape and rump greyish in females, stark white in males. May live 20 years.

Distribution
Abundant throughout Australia, although absent from large areas of the far north. Black-backs over most of the country except in south-east, north to about Canberra, which is dominated by White-backs. These two subspecies interbreed and, where distributions overlap, hybrid zone exists. Western form confined to south-west. Black- and White-backs introduced to New Zealand between 1864 and 1874.

Habitat
Native to open savanna woodland, now common in both rural and suburban areas.

Food
Ground-feeding omnivores; mostly consume insects; known to take occasional frog or small snake; thrive on lawn grubs and beetle larvae in suburban gardens; readily take food handouts; prey detected visually and aurally.

Breeding
Breeding season July to November in the north, and later in southern populations. In southern Australia and New Zealand, territories contain 2–25 birds, breeding is cooperative. Territories in northern half of country typically have only a single 'monogamous' pair. Nest an open bowl of twigs; 1–6 eggs; incubation 20 days; nestlings take 4 weeks to fledge; fledglings unable to fly for 1–2 weeks; dependent on parents for further 2 months. City birds are often able to produce 2 clutches of young in one season, probably due to the amount of high-quality food they receive from humans.

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Nick Cilento is from the Suburban Wildlife Conflict Group at Griffith University. He has been studying the overt behaviour of Magpies in Brisbane since 1994.

ESTHER BEATON/TERRA AUSTRALIS PHOTO AGENCY

It confirmed its place in the pebble-mound fraternity by flicking and sorting and kicking and packing pebbles into a variety of piles, none of which ever seemed to satisfy it.

QUEENSLAND PEBBLE-MOUND MICE ...UP FROM THE TAILINGS

BY STEVE VAN DYCK

THE OLD SAYING 'BIG IS NOT necessarily better' is embraced by no-one more passionately than Australian rodentophiles with small, furry research interests. While you cannot deny that a big smelly Water-rat (*Hydromys chrysogaster*), capable of ring-barking a slow human thumb in less than five seconds, is an arresting beast, it is actually the suite of Lilliputian-look-alikes that is providing one of the most exhilarating challenges to native rodent researchers around Australia. One bizarre subgroup within this 26-or-so species-strong package comprises the pebble-mound mice, which until recently were monopolised by the western States.

Research into their unsuspected presence in Queensland began around six years ago and proceeded only as a result of the marriage of two unlikely bed-fellows—zoological taxonomy and exploration geology.

PHOTOS: MICHAEL CERMAK

Right: The recently rediscovered pebble-mound mouse, *Pseudomys patrius*, from Hidden Valley, Queensland. Above: After a night of hard labour at the goolie pile, a Hidden Valley pebble mounder can be forgiven for stopping briefly to wipe its brow!

SOMETHING OLD...

Brisbane-based geologist Jenny Birch really began it all when, at Charters Towers in 1991, she persuaded her 71-year-old friend, Nell Mott, to board a flight home to Brisbane with a very alive, Museum-bound mouse secreted in her cabin luggage. In the name of science, Nell put on a brave face at the airport but baulked on the western side of the security X-ray tunnel. Imagining the awful possibility of the X-rays cremating the living components of her handbag and anticipating all the fuss if her dilly-bag emerged smouldering from the other end, she decided that advance attack was the best approach. She confessed and was whisked off to the security office for a grilling of her own.

Jenny had telephoned me a few months earlier regarding some small piles of marble-sized pebbles she had seen while surveying for gold near Charters Towers. Her challenging question was whether these little volcanic burrow entrances could represent the workings of a small mouse she thought only occurred in Western Australia.

Obviously the hot northern sun had taken its toll of such an otherwise well-informed professional! Everybody knew Charters Towers had been systematically prospected, poked, gouged out and blown up since Jupiter Mossman found the first gold nuggets around Christmas 1871 while looking for horses that had bolted during a thunderstorm. If pebble-mound mice occurred anywhere in Queensland, there was no chance that anything more significant than piles of goat droppings could come from such an impoverished landscape as that around Charters Towers. So, to hasten the end

An unpretentious mound from open forest near Kilkivan, south-eastern Queensland. The unearthing of *Pseudomys patrius* just a few hours north-west of Brisbane resulted from grazier Margaret Woolrych's response to a newspaper article.

STEVE VAN DYCK

EASTERN PEBBLE-MOUND MICE

Pseudomys patrius
Pseudomys sp.

Classification
Family Muridae (worldwide rats, mice, squirrels, beavers etc.); genus *Pseudomys* (small non-hopping Australian native mice with moderately long, non-tufted tails).

Identification
Both small, head–body length 56–78 mm, tail 63–81 mm. *Pseudomys patrius* heavier (12–17 g) than *Pseudomys* sp. (7–9 g). Colour variably orange–brown to biscuit brown above, lighter to white belly. Superficially similar to other Australian pebble-mound mice. Both Queensland species clearly differentiated from others by cranial features.

Distribution and Habitat
Pseudomys patrius: dry, exposed eroding woodlands and grassy uplands along or near Great Dividing Range from near Townsville to Kilkivan.
Pseudomys sp.: open, exposed spinifex grassland and gibber from near Cloncurry to Camooweal. Both species absent from Great Artesian Basin.

Food
Unknown but probably seeds and insects, which are eaten in captivity.

Life Cycle
Unknown, but animals kept in captivity by Mike Cermak (James Cook University) have produced litters of 2 or 3 young.

BRUCE COWELL/QUEENSLAND MUSEUM

Mouthing and pawing of pebbles around a burrow entrance may throw up a shovelful of spicy information for other *Pseudomys patrius* to read off the wind.

of this hoax call, I invited her to send photos.

To my disgrace, the pictures, which looked identical to any mouse-made pebble-mound I'd ever seen published, arrived. And in a final twist of the knife, Jenny's next chirpy phone call announced that she was sending down (with Nell) the mouse responsible for the pile.

Meanwhile, under the eyeball of the slightly agitated airport official, Nell (who was scarcely bigger than a pebble-mound mouse herself) must have seemed like the proverbial baby ready to be plucked of its candy. But Nell's ash-blond hair hid a mind honed to a keen edge through a challenging professional history in the Federal Public Service that entailed dealing charmingly and uncompromisingly with officialdom. Our mouse-courier had not been selected on a whim. She calmly explained that what she had in her bag was a totally new species of native mouse, a once-in-a-lifetime opportunity to contribute signif-

icantly to the natural history of her State; that security staff would be unnecessarily thwarting the cause of science if she was prevented from taking the mouse on board; and that zoologists from the Queensland Museum would be waiting for its safe arrival on that flight in Brisbane! The significance of the find, however, went well beyond Nell's articulate defence, for the following reasons.

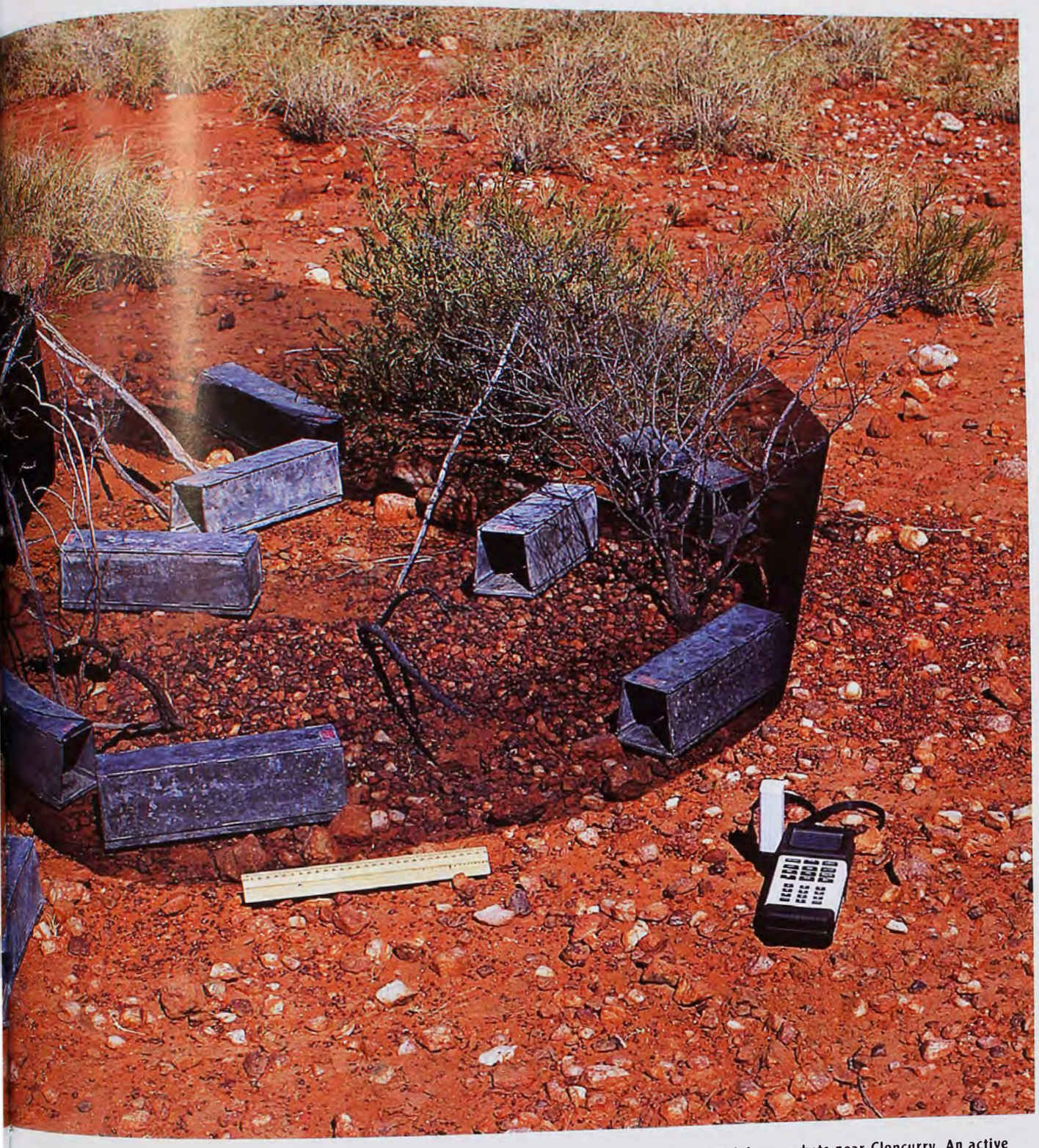
It was a tiny 12-gram mouse that, with its broad incisors and poorly developed ear bones, was unlike either of the two species of pebble-mound mice from the Northern Territory (*Pseudomys johnsoni* and *P. calabyi*) or the two from the Kimberleys and Pilbara of Western Australia (*P. chapmani* and *P. laborifex*), all described within the last 17 years. Yet in its Museum cage, as in Jenny's esky where it had happily lived for the week after capture, it confirmed its place in the pebble-mound fraternity by flicking and sorting and kicking and packing pebbles into a variety of piles, none of which ever seemed to satisfy it.

Nor did it conform with any of the other little native mice species (*Pseudomys* and *Leggadina*) that occurred in just about every habitat Australia has to offer (except tropical rainforests and mangroves). So, was it likely to be something new? Probably yes...but possibly no. There was just a niggling chance that it could represent a species that was old and forgotten, perhaps extinct. How

MICHAEL CERMAK

embarrassing to announce a new species to the world, give it a fancy name, and then to find out later that it had already been described in another lifetime under a different but 'legally' binding name. Two mammalogists, John Calaby (now retired from CSIRO Wildlife in Canberra) and Mike Fleming (then with the Conservation Commission of the Northern Territory) were quick to point this out, and were even prepared to put their money on the species they suspected it to represent, *Pseudomys*

Pseudomys patrius **have been successfully bred in captivity. Between two and three young are born in a leaf-litter nest.**



STEVE VAN DYCK

Hedging our bets near Cloncurry. An active mound, a fly-wire fence, and a live trap or two where a new species of pebble-mound mouse was found during this study.

patrius, a little mouse of confused scientific identity. This species had not been knowingly seen alive by anyone since 1907 when the original six specimens were dug up by William Stalker from Mt Inkerman, near Ayr, in tropical coastal Queensland. These specimens are kept in the Natural History Museum, London (which does not usually lend such material for comparative research).

But while Australian and British correspondence crisscrossed in a series of questions and answers regarding diagnostic features of the skulls, geologists from the Department of Mines and Energy arrived at the Queensland Museum with photos of multiple mounds from the Clermont area. With the field of interest broadening as it was, Jenny and I decided to send a short article on the mouse, along with photos, to 53 regional Queensland newspapers, hoping this would open up the issue and allow us to look at the variation that occurred naturally in the species. (What if the single Charters Towers specimen was nothing more than just a slightly-out-of-whack Delicate Mouse *Pseudomys delicatulus*, which is superficially similar to *P. patrius* and thought by some to be identical to it?)

In the meantime more inexplicable waves of unsolicited reports of pebble piles started coming to us from Queensland-based geologists. Even a visiting professor of zoology from California State University at Fullerton had posted me a preserved mouse he had found among strange pebble mounds near Paluma during this period. Not long after the newspaper articles came out, we received a trickle of replies from graziers, national parks rangers, naturalists and tree poisoners from as far as Camooweal on the Northern Territory–Queensland border through 18

BRUCE COWELL/QUEENSLAND MUSEUM

***Pseudomys patrius*, the first photographed pebble-mound mouse from Queensland. This 12-gram female was caught by Jenny Birch near Charters Towers.**

other sites down finally to Kilkivan, just two-and-a-half hours north of Brisbane. The Natural History Museum (London) agreed to lend us one of the original Mt Inkerman mice, and it could now be compared against the 17 Queensland specimens we had been able to either collect by live-trapping (ten), extract as bone fragments from regurgitated owl pellets (five), or find among incorrectly identified specimens (two) already in the Queensland Museum collection.

Beyond a doubt, all the tiny mound-builders from along the Great Dividing Range and major associated ranges between Paluma (near Townsville) in the north-east, out in a rough semicircle through Burra Range, Clermont and Springsure in the central-west, and then back east to Kilkivan belonged to the once-presumed-extinct species *Pseudomys patrius*. A prodigal native pipsqueak had resurfaced after 89 years of unobtrusive quarrying.

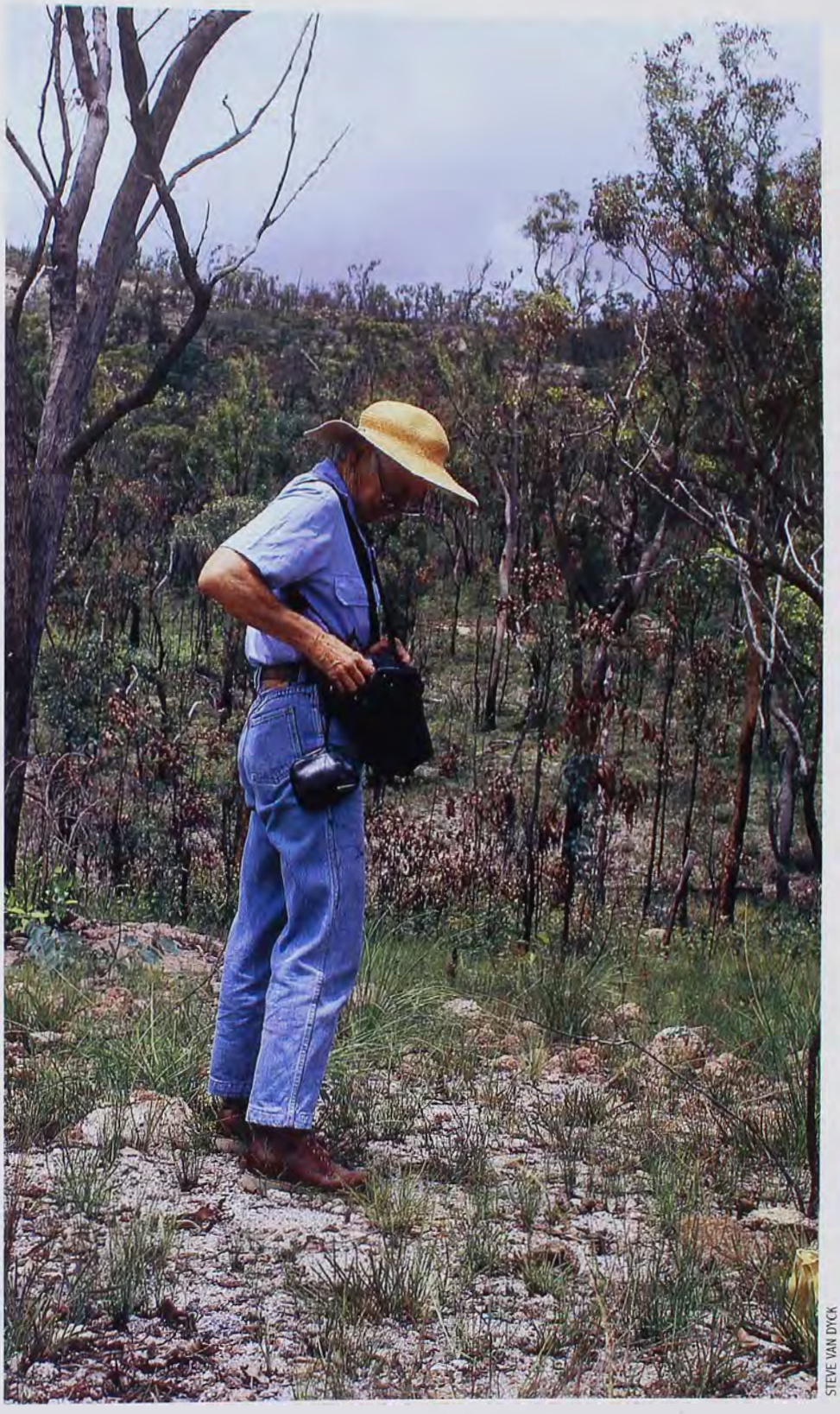
SOMETHING NEW...

Well to the west of the Great Divide, however, the little pointy-faced pit-workers from the spinifex and gibber around Cloncurry, Mt Isa and Camooweal represented a new species currently being described. Here we have found a great disparity in the number of records of rocky mounds compared to those with mice actually at home. In fact at this stage only a single carefully grazed property near Cloncurry is known to support living representatives of this new (and jealously guarded) species. In many ways this is to be expected, given the higher density of mound-conscious geologists in that mineral-rich area compared to regions farther to the east. Most sites we simply have not yet been able to get to, but some we have investigated and in these mouse-scarce areas, feral cats, full of everything from grasshoppers to kangaroo carrion, have been watched at night sitting on top of pebble mounds presumably waiting for the workers to emerge. Talk about trouble at the mines!

Feral cats, full of everything from grasshoppers to kangaroo carrion, have been watched at night sitting on top of pebble mounds presumably waiting for the workers to emerge. Talk about trouble at the mines!

SOMETHING BURROWED...

Both Queensland species of pebble-mound mice build shallow burrows under their pebble volcanoes and goolie carpets. Theirs is a harsh niche of scalding summers, skeletal soils and tough tunnelling. Gathered marbles not only form a doona over the burrows but are also pulled inside and packed throughout the burrow system. One or two inconspicuously plugged pop-holes, not so heavily fortified and not far from the main 'volcano', wait ready to conduit exiting mice to freedom should a goanna or a dog start scratching at the big entrance. The combined effect of all the pebbles may be good for both protection and insulation. But they may also serve



STEVE VAN DYCK

Exploration geologist Jenny Birch, whose determination led to the rediscovery of *Pseudomys patrius*.

another purpose. The little rocks are picked up and carried around in the mouth and patted into place with the forefeet, rolled along under the body and kicked with the hind feet. What goes on to each smooth pebble surface in the way of spit and polish must, to an itinerant mouse, read like a Lonely Hearts clientele prospectus. In fact the whole pile might act like a cross between a flashing neon light and a smelly armpit humming with sniffable information about the occupants and their potential state of play. In this connection it is interesting to note that, unlike most other native mice, pebble-mounders (at least those from Queensland) produce a strong, but not entirely unpleasant, aroma when housed in captivity.

SOME THINK DEW...

Biologists in the past have suggested that pebble piles are constructed as dew-collecting surfaces, and this is probably also correct. In Queensland, it seems the farther west you go, the broader the pebble piles become. Certainly in more heavily vegetated coastal areas where morning dews are common on rocks and plants, mounds are often no more than a few dozen pebbles around a burrow entrance. Out at Camooweal, where a good dew is worth bottling, marble carpets measuring more than four metres across are not uncommon. But even more astonishing is another water-collecting tactic used by *Pseudomys patrius*. Near Clermont, in perishingly dry ridges of the central-west, some burrows are built among the roots of living, scrawny eucalypts. Under the surface, bark is stripped from the roots and free water drips into the burrow system, cooling and humidifying the plugged-up tunnels, and, presumably, providing water to mop the brows of the furry miners.

But back to another sweating brow... The airport officer, to his great credit, agreed that the lives of the passengers and crew might not be 'undewly' inconvenienced by a restrained pebble-mound mouse, so long as Nell kept her promise that the handbag was to be kept shut during the flight. "And that wasn't all that had to be kept shut", he had said with a touch of a grin. More specifically, the word 'mouse' was not to pass Nell's lips given that for some in-flight company the word could elicit more panic than a brandished grenade. Nell boarded the plane, and she and the mouse went safely through to Brisbane. Without observant geologists, graziers, bush naturalists, and devoted professionals like Jenny Birch (and Nell Mott), Queensland pebble-mound mice might still be hidden under the tailings. ■

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Many surfaces of apparently barren, lifeless deserts are teeming with tiny lichens, mosses and liverworts.

CARETAKERS OF THE DESERT

BY DAVID ELDRIDGE

SEMI-ARID AND ARID LANDSCAPES occupy nearly three-quarters of the land area of Australia. The climate in these environments is typically dry and unpredictable, and the soils generally infertile. Consequently the plant and animal communities they support have had to adapt over millions of years to the special limitations placed on them. Droughts are a common occurrence in these environments, as are periods of plenty when swollen lakes and rivers support a multitude of wildflowers, insects and bird life in an area that is normally devoid of such organisms.

HEINO LEPP

Biological soil crusts, made up of mosses, lichens and liverworts, cover large areas of Australia's arid and semi-arid rangelands. These tiny plants are vital for the health and stability of our rangelands.

The surface of *Eremastrella crystallifera* resembles a series of pyramid-shaped crystals which are thought to allow the lichen to regulate temperature.

Against this backdrop of boom and bust in the desert live the tiny mosses, lichens and liverworts, eking out an existence in an environment where temperatures can drop below freezing during winter, or soar above 60°C in summer. These tiny caretakers of the desert hold the fragile soil surface together, as well as providing nutrition and shelter to a host of small plants and animals.

Many surfaces of apparently barren, lifeless deserts are teeming with tiny lichens, mosses and liverworts. When these organisms establish themselves in the top few millimetres of the soil, they produce a biological soil crust. These biological crusts, also known as cryptogamic or microphytic crusts, are a closely knit community of fungi, cyanobacteria (blue–green algae) and bacteria, as well as the more visible mosses, lichens and liverworts. They are common across much of the winter rainfall areas of southern Australia, where they thrive on soils rich in calcium carbonate.

The biological nature of these crusts separates them from physical soil crusts, which often result from raindrop impact or erosion, and are regarded as undesirable. Instead, biological crusts are alive, and remain in a sort of dormancy when the seasons are unfavourable. They are easily visible to the naked eye even when conditions are dry. To the observant, they appear as tiny greenish, brownish, whitish or blackish warts, bumps, scales, tufts or straps on the soil surface, often blending in with the brown or red soil. Their suspended animation is quickly broken by even small falls of rain or dew, as crust organisms rapidly spring to life. Within minutes mosses begin to unwind and photosynthesise. Tiny algae and cyanobacteria, both free-living and in the lichens, absorb water, turning green or blue–green. Strap-like (thallose) liverworts slowly begin to unfold, exposing their delicate green photosynthetic surfaces to the sunlight.

Despite their widespread distribution, little is known about biological soil crusts or the ecology of their organisms. Pioneering work in the late 1960s by Rod Rogers, now Associate Professor of Botany at the University of Queensland, showed the extent to which landscapes in southern Australia are dominated by soil crusts. His collaborative efforts demonstrated that soil crusts supplied substantial amounts of nitrogen to Australian deserts. Although reported in the prestigious British journal *Nature*, the value of this early work was not fully appreciated.

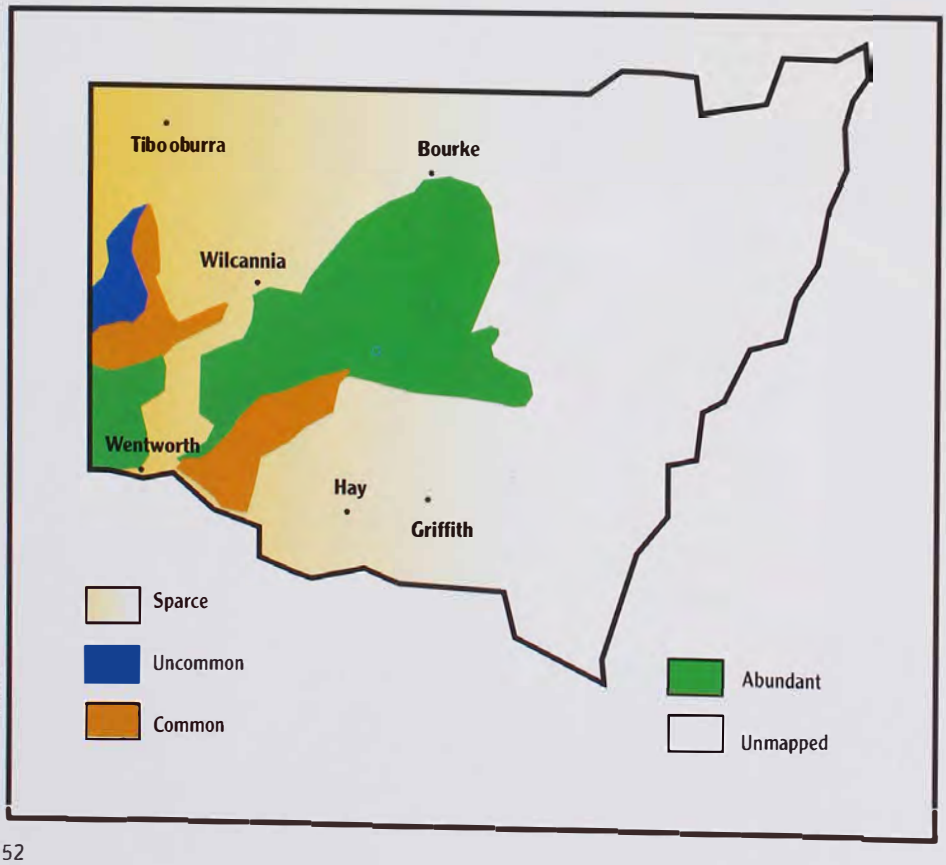
Why are mosses, lichens and liverworts so abundant in such harsh environments? It is probably because their small size and their ability to exploit small patches in the environment mean that they are not competing directly with flowering plants for the same territory. Equally important, many of these organisms have evolved specialised mechanisms that allow them to cope with life in a harsh environment.

These tiny caretakers of the desert hold the fragile soil surface together, as well as providing nutrition and shelter to a host of small plants and animals.

LICHENS RESULT FROM A COMPLEX AND highly successful symbiotic relationship between a fungus and an alga. The composite organism behaves as a single

***Funaria hygrometrica* is one of a group of gregarious mosses that often appear after fire. Each tall, reddish stalk is up to three centimetres high, and supports a capsule in which hundreds of tiny spores are located. Although the *Funaria* group is common in rangelands, plants with capsules are usually only found after wet periods.**

PHOTOS: HEINO LEPP



COURTESY DAVID ELDRIDGE

entity, with the alga providing sugars through photosynthesis, and the fungus using these sugars and providing the alga with shelter, moisture and nutrients. Approximately three-quarters of Australia's soil lichen flora is made up of crusty (crustose) and scaly (squamulose) lichens. These types are often rather dull and unattractive, and would seldom be recognised as lichens by most people. Crusty lichens are almost two-dimensional, lacking a discernible lower surface. This means that they are usually tightly bound to the soil, which provides them with most of their moisture and nutrients. The body or thallus of scaly lichens is much thicker, and is often anchored to the soil by rhizines or holdfasts. In arid Australia, less than a quarter of our soil lichens have leafy (foliose) and shrubby (fruticose) growth forms. These forms are more common in the higher rainfall areas.

Diploschistes thunbergianus is a common crusty soil lichen, whose thallus is

Crusts indicate how healthy the land is—the more species of mosses, lichens and liverworts, the healthier the soil. This map shows the abundance of crusts over much of New South Wales.

When dry, the leaves of *Triquetrella papillata* moss appear rope like. When wet, they rapidly open up covering large areas of the soil.

for meat and milk.

Chondropsis semiviridis is an amazing lichen that spends most of its time rolled into a marble-sized ball blowing freely across the soil. When wet, the lichen gradually unrolls, flattening out into a series of lobes less than five millimetres across. It is one of the few unattached or vagant (from the Latin word *vagare* meaning to wander) lichens found in Australia. Another vagant lichen, in the genus *Aspicilia*, is common in the Middle East and is thought to be what was referred to as the "manna from heaven" in the Bible. Its close relative in Australia *Aspicilia calcarea*, however, is always attached to rock or soil. Interestingly, when attached to soil *A. calcarea* has a crusty appearance, but when attached to rock it often changes to a shrubby form.

Soil lichens come in a wide variety of colours. These colours reflect the numerous chemicals present in their tissue and sometimes the environment in which they live. Chemical differences are often so distinct that they are used to classify lichens, along with the usual physical characteristics. Lichens are known to produce certain chemicals in response to environmental stress, and for centuries these chemicals have been used to make litmus paper, to treat cranial disorders and skin infections, to set perfumes, ferment beer and make toothpaste, among other things. Some have even been used to poison wolves.

Mosses and liverworts (together known as bryophytes) tend to become less conspicuous as conditions become more arid. In dry areas, mosses have a number of drought-survival mechanisms. *Didymodon torquatus* and *Barbula calycina* are two of many mosses that survive drying out by curling and twisting their leaves around their stems. This twisting encases the whole plant in an armour-like structure formed by the dark-coloured midrib and lower surface of the leaf. This action reduces the whole surface area of the plant, and protects the more delicate upper photosynthetic surface of the leaves. *Barbula crinita* is a moss associated with soil crusts in open woodlands and low shrublands. In these environments it often grows to more than a centimetre high. When the leaves are dry and twisted, long fine hairs on the ends of the leaves insulate the plant against the sun, and collect moisture when conditions are damp. After rainfall the grooved

made up of dozens of tiny segments (areoles), each less than a millimetre wide. Together these whitish-grey segments form a large patch of lichen that resembles a large bird dropping many centimetres across. The thickened, leathery surface protects it against physical damage and aids in temperature control. The surface of the scaly lichen *Eremastrella crystallifera* resembles a series of pyramid-shaped crystals. This crystalline shape is thought to minimise heat absorption, but may also be useful for channelling water into the centre of the thallus. *Cladia aggregata* is a common shrubby lichen that grows on soil and rocks, and comes in various shapes and colours. Closely related species from the northern hemisphere, known as 'Reindeer lichens' (*Cladonia* spp.), are an important food for Reindeer or Caribou (*Rangifur tarandus*) during their winter migrations, but also absorb heavy metals and radioactive fallout. Unfortunately these substances accumulate in animal fat tissues, posing a health risk to humans who rely on the animals

The greyish shrubby lichen *Cladia corallaizon* often occurs over large areas of the soil in dry forests on the edge of the rangelands.

PHOTOS: HEINO LEPP

PHOTOS: HEINO LEPP

***Asterella drummondii* is a large plate-like liverwort, common in higher rainfall rangelands or below rock outcrops where water accumulates. After rain, (bottom) the plant uncurls, moving the scales away from the top of the plant and exposing the green photosynthetic structure inside. These liverworts may open up after less than a millimetre of rain. As the plant dries out, (top) the sides curl inwards and the plate-like scales cover and protect the plant from the scalding sun.**

leaves channel water into the interior of the plant. The silvery transparent leaves of *Bryum argenteum* and *Gigaspermum repens* act as shields, protecting the plants against sunlight as well as mechanical damage.

The other group of crust organisms, the liverworts, is so named because some are supposedly shaped rather like a human liver. Liverworts are among the most ancient plants on Earth, and in the 16th century were used as medicines in the belief that they would cure liver ailments. The liverworts *Asterella drummondii* and *Riccia limbata* look rather like forked or Y-shaped straps on the surface of the soil. As the plants dry out and the sides curl inwards, purplish-black plate-like scales up to a millimetre across on the lower surface close up like a giant clam, protecting the plants from the sun like sheaths of armour. When the plants are wetted again, the scales retract in less than an hour, and the porous upper surface of the liverworts is able to soak up and store moisture. When fully open these plants can cover extensive areas of the soil surface, providing an effective barrier against wind and water erosion.

IN AUSTRALIA MUCH IS KNOWN ABOUT THE loss of biodiversity of animals and flowering plants after 200 years of European occupation. However there is little known about the biodiversity and conservation status of arid-zone lichens, mosses and liverworts. During the past four years, together with colleague Merrin Tozer from the Department of Land and Water Conservation, I have been studying biological soil crusts over a wide area of semi-arid and arid New South Wales. We examined more than 300 sites over an area of 600,000 square kilometres as part of a larger project to assess the importance of soil crusts in sustainable land use, as well as in soil and erosion processes. Our research confirmed that soil crusts are widely distributed in most landscapes, except the mobile dunes associated with the Strzelecki dune fields where New South Wales meets South Australia and Queensland. Across the western part of the State, more than 120 species of mosses, lichens and liverworts are associated with soil crusts, and these crusts are most strongly developed in the semi-arid woodlands between Bourke and Cobar, and in the mallee (*Eucalyptus* spp.) and Belah (*Casuarina cristata*) plains in the far south-west.

Our field survey showed that, although a core group of about 15 moss and lichen species dominated most sites, some species were restricted to only a few sites. Three mosses, *Archidium stellatum, Bryum caespiticum* and *Bryobartramia novae-valesiae*, were reported for the first time for western New South Wales, and the tiny, rarely collected moss *Stonea oleaginosa* turned out to be very common on arid soils. Its reddish colour, resembling the red sand grains typical in arid Australia, provides the perfect camouflage. Some lichens, in particular *Peltula imbricata, Acarospora reagens* and *Xanthoparmelia constipata,* were found only in areas where sheep and cattle had been excluded for more than 50 years.

The soils of arid and semi-arid Australia generally have low natural levels of aggregation; that is, they tend to disintegrate when disturbed. Trampling by sheep and humans, as well as damage from motorbikes and off-road vehicles, tends to pulverise the soil, making it easy to wash or blow away. However, free-living cyanobacteria in the crusts, and hyphae from the fungal component of the lichens, exude gel-like substances that glue tiny soil particles into larger particles, holding the soil together and making it less prone to erosion. *Microcoleus vaginatus* is a free-living cyanobacterium that is common in crusty soils. It consists of a bunch of finger-like filaments enclosed in a large sticky sheath, rather like a tube worm. When the soil is wet, the sheath swells, forcing the filaments out into the soil. As the soil dries out, the filaments manufacture their own sheath material, and eventually the soil is crowded with these sheaths, like the fibres in

fibreglass. Old sheath material may remain for many years, gradually increasing the organic content of the soil, and providing a source of nutrients for soil animals such as mites and termites.

The crust is an important habitat for microscopic soil animals. Mites and other soil invertebrates digest cyanobacteria and lichens, releasing nitrogen and making it available to plants. They also increase the level of organic matter in soils, helping to bind the soil together. In turn, mites are preyed upon by larger soil animals whose burrows increase aeration and infiltration of water through the soil.

Experience suggests that crusts will protect the soil surface as long as it is not too disturbed by trampling. Early work by Rod Rogers showed that sheep congregating close to a dam eliminated many soil crust lichens. In an attempt to get more objective information on how much trampling soil crusts can tolerate, we designed an experiment where we subjected 25 slabs of undisturbed, crusted soil 50 centimetres long by 25 centimetres wide to a range of stocking rates (zero to 1.6 sheep per hectare). Trampling was done using an artificial sheep hoof, after which the soils were subjected to an artificial rainstorm using a raintower at the CSIRO's Division of Soils in Canberra. The trampling treatments were carefully designed to mimic as closely as possible the range of stocking rates found in western New South Wales, and were based on calculations of how far a sheep walks in 12 months, and the number of impacts a hoof makes on the soil surface. For trampling rates up to 0.8 sheep per hectare, erosion was surprisingly low, provided there was sufficient crust remaining on the surface to trap any eroding sediments. Only after severe trampling (equivalent to 1.6 sheep per hectare, which would occur close to watering points) was the soil crust completely pulverised, making re-establishment of the crust extremely difficult.

Xanthoparmelia species are yellow leafy lichens that are particularly susceptible to trampling. Although these lichens spread by spores, they are thought to spread mainly by vegetative means, whereby small fragments of the thallus detach and scatter to new sites. While low rates of trampling produce many potential new lichens for dispersal, excessive trampling completely destroys these lichens. Consequently, the presence of *Xanthoparmelia* species on the soil surface usually indicates that the soil is well managed.

Studies at Koonamore Vegetation Reserve in South Australia's pastoral zone indicate that recovery of soil crust organisms after overgrazing and trampling is very slow, and may take more than half a century. Some species recover faster than others. For example, cyanolichens such as *Collema, Heppia* and *Peltula* species, which have a blue-green rather than green algal component, are better adapted to soils recovering from erosion than other lichens because they are able to fix their own atmospheric nitrogen. Increasing levels of nitrogen and other essential minerals, produced by cyanolichens and free-living cyanobacteria such as *Microcoleus vaginatus*, pave the way for establishment of other lichens and mosses, and eventually, flowering plants.

When dry, this lichen (*Chondropsis semiviridis*) rolls up like a ball and is free to blow across the land, often piling up on fences. When wet, the lichen unfolds and begins photosynthesis within 30 minutes.

As with other organisms, the best way to ensure the biodiversity of soil crust lichens, mosses and liverworts is to sustainably manage the landscapes in which they live. In Australia's arid and semi-arid rangelands used for grazing, this means adopting management strategies that do not pulverise the soil surface, such as running stock over large paddocks, increasing the number of watering points in each paddock, and restricting motor vehicles to defined tracks.

But the first step to managing biological soil crusts is to be aware that they exist and are important. The constituent organisms may be tiny, and often difficult to see, but their influence on the ecology of arid and semi-arid landscapes makes them particularly deserving of our attention.■

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Dr David Eldridge is a Research Scientist with the New South Wales Department of Land and Water Conservation, and is based at Macquarie University's Graduate School of the Environment. He has a long-standing interest in arid-zone ecology, and has concentrated recently on how soil crusts, ants and termites influence landscape and ecological processes in rangelands.

The male tests the acoustics of the burrow at several stages of construction by standing in the singing position and producing a few chirps, like a musician tuning his instrument.

THE HARMONIOUS MOLE CRICKET

BY ALISDAIR G. DAWS

AT DUSK ON WARM SUMMER evenings, the strains of insect song drift through the air as males of various species try to attract a mate. The well-known sounds of cicadas and crickets are heard throughout the countryside and deep into suburbia, where they form a familiar backdrop to conversation around dinner tables and backyard barbecues. Many of us clambered into trees as children, risking life and limb to capture cicadas prized as much for their brilliant colours as for their song. Common field crickets also have a special place in both folklore and peoples' hearts. Their glossy black bodies and cheerful chirping were thought to bring good luck to a household. Walt Disney even deemed crickets sufficiently charismatic to warrant their own cartoon character. However, there is another type of cricket that is little known and rarely seen, even though they sing from right beneath our feet. Mole crickets, found throughout Australia, are among our most remarkable singing insects, yet they are also among the least recognised.

Mole crickets spend most of their lives under ground, feeding on the roots of plants and other organic material. They have specialised forelegs, shaped a little like garden trowels, which they use to dig an extensive network of tunnels. The entrances to these tunnels are generally obscured with a thin layer of soil or dead leaves to deter unwanted visitors from venturing within. At dusk, the female mole cricket leaves the shelter of her burrow to fly clumsily through the sky in search of a suitable male. She chooses her mate by the quality of his song; however, this can be difficult because, when it comes to singing, mole crickets are virtuosos.

MOLE CRICKETS PRODUCE THEIR SONGS in much the same way as other crickets: by rubbing their wings together. This process, called stridulation, involves drawing a hardened scraper on the inner margin of one wing across a row of tiny raised teeth on the underside of the other wing. This action is similar to running your thumbnail along the teeth of a comb. With each closing stroke, a thin region of cuticle at the centre of the wings, known as the harp, vibrates to produce an almost pure tone. The frequency of this sound is specific to each species, and so can be used by females and males alike to identify a calling individual, although only males produce a calling song.

Mole crickets are unusual in that, unlike most other crickets, females possess a rudimentary stridulatory appara-

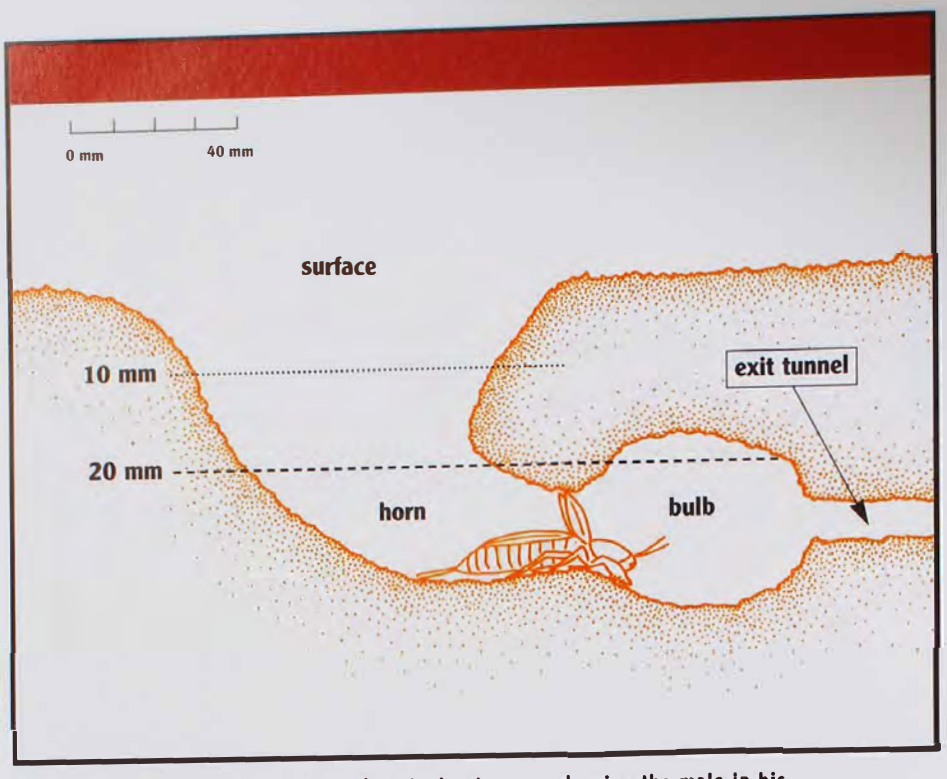
REG MORRISON

The specialised forelegs of mole crickets are shaped like garden trowels and enable them to dig extensive networks of tunnels.

tus similar to that of males. Females of some species have been observed responding to a calling male with quiet chirps once within his burrow.

In mole crickets, the male remains under ground, and calls from within a specially constructed singing burrow, which connects to the rest of his tunnel network. The singing burrow of *Gryllotalpa australis*, a mole cricket found in the south-east of Australia, allows the male to produce one of the loudest songs recorded in the insect world. Only certain cicada species are known to produce songs louder than those of mole crickets. Depending on the species, mole crickets may construct a fresh singing burrow every night or use the same one for up to a week, and different species dig burrows with slightly different shapes. The male tests the acoustics of the burrow at several stages of construction by standing in the singing position—a specific spot in the burrow—and producing a few chirps, like a musician tuning his instrument. As the burrow approaches completion, which may take up to 15 to 25 minutes, these chirps become louder and the frequency of the song becomes more pure. Finally, the mole cricket launches into song, a long, continuous train of pulses which in *Gryllotalpa australis* has a frequency of about 2.5 kilohertz, or 2,500 cycles per second. The song he produces from this special singing burrow is more than 200 times louder than if the mole cricket was singing on the surface.

This remarkable feat of acoustics relies on the shape and dimensions of the singing burrow. The burrow has two main components: an outer flared horn, which opens to the surface, and an inner ellipsoid chamber called the bulb. The singing position of the mole cricket is at the point where these two components are joined by a narrow constriction. The insect places himself with his head and thorax in the bulb, and his abdomen in the throat of the horn pointing towards the surface. While stridulating, he raises his wings so they effectively block the narrow junction between the horn and the bulb. As sound is radiated from both the inner and outer surfaces of the wings, two sound waves are produced during stridulation: one is directed into the bulb and the other into the horn. By placing his wings in the constriction, the



ALISDAIR DAWS

A side-on view of a typical mole cricket singing burrow, showing the male in his singing position.

AUSTRALIAN MOLE CRICKETS

Classification
Order Orthoptera, family Gryllotalpidae. Five genera with 50 spp. worldwide. Australia has 12 native *Gryllotalpa* spp. (plus several undescribed) and one introduced *Scapteriscus* sp.

Identification
Near-cylindrical body, usually 25–35 mm long. Colour ranges from rusty brown to blackish brown. Distinguishing features include large shield-like pronotum extending posteriorly from head to base of wings; and forelimbs bearing claw-like projections adapted for digging. Juveniles smaller than adults, and do not possess wings. Females have a long, slender ovipositor projecting from posterior of abdomen.

Habitat and Distribution
Found all over Australia, from coastal regions to far inland, usually in moist soil or close to water.

Biology and Behaviour
Males produce among the lowest-frequency calls of all insects, from specially constructed singing burrows. These are used to attract females, which may lay their eggs in the male's burrow after mating. Females of some species remain nearby until eggs hatch, giving impression of parental care. Life cycle lasts 1–2 years, with newly hatched larvae undergoing several juvenile stages before becoming mature adults.

mole cricket largely prevents the sound waves from one side of the wings leaking around the edges to interfere with the sound waves produced by the other side of the wings. African and North American tree crickets achieve a similar effect by chewing a hole in a leaf, and then singing with their wings placed in the hole. Such a device to minimise acoustic interference around the edges of a sound source is known as a baffle. However, this baffling behaviour is just the first example from the mole crickets' acoustic bag of tricks.

THE HORN OF THE singing burrow is flared in much the same manner as that of a tuba, and for the same reason. Small sound sources, such as the wings of a mole cricket or the mouthpiece of a tuba, are not very good at producing low-frequency sounds. But low-frequency sounds travel farther than high-frequency sounds, and so, for the cricket, are likely to attract females over great distances. One way to improve the situation is to guide the sound wave along a flared horn. The area of the wavefront increases as it travels the length of the horn until, by the time the sound wave reaches the end of the horn, it is great enough to propagate low-frequency sounds effectively. So, just as the broad, flared horn of the tuba allows it to play deep, booming bass notes, the flared horn of the singing burrow allows mole crickets to produce songs with some of the lowest frequencies of all singing insects.

The mouth of the horn is often split into two or four, so that there are a number of openings to the surface clustered close together. This arrangement affects the way sound is radiated from the burrow, further increasing the effective size of the sound source. Instead of being

ALISDAIR DAWS

An adult mole cricket at the entrance to its burrow.

radiated equally in all directions as an expanding hemisphere of sound from a single circular opening, sound waves emerging from the multiple openings are added together where they meet at the midpoint between the burrow mouths. The result is an elliptical wavefront that acts like an acoustic signpost; a female circling overhead is able to use the spatial pattern of the sound intensity to determine the location of a particular male more accurately. Why place a lonely hearts advertisement without providing directions?

The bulb of the burrow, the inner end of which opens into the mole cricket's network of tunnels, also serves a purpose. It would represent a considerable waste of energy if the sound wave directed into the bulb was lost in the tunnels, where a flying female would be unable to hear it. Instead, the mole cricket digs the bulb in such a way that sound is reflected from the far wall of the bulb, back towards the horn. When the reflected sound reaches the constriction, it is in phase with vibration of the wings, adding to the energy of this vibration and nearly doubling the energy of the sound wave in the horn. In doing this, the bulb acts like a cabinet placed behind a loudspeaker, maximising the amount of sound directed towards the desired audience.

Mole crickets have still other acoustic tricks. The combined length of the bulb and the horn is about three-quarters of the wavelength of the song frequency. This allows a standing wave to form within the burrow when the mole crick-

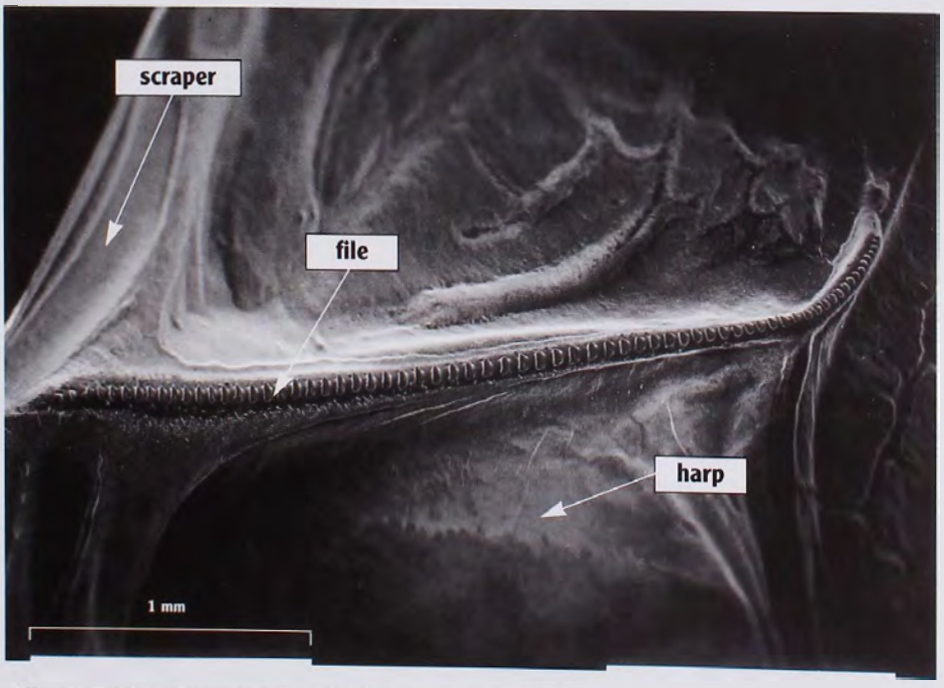
PAVEL GERMAN/NATURE FOCUS

A mole cricket singing on the surface would need about 100 times as much energy to produce the same amount of sound as one singing in its burrow.

et is singing. To picture what a standing wave looks like, imagine tying one end of a rope to a fixed object, and then flapping the free end up and down at just the right rate so that certain points along the length of the rope appear fixed, even though the rest of the rope is in constant motion. These points are called nodes, and a pressure node occurs within the singing burrow at the place where the mole cricket places his wings to sing. At this point the forces on either side of the wings are exactly balanced, which dramatically improves the efficiency of the mole cricket's stridulation. It would take a cricket singing on the surface about 100 times as much energy to produce the same amount of sound as a mole cricket singing within his burrow.

When this kind of wave occurs within a tube it is known as pipe resonance, after the standing waves that form within organ (and other) pipes. Effectively, the whole singing burrow acts as a pipe resonator tuned to the insect's song frequency, which allows the mole cricket to produce very loud, pure-tone songs.

Of the countless insects to be heard on a summer's evening, mole crickets hold a special place in the chorus. Many species of cicadas, field crickets, bush crickets, tree crickets, and even some moths, have evolved ingenious solutions to the problems faced by small insects trying to project sound far enough to be heard by a potential mate. Few of these, however, can compare with the complex behaviours of mole crickets as they build and tune their singing burrows. So the next time you hear the strains of a mole cricket song rising from the ground, stop and spare a thought for the remarkable feat of engineering right beneath you, and the tiny virtuoso that builds his own instrument. ■



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Mole crickets produce their remarkable song by rubbing their wings together. This scanning electron micrograph of the wing of a mole cricket shows the apparatus they use.

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Dainty Green Tree Frog (*Litoria gracilenta*) by Michael Prociv

Northern Orange-eyed Tree Frog (*Litoria xanthomera*) by Mike Trenerry

PHOTOART

TROPICAL FROGS

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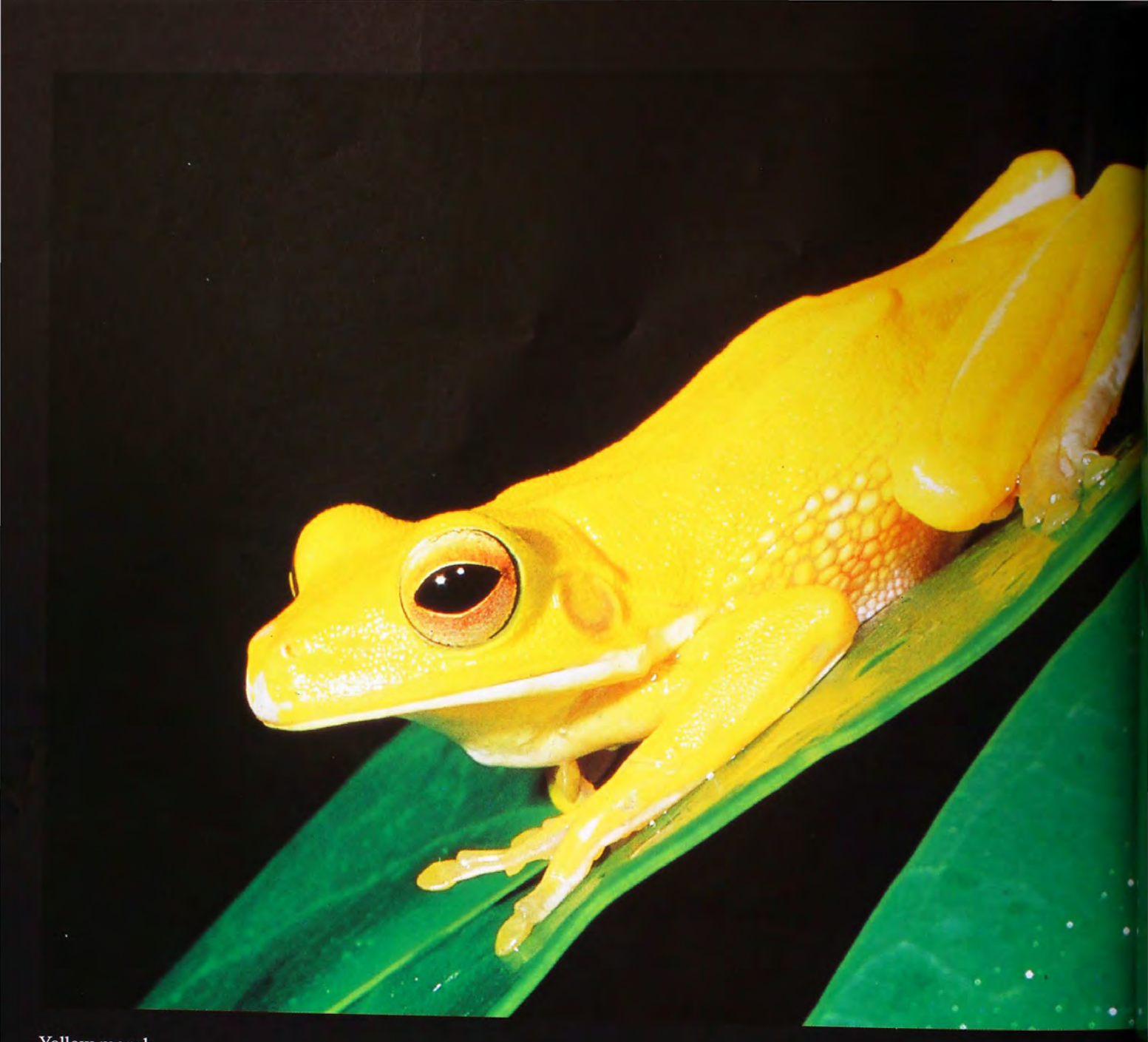

Yellow morph of the White-lipped Tree Frog (*Litoria infrafrenata*) by Michael Prociv

Northern Orange-eyed Tree Frog (*Litoria xanthomera*) by Mike Trenerry

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Desert Tree Frog (*Litoria rubella*) by Dominic Chaplin

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In some deposits, the number of wombat fossils was so great that the ground must have resembled an oversized Swiss cheese.

WORRIES ABOUT WITHERING WOMBATS

BY MICHAEL ARCHER

SUNDAY AFTERNOON FOUND us bouncing along another dusty track, trying to find a reportedly fossil-rich Pleistocene cave marked on our map of the Nullarbor Plain. When we arrived at Nullarbor Station homestead to ask directions, the owner greeted us at the gate with an enormous, fat and obviously relaxed Southern Hairy-nosed Wombat (*Lasiorhinus latifrons*) draped over his shoulder. While fossils of this species were common in the Nullarbor caves, this was the first live one I had ever seen. He offered us, besides directions, an invitation to a sumptuous dinner—this wombat's cousin done to a turn. Local high wombat numbers, and the fact that his house had almost been undermined by wombat burrows, enabled him to obtain a permit to occasionally make one the guest of honour for dinner. But after looking into the big brown eyes of his docile pet, we declined the otherwise attractive offer to help him eat away his problems and headed off in search of less tender fossil wombats.

Twenty years later even more interesting fossil wombats were found in the World Heritage fossil deposits of Riversleigh, north-western Queensland. Here were early Miocene 'protowombats' whose teeth had low crowns and long roots, suggesting they fed on soft, non-abrasive plants. Other early to middle Miocene 'protowombats' had teeth with longer crowns and shorter roots, suggesting they had adapted to more abrasive foods. By late Miocene time, Riversleigh's only modern-type wombat had appeared with teeth that were rootless. This adaptation enabled their teeth to grow throughout life like the incisors of a rodent or rabbit—the ultimate solution for a diet so abrasive that it probably wore away in one year more tooth crown than most humans will lose in a lifetime.

From other areas of Australia, the Pliocene and Pleistocene record then seems to explode with different kinds of rootless wombats, snuffling and snorting in all shapes and sizes right up to the late Pleistocene *Phascolonus gigas* whose skull was as big as a cow's. In some deposits, the number of wombat fossils was so great that, presuming they were all burrowers, the ground must have resembled an oversized Swiss cheese. Evidently, the spread of grasslands had triggered this, the finest 'hour' of the wombats.

Then crises resulting from late Pleistocene to Holocene climatic change, humans, agriculture and exotic pets began to take their toll. Now all except one group of wombats are extinct, the whole superfamily having been reduced to just three relatively similar species. One of these is the endangered Northern Hairy-nosed Wombat (*Lasiorhinus krefftii*), a wombat with a strange history of discovery. It had its scientific debut in 1872 on the basis of a fossil snout found in the Wellington Caves of New South Wales. Years later, living hairy-nosed wombats were discovered near Moonie River in southern Queensland, Deniliquin in southern New South Wales and Epping Forest in central Queensland. Although the Deniliquin and Moonie River wombats were named *L. gillespiei* in 1900 and the Epping Forest form was named *L. barnardi* in 1939, both species were concluded in 1983 to be the same species as *L. krefftii*. As a result of this taxonomic judgment, *L. krefftii* found itself rescued from the dead—a Lazarus among *Lasiorhinus*. It has been estimated that these populations would have held at least several thousand individuals. Unfortunately, as demands for agricultural land increased, the widespread warrens of this born-again wombat steadily emptied. By 1910 the Deniliquin and Moonie River populations were extinct and the Epping Forest population, at last count, was down to about 70 individuals, quite possibly the smallest number for any large mammal on Earth. Although rumours of other populations pop up from time to time, these are always of even smaller-sized groups.

Some geneticists argue that, if population numbers of any large mammal drop below 500, it is in serious trouble. For this reason, geneticists Andrea Taylor (now at Macquarie University), Bill Sherwin (University of New South Wales) and Robert Wayne (Zoological Society of London) have quantified just how much

DAVE WATTS/NATURE FOCUS

The Southern Hairy-nosed Wombat is one of the few representatives left alive today from a group that was once diverse and numerous.

trouble the Epping Forest population was in by examining the genetics of every individual. Similar studies of other endangered animals such as the Cheetah have revealed surprisingly little genetic variation from one individual to the next. In some respects, they are almost like clones of each other. Taylor and her colleagues found that an alarming decline in genetic variation had indeed occurred in the Epping Forest wombats. The reason seems to be that in small, isolated populations there is a greater likelihood that rarer bits of genetic variation simply fail to get passed on. For populations to stay healthy, it has been suggested they need as much genetic variation as possible to maximise their ability to respond to the demands or opportunities of a changing environment. Studies of captive Cheetahs have shown, for example, that they are poor survivors in situations where other genetically 'healthy' cats seem to do very well.

Taken as a whole, Australia's human populations are unlikely to confront problems such as those faced by the Cheetah or the Northern Hairy-nosed Wombat for at least the next million years or so, because we exist in such prodigious (probably excessive) numbers. What could, however, push us faster in a risky direction are our cultural taboos that combine with geographic barriers to restrict matings outside of our own 'clan'. As territorial primates paranoid about 'outsiders' moving in on our bananas, from time to time individual human groups attempt to lock themselves away from the rest of the world. Some of these, as a consequence, are now handicapped by genetic problems. Consider the relatively common occurrence of Ellis van Crevald Syndrome (dwarfs with 12 fingers) among members of Pennsylvania's Amish community whose individuals, for religious reasons, breed only among themselves. Similarly, the Royals of England, like closely bred families in many other areas of the world, have a legacy of genetic embarrassments. In all cases, regular marriages to genetically different 'outsiders' might have produced a 'hybrid vigour' that would have reduced or even given the flick to these problems.

Seemingly unaware of the long-term risks of isolation, Pauline Hanson, Australia's Honourable Member for Oxley in Queensland, has suggested that we 'wake up' and restrict immigration of Asians to maintain 'traditional' Australian values—'traditional' to her meaning the culture and skin colour of Australia's European invaders. But to put the brakes on biological or cultural change, for tribal, prejudicial or any other reason, may be in the long run to court the same sort of problems that threaten the Northern Hairy-nosed Wombat. For 3.5 billion years the capacity for change, not conservatism, has been Life's absolute requirement for long-term survival. The fossil record of humans, like that of wombats, is littered with the carcasses of species that were slower than others to change.

The future of Australians is surely far better served by maximising our biological and cultural diversity, particularly if this can increase our capacity for change. If as a result the cultures, skin colours or languages of Australians steadily change with time, that is something we should celebrate, not fear, as unmistakable signs of biological health. The last thing we should aim to become is living fossils of the colonial or any other period in time. Fear of change, whether cultural or biological, is something best left to fossils.■

Further Reading

Taylor, A.C., Sherwin, W.B. & Wayne, R.K., 1994. Genetic variation of microsatellite loci in a bottlenecked species: the Northern Hairy-nosed Wombat *Lasiorhinus krefftii*. *Molec. Ecol.* 3: 277–290.

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

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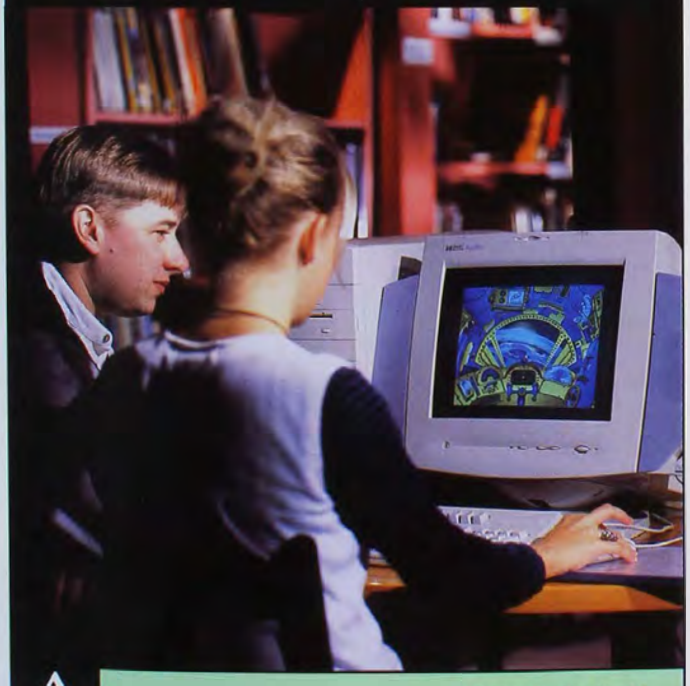

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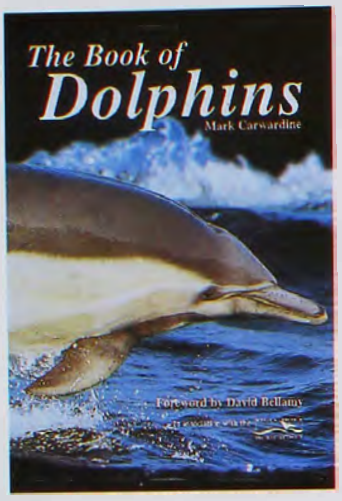
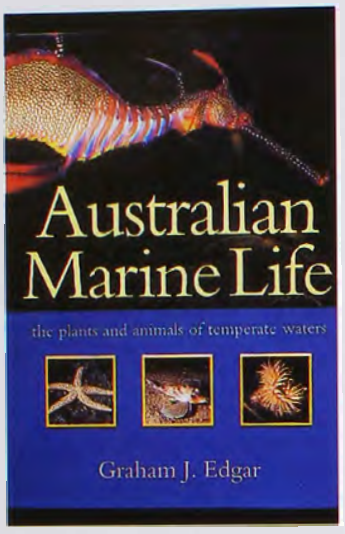


The Book of Dolphins

By Mark Carwardine. Lothian Books, Vic., 1997, 160pp. $55.00rrp.

Over the past few years there has been an explosion in the number of publications on whales and dolphins. This book, unlike many others however, has not tried to cover all the species in the order Cetacea but, instead, has concentrated solely on the dolphins. Even within this group, it does not attempt to cover all of them. This is not a book to use if detailed information is required about particular species, especially descriptions and distributions. Instead it provides general information on the basic biology and behaviour of dolphins. It also devotes a large section, some four chapters, to the topic of dolphins and their often fatal (to them) contact with humans. Topics covered include dolphin research, exploitation, conservation and just watching. As this book points out, it is often not even the direct contact that kills. Human actions at sea, be it fishing, recreational activities or garbage dumping, can have long-term detrimental effects on dolphins. They may choke on plastics, drown in nets, or they can be hit by fast-moving boats or killed by pollution. However, they can also entertain, enthral, delight and amaze. What can you do about protecting these mammals? That topic is covered as well.

—Linda Gibson
Australian Museum



Australian Marine Life: The Plants and Animals of Temperate Waters

By Graham J. Edgar. Reed Books, Vic., 1997, 544pp. $69.95rrp.

If you have ever walked along a beach, peered into a rock pool or snorkelled or dived in the southern half of Australia, and you have wanted to identify the organisms you have seen, then this is the book for you. •

The diversity and colour of the marine life of southern Australia is often considered second class to that of our tropical waters, which are dominated by in-your-face corals and fish. Yet southern Australia does have a similar diversity and is also full of beauty and colour. More importantly, many marine species, genera and even families are endemic, that is, they are found nowhere else.

Graham Edgar has obviously devoted a large amount of time to preparing this book. He has successfully presented a range of the diverse and unusual marine life of southern Australia. Each of the more than 1,200 species is illustrated with a small, but clear, good-quality colour photograph, and is supported by text that includes the species name, common name (if available), habitat, distribution in Australia and elsewhere, maximum size, and a brief but informative paragraph describing the characters that distinguish each species, and often some life history information as well. All this is written in accessible language that does not require a degree to understand. Occasionally technical words are used, but these are supported by a comprehensive glossary. And the excellent bibliography directs you to additional information on any particular group of organisms.

The coverage is impressive. It concentrates on species in shallow water (less than 30 metres) in southern Australia (Perth to Sydney), but also includes many tropical species that may be seasonally found in southern waters. It starts with the simplest organisms, bacteria and unicellular plants and animals (most of which can only be seen with the aid of a microscope); continues through the algae, fungi, plants (seagrasses and mangroves), invertebrates (sponges, worms, crustaceans, echinoderms), and the many obscure groups in between; all the way to the vertebrates (fishes, turtles, a few birds and marine mammals). It's not comprehensive, but does include almost anything you're likely to see while on a beach or in the water.

The introduction provides perhaps the best summary of the naming and classification system used for organisms I have seen. There is also an address to the author's WWW home page, which will be updated with changes to names or distributions. However, this had not been updated in time for this review.

Australian Marine Life is difficult to fault. Not all localities in the text are shown on the locality map, a few of the scientific names are now out of date, and there are a few errors in distributional limits; but these are trifling criticisms. Overall the book is accurate, well-edited and has an attractive layout.

This is an excellent guide for the money, and is accessible enough for the casual beachcomber, and detailed and comprehensive enough for divers, students and academics.

—Tom Trnski
Australian Museum

Birds of Queensland's Wet Tropics and Great Barrier Reef

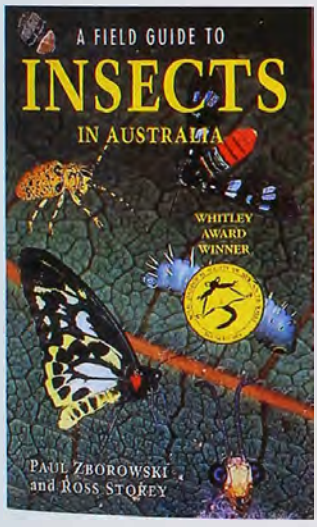
By Lloyd Nielsen. Gerard Industries, SA, 1996, 331pp. $29.95rrp.

This handy guide to the birds of north-eastern Queensland between Townsville and Cooktown is sure to be of assistance to any birdwatchers in the area. Most of the book is dedicated to an identification section that comprises illustrations and written descriptions which emphasise diagnostic features and similar species. Rather than being arranged in taxonomic sequence, as in conventional field guides, the birds are grouped by similar appearances, such as size, colour or posture. The illus-

trations should permit identification of most birds seen, but the range of plumages is not as comprehensive as in field guides. In this respect, this book would be best used as a companion reference to a field guide. In one area, however, it probably exceeds these guides in usefulness of identification. Groups of species offering particular difficulties in separation are considered in depth, detailing those characters that differentiate them.

The last two sections of the book deal more specifically with finding birds. The first treats each species individually, describing its status in the area, its habits and the localities at which it might be found. The second approach presents maps and written descriptions to the top birdwatching sites in north-eastern Queensland and lists of the birds that can be expected. This section will be particularly attractive to visitors. All in all, the book should prove a welcome resource for the northern Queensland birdwatcher.

—Walter E. Boles
Australian Museum



A Field Guide to Insects in Australia

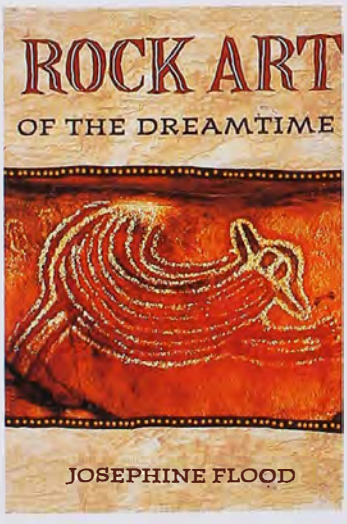
By Paul Zborowski and Ross Storey. Reed Books, Vic., 1997, 207pp. $29.95rrp.

This is a book that provides an excellent overview of the Australian insects and their classification. It is primarily designed to help the reader classify insects to the level of order and to some extent family as well. There are around 240 excellent colour photographs of live insects that represent almost as many families. Many high-quality line drawings complement the photographs. The authoritative text is concise and easy to understand and, while it is primarily designed for those with little or no prior knowledge of insects, it is not a superficial text. There are interesting chapters on insect structure, life cycles, mimicry, collecting and preservation. The overview of orders and families makes up the bulk of the book and is remarkably informative yet concise.

My only criticism is the over simplification of the key to orders, which has reduced its practical value. Unfortunately wingless ants and wingless termites will not key out. However, such shortcomings are largely overcome by the illustrations accompanying the key.

The overall quality of this book was recognised last year when it won the Whitley Award for Best Field Guide. It is already in its second printing, reflecting its popularity and usefulness. This book is good value for money and I strongly recommend it to anyone with a broad interest in insect identification.

—M.S. Moulds
Australian Museum



Rock Art of the Dreamtime

By Josephine Flood. HarperCollins, NSW, 1997, 372pp. $35.00rrp.

For at least 60,000 years the indigenous peoples of Australia have been transforming natural landscapes into culturally meaningful and relevant places in enduring, long-lasting ways. This was one of the ways people socialised the land and now more than 100,000 rock art sites, consisting of engravings, paintings, stencils, prints, and motifs made from native beeswax, dot the continent. But, unlike many other parts of the world, dozens of large, significant sites continue to be 'discovered' by scientists and amateurs each year. And also unique to Australia, there are still many knowledgeable elders who painted or engraved the land or witnessed their relatives adorning rock shelters with elaborate imagery when they were young.

There has been a steady interest in Australian rock art by non-indigenous people for over 220 years but since the early 1980s rock art research in Australia has increased at an incredible rate, so that each year a vast array of scholarly papers and reports burst into print. Lately there has been a trend to synthesise the new data with the old, and Josephine Flood's *Rock Art of the Dreamtime* is the most recent attempt. This well-written and well-illustrated account is both scholarly and a darn good read! Flood injects the thrill and excitement of discovery into the minds of the reader, as well as warning of the pitfalls of academic rivalry in the pursuit of knowledge. Although much of the book focuses on the more ancient forms of engraved art, Flood concludes with brief discussions about the contemporary Aboriginal significance of tropical Australia's wonderful rock paintings. If you are at all interested in Australia's past, I highly recommend this book. However, ideally it should be read in conjunction with Robert Layton's *Australian Rock Art: A New Synthesis* (Cambridge University Press, 1992) and Tim Flannery's *The Future Eaters* (Reed Books, 1994), in order to more fully experience the richness of Australia's unique past and its lessons for the present.

—Paul S.C. Taçon
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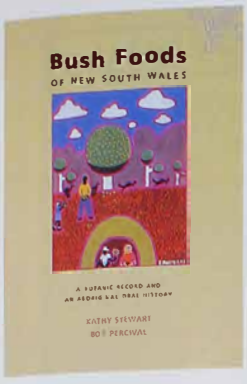

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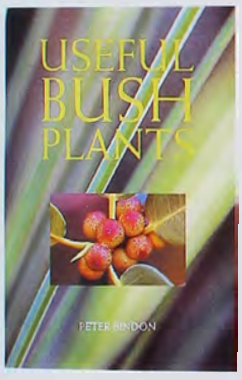

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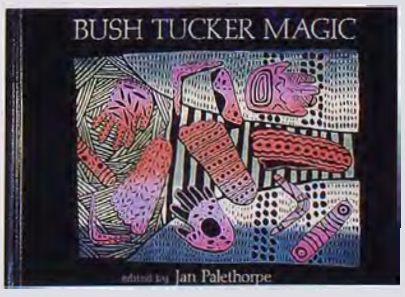

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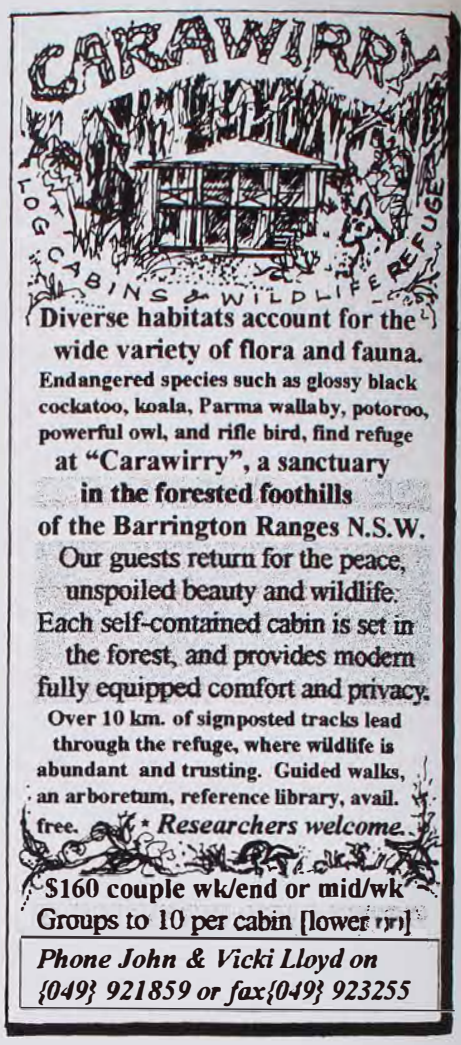

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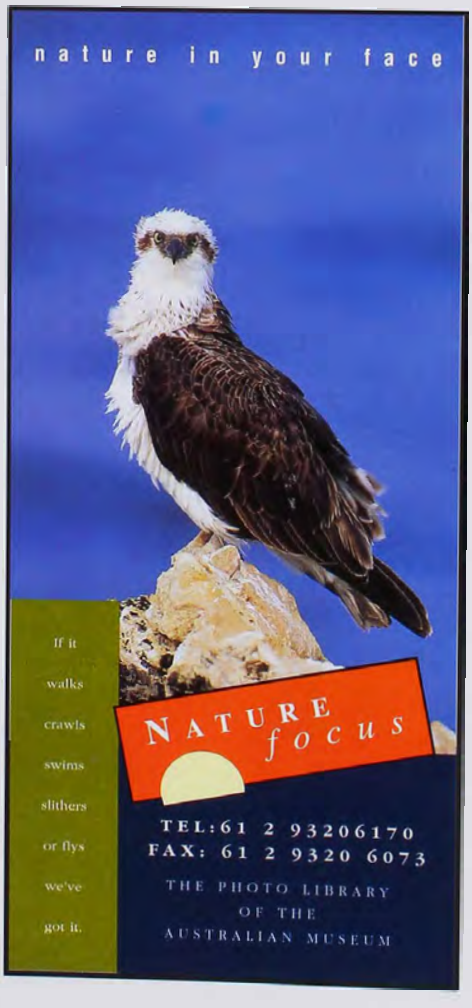

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Q&A

'Eyeballs'

Q: *I was bushwalking near the Glow Worm Caves at Newnes, New South Wales, approximately four weeks ago when I came across a series of shaded puddles with water trickling through them. They were about three to four inches (7.5–10 centimetres) deep and there appeared to be eyeballs floating in the puddles, which I presume were some sort of frog's eggs. They were about the size of a golf ball, a soft jelly consistency, mostly opaque bluish white, with a light clear brown 'iris' and a darker brown 'pupil', but I couldn't make out any particular shape. There were about 20 eggs in total, floating at different levels within the puddles depending on how developed the 'iris' and 'pupil' area was. The eggs sitting on the bottom of the puddle were mostly all white, while those that appeared to be more developed floated closer to the top of the puddle. I would appreciate any information you could give me about the eggs.*

—J. Bensley
Richmond, NSW

A: If each object was the size of a golf ball, they would be much too big for frogs' eggs as they are usually two to five millimetres in diameter (not including the surrounding jelly capsule). The fact that you could not distinguish any tadpole-like shape inside also argues against frogs' eggs. My colleague Michael Harvey has suggested the objects might be faecal sacs from a lyrebird chick. They are jelly-like with a deep brown centre and varying amounts of white excreta enclosed in the jelly.

—Liz Cameron
Australian Museum

Wayward Butterflies

Q: *I live in Hargraves, about 40 kilometres south-west of Mudgee, and on the afternoon of 28 October 1996 I witnessed what appeared to be a 'snow storm' of butterflies heading due east. It took about four hours to pass. I went to my copy of* Butterflies of Australia *by Common and Waterhouse and saw that they were Caper Whites and that the Australian Museum was doing research on them. Could you explain what they were doing in Hargraves and in such numbers?*

—Julie Wilson
Hargraves, NSW

A: Last October the phone lines ran hot with people from the Blue Mountains asking where the sudden influx of butterflies had come from. The simple answer was from the west. But, like all simple answers about insects, that was only part of the story.

The butterflies that you saw in Hargraves and that had suddenly appeared in the Blue Mountains were indeed Caper Whites (*Anaphaeis java*), a species that lives mainly on the western side of the Great Divide where their caterpillars feed and develop on caper trees (*Capparis* spp.) and Warrior Bush (*Apophyllum anomalum*). Each spring and early summer the butterflies migrate towards

Caper White butterflies have a characteristic white, yellow and black wing pattern that will help you identify them next time they get blown off course.

T. & P. GARDENER/NATURE FOCUS

PIC TEASER

Do you recognise this? If you think you know what it is, then send your answer to Pic Teaser, *Nature Australia* Magazine. Please don't forget to include your name and address. The first correct entry will win a $20 gift voucher for the Museum Shop Catalogue. Winter's Pic Teaser was the view into the hollow trunk of a Strangling Fig (*Ficus watkinsiana*).

PETER ROWLAND

the north, not stopping until they are well into Queensland. When this big flight happens to coincide with westerly or north-westerly winds, the butterflies are blown off course and when the winds are strong enough many of them are blown over the mountains into coastal New South Wales. There are a few caper trees in Sydney, and when the Caper Whites arrive they seek them out and lay thousands of eggs. The trees somehow cope with the defoliation by the caterpillars which follows, putting out another flush of fresh green leaves. If the butterflies are lucky, they will be able to resume their flight to Queensland but, if the winds are persistent, many of them are likely to be blown out to sea and lost. There have been times when they have been washed up in windrows on the beaches, so great has been the slaughter.

The migrations take place every year but in those years when the populations are naturally low you won't notice them unless you keep a careful watch and check the flight directions of the few you do see.

—Courtney Smithers
Australian Museum

Frogs and Pest Repellers

Q: *In my aquarium I have a number of tadpoles just turning into frogs, ever so cute and about the size of a ten-cent piece. In the next room I have an electronic pest repeller (an electrically powered device that produces an ultrasonic shriek) that is great for getting rid of mice, cockroaches, flies etc. The question I have is, will it affect my frogs? It does not bother the adults outside in the fish pond and it did not worry the tadpoles as they were under water.*

—Marion Field
Geraldton, WA

A: Your pest repeller probably won't upset your frogs and tadpoles if it hasn't upset them already. Unfortunately, from some reports I have read it may not worry your household pests either! I've seen an experiment where one type of electronic repeller (brand unspecified) was placed in a container with a colony of cockroaches. Not only did they not seem disturbed by it, they ended up living inside it as the electrical activity made it a nice, warm breeding site! Such may not be the case with yours though.

Frogs usually respond to sound frequencies similar to the range they produce themselves and either ignore or don't hear others unless there is a good reason to do so (for example, the ultrasonic cries of frog-eating bats!). Also, as frog breeding sites often contain many species with a range of volumes and sound frequencies, it isn't too surprising that they seem tolerant of your repellent. Should you notice any interesting results with other frog species, record your findings and contact your State natural history museum as the results may prove of use in the future! You will, however, need to identify both your current species of frog and any others you observe for the results to be useful.

—Martyn Robinson
Australian Museum

Answers to Quiz in Nature Strips (page 17)

1. Nitrogen
2. By day
3. Anti-clockwise
4. Humans
5. Mars
6. Australia and New Zealand Association for the Advancement of Science
7. Two
8. Scent
9. Giant Panda
10. Orca

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The present predicament of the Kangaroo Island population is surprising only in that it took so long to occur.

KOALA POLITICS

BY ROGER MARTIN

LATE LAST YEAR THE Minister for Conservation in South Australia announced that his Government would spend $635,000 on sterilising and translocating some 2,000 Koalas (*Phascolarctos cinereus*) from Kangaroo Island to prevent them over-browsing and degrading the island's remnants of native forest. The Minister's decision went against the advice of an 11-member Task Force that had unanimously recommended that Koala numbers at severely affected sites be immediately reduced by a culling program.

Several weeks before the South Australian announcement, the Victorian Government released details of a three-year trial of various contraceptive means to control burgeoning Koala populations at a number of locations in that State. The budget for the Victorian program is rumoured to be over $200,000.

In an era when 'economic rationalists' dominate the political arena, and when dollars for conservation activities are becoming increasingly scarce, it is illuminating to review the history and biology of the populations concerned. All are derived from a small group of Koalas released late last century onto French Island, Victoria. This first introduction was probably carried out by Jim Peters, a Western Port naturalist. Jim gathered together a few Koalas in the Bass Valley that had survived the devastating bushfires of 1898 and shipped them to the island.

The small size of this founder group is evidenced by recent genetic studies, which show that French Island Koalas, together with their Kangaroo Island cousins, have the lowest level of genetic diversity of any wild Koala population so far examined. The animals translocated by Jim Peters also appear to have been disease-free. On French Island there is no evidence of infection from the urogenital strain of *Chlamydia*, which is known to depress fertility in most mainland Koala populations.

Some people have suggested that the propensity for these populations to multiply to the point where they defoliate and kill their food trees is a result of a disrupted social organisation caused by their translocation. There is no evidence to support this view. A more sensible explanation is the disease-free status of the populations. A disease-free female Koala is capable of producing one young per year from sexual maturity (two years) until she is at least 15 years of age. A population with this level of fecundity will double its size in less than 2.5 years and, while this appears an extraordinary growth rate for a wild population, Jim's Koalas were and still are unquestionably capable of achieving it. In the mid 1920s more than 2,300 Koalas were counted in a five-mile stretch along the west coast of French Island. More recently, 20 animals released onto the nearby Victorian coastline at Sandy Point increased to more than 2,000 in 17 years. Such irruptions occur at regular intervals in Victoria and translocation remains the main way of dealing with them. To date over 13,000 of Jim's Koalas have been released throughout south-eastern Australia, including 18 animals onto Kangaroo Island in 1923–25. The present predicament of the Kangaroo Island population is surprising only in that it took so long to occur.

There are many ironies in this situation. Only last year several groups were petitioning the Federal Government to list the Koala as an endangered species, predicting that on present trends it would be extinct in the wild within a decade. Now we have this icon, this symbol of the forests, so abundant that it threatens to degrade many surviving remnants of native forest in the south-east. The ethical milieu engendered by the animal rights movement has raised the consciousness of Australians towards wildlife but it has also left us unable to deal pragmatically with the problem of overabundance. And this leads us to perhaps the greatest irony of all, as the agent that once regulated the abundance of Koalas appears to have been man himself.

Koalas were in low abundance when Europeans first arrived in south-eastern Australia and many settlers recorded how relentlessly the indigenous inhabitants, the Koori people, hunted them. Unlike the European belief system, theirs was attuned to ecological reality. It enabled them to treat a species with reverence even as they killed individual animals to utilise their flesh and fur. With the demise of the hunters, the abundance of Koalas increased and the European settlers, while not developing any spiritual or culinary appreciation of them, were sensible enough to recognise a surplus when they saw one and pragmatic enough to utilise it. By comparison, we modern Australians are unable to come to terms with the idea of killing and utilising our native fauna. Our elected representatives reflect this impotence and will do little else than throw money at such problems. However, we need to bear in mind that this is public money and when conservation budgets are tight it is a lot to spend on an animal that is already widespread and abundant in southern Australia. We also need to bear in mind that the solutions currently being proposed are short-term ones that will last only a little longer than the terms of office of the incumbents who have authorised them.■

The agent that once regulated the abundance of Koalas appears to have been man himself.

Roger Martin is a Research Associate in the Department of Ecology and Evolutionary Biology at Monash University, Victoria.

The Last Word is an opinion piece and does not necessarily reflect the views of the Australian Museum.

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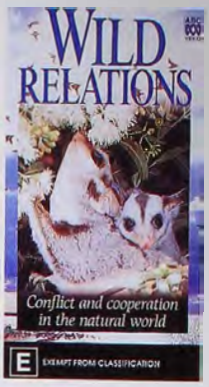

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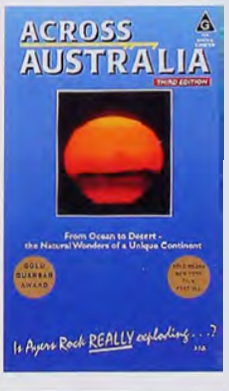

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