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Australian Natural History

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Feathered Minstrels of the Australian Bush

Upside-Down Flies

Crabs that Breathe through their Legs

Regulars: Robyn Williams and Densey Clyne

Spring 1985
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The Australian Museum

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AUSTRALIAN HIMALAYAN EXPEDITIONS

Australian Natural History

from the INSIDE

One of Australia's most spectacular landmarks, the Bungle Bungle sandstone massif in the far north of Western Australia, is soon to become a National Park. It is an area under threat from a growing number of tourists. This largest known array of sandstone towers is a sensitive environment requiring both protection and further study. The traditional owners, East Kimberley Aborigines, call their home Purnululu and desire a major say in its management. *ANH* examines this geologically fascinating and politically volatile landmark.

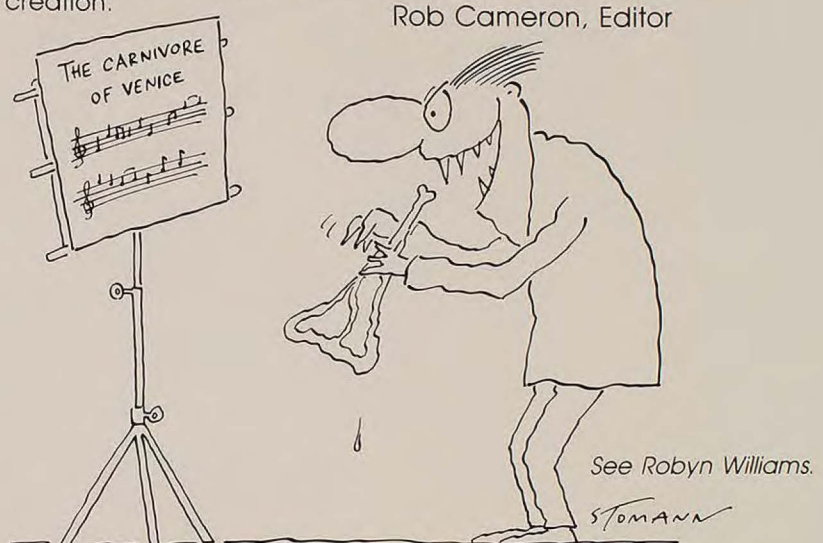
Another feature looks at the tantalising world of mushrooms, from the poisonous to the edible to the hallucinogenic.

Famous Australian songbirds that grunt like pigs, moo like cows, or whoop, hoot and trill are the subject for a colourful article "Feathered Minstrels of the Australian Bush".

ANH travels to the Indonesian island of Sulawesi to observe lush rainforest and some peculiar animals, including a double-tusked pig with very long legs.

Make sure you put this edition's liftout poster on your wall. It's a Longicorn Beetle that could be a Spielberg creation.

Rob Cameron, Editor



See Robyn Williams.

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Anaru, a Mianmin hunter, with two Ground Cuscus *(Phalanger gymnotis)*, the result of a morning's work. Photo: Tim Flannery; by courtesy National Geographic Society. See Forum, page 430.

COVER — MOTH FACE: this must be the nearest thing to a Teddy Bear in the insect world — it looks so cuddly! It's the face of a male Emperor Gum Moth *(Antheraea eucalypti)*. Photo by David Maitland. Also see Photoart page 437.

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Trust President: Kris Klugman
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EDITOR
Robert Cameron

ASSISTANT EDITOR
Georgina Hickey

PRODUCTION ASSISTANT
Tina Powis

CIRCULATION
John McIntosh

ART DIRECTOR
Sue Oakes

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mushrooms

POISONOUS, EDIBLE, HALLUCINOGENIC

Mushrooms are both feared and revered. They count among their number some of the most delectable delicacies, potent poisons and dizzying hallucinogens. But far too little is known about them. Brisbane biologist Tim Low, author of a forthcoming book *Wild Herbs of Australia*, clears the air for *Australian Natural History*.

During Australia's colonial days, farmers ploughing new fields were sometimes startled to come across huge underground 'stones', packed with what appeared to be compacted boiled rice. Local Aborigines knew these stones as 'boee wan', the white centres of which were relished as a delicacy. The 'stones', up to 20 kilos in weight, are storage organs of a curious fungus known as native bread *(Polyporus mylittae)*. It sprouts forth mushroom caps, not after rain in the manner of most mushrooms, but after bushfires.

By any reckoning, mushrooms are peculiar plants. Lowly and primitive, often feared and revered, they count among their number some of our most delectable delicacies, potent poisons, and dizzying hallucinogens.

Take for instance, the fly agaric *(Amanita muscaria)*. This is the familiar fairy tale mushroom with the spotted scarlet cap. Medieval housewives placed pieces of its flesh in saucers of milk to poison flies, hence the name. In northern and eastern Siberia the caps were devoured as hallucinogens, inducing states of violent euphoria. As the active constituents are passed in the urine unchanged, the urine of the drugged was collected and drunk to prolong the revelry. In Italy and Eastern Europe this species is eaten as a harmless vegetable after careful preparation (but mistakes do happen)! In Australia it is an introduced species found in Victoria, New South Wales, Tasmania and South Australia (Mt Lofty).

Part of the mystique of mushrooms lies in the ease with which poisonous and edible species are confused and disputed. The European blusher *(A. rubescens)*, found sometimes near Adelaide, is a close relative of the fly agaric with a paler cap, usually considered fine eating. Yet some authorities allege it has been known to poison. The grisette *(Amanita vaginata)* widely believed to be toxic in Australia and the USA, is esteemed as a delicacy in North Africa and Spain; and *A. gemmata*, considered edible in Europe, has killed in Chile. Chemical constituents vary from place to place, but the processes are little understood.

People also vary in their tolerances. Parasol mushrooms *(Macrolepiota dolichaula)* and iodoform mushrooms *(Agaricus arvensia* var. *iodoformis)*, both sometimes eaten in Australia, make some people ill, but do not affect others. The edible ink cap *(Coprinus atrementarius)* becomes toxic only if taken with alcohol. Overseas mushroom guides often venture comments like, "some mushroom books list this species as edible, but . . .".

Given the apparent health hazards, why do people persist in eating wild fungi? Experienced foragers say they can easily distinguish the dangerous forms and that the risks are less than they seem. Many poisonous species warn of their toxicity by smelling or tasting repulsive. The aptly-named sickener *(Russula emetica)* has an acrid peppery taste, while the curry punk *(Piptorus australiensis)* smells of curry. Most poisonous fungi are only mildly toxic — the symptoms are indigestion or nausea, perhaps diarrhoea and vomiting. Only a handful of species — fewer than 0.01 per cent of the total — are known killers.

Of these, the death cap *(Amanita phalloides)* is the mushroom hunter's nightmare. Roman Emperor Claudius and Pope Clement VII both succumbed to its effects. A northern hemisphere species, it has recently appeared in Canberra and Melbourne and is worth describing in detail: the large shiny cap is grey-green with white gills, and the stalk is white or greyish, bulbous at the

The fly agaric, *Amanita muscaria*, is often featured in fairy tale illustrations. The caps are potential hallucinogens. Photo: Tim Low. ▶

base, up to 11 cm tall. It grows beneath exotic trees. Ninety per cent of world mushroom deaths are blamed on this or closely related species.

Death cap is an invidious killer, not because it resembles edible species — it does not — but because it tastes so good. The toxins work away slowly and discreetly, corroding the liver and kidneys. By the time severe symptoms are felt and medical treatment sought — often two to four days after ingestion — the victim's fate is sealed. Death can be a drawn-out process — the patient may linger a week or more.

The German botanist Herr Falkenham was puzzled to know why people ate death caps and he questioned a number of terminal patients.

"I found out that a good deal of them had not mixed up edible mushrooms with poisonous ones," he said. "Rather, they had no knowledge at all in this field. To me they seemed to be attracted to the forest by an instinct, by some kind of atavistic desire to collect their food."

"I think these people do not want to learn," he concluded, "and so we cannot help them".

European scientists have developed a number of treatments for death cap poisoning and the fatality rate is now below 40 per cent. One experimental treatment uses extracts of the variegated thistle *(Silybum marianum),* an ancient herbal cure for liver complaints.

Only one known death cap poisoning has occurred in Australia, and the victim survived. The mushrooms had been picked in the grounds of a Melbourne hospital. It remains to be seen whether any native Australian *Amanita* species share the toxicity of the death cap. *A. preissii* of Western Australia is quite poisonous, but its toxins are not of the death cap kind.

Needless to say, very few wild mushrooms are eaten in Australia. The British who first settled here were not a fungus-loving people and they did not experiment with the native species. Mushrooms eaten in Australia today are nearly all those with cosmopolitan distributions, known to be eaten in Europe and America. Most of these are probably introductions to Australia, for they favour unnatural habitats like roadsides, paddocks and rubbish tips. A few are perhaps self-introduced, for the tiny spores of fungi can voyage

Many boletes — species *Boletus* — are edible . . . yet some are not. Photo: Otto Rogge ANT. ▼

***Armillaria* species. Photo: T. Hawkeswood.** ▶

Amanita farinacea, of the agaric group is always distinctively white and meringue-like. Photo: Otto Rogge ANT. ▶

thousands of kilometres through upper air currents.

By far the most widely-eaten species is the field mushroom *(Agaricus campestris)*, a close relative of the cultivated mushroom. Its gills are pink, turning dark brown with age, and the caps are white or scaly. Field mushrooms are a familiar sight on lawns and paddocks after rain — one of a complex of closely related edible species found in Australia, some of which are native. It must not be confused with iodoform mushrooms or the yellow stainer *(A. xanthodermus)* which stains yellow when scratched. Yellow stainer makes most — but not all — people ill.

Also edible are the puffballs of genus *Lycoperdon*, the little white balls of putty which pop up on lawns after rain. These are good to eat while firm, hard and white throughout, becoming rubbery and dry after a day or two.

The giant puffball *(Calvatia gigantea)* is called in French 'Tete de Monde', for when growing scattered in the fields, its big white balls resemble bleached skulls. Especially large specimens have measured a metre across. The flesh is tasty when white and cheesy.

In Europe, morels are a delicacy. This Australian species is the *Morchella*, or sponge fungus. Photo: ◀ Cyril Webster ANT.

The edible ink caps *(Coprinus* species*)* putresce into an inky fluid, once used as a watery writing ink. A colony of glistening ink caps *(C. micaceus)* sprouts regularly around the base of a dead mandarin tree in my garden. During autumn this colony supplies more mushrooms than I can eat. This fungus relishes rotting tree roots, and thanks to its beneficience I no longer regret the death of my mandarin tree — it still supplies the larder, albeit indirectly so.

Other edible fungi include the parasol mushroom *(Macrolepiota procera)*, beef steak fungus *(Hepatica fistulina)* and the coral fungi *(Ramaria flava* and *R. ochraceo-salmonicolor* — not to be confused with the bitter *R. formosa)*.

The hairy jew's ear *(Auricularia polytricha)* is probably a native species, for it occurs well within moist native forests on rotting logs. This same species is cultivated in Asia as a (rather tasteless) ingredient of Chinese cooking. It was once exported from Australia for the Chinese market.

Like the jew's ear, hundreds of our native forest fungi are surely edible, but discovery of these is severely hampered by two factors — lack of scientific research and a want of data on Aboriginal use.

Classification of Australian fungi is a woefully neglected subject. Many species cannot even be assigned to a genus, much less

given a name. Mushrooms tend to be shunned by botanists because they are furtive and economically insignificant and because they shrivel almost beyond recognition when dried in museum collections. Without reliable names, it is difficult to collate data on edible and toxic species.

Traditional Aborigines were not a fungus-loving people and the ethnographic record yields little information. In central Australia the Aranda shunned all gilled mushrooms, believing them to be malignant fallen stars. Apart from two species of native bread *(Polyporus mylittae* and *P. tumulosus),* Aborigines are listed eating the horse-dropping fungus *(Pisolithus tinctorius),* the bolete *(Boletus)* and the desert truffle *(Elderia arenivaga).*

The desert truffle represents an intriguing food source, not least because it is akin to the gourmet's truffle of France. Anthropologist Peter K. Latz records its use in central Australia: "Difficult to find, it required an intimate knowledge of its particular habitat requirements and skill in finding the small hairline cracks in the soil which indicated its presence. Nevertheless, in the right season, quite large quantities of this delicacy were gathered.

"This fungus could be eaten raw but was usually roasted in hot sand before being eaten. Gathered when fresh, a considerable amount of drinkable water could be wrung from them. Truly a remarkable plant, providing both food and water."

But he notes: "During my childhood at Hermannsburg we often gathered this food in considerable quantities. In recent years, however, this truffle has become quite rare, it is possible that heavy predation by rabbits and changes in burning practices could explain its decline."

This *Mycena epipterygia,* of the agaric group, has a cucumber-like odour which becomes stronger when picked. It is not thought to be edible. Photo: G. Cheers ANT. ▼

This glistening ink cap, *Coprinus micaceus,* is good sliced raw in salads, but is easily spoiled by overcooking. Photo: Cyril Webster ANT. ▼

The yellow coral fungus, *Ramaria flava,* an ▲ edible fungi with a cosmopolitan distribution. Photo: T. Hawkeswood.

While the Aborigines did harvest a few odd fungi as food, it seems certain they didn't use any as hallucinogens. Claims that Aboriginal rock paintings were rendered under the sway of gold tops are a scurrilous invention. Much of the spectacular rock art comes from dry areas in which such fungi do not occur.

In fact, not many cultures anywhere in the world use mushrooms as drugs. Apart from the mystical Mexicans, the urine-quaffing Siberians and a few groups in New Guinea, the major users today are the Western youth of America, Australia and Europe. This is despite an almost worldwide distribution of hallucinogenic fungi.

The Western world's fascination with 'magic' mushrooms was spawned in the late 1950s when New York banker and mushroom aficionado, Gordon Wasser published in Life magazine a glowing account of his discovery of 'divine mushrooms' in Mexico. In

▲ Flies are attracted by the disgusting smell and then transport the spores of this maiden's veil fungus, *Dictyphora indusiata* of the stinkhorn group. Photo: C. & D. Frith ANT.

1960, Harvard Professor Timothy Leary sampled sacred fungi during a holiday in Mexico, and saw his life changed before his eyes. At about the same time the CIA, deeply embroiled in Cold War machinations, was pouring funds into research on hallucinogens as potential truth drugs for interrogation of foreign spies. Black prisoners were being injected experimentally with mushroom extracts and adventurous psychiatrists were even serving up gold tops and blue meanies—fried in butter—as potential 'cures' for homosexual thoughts.

The hallucinogens proved unamendable as tools of psychiatry and warfare—their effects were unpredictable and hard to control. But to a new generation of Western youth, bent on indulgent self-exploration, they opened doors to unimaginable new experiences.

The mushrooms favoured by Western drug-takers are those containing psilocybin and psilocin, chemicals of similar effect to LSD, which was itself originally derived from a fungus (ergot). Of 100 odd species of hallucinogenic mushrooms occurring worldwide, most owe their effects to these substances. Eighty-one are members of genus *Psilocybe,* to which the infamous gold top belongs. Also containing psilocybin is the blue meany *(Copelandia cyanescens).*

Giant puffballs like this *Calvatia* species are edible when completely white inside. Photo: T. Hawkeswood. ▶

Quite different in chemical composition is the fly agaric *(Amanita muscaria)* and related panther *(A. pantherina),* which both yield muscarine. Off-beat biblical scholars have argued, somewhat tenuously, that the New Testament was created by an ancient fly agaric cult. The mushroom is also attributed with inspiring the hymns of the Rig-Veda, a seminal work of Hinduism. Other hallucinogenic mushrooms include the *Russula* species used in New Guinea to induce indulgent mischief.

The gold top *(P. cubensis)* is the most widely eaten of all mind-altering fungi. Though possession is strictly illegal in Australia, as elsewhere, it is regularly harvested in subtropical New South Wales and Queensland. It is sometimes eaten by mistake as an edible species, despite its distinctive yellow cap and blue-staining flesh.

The following anecdote relates a typical case of accidental ingestion —though restaurants are not usually involved! Mishaps of this kind were common in the 1950s, long before deliberate use began.

During August 1983, Rosemary Read, 47 and mother of four, ate a Chinese meal containing mushrooms at a restaurant in Ballina, northern New South Wales. Later that night she began weeping and laughing without apparent cause. When she tried to calm herself by reading, her eyes could not focus. What followed was a panorama of pleasant hallucinations—images of friends and family, soothing ideas and thoughts. The experience bore no ill-effects, apart from initial fear, and Rosemary recalls it today more with bemusement than disdain.

Vivid halluncinations are a frequent manifestation of the mushroom 'trip', especially at higher doses. Sounds seem disassociated, colours throb, faces leer from patterns in curtains and carpets.

In Australia, the gold top harvest takes place in damp and grassy paddocks in the showery autumn months, when caps sprout prolifically from the nutrient-rich dung of cows. In America, drug users have developed sophisticated techniques for rearing the fungi in agar. Subversive books are published on the subject and spores can be bought by mail order. The fungal threads are easily cultured, but the mushroom caps apparently only sprout after illumination.

The gold top's dependence on cow dung poses a botanical mystery—from where has the mushroom come? It was discovered first in Cuba and became infamous in Mexico, though its natural habitat, cow dung, only reached the Americas on the heels of the Spanish conquest. Mexicans know their native hallucinogens by many names, but have only one or two for the gold top—strong evidence for its introduction there. Gaston Guzman, world authority on the genus, postulated an African origin, though it is unknown on that continent. The gold top is certainly not native to Australia, unless it once grew upon dung of extinct diprotodonts and other giant marsupials.

Australia is home to several native species of *Psilocybe* and a number of these, growing on wallaby dung or damp forest floors, are hallucinogenic. Guzman recognises 13 psychotropic forms from the Australian-New Guinea region, not all of them native (against 32 hallucinogenic species in Mexico, eight in Europe and only one in Africa). These psychadelics can all be recognised—curiously enough—by their pleasantly starchy smell and taste and by their bluish stain upon bruising.

Drug takers know more about these species than the scientists. In 1972 *P. collybiodes* was recorded botanically from Australia for the first time; the specimens were collected by police from a fridge in Tasmania. The dried out, crushed fungi were being packed into gelatin capsules for illicit sale in Hobart at $6 a 'hit'.

Psilocybin withstands drying and heating and dried mushrooms have been posted to friends by mail. Psychadelic mushroom soup can be stored in the freezer for months on end.

In north Queensland the common narcotic mushroom is probably *P. subcubensis,* a gold top look-alike also found on dung. It is most likely this species is cooked into the hallucinogenic omelettes served in Bali's Kuta Beach restaurants. Young Australians are the main customers, though middle-aged Americans are know to indulge, sometimes regrettably so, misguided by the tourist dictum "When in Rome . . .". □

RARE & ENDANGERED

World's Largest Butterfly Threatened

Queen Alexandra's Birdwing Butterfly *(Ornithoptera alexandrae)* is the world's largest butterfly, the larger females having wingspans of 25 centimetres or more. The first specimen was collected in 1906 by Alfred Meek who actually used a shotgun to bring it down. The female was sent to Meek's employer, Lord Rothschild, a wealthy British collector who named the butterfly in honour of Queen Alexandra of England.

There are nine species of *Ornithoptera* and all but three are endemic to Papua New Guinea (P.N.G.). They are much sought after by insect collectors for their size, beauty and general unavailability. *Ornithoptera alexandrae,* being typical of its genus, displays sexual dimorphism. The male is brightly coloured with pale blue, yellow and pink on black. The female is predominantly brown marked with cream.

Most of the species of *Ornithoptera* were considered extremely rare and localised and, in 1966, were declared protected fauna by the P.N.G. Government. As a signatory to the CITES International Agreement on Endangered Species, the Australian Government prohibits their import.

As the rarest species, *O. alexandrae* certainly merits its protected status. It is entirely restricted to the rainforest tracts of a small coastal plain, on which the town of Popondetta is sited, in the Northern Province of P.N.G. Unfortunately, this area has suffered much ecological disturbance from the continually expanding oil palm and logging industries. For these reasons, a detailed study of the biology and conservation of *O. alexandrae* was begun by the P.N.G. Wildlife Division in 1979.

The larvae feed exclusively on *Aristolochia dielsiana,* a tough-leafed vine that grows 40 metres tall in primary forest in southeastern mainland P.N.G. and on two islands off the northern coast. The distribution of its foodplant is far wider than the butterfly itself, which seems to limit its flights to "home range" areas. Perhaps it is slow to colonise new areas.

Experiments have shown that, if allowed to feed on *A. tagala,* a softer-leafed vine that occurs throughout the Indo-Australian region, *O. alexandrae* larvae will mature faster. The leaves are more easily chewed and provide greater nutrition per volume of foliage than *A. dielsiana*. The vine is, however, strongly competed for by two other, more common P.N.G. birdwings, and their eggs are also parasitised by a minute wasp species. It is possibly for this reason (and interspecific competition) that *O. alexandrae* utilises the tough-leafed *A. dielsiana,* which does not permit optimum developmental rate.

Adults can live three months or longer in the wild, in which time females can lay at least 240 eggs. The eggs take 122 days to develop into adults. During this period, eggs, larvae and pupae are prey for ants, wasps and small marsupials. Some birds, such as Kookaburras and especially the Grey-breasted Brush Cuckoo, may be specialist predators of larvae. It is thought that, like other *Aristolochia* - feeding butterflies, *O. alexandrae* can store certain toxins from its foodplant. The larvae are, therefore, warningly coloured black with bright red, fleshy spines and a yellow saddle mark to deter predators.

International trade in *O. alexandrae* was prohibited with its protection in 1966. It is still very probable that some specimens are sold on the black market. They are easily concealed for shipping and the rewards to smugglers are high. However, the main threat to their survival is the constant depredation of their habitat. The Popondetta oil palm project and a private developer have caused the loss of at least 2,700 hectares of actual or potential *O. alexandrae* habitat. There is no long-term limit set on the ultimate area to be exploited. About 60,000 hectares to the west of Popondetta have been loosely defined the Kumisi Timber Area and exploitation of this region began two years ago by a large logging company.

So far only one large Wildlife Management Area of about 10,000 hectares has been established north of Popondetta. Certain areas within it are known to be used by *O. alexandrae*. Urgent governmental and private support is needed to protect as much of the remaining *O. alexandrae* habitat as possible.

Ironically, if the future of the world's largest butterfly can be assured in this way, it could become an extremely profitable export and promoted as a prime attraction for P.N.G.'s tourist industry.

Top: The female Queen Alexandra's Birdwing, *Ornithoptera alexandrae*, resting on the pupal case from which it has just emerged. Photo: M. J. Parsons.

Above: The fourth stage larva of Queen Alexandra's Birdwing — a huge, strangely coloured caterpillar. Photo: R. Straatman.

Michael Parsons,
British Museum (Natural History)

Densey

A young Frillneck snaps up a ▼ march-fly. Photo: Densey Clyne.

In early Victorian times a lady setting out on a solitary walk was advised to take a large umbrella. Any dangerous male met along the way could be put to flight by its sudden unfurling and a series of rapid lunges with the sharp end.

Quite disconcerting, I should think, especially if at the same time the lady bared her teeth and hissed. The strategy certainly works well for Frillneck Lizards.

The Frillneck faces its enemies with jaws agape, the colourful frill held erect around its head by a set of fine, flexible spokes. The two actions are linked — opening the jaws unfurls the 'umbrella' automatically. The spokes are extensions of the hyoid bones at the base of the tongue.

The lizard's threat display is no mere bluff — it will readily charge and chase an attacker. This is of great benefit to a photographer wishing to get a head-on view of the frill. You have to be quick, though — a Frillneck is quite likely to close its jaws on the lens before you've had time to hit the button.

Sooner or later the lizard will turn and head for the nearest tree. A Frillneck on the move is a sight worth seeing. It runs with astonishing speed, erect on its muscular hind legs, front feet dangling and nose up in the air. All the time it moves its head from one side to the other, keeping one eye out for signs of a pursuer.

However the display alone is usually enough to deter birds of prey and other enemies. The suddenly expanded frill says: I'm bigger than you think! And it all suddenly seems too much of a mouthful.

Speaking of mouthfuls, the Frillneck's scientific name of *Chlamydosaurus kingii* might strike you as being one. But it's quite simple when you work it out. *Chlamydo-* comes from the Greek word for garment or cloak, and *-saurus* just means lizard. A cloaked lizard.

At rest the frill would be better described as a shoulder-length cape than a cloak. A baby Frillneck has little more than a fold of skin with a scalloped border, relying mainly on camouflage for protection. In fact Frillnecks of all ages spend much of their time basking in the sun pretending to be a broken branch or stump. The frill, with its colours hidden, becomes nothing more than an aid to the camouflage.

The first description we have comes from Allan Cunningham who wrote a short note in 1820 about "a lizard of extraordinary appearance . . . with a curious crenated membrane like a ruff or tippet around its neck . . . "

This was more than a century after William Dampier's description of another Australian lizard, the armour-plated Stumpytail or Shingleback Lizard that wanders unconcerned around the outback without the Frillneck's need of camouflage.

There is nothing quite like the Frillneck anywhere else in the world. It occurs only across the north of Australia and down the east coast to Brisbane and it has no close relatives. Most people know it best from television coverage and from its image on the two cent coin. But in the south it's name is very often given to a more common lizard.

Pogona barbata, the Eastern ▶ Bearded Dragon, faces an enemy. Photo: Densey Clyne.

Clyne looks at.....

DRAGONS WITH CLOAKS AND BEARDS

▲A young Frillneck up a tree becomes part of the scenery. Photo: Densey Clyne.

More times than I can remember I've been told about a 'Frillneck' living in someone's Sydney backyard. It always turns out to be a bearded dragon.

The Eastern Bearded Dragon, *Pogona barbata*, lives in most of the southern half of the continent and it's often seen in suburban gardens. Let me correct that. It's often in suburban gardens but seldom seen there. Like the Frillneck, a Bearded Dragon can become almost invisible at rest in a tree, basking in the sun. And it has a sneaky way of slithering around to the far side long before you spot it.

The game's given away — if you happen to be looking in the right direction — when a suspicious eye slowly comes into view as the dragon leans out to check on you.

If you meet a Bearded Dragon face to face it will inflate the pouch under its chin. The spiky scales stick out around the pouch making it look even more like a bristly beard.

At the same time the dragon will open its jaws and hiss, displaying a bright orange-yellow mouth with a formidable array of little pointed teeth. Make no mistakes, it will readily snap its jaws shut on a human finger, but this causes more shock than pain, and no Australian lizard is poisonous.

The Frillneck and the Bearded Dragon both belong to the great family of lizards usually called dragons. And back on the subject of scientific names, the one used for the dragon family — Agamidae — has nothing to do with dragons.

There's a little lizard of the Caribbean Islands known as "agama". This name was apparently — and rather surprisingly — adopted for a genus of lizards that doesn't occur in the Americas at all. In turn this genus *Agama* gave its name to the entire dragon family, with members on all the other continents.

One group of agamids does reflect the world of mythology in its scientific name.

The dragons of myth — and perhaps race memory — were called by the ancients "draco", meaning "one who sees clearly" (which is an odd choice of name when you think of the more striking aspects of dragonhood). It's from this word "draco" that we get our word dragon.

As dragons were often depicted with wings, *Draco* was an appropriate name to give to a genus of 'flying lizards', the little arboreal dragons of southeast Asia that use winglike membranes for gliding.

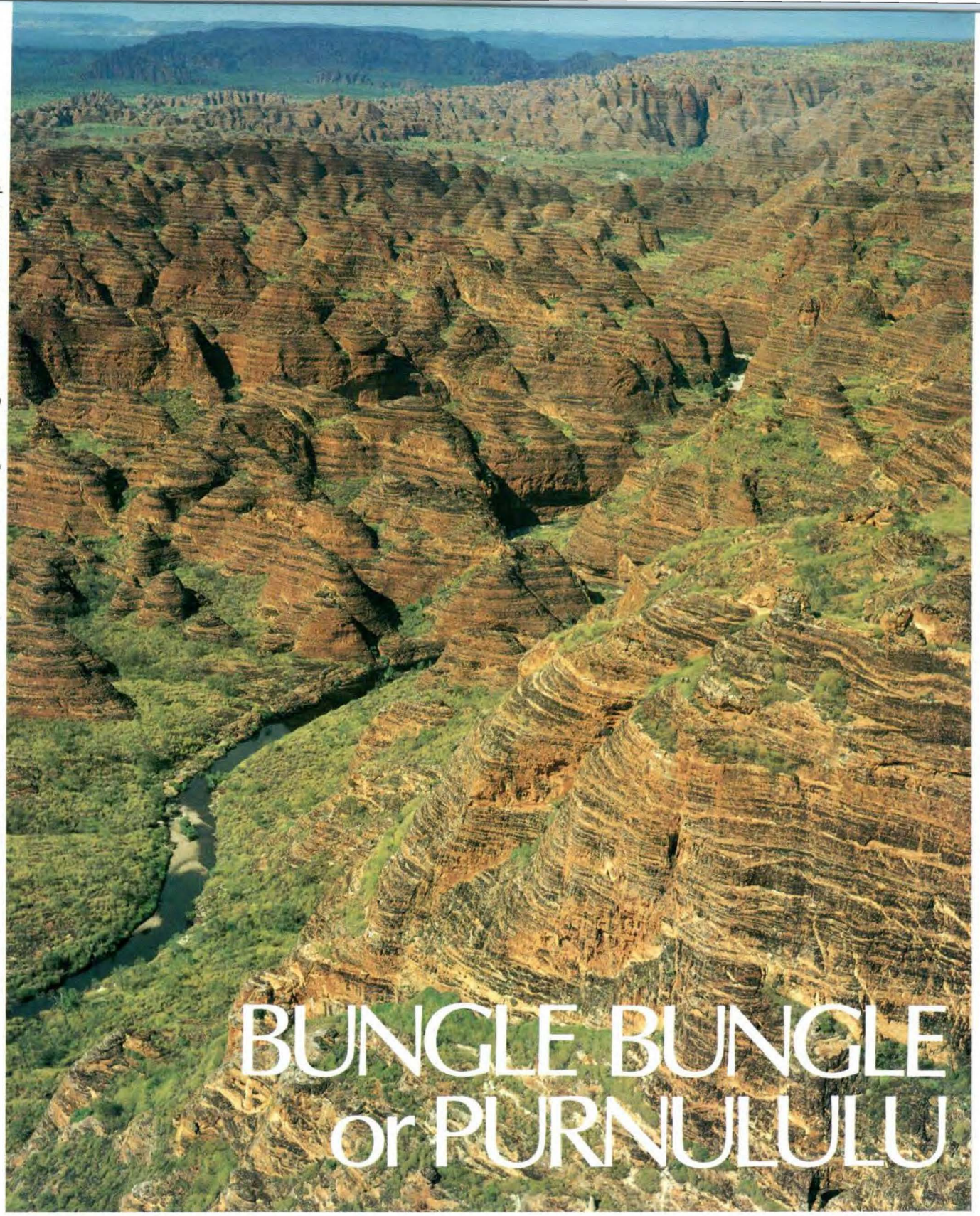
While present-day dragons are not very big and they don't breathe fire, the emotion they inspire is more often fear than delight. But not always. Our Frillneck Lizard recently took the Japanese people by storm after it appeared in an American television documentary.

This dragon became for a short time a star and a minor cult figure, elegantly modelled in metal, plastic and precious jewels and printed on T-shirts, posters and car-stickers — Love Is A Frillneck Lizard?

What was it about this particular lizard that could turn the affections of a nation so readily away from the conventional cuddly Koala to an unknown scaly reptile?

I think I know. I think it was the sight of that cute, umbrella-like frill in operation. After all it was in the East that the principle of the umbrella — originally a sunshade — was invented more than 3,000 years ago. Re-invented, I should say. Our Australian Frillneck got in first. □

Chlamydosaurus kingii, the Frillneck Lizard, in full threat display. Photo: Densey Clyne.▼



▼ View of south west escarpment of the Bungle Bungle. Photo: R. Woldendorp.

BUNGLE BUNGLE or PURNULULU

One of Australia's most spectacular landmarks, the Bungle Bungle sandstone massif in the far north of Western Australia, is soon to become a National Park. It is an area under threat from a growing number of tourists. This largest known array of sandstone towers is a sensitive environment requiring extensive study. This article was written by four experts. Bob Young from the Geography Department at the University of Wollongong looks at the geomorphology. Nancy Williams, an anthropologist with the Australian Institute of Aboriginal Studies, tells us about the East Kimberley Aborigines, a people who desire a major say in the management of the area. Kevin Kenneally (Western Australian Herbarium) and Stephen Forbes (National Herbarium of Victoria) recently carried out a botanical survey and discovered that there is still much to learn about the flora of the Bungle Bungle massif and the surrounding area.

A Geological Masterpiece

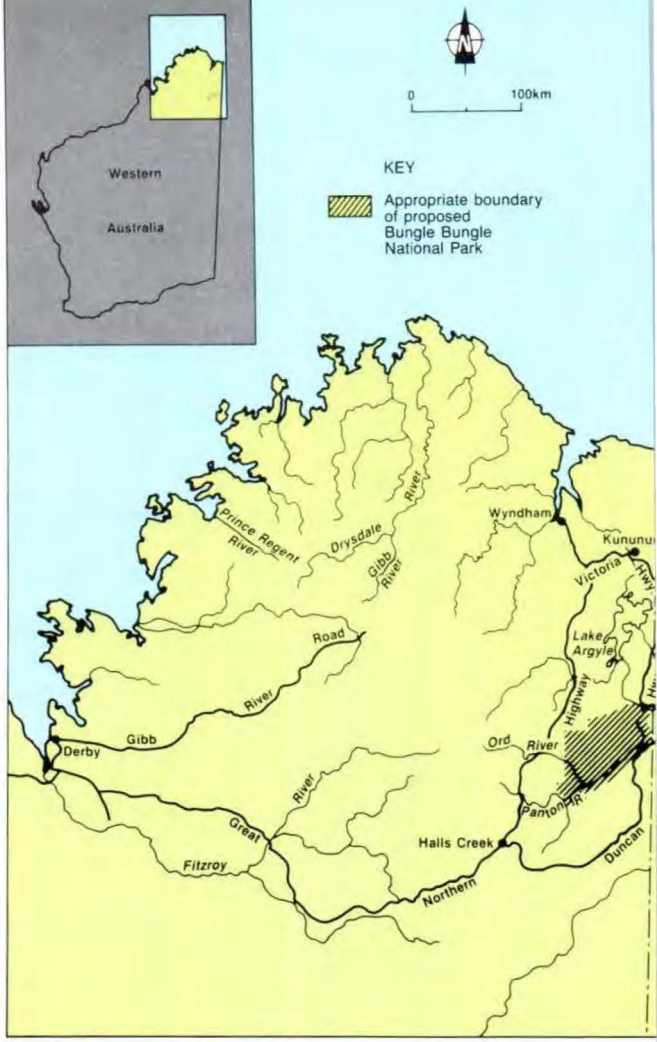
Undoubtedly the Bungle Bungle massif is one of Australia's most impressive landscapes. On its western side the massif is bounded by cliffs that rise abruptly from the surrounding lowlands. In places these cliffs have been cut into great slabs which, because of their rounded summits, look like smaller versions of the domes of the Olgas. Sheer cliffs and spires with rounded summits also line the narrow gorge cut deeply by Piccaninny Creek into the heart of the massif. However it is in the east and south that the landforms are most spectacular, even bizarre. There, the summit of the massif is studded by rocky towers and its flanks are dissected into a bewildering array of towers and knife-like ridges. Many of these ridges are sinuous and are separated by box-like valleys with flat floors and vertical sides.

Landforms such as these are almost invariably found on limestone, but here and also at the "Ruined City" of Arnhem land, they are carved from highly siliceous sandstones. Paradoxically, silica solution played the critical role in forming towers not only on limestones, but also on the very chemically resistant sandstones. The explanation must be sought in the great age of this terrain and its prolonged exposure to weathering under tropical climates.

The summit of the massif is a fragment of an ancient erosional surface that can still be traced over much of the Kimberleys. The precise age of the surface is not known, but it almost certainly dates back far into Tertiary times, perhaps even to the late Cretaceous. During most of this time, northern Australian climates were conducive to deep lateritic weathering. It was this intense weathering that apparently mobilised silica from the Elder Sandstone in which the Bungle Bungle towers have developed. The effects of silica solution are strikingly illustrated by Scanning Electron Microscope images. Not only do these images show the quartz grains to be heavily etched, they show that most of the cement between the grains has gone. While the close interlocking of the quartz grains gives the sandstone a considerable mass strength, allowing steep faces to be maintained on the towers, individual grains are easily removed by running water.

Solution of silica was the critical prerequisite for the development of the towers. Nonetheless, they were actually shaped by the granular disintegration and erosion of the highly weathered rock. Grains can be readily brushed from fresh exposures and the streams carry large quantities of sand and pebbles. Clearly, some of the towers have resulted from gully incision down major joints in the sandstone. Frequently case hardening along the joints has resisted erosion, so that the joints occur either on the crests or high on the flanks of towers.

Virtually all outcrops of the Elder Sandstone have very prominent orange and black banding which generally runs parallel to bedding planes. Curiously, there is little difference, except perhaps in permeability in the rock behind most of these parallel stripes. The prominent visual effect is caused by surface skins and algal-growth. There is certainly some iron and manganese



Typical water hole of the region.
▼Photo courtesy W.A. Photo Index.

staining, but the skins examined by myself consisted of high concentrations of kaolinitic clay between quartz grains. As these skins occur only on the rock surface and can even be found in some stream beds, they are almost certainly still forming. The skins, which can be up to one centimetre thick, play a very important role in retarding the erosion of the otherwise quite friable rock surface. Preserving them will be a key issue in the management of the area.

The convex crest on most towers and ridges is probably due to the very well developed bedding of the Elder Sandstone. Most bedding planes have tiny notches or undercuts, with small benches in front of them. The vertical stacking of these benches seems to impart a general convexity to the slope.

Changes in the Elder Sandstone control the distribution of towers over the massif. In the east and south, where the towers are concentrated, the rock is a fairly uniform sandstone with minor pebbly beds. In the west, where the towers are replaced by cliffs, the rock is conglomeratic with small sandstone beds. Additionally, in the Piccaninny Gorge where towers give way abruptly to cliffs, there are numerous quartz veins in the rock. Similar trends can be seen in some other sandstones, especially in the Keep River National Park where, incidentally, there is excellent road access to a small group of towers.

Sandstone towers occur on ancient shields in other parts of the world, notably in the Sahara. Yet the Bungle Bungle massif seems unrivalled in the complexity of its tower terrain and certainly in the clear evidence it gives of the importance of ancient weathering regimes in the shaping of sandstone landscapes.

— Bob Young

Piccaninny Gorge in south west ▼region. Photo: R. Woldendorp.

Tommy Yiliyarri, who married into ▶ one of the families that are traditional owners of the Purnululu area. Photo: Ian Kirkby.

Aboriginal Traditional Owners

"Purnululu is the name of that country," the Aborigines of the East Kimberley say. They wonder where "Bungle Bungle" came from — it is a name they first heard from English-speaking people when cattle was king in the Kimberley.

Creeks and rivers that drain from Purnululu south into the Ord River are all known and named, from their headwaters in the massif to the Ord. The features of the river itself are similarly named, all along its meandering course to the Cambridge Gulf where it enters the Indian Ocean. All these named features signal important places in the country, well known to Aborigines of the Kimberley.

In the past, before pastoralists, miners and other whites invaded the Kimberley with their superior fire power, and killed Aborigines or drove them out of their countries, they had tuned their occupation and use of this land to their knowledge of the seasonally abundant resources and their management of them. Seasonally, the Aborigines in this part of the East Kimberley moved broadly out into the lower, open country during the dry part of the year, then during the wet season they moved to the headwaters of rivers and streams, to rock shelters in the ubiquitous limestone ridges. This pattern of resource use in the past regularly took the local Aborigines to the top of the massif, where evidence of their presence can still be seen in rock paintings and engravings as well as in such practical activities as grooves made in sandstone during the process of shaping and sharpening stone tools.

Along the Ord south of the Purnululu massif the traditional owners point out places where they used to camp years ago with large numbers of people from surrounding countries. They recall their way of life and they describe with sadness how the land and the rivers, the once large and abundant water holes are "covered up". Familiar water holes have little or no water in them; places they remember as big, deep waters filled with fish — bream, rock cod, barramundi, catfish — and crocodiles, water goannas and turtles, are stagnant shallows with few fish or other creatures in them. Food plants recounted as good "bush tucker" are no longer to be found.

Some animals that they say used to be plentiful and were highly valued for their flavour, texture and richness, are now not to be found anywhere in the area. These now apparently extinct animals include the bandicoot and the possum. In talking about the the disappearance of these animals, Aborigines express puzzlement and speculate about the reasons. They wonder if the *Ngarrunggarni* "Dreaming" took them away because the Aboriginal owners are no longer in full control of their countries and therefore have not looked after the country (by such means as controlled burning and the regular performance of ceremony). "No more Aborigines to live in it; Dreaming has taken back the animals and plants given for Aborigines to use," one man said. *Ngarrunggarni* are ancestral spirit beings who travelled through the country in time beyond memory and by their acts invested the earth and its features with sacred meaning and bestowed the land on the ancient forebears of the present traditional owners.

The Aboriginal owners of this country — mostly speakers of Kija and Jaru languages (but also including some Miriwung and Malngin speakers) — have shown us some of the signs of their presence and the presence of their ancestors in Purnululu. They tell stories of the *Ngarrunggarni,* who left signs in this place to tell that they had been here and where they performed sacred acts by which living people

should understand how the land was bestowed on them. These Kija and Jaru people also tell stories from their own lives, of time spent growing up in this country. Raymond Wallaby points out the place where one of his grandfathers was shot by whites and buried. He also points to the place where his other grandfather is buried — not far from the place, Gawarra, in the Purnululu area, where he hopes to establish a secure home for himself and his family. He himself was born in the Purnululu region. A younger relative of his, Sam Butters, was married in 1953 and his birth certificate states his birthplace as "Bungle Bungle".

The kinds of ties that the contemporary Aboriginal owners have with the Purnululu area are much the same as those that link Aborigines with their traditional lands elsewhere in Australia. In sum, they are religious in origin and rationale, expressed in terms of the closest personal bonding, manifested in attitudes of concern, respect and practised in stewardship that is based on an ancient culture of detailed ecological knowledge.

It is astonishing after spending only a limited period recording some details of the traditional owners' relationships to the Purnululu region, to read newspaper and magazine accounts of the "recently discovered" wonders of a "lost world". In fact, certain Aboriginal practices of resource management may well be the most significant aspect of what has been lost. More precisely, although the practices themselves have lapsed or have been curtailed or even prohibited by white pastoralists, the knowledge remains alive in the minds of Aboriginal people, some of whom are no more than middle-aged now.

A striking example is the results of the supression of Aboriginal practices of pyrotechnology, seen in the changing distribution of the cypress pine, *Callitris columellaris*. A site on the western border of the Purnululu massif bears the Aboriginal name for cypress pine (Guwirrin) and in the past was a place notable for a stand of those trees, still valued for medicinal and ceremonial uses. At present no more than two or three cypress pines remain at that site. This species, as Haynes discovered in Arnhem Land, will not tolerate hot fires; it is, therefore, a good indicator of regular controlled burning practices, characteristic of an Aboriginal fire regime. The decline in the cypress pine can be correlated with the disruption to traditional management practices which accompanied the movement of Aboriginal people from their countries to mission stations, pastoral stations and towns.

Many non-Aboriginal residents of the East Kimberley as well as the local Aborigines knew the features of the mountainous area Purnululu before they were "discovered" by the media. Even young Aborigines who had yet to visit the area knew about its features and its stories. Middle-aged Aborigines now living at Turkey Creek and its surrounds point out tracks in the Purnululu area that they made. They also point out the places where they camped and, barely scratching the surface of the ground, reveal evidence of their earlier habitation — objects such as rusting tobacco tins and pannikins as well as stone tools. Some fathers had painted with pipeclay the outlines of their children's hands on the walls of rock shelters and the children, now adults, identify their child-hand stencils. Older men point out the features of the ceremonial grounds where they were initiated into some aspect of the religious life. They tell stories of how they helped pastoralists in the Purnululu area in the past. They point to sites where objects of ritual are in the process of ceremonial exchange (called *wunan* in this area) that links the local people with Aborigines in the Northern Territory.

In Purnululu, evidence of ancient habitation and use is as abundant as that of the recent past and the present. There are rock paintings that appear very old as well as one, for example of a motor truck; there are grooves on rock faces where stone axes were sharpened. All these things the traditional owners point to as tangible evidence of the many kinds of ties they have with their country.

The concept of national parks as dedicated to the preservation of "wilderness" has now shifted internationally to the more realistic aim of preserving a heritage. That shift is perhaps nowhere in the world more appropriate than in Australia: after at least 40,000 years, Australia is an Aboriginal artifact, moulded during the millenia of their management of its environment. Managed in such a way that it was perhaps inevitable that Europeans would see it as "pristine"; after less than 100 years of European occuation of the Kimberley, parts of that environment were so degraded, that, in 1967, the Western Australian Government resumed pastoral leases and established a reserve over the area for the purpose of "regeneration of eroded areas in the Ord River catchment area".

The Western Australian Government is considering the Environmental Protection Authority's recommendation, based on a government working group's study, that an area of approximately 3500 square kilometres should become a national park and be managed jointly by the National Park Authority and the Aboriginal traditional owners. The Premier of Western Australia announced in June that a joint plan of management will be adopted. Although that falls short of the traditional owners' claims of ownership (and it is certain that their

At Raymond Wallaby's "Gawarra Community" in the Purnululu region where he plans to build for year-round residence nearby. Photo: Ian ▼Kirkby.

claim would succeed if it were heard under legislation like that of the Northern Territory), they anticipate collaborating with the park authorities on the design of a management plan. The traditional owners have been actively discussing the implications of a national park on their country, and their role in its management. They are particularly concerned about what tourists' visits will mean, and about the possible tourism developments that they are being urged to endorse. They do, however, expect to be involved in working out the details of these and any such related developments that may eventuate.

Whatever plans are afoot, it makes much sense to have the traditional owners involved in the planning and management of a national park. □

— Nancy Williams

A Botanical Mystery

The flora of the Bungle Bungle massif reflects its dry, semi-arid climate. The area contains no conservation reserves and is poorly known botanically. Although generally supporting rather depauperate vegetation, the survey recorded a number of rare or restricted species, new records for Western Australia, two new species and elements of biogeographic significance.

◀Beneath sandstone cliffs, a *Livistona* palm grows near a boulder of conglomerate brought downstream from rocks deposited about 400 million years ago in Devonian times. Photo: R. Woldendorp.

Livistona species 'Victoria River', an undescribed fan palm characteristic of sheltered gorges in the massif, is considered a restricted species of horticultural potential. The first collection of a daisy, *Blumea pungens*, other than the type, was also made in these gorge tracts. New plant records for Western Australia include a moss *Uleobryum peruvianum*, a fern *Taenitis pinnata*, a sedge *Cyperus eleusinoides*, a shrub *Jacksonia odontoclada*, a scrambler *Stephania japonica* and a tree *Leptospermum longifolium*. New species of *Grevillea* and *Comsperma* were also collected.

The Bungle Bungle is surrounded by an uneven woodland fringe, developed on sands derived from the massif forming extensive red and yellow earths. The silver-blue shoots of the dominant *Eucalyptus collina* readily distinguish this fringe from adjoining communities. The density of *E. collina* indicates the water catchment value of the massif. Shrubs and small trees include *Dolichandrone heterophylla, Grevillea miniata, G. pyramidalis* and *Crotalaria cunninghamii*. Wattle scrubs, dominated by *Acacia lysiphloia, A. turmida* and *A. stipuligera* occur in some areas; Aboriginal evidence suggests that these are the result of a relatively recent absence of fire and may eventually be excluded by competition if fires can be prevented. Spinifex, including *Plectrachne pungens* dominates the understorey.

Black soil plains are limited to narrow bands west and north of the massif, within the study area. The plains are now grossly degraded with extensive sheet and gully erosion and only minimal ground cover. *Parkinsonia aculeata, Acacia farnesiana* and *Calotropis procera* occur in thickets around the Bungle Bungle Outcamp. These species are considered invasive of overtrampled areas, although only the two introduced genera, *Calotropis* and *Parkinsonia*, are established away from the Outcamp. Scattered shrubs of *Cassia venusta* characterise the shrub layer, with the alien *Aerva javanica* occasionally on the most degraded sites. The ground layer, where present, is dominated by *Cenchrus* species. All of the above species are colonisers.

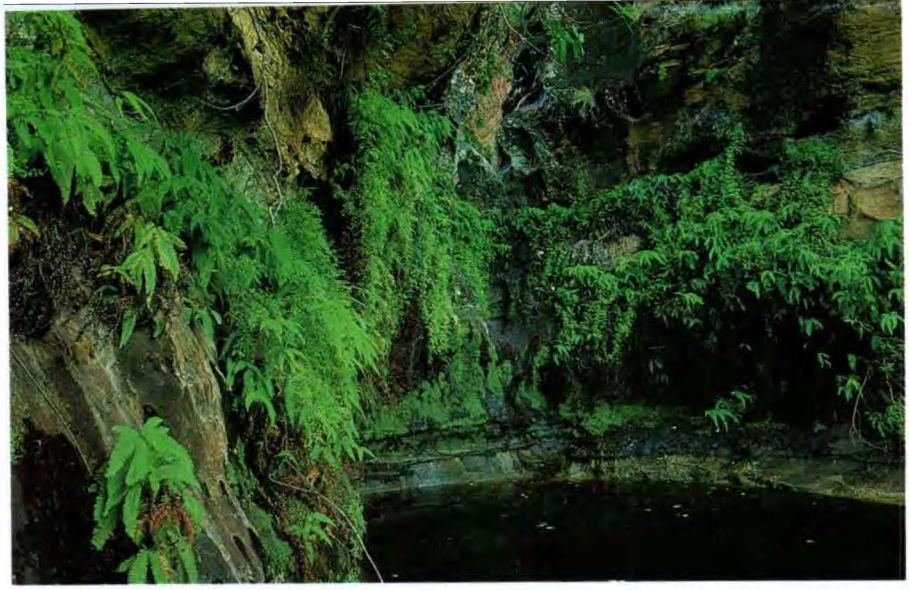
In an undisturbed state the black soil plains carry scattered emergent trees, particularly *Terminalia arostrata, T. volucris* and *Lysiphyllum cunninghamii*, while in the associated grasslands perennial grass species including *Astrebla, Dichanthium, Chrysopogon fallax* and *Themeda australis* are now virtually absent, due to overgrazing.

The escarpment of the massif is surrounded by a narrow band of boulder and scree which carries a low open woodland dominated by *Eucalyptus pyrophora*. *E. brachyandra* is an occasional subdominant. Shrubs include *Calytrix exstipulata,*

▲The most prominent shrub species of the Bungle Bungle plateau is *Grevillea wickhamii* with its dense clusters of red flowers. Photo: K. Kenneally.

Grevillea miniata, Persoonia falcata, Gardenia pyriformis and undescribed species of *Comesperma* and *Grevillea*. *Ficus* species are common on rock surfaces. The ground layer is dominated by grasses including *Cymbopogon procerus* and spinifex.

The plateau carries a rather depauperate low open woodland dominated by *Eucalyptus pyrophora* and scattered stands of *E. collina* with a sparse shrub layer of *Grevillea refracta, G. wickhamii, Acacia acradenia, A. eripoda* and *A. retive-*



◀ One of the permanent pools of the Bungle Bungle, sharing moisture-loving vegetation confined to sheltered positions. Photo: R. Woldendorp.

▲The dominant tree of the sand plains surrounding the Bungle Bungle massif is *Eucalyptus terminalis*. Photo: K. Kenneally.

nia. *Petalostylis cassioides* is an uncommon associate. The lichen *Microthelia aterrima* forms a conspicuous epiphyte over extensive areas of otherwise bare rock.

All streams on the plateau are ephemeral, although permanent water is found in rockholes in streambeds. Where permanent water occurs the emergent aquatic *Aponogeton elongatus* is common. Streams incise sandstone gullies, commonly to about ten metres, which offer niches not available on the remainder of the plateau. Accordingly the majority of species recorded for the plateau are from stream surrounds. The overstorey is a low open forest characterised by *Eucalyptus aspera* and *E. collina* which on the plateau, are restricted to such sites.

Permanent water is absent below the plateau apart from a few plunge pools. Streams are characterised by deep gorges, although with broader valleys than those of the chasms. Low open forest fringing the stream is characterised by *Eucalyptus aspera* and *E. collina*. *Lophostemon grandiflorus* subsp. *riparius* is restricted to larger streams including Piccaninny Creek. The understorey is composed of shrubby thickets of *Acacia* species, *Jacksonia thesiodes* and *Templetonia hookeri*. The palm *Livistona* species 'Victoria River', *Myoporum accuminatum* and *Dodonaea vicosa* supsp. *mucronata* are common in rocky tracts. Sandbanks suppoort *Clerodendrum tomentosum* and *C. floribundum* and fine examples of *Leptospermum longifolium*. Spinifex is usually present as a ground layer in all situations.

Streambeds draining the plateau are comprised of white pebbles derived from surrounding conglomerates and are typically bare of vegetation.

Chasms may be 100 metres deep and less than ten metres wide with an extensive catchment. As a result, scouring of the sandstone and conglomerate chasm floor precludes significant humus accumulation in most sites and soils are largely sands and lithosols.

The narrow floors of chasms may support a weakly developed low closed forest. The absence of permanent water, other than in plunge pools, precludes closed forests as is found in the sheltered gullies of streams in the nearby Osmond Range.

The dominant trees are *Mallotus nesophilus, Celtis philippinensis, Ficus virens* and *Alstonia actinophylla*. The understorey is dominated by *Bridelia tomentosa* var. *glabrifolia*, a two to three metre shrub with rampant, arching canes. *Livistona* species 'Victoria River' is a handsome palm associated with this community in rock crevices and at cliff bases, but is more conspicuous on adjacent rock walls. The palm appears restricted to the western massif. Another species of the rock walls, *Pandorea* affin. *doratoxylon*, a pendulous twiner or semi-shrub with white tubular flowers, is most conspicuous on the cliff faces of Piccaninny Gorge. Two other creepers, *Marsdenia velutina* and *Stephania japonica*, are common in the chasm floors.

Sheltered seepage areas support *Stemodia viscosa, Leptospermum longifolium* and the fern *Taenitis pinnata*.

Sheltered moist habitats, such as occur in the permanently moist chasms and gorges of the Bungle Bungle, are of high conservation significance as they support specialised communities. These areas are very restricted in their occurrence within the region and often provide refuge areas for species in times of drought. As access to the Bungle Bungle massif is via the gorges (e.g. Piccaninny Gorge) tourist pressure will be concentrated on the most sensitive and vulnerable areas.

The sand plain surrounding the Bungle Bungle forms part of the Ord River Regeneration Reserve and is severely degraded due to a past history of overgrazing combined with the present impact of feral cattle and donkeys. This reserve was set aside in 1967 for the purpose of regenerating the eroded areas and to control siltation damage to the Ord Dam at Lake Argyle. The uncontrolled access of vehicles in this area will compound the already serious erosion problem and could lead to the spread of undersirable plant species. For example, local Aborigines have advised us that the native Spear Grass *Heteropogon contortus*, with its abundant pungent seeds, is favoured by burning and other disturbance and has increased its occurrence throughout the sandplain. Additionally, the introduced species *Calotropis procera* (Caltrope) and *Parkinsonia aculeata* occur near the Bungle Bungle Outcamp and could be spread by vehicles throughout the area.

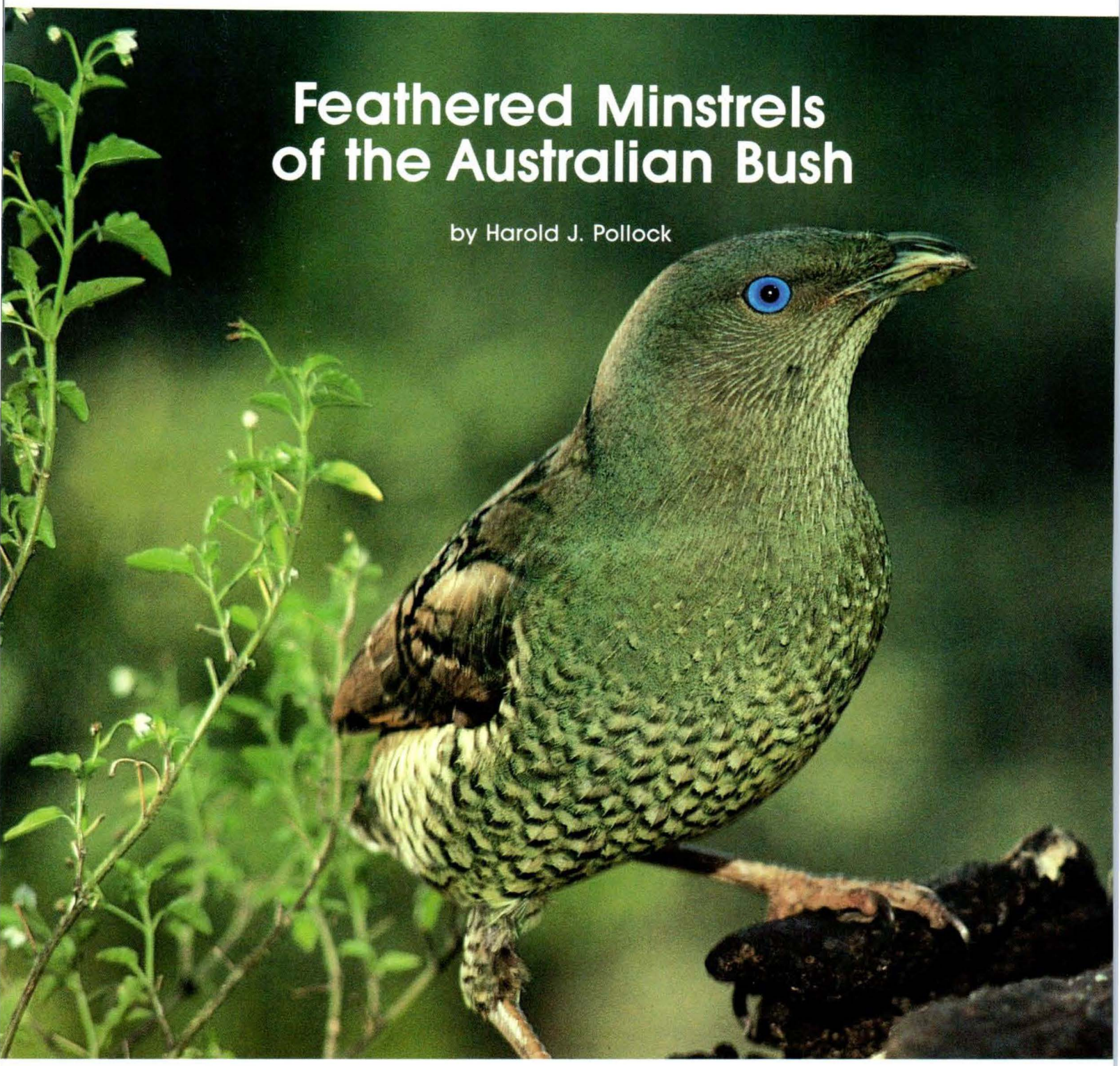
Little is known of the role of the lower plants in the area such as the soil lichens and fungi which not only bind the soil but also add nutrients. The impact of large numbers of tourist vehicles creating their own tracks would be to not only exacerbate the erosional problem but also damage this valuable soil flora.

In the absence of detailed biological surveys of the region it is hardly possible to consider the conservation significance of species collected or habitats recorded in terms of overall regional representation. Only with further surveys of the east Kimberley will such an appraisal become possible. □

– Kevin Kenneally
and Stephen Forbes

Feathered Minstrels of the Australian Bush

by Harold J. Pollock

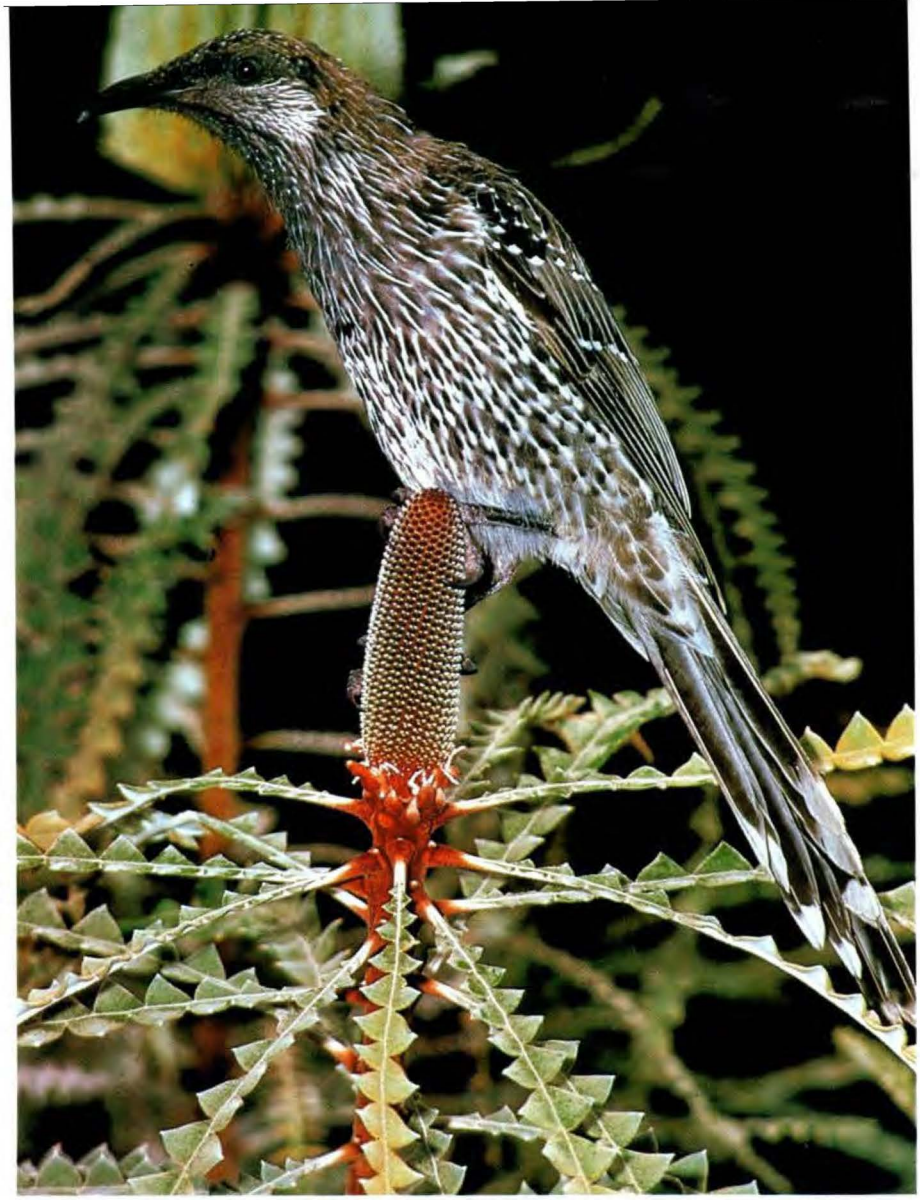


A female Satin Bowerbird. It shares with its shining black male counterpart those brilliant sapphire eyes and brilliant art of vocal mimicry. Photo: Paul Gobert.

The Nightingale has probably inspired more poets and writers with its song than any other bird. Mainly through their influence it has come to be regarded by many people as one of the finest of all bird singers. Today the very name Nightingale conjures up thoughts of sunny, spring days and melodious bird-song.

The Nightingale's song is certainly pleasant enough, but does this rather drab-looking, little bird really deserve its reputation as one of the finest of all bird songsters?

In various parts of the world, including Australia with its 700-odd species, there are probably many songbirds with voices equally as musical, or even more so, than that of the Nightingale. However, it seems that Australians did not always recognise the beauty of their bird-song. An early settler, apparently bitterly disappointed that the Australian landscape was so different from the gentle, undulating, green hills of the Home Country, wrote: "The leaves are blue, the flowers have no fragrance and the birds no song".



The calls of the Little Wattlebird reminded the famous, early English bird-man, John Gould, of the act of vomiting. Photo: A.J. Salter NPIAW.

One colonist even suggested the Nightingale be introduced to Australia to teach the native birds how to sing. Perhaps these early Australians were too busy with the toil of living to listen to the songs of the birds, or they may have heard the bird-song but were too biased to admit its beauty.

If an international competition for bird songsters was organised and each country represented by six of its finest songbirds, I dare say that the Australian team would probably win the Gold Medal. That said, just who are our star Australian songbirds — the professionals, so to speak?

Anyone at all familiar with our birds will undoubtedly place the Pied Butcherbird as this country's number one songbird. Almost twice the size of the Common Starling, the Pied Butcherbird is a bold fellow with a wicked-looking hooked bill, which it sometimes uses to wedge small birds, insects and reptiles between branches or onto thorns. The common name of butcherbird is derived from this habit.

Also known as the Organ-bird, the Pied Butcherbird has an extraordinary variety of flute-like calls that are often rendered from the topmost branches of tall, dead trees. Butcherbirds sometimes sing a duet, each voice complementing the other, while they spread their wings and bow to one another in a charming fashion.

Early one morning in Murwillumbah, northern New South Wales, I sat on a eucalypt stump and listened, enthralled, to the dawn song of a Pied Butcherbird. The lovely melody filled the still air as the flute-like voice went smoothly up and down the scale. One musical cadence was completed with a few delightful bubbling notes. The singing session lasted perhaps ten minutes and ended with a clear pronunciation of the word "Waipukarau", the Maori name of a small town in the North Island of New Zealand. In all my years in the Australian bush I have never heard a Pied Butcherbird sing as long or melodiously as this one did that sunny, spring morning in Murwillumbah. I have since come to the conclusion that he was a maestro of his kind. But John Hutchinson, an expert on Australian birdsong, avers that one of the most common calls of the Pied Butcherbird reminds him of the opening bars of Beethoven's Fifth Symphony.

The butcherbirds of Australia (there are four in the group) are a distinguished band of bird minstrels. The Black Butcherbird of northern Australia and Papua New Guinea, a much larger bird than its pied relative, has a rich, yodelling song of great variety and beauty. This shining black bird with a metallic sheen is rather shy and so is much more often heard than seen.

Another in the group, the Grey Butcherbird, has a wide variety of rollicking, musical calls, which are perhaps not as loud and clear as those of the pied variety. This lively bird, found in all Australian cities, is a popular visitor to parks and public gardens and becomes quite tame if fed.

The fourth kind, the Black-backed Butcherbird, is only found on Cape York Peninsula and has a whistling song very similar to that of the grey variety, although maybe quieter and less musical.

The Crested Bellbird has a bell-like voice. Photo: J. Gray NPIAW.

The Golden Whistler. Photo: J. Gray NPIAW.

Next on the ladder of famous Australian songbirds would be the Grey Shrike-thrush — a handsome, grey bird with large, dark eyes, found almost throughout Australia. Its beautiful, liquid and varied song is often heard in private gardens and public parks. The Superb Lyrebird, the cleverest mocking bird in the world, obviously appreciates the melodious notes of "Whistling Dick", for he seldom fails to include this song in his extensive repertoire of imitations. Sometimes he embellishes the Grey Shrike-thrush's song in charming manner, as though to show the original owner how it should really be sung.

Another Australian bird with a sweet, whistling call is the tiny White-throated Gerygone. This tiny sprite, barely a finger's length from beak to tail, has a pleasing melody comprising a descending trill ending with an upward slur. For one so tiny its voice carries a surprising distance. It is said that, apart from the cuckoos, this warbler is one of the few birds in the world whose voice descends the scale.

Apart from the songbirds, the Joan Sutherlands of the Australian bush as it were, many other Australian birds have voices as unusual,

The Gang-gang Cockatoo's voice sounds like a rusty gate being opened. Photo: J. Christesen NPIAW.

The charming song of the Grey Shrike-thrush is often included in the Superb Lyrebird's extensive repertoire of imitations. Photo: G. Weber NPIAW.

varied and bizarre as many in the world.

For some unknown reason, it is claimed that Australia has more mocking birds than any other country. The present tally is about 50 species but new mockers keep turning up.

As mentioned before, the most talented mimic of all birds is the Superb Lyrebird, a rather plain-looking brown bird about the size of a barnyard chook. The Superb Lyrebird usually displays and sings on a little mound of earth that he has cleared just for this purpose. The undersides of his long tail feathers are silvery white and, when he displays and sings, he usually throws his great tail forward over his head so that his body is completely hidden. He prances around his mound, shimmering his tail feathers and dancing to his own music — a rapid potpourri of his own loud calls and mimicked songs of other birds that live in his territory.

He must have a marvellous memory and musical ear for some of his imitations are well nigh perfection. If one or two of his imitations are separated from the others on magnetic tape, even an expert on bird calls, when played the tape, is hard put to tell the stolen sounds from the original.

Although not generally so well known, the female Superb Lyrebird is also a competent mimic. Because she has to brood the egg in the nest for six weeks and then feed the chick almost every half hour of daylight for another six weeks, she probably has little time to practise the art of mimicry.

The shining violet-black Satin Bowerbird with those brilliant sapphire eyes, is another Australian mimic of considerable ability. I have heard this bird, towards the end of a passage of his song, imitate a Laughing Kookaburra and an Australian Raven, while at the same time singing his own song — truly a remarkable achievement.

In fact, all the bowerbirds — there are eight species in Australia — are mimics of astonishing ability. I have heard it said, although I will not vouch for its truth, that the Spotted Bowerbird can imitate human voices. But I have heard a Great Bowerbird, in a tree near the men's quarters in Mary Kathleen mining town in central Australia, give a most realistic imitation of a smoker's cough.

Mrs H. Curtis of Tamborine Mountain, southern Queensland, once gave a colourful account of the mimetic abilities of a sub-tropical Albert Lyrebird, a close relative of the Superb variety, and a Yellow-throated Scrub-wren. The little scrub-wren cleverly imitated the song of the Grey Shrike-thrush, the Golden Whistler, the explosive whip-crack of the Eastern Whipbird and the "quick, quick, quick, quick" of the Southern Logrunner, together with several other calls. The lyrebird whistled like a goshawk, shrieked like a flock of terrified lorikeets, crooned like the Brown and Wonga Pigeons, screeched like a King Parrot, shouted like a flock of Pied Currawongs, cried like a Green Catbird, laughed like a Laughing Kookaburra, and then turned himself into a glorified Grey Shrike-thrush, a flock of Crimson Rosellas, a spirited Southern Logrunner and, at the last, a very assertive frog." †

So, it seems, many Australian birds are songsters with melodies as beautiful as any in the world and mocking birds almost without parallel. But the songsters and mockers are not the only Australian birds with outstanding and unusual calls; many others have voices that almost defy description.

For instance, in addition to the Laughing Kookaburra, whose call probably more nearly approaches human laughter than any other bird's call, we have the Green Catbird, which yowls like a midnight tom, and the Southern Stone-curlew whose weird, wailing calls would do justice to any midnight ghost. The Restless Flycatcher with its whirring, rasping call, which sounds like scissors being sharpened on a grind stone, is often referred to as the Scissors-grinder. The Gang-gang Cockatoo has a voice that sounds like a rusty gate being opened and the White-headed Stilt yaps like an excited terrier. The famous, early English birdman, John Gould, wrote that the calls of the Little Wattlebird reminded him of the sound of retching.

While the Emu's voice suggests a military rat-a-tat beaten on a kettle drum, the tall Brolga's loud bugling call may well be thought of as the Australian "Call of the Wild". The Cape Barren Goose, the Australian Pelican and the great Australian or Southern Cassowary are examples of several species which grunt like bacon-ready pigs.

Other Australian birds have bell-like voices. The best known of these is the tinkling Bell Miner which, when calling in a flock, sounds for all the world like a Christmas sleigh. The beautiful Crimson Rosella and the ventriloquial Crested Bellbird also have bell-like voices.

The Grey-crowned Babbler yodels like a Swiss mountaineer, while the male Eastern Whipbird seems to blow himself up like a Lilliputian bomb as he utters his loud stockwhip call. His mate or other females answer with a call that sounds like a "choo-choo" or, if there is no answer, the male adds the "choo-choo" himself. This whip-crack call is one of the strangest of all bird voices.

The voice of the Large-tailed Nightjar of northern Australia sounds like wood chopping. The bird varies the number of "chop-chop-chop" calls from one or two to five or more, and is sometimes called the Hammerbird. It is said that the Malayan Chinese used to bet on the number of "chops" the bird would utter in sequence, hence it is also called the Betting-bird.

Apostle birds, as the name suggests, usually feed on the ground in flocks of a dozen or so. They have many harsh, grating calls and chatter incessantly. In the country, they are known as C.W.A. (Country Women's Association) birds.

There are other birds not yet mentioned. One bird moos like a cow, another cooees, yet another buzzes; others in turn whoop, hoot, trill, and we even have one that rattles like a half-empty tin matchbox when shaken. If, early one morning, all these birds were induced to call at the same time and in one place, it would sound like the morning chorus of Hades.

Of the 700-odd species of birds found here since the coming of white man to Australia, only two species of Dwarf Emu have become extinct. However, others must be on the verge of extinction, for they have not been sighted for a considerable period and are no longer found in their previous known habitats. I fear that the year may come when we will never hear or see many of the feathered minstrels of the Australian bush mentioned in this modest article. □

†*Extract from "Birds That 'Steal' Sounds" by Alec H. Chisolm, from "Land of Wonder" edited by Alec H. Chisolm. Reprinted with the permission of Angus and Robertson Publishers.*

FORUM

Losing Our Way

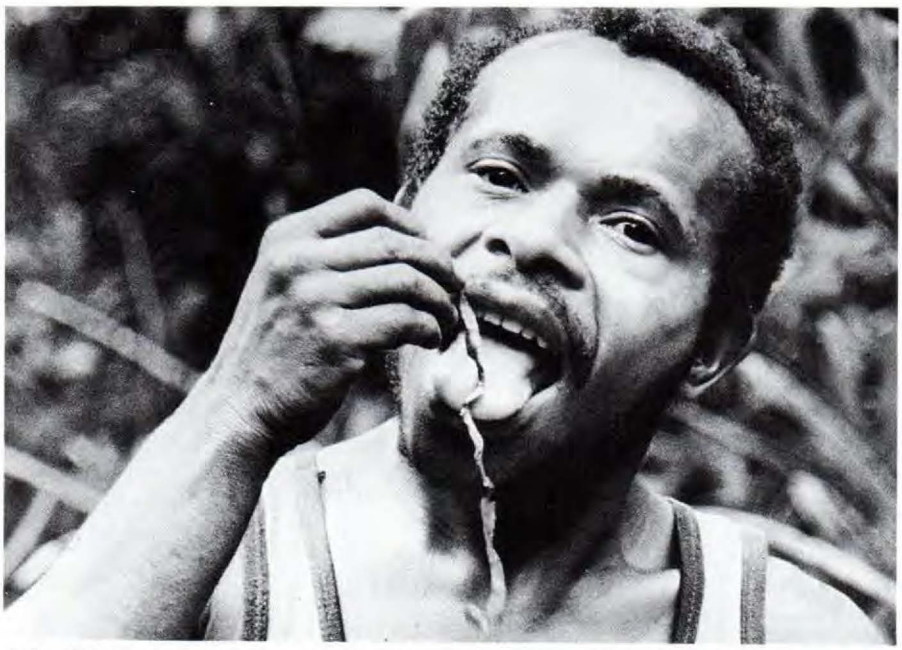
BY DR TIM FLANNERY
Scientific Officer
Australian Museum

Urban dwellers' view of their place in nature is rapidly changing. This is reflected in a series of seemingly unrelated phenomena including the increasingly popular concept of wilderness areas, the growth of vegetarianism and of animal liberation groups, and a rejection of animal research. What do these movements have in common? They tend to distance humanity from the environment in "traditional" interactions. Perhaps they reflect a sense of guilt — a feeling that whenever people and animals or ecosystems interact the latter are always the losers. Here I will discuss the philosophy behind this changed view of our place in nature and whether it corresponds with our actual relationship with the environment.

To live as I have with New Guinean hunters brings sharply into focus many aspects of our own culture, for it provides a comparison — a radically different view of man's place in nature. Dealing with this diverse topic, I have chosen to examine one aspect: the relationship between humans and wild animals. Here startling cultural differences and similarities emerge. Surprisingly, animal liberationists and New Guinean hunters hold in common some views not widespread in the rest of our community. For instance, compared with the Judaeo-Christian view (where people alone have souls), the distance between animals and Man is diminished. New Guinean mythologies abound with human-cum-animal beings and, indeed, as do animal liberationists, New Guineans often explain animal actions in terms of human motives. Thus both groups have an anthropomorphic view of animals. But here the similarities end. Such views bolster the animal liberationist's belief that animal life is sacrosanct. For New Guinean hunters, however, it is nothing to throw the living, naked pouch of a young possum onto hot coals, or to leave a horribly mutilated animal alive for hours before killing it. These people do not regard this as cruelty, but simply the best way to preserve and deal with food. Indeed, New Guinean hunters identify themselves primarily as carnivores. I have often heard other animal carnivores (such as the New Guinea Native Cat, *Dasyurus albopunctatus*), referred to as "stilman" (thief in Pidgin) — one who steals the prey of Man.

Hand in hand with these attitudes is a great respect for animals and the environment. Certain animal species are admired for traits such as toughness or obedience of their young, and New Guineans are fully aware that over-exploitation of some resources can deplete them, to everyone's disadvantage. Rules and taboos restrict their use of weapons in areas where they may lead to over-exploitation. Thus, despite their view of themselves as carnivores and the ultimate users of the environment, most New Guineans have great respect for the land with which they live in intimate association.

In contrast, many urbanised Europeans have an exaggerated concern for the welfare of *individual* animals. To some, the concept of protection of a species or the environment is confused with their concern for specific animals. This is perhaps due to the fact that most urbanites have little or no first-hand knowledge of Australian ecosystems or animals in the wild. To such people, animals are family pets or those furry little things that are so cutely portrayed by Beatrix Potter or Norman Lindsay. It is for this reason that people are regularly killed while attempting to feed or fondle bears in the United States. To exploit, use or eat animals is unthinkable. Indeed, the empathy that some animal liberationists feel for animals resulted in death threats recently made to animal experimenters at Victoria's Monash University. The view of the New Guinean hunter is thus turned on its head — it's perfectly alright to take human life to protect individual animals, but forbidden to take animal life to enhance our own! In this view of the world, people are seen as evil forces despoiling a world of natural innocence.



▲An Atbalmin hunter eating a tapeworm taken from the intestine of a Ringtail Possum. Nothing is wasted from the day's catch by these conservation conscious people. Photo: Tim Flannery.

"... the concept of protection of a species or the environment is confused with their concern for specific animals. This is perhaps due to the fact that most urbanites have little or no first-hand knowledge of Australian ecosystems or animals in the wild ..."

Which of these views most accurately reflects our present relationship with our environment, and which contributes most to the fullness of human life?

To answer this we must realise that people are an integral part of the environment. Even us urbanites are just as much carnivores and users of the land as the New Guinean hunters. The difference is simply that we pay others to use the land for our benefit. Should we feel guilty of such use? To do so we must feel ashamed of what we are — the most successful users of the land.

To survive, our guiding goal must always be to ensure that maximum natural diversity is maintained. Every species that becomes extinct is a potential asset — both aesthetic and economic — that is lost to us all. But equally, we must manipulate animals and take life to survive. This fact is lost on many because we are alienated from the daily struggle to produce food, defend ourselves against disease and a myriad other areas of endeavour where we must kill to survive. To accept what we are, and to be proud of our place in nature, as are New Guinean hunter-gatherers, is perhaps the key to the moral and philosophical turmoil that besets many "environmental" debates today.

So, which philosophy best fits man's place in the modern world? I must come down on the side of those New Guinean hunters and admit that we urbanites have truly lost our way. □

letters

Killer Cassowary

Thank you for publishing the splendid colour photos and very interesting article on the nesting of the Cassowary at Mission Beach.

You may be interested to know that there was another fatality caused by a Cassowary during my early secondary school days. From time to time we were taken to Healesville Sanctuary as the Sir Colin MacKenzie Fauna Park was then known. On one of these visits I recollect reading a notice on the padlocked gate of the Cassowaries' enclosure, saying that entry was forbidden because the birds were nesting and dangerous. The enclosure was full of undergrowth and we had only a brief glimpse of one of the birds moving through it.

Shortly after this visit, there was a report in the paper (probably the Age, maybe The Argus) that a man had in fact been attacked and killed by one of the Cassowaries at Healesville. Later there was a report of the inquest. According to my recollections, the victim had wished to photograph the birds. Despite warnings by park staff, he had managed to enter the enclosure, and was attacked and killed.

I know one's early memories can be misleading, but I was extremely interested in natural history at the time (and still am) and I am sure this memory is correct. Having seen the warning notice myself and having read of their ability to attack dogs and people I took notice. This would have been sometime in the period 1952-1954.

Anthea Fleming
Ivanhoe, Victoria

Damage to Mound Springs

Winston Ponder's article (A.N.H. Vol. 21, No. 8) on the South Australian mound springs highlights the importance of these areas as part of our natural heritage. Indeed, some of the mound springs are within the Lake Eyre National Estate Area. Unfortunately this did not seem to have any bearing on the choice of site for water extraction to meet the Olympic Dam Joint Venturers' needs.

To update Winston Ponder's last paragraph, I would like to say; recent excursions to the Hermit Hill-Lake Eyre mound springs area revealed damage taking place as a result of the Wellfield A development. Damage recorded includes: vehicle tracks made during the company's spring and bore monitoring program; tree decline along the Gregory Creek, connected with water use/dumping from a flow test at bore GAB6; erosion and the escape of water from an aquifer near Fred Springs, caused by failure of a capped exploratory bore in the Wellfield A series; and aesthetic impairment of the landscape, through poorly situated monitoring and production bores.

Clearly some mistake was made in the selection of this area of the National Estate for the location of an industrial water extraction complex. People with an interest in such areas should strongly protest their use for such purposes. In the Wellfield A case the company's environmental consultants did inform me that an alternative choice of site was a mitigation option. Unless the use of such options are demanded, company decisions will always follow the line of the least expense. In this case, the expense is met at the cost of our National Estate.

— Paul Reader
Conservation Council of South Australia

poster

Longicorn Beetle

The family Cerambycidae, of which *Dihammus vastator* is a member, is known collectively as Longhorned or Longicorn Beetles for obvious reasons. The majority of members of this family of about 20,000 species are tropical in distribution, often being restricted to one or a small number of food plants.

The larvae bore into plant stems, roots or tree trunks, feeding either under the bark or in the heartwood, depending on the species of beetle. Some species feed on dead wood, some on live wood.

Wood eating insects often have difficulty in digesting cellulose and compensate by such means as devouring large amounts of wood for sap or other non-cellulose protein, for example Cossid Moth larva, or by possessing bacteria or protistans in the gut which break down the cellulose for them, as do Termites. Longicorn Beetle larvae seem to be exceptional in that they apparently secrete the enzyme necessary to break down cellulose.

The larvae often take years to reach maturity — the exact time depending on the species involved, the food plant involved, and the temperature. There is a record of one species, *Hylotrupes bajulus*, living for 32 years before emerging as an adult beetle. Once the larva reaches full size it makes suitable arrangements for pupating. In the tree boring species this involves making a tunnel to the surface and plugging it with wood fibres or chalky mucus. This is because the adult beetle is not powerful enough to bite through solid wood but can chew through the plugs.

The larvae are sought by many predators and parasites. In Australia the Aborigines winkled the larger species out of trees with hooked vines, twigs and axes. Eaten raw or cooked in ashes they were a tasty delicacy — one of the well known Witchety Grubs.

Because of the larval feeding tunnels in both living and dead wood, some species are regarded as economic pests. Infested timber can be rendered unsightly and is structurally weakened by the tunnels. Other species become pests by feeding on food-bearing plants (the poster species illustrated is one of these). It has been given a variety of common names over the years as a result of its attacks on a variety of plants — Passion Vine Longicorn, Vine Destroying Longicorn, Fig Tree Longicorn and Buff-coloured Fig Longicorn. It has been known to feed on passion vines, grape vines, wisteria and Moreton Bay fig.

As would be expected from a wide range in diet it is widely distributed in Australia, being found in Queensland, Victoria, New South Wales and South Australia as well as islands such as Lord Howe and Kangaroo.

The larva is a shiny dull white with a dark brown head. The first segment behind the head is thickened and somewhat flattened giving rise to one of the common names for cerambycid larvae — "Cobra Grubs". The larva can be up to 37 mm while the adult beetle is around 25 to 33 mm with the antennae adding another 56 mm or so to the total length. It has a dark brown body covered with a yellowish grey pubescence or "fuzz". This species, along with several other cerambycids, is capable of producing sound (stridulation) when restrained or disturbed.

— Martyn Robinson

books books books books books books

Vertebrate Zoogeography and Evolution in Australasia (Animals in Space & Time)

Edited by Michael Archer & Georgina Clayton. Hesperian Press: Carlisle, Western Australia. xxiv + 1203 pp. $55.00

This book is phenomenal by any standard. Soft covered it weighs nearly three kilos, has over 1200 pages and probably close on one million words; there are more than 1500 numbered figures with many unnumbered sketches, cartoons and tables, 24 coloured plates and extensive bibliographies. This mammoth production arose from lecture courses on Australian vertebrate zoogeography by Dr. Archer. This format is retained, in that each section has an introduction to the principles of the subject and a background of current knowledge before dealing exhaustively with the Australian faunas.

The opening section of the book sets the scene with discussion of the geological history of Australia, its climate and flora. There follow sections on fish, amphibia, reptiles, birds and mammals. It is however the mammals that dominate the book with 600 pages and over 1,000 illustrations. There is a final section on the vertebrate faunas of New Zealand, Papua New Guinea and Lord Howe Island.

Of 80 chapters, the longest (250 pages, including 16 pages of references) is by Michael Archer on the marsupial radiation. Archer has nearly 20 years experience studying marsupial faunas and demonstrates here his mastery of the subject, a powerful *tour de force*. Each family is treated in terms of its anatomy (soft and hard) for all taxa, fossil and living. The ecology and distributions are noted and throughout the data are supported by abundant illustrations. The chapter ends with a masterly synthesis of our knowledge and an attempt to unravel the evolution and history of the families. We are presented with a forest of phylogenetic trees, cladograms and classifications; the review explores ideas and critically assesses their value. The section on kangaroos begins '. . . nonrootine roobounding roominants . . . a radiation to melt the mettle of any systematist'. Don't be put off by the asides and cartoons; there is lots of meat (the best oysters) here and very attractively presented.

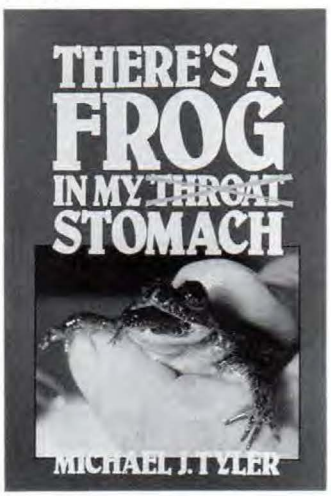
A volume of these vast dimensions could be unbearably dry, but this is far from being so. The text is authoritative (165 authors), thorough and up-to-date. There are inevitable repetitions but each chapter reads well and is fully supported with figures, photographs, diagrams and exhaustive bibliographies. The presentation of the book is attractive and there are innumerable sketches to enliven the scene. Chapter headings include 'Earth shattering concepts', 'Quills and bills' and 'On the importance of being a Koala'. There are superb restorations of extinct animals and a cover illustration of the mythical Australian 'all-classes' vertebrate *VZEA*.

Nearly half the book is penned by the senior editor Michael Archer and it exudes his enthusiasm for Australian animals in space and time. Nobody who wants to know anything about Australian vertebrate faunas, past or present, can afford to be without this magnum opus.

— **Bob Savage**

There's a Frog in my ~~Throat~~ Stomach

Michael J. Tyler. Collins, Sydney, 1984: 52 pp., $5.95.



This is an excellent little book on one of Australia's most remarkable animals, the Gastric Brooding Frog, the only animal known to brood its young in its stomach. The book explains how the animal and its strange habit were discovered, its general biology and the medical implications (for ulcer sufferers) of shutting off the stomach acid during brooding. It is written against a background of general frog biology, especially other unusual brooding habits for which frogs are well known. It has a fast-paced style that captures the tension and excitement of the rapidly developing, multidisciplinary research on a frog species that has gone from being unknown 14 years ago to one of the best known today. The book is an excellent introduction to the species for anyone — school report plagiarist to professional biologist.

— **Dr. Allen Greer**

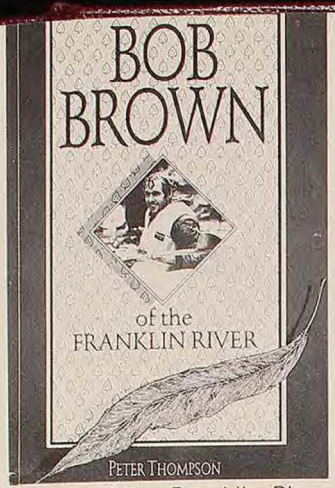
Bob Brown of the Franklin River

Peter Thompson.203 pp. George Allen & Unwin Australia, Sydney, 1984, $9.95, 203 pp.

This book traces the life history of Bob Brown, conservationist, adventurer, philosopher and, amongst other things, social agitator. The opening chapter deals briefly with Brown's childhood days, his family environment, adolescence and university training. The reader is left with the impression of a sensitive and intelligent youth with a dislike for formalised education, who was distinguished by his shy and introverted nature.

The following chapters focus on Brown's exploration of and involvement with the Tasmanian wilderness and the political process and bureaucracy which sought to determine the future of its wildest river. The frequent excerpts from Brown's diaries and letters to friends etc., provide a detailed insight into his character development and the motivation behind his continual social agitation. They form a powerful component of the book.

Wrestling with his introverted nature as he went, Brown had the courage to speak out and challenge a conservative community over its environmental values (or lack of them). In the process, he assembled a highly organised environmental lobby group (the Tasmanian Wilderness Society), which evolved into a powerful political voice. Bob Brown undoubtedly was the central figure in the preser-



vation of the Franklin River and this book provides a very readable account of his commitment to it. It provides an excellent overview of the five year Franklin campaign and gives an insight into the struggle for wilderness conservation within Australia.

It is illustrated with black and white shots of some of the conservationists, politicians and bureaucrats who contested the Franklin campaign. Hopefully, this book will help to maintain public support behind wilderness conservation as an effective and viable form of land management. It is well worth reading.

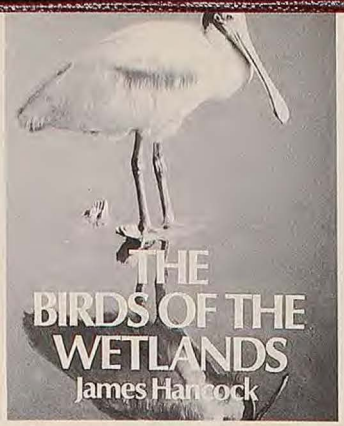
— **Paul O'Connor**

The Birds of the Wetlands

James Hancock. Croom Helm, 1984, $25.95, 152 pp.

Persons interested in natural history, ornithology, wetland birds or wetland ecosystems should be cautioned that this is not a book about wetland birds in general but a book about some waterbirds of nine different wetlands around the world. Basically the book is an attempt at a different approach in an area of natural history writing that has become increasingly more competitive.

A chapter has been allocated to the author's observations of each wetland and its waterbirds. Some of the observations are fairly comprehensive and are based on repeated visits to the wetlands (The Everglades and the Coto Donana of Spain); the others, however, are based on single or few visits and the text is more scanty (The Zhalong Reserve in China, the South



Alligator River Region of the Northern Territory, a wetland area in northern Argentina, the Tana River of Kenya, Bharatpur in India, the Shinhama Reserve of Japan and Pulau Dua of Indonesia).

A book often rises or falls on the basis of what it claims to achieve. This book claims to describe one major wetland on each continent; this it does. It claims to consider conservation problems of each area; again this is achieved if only in a superficial fashion for most. It intends to illustrate the similarities and incidence of convergent evolution of waterbirds between these separated areas. While the species similarities are apparent from the text, matters of convergent evolution are far beyond the level at which the book is pitched.

The book also claims to explain the "complicated ecosystems" of wetlands and waterbird populations. Here it fails and this is perhaps not unexpected when there are some 113 colour plates in the book's 152 pages. Moreover, it is not unexpected when entire books of considerable length are devoted to the ecosystem processes of a single wetland or similar processes in different wetlands. As (some) wetlands are amongst Earth's most productive ecosystems the physical and biological processes involved are extremely complex. This book barely scratches the surface in this area.

Despite its faults, it is beautifully illustrated with many high quality colour photographs taken on site by the author. The text is entertaining and very informative although locality maps would have made it much more comprehensible. The book forms something of a "Traveller's Guide to (the) Wetlands". The only problem with this idea is locating souls (with perversities similar to mine) who find wetlands desirable places to go out of their way to visit. And, as a final thought, as co-author with Hugh Elliott of *Herons of the World* (1978) the author's biases are (sometimes painfully) evident in his treatment of waterbirds. Some of these passages I read with rEGRET.

— **Paul Wettin**

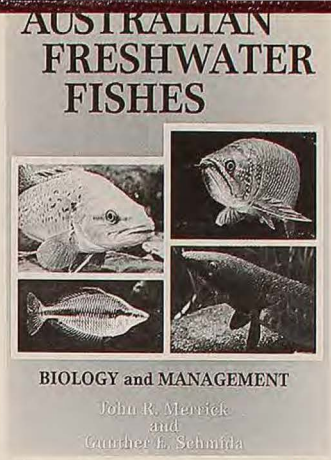
Australian Freshwater Fishes, Biology and Management

John R. Merrick and Gunther E. Schmida. 1984, 409 pp. $45

Australia's dry continent supports relatively few freshwater fishes, a mere 180 species compared with the 3,400 species found in our marine waters. However, our freshwater fishes have been the subject of numerous studies in the last 15 years and this new book, covering all of our freshwater fishes, summarizes the results of those studies.

The book includes chapters on the geologic history of the continent, the river drainage systems and factors affecting fish distribution, environmental changes and endangered species, identification and the classification of species, collecting and photography, glossary and 35 pages of references. The bulk of the book, some 315 pages, is taken up with the description and discussion of the 180 species. Each species is illustrated with one or more magnificent colour photos by Schmida and the text includes a description, discussion of habitat, life history information including reproduction, feeding, and distribution.

Anglers will certainly be interested in the information on such species as



the Murray cod, yellow belly and Australian bass, as well as introduced species such as trout and redfin. The book will also appeal to aquarists, with up to date information on rainbowfishes, blue eyes, gudgeons and galaxias. The book has been written for laypeople as well as specialists, and the writing is not overly technical. Although clearly the finest work produced to date on Australian freshwater fishes, no book is perfect in the eyes of all beholders. I for one would have liked more detailed information on the distributions of each species, rather than the mere listing of the drainage systems of each species. The map of drainage systems reprinted throughout the book could have shown the individual distributions of each species. The book is remarkably free of printing errors; one that wants correcting however, is Potamolosa for Pomatolosa on page 66. These minor criticisms do not detract from the worth of the volume, which is a must for anyone interested in Australian freshwater fishes.

The book is superbly produced with clear, large text and beautiful separation and printing of the 280 plus photographs; the Australian printers can be proud of the job they have done. The book has been privately published by Merrick, and although available in some bookstores for $45, it can also be purchased directly from J. R. Merrick, School of Biological Sciences, Macquarie University, North Ryde, NSW 2113 for $35 plus the postage charges for 1.75 kilos.

— **Dr John Paxton**

ROBYN WILLIAMS

Sir Alister Hardy – Water Babies and the Search for God

A.B.C. RADIO SCIENCE SHOW

"Hypotheses are the fuel of scientific progress, but are only valuable if they lead to their being tested by further observation and experiment". So wrote Alister Hardy in 1981, in the foreword to Elaine Morgan's book, *The Aquatic Ape*. For him it was a plaintive remark, not just an observation of correct procedure. The two theories for which he was best known in the last decades of his life (Sir Alister died earlier this year at the age of 89) were not taken very seriously by scientific colleagues and remain oddities or, at best, great leaps of the imagination. One is the belief that humans spent a long period of their evolutionary history in or close to water. The second is that there is a biological basis for religious experience.

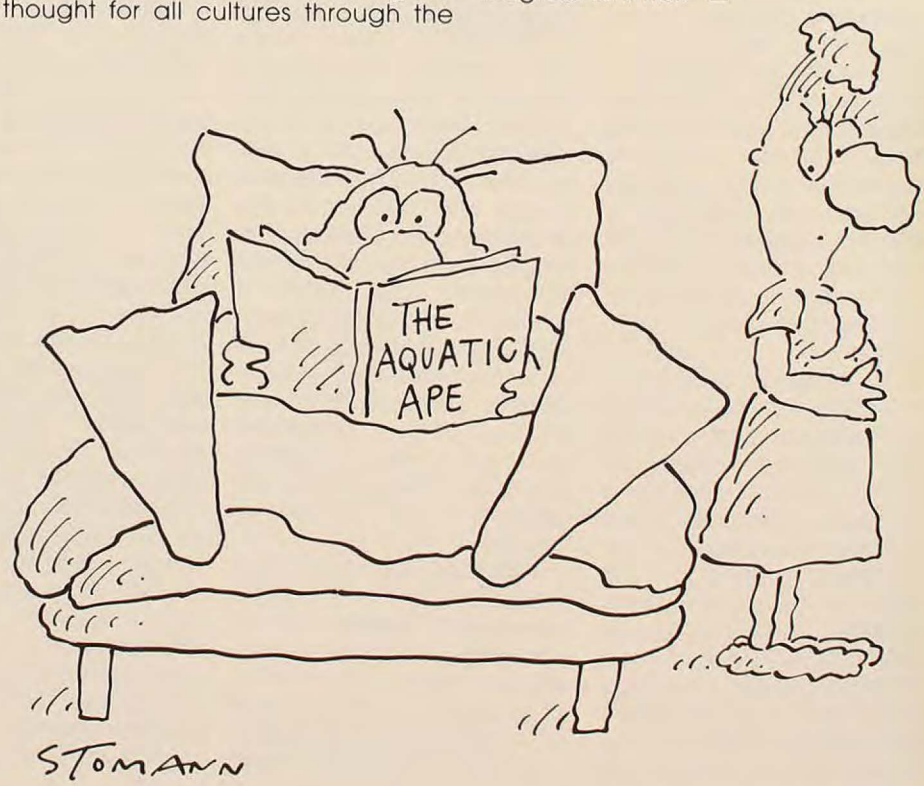
First the water babies. I find this one the best fun because it leads to countless ideas that may provide answers to many as yet unanswered questions. Why are we hairless and upright? Why do we cry? Why is there such a gap in the fossil record — five million years or so — when we seem to have disappeared from the planet? Did we step into the sea? Why is the human nose so prominent (unlike other apes we have outstanding conks)? Why do we have so much subcutaneous fat?

It was the fat that put Hardy on the water trail. He happened to read the observation — that we alone among land mammals have a thick layer under the skin — while musing in his study at Oxford. Immediately he connected this fact with similar attributes shown by marine mammals. Their skin is tight, like ours, bound by their insulation to the body. People aside, land mammals have a mobile skin. You can pull up a fistful of skin from a dog, cat or, significantly, an ape. But not from people. Could it be that we too had long ago adapted to a life in the water? Had some climatic catastrophe forced us from a life near the shore into the sea itself? Were we like seals, amphibious, but very much at home in the sheltered waters near the shore? Is this why we are so drawn to Noosa and Bondi beaches?

Hardy's speculation led him to many suggestive clues. He grew more excited and quite convinced. But he kept his conviction to himself — an Oxford professor of Zoology could not afford to look silly. But then he chanced some of his observations in what he thought to be a closed lecture. The next day the British papers heralded the fact that humans came from the sea. Hardy thought his career destroyed and old colleagues, like Le Gros Clark, said as much. But the uproar subsided as it always does and Hardy began to write a sensible account of his theory. It was Elaine Morgan, a literature graduate from Oxford, who popularised these accounts with the publication of *The Aquatic Ape* — a slim book, easy to read and full of startling asides. Are we really to believe, for example, that elephants too were once water creatures so that, like ourselves, they cry, have little hair and forward-placed vaginas?

The aquatic theory can be denied, of course, but it remains a fascination. Hardy's second preoccupation — that people believe in God because religious experience is some sort of biological entity — I find less intriguing. No doubt, religious experience is a biological entity; the believers (and non-believers) are biological! But Hardy was not put off by tautology and, instead, established The Religious Experience Research Unit at Manchester College, Oxford. If there was some consistent pattern of religious thought for all cultures through the ages, then one could, perhaps, infer the existence of some deity. But Hardy was eclectic: from paranormal to pantheistic he noted how folk described what they saw and how they felt. As an anthropological record and in the study of the structure and function of human society, the Unit's work has been useful. In Jonathon Cape's *The Biology of God* (1975), Hardy is shown to be more philosophical than sociological and this theme is traced from Plato to Whitehead. Let me end with a quotation from this book. It shows both Hardy's enthusiasm and his intellectual courage (though some would call this quixotic).

"The systematic study of the experience of God carried out in the spirit of naturalists, the pioneers working towards a more natural theology, can, I believe, prepare the ground for a religious faith in harmony with the true spirit of science: an experimental faith which can go forward and develop just as science enlarges its horizons. And just as science is science in any country of the world, so in the future there may be a faith to bind all people together in a universal recognition that what they in their different ways call God, Nirvana, Kwoth and other names, is in truth a demonstrable part of the very nature of Man — Man the religious animal." □



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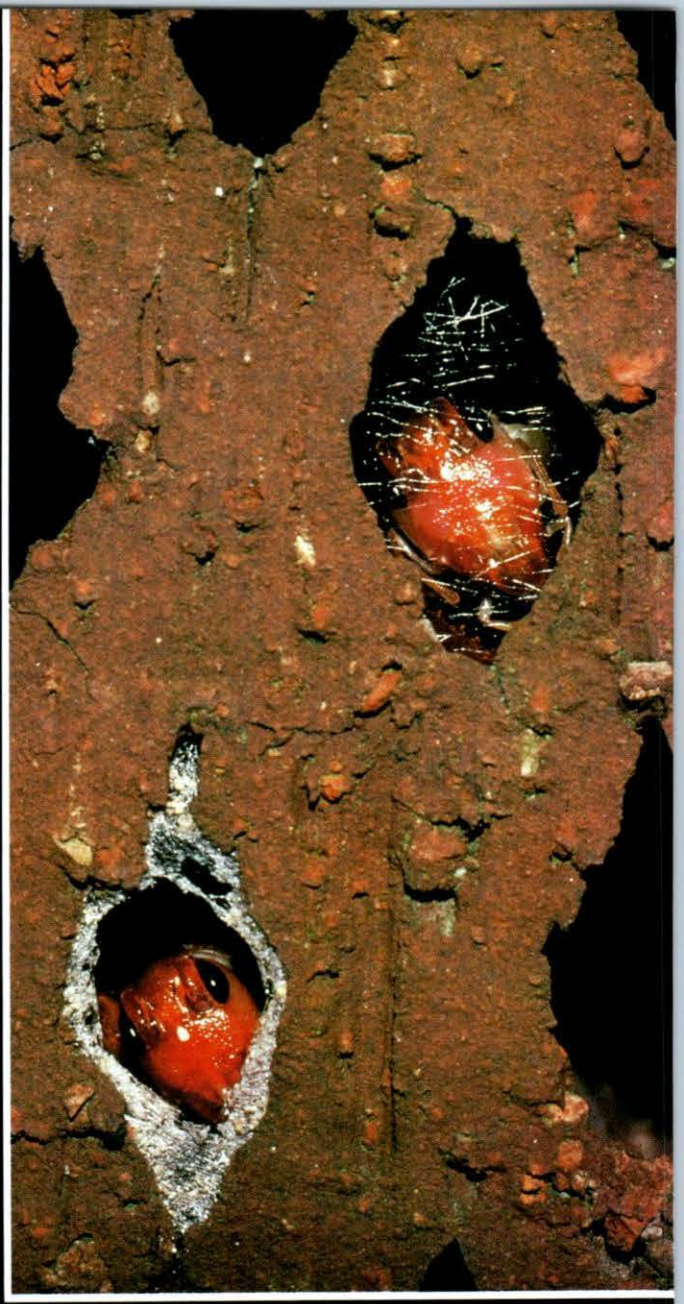
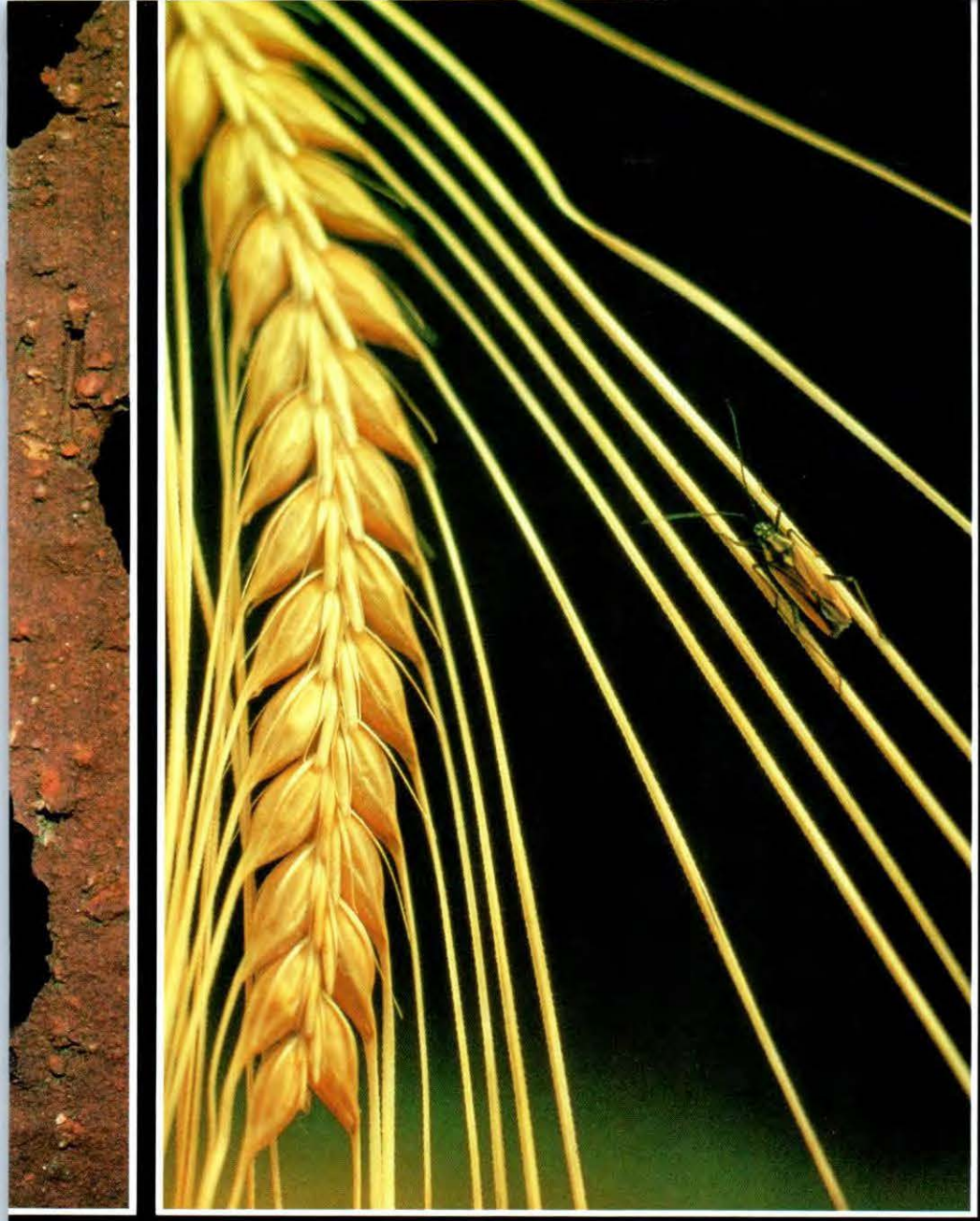




5

Natural History

Originally from St Andrews in Scotland, David Maitland is studying for his Ph.D. in Zoology at the University of New South Wales. It was a passion for collecting animal bric-a-brac and studying natural history that spawned his interest in photography and which has in turn developed into a passion. His photography has for a long time been purely recreational but recently, together with his wife Pamela, he has written and illustrated articles for *A.N.H.*

"Natural history photography can often be a bit dry tending towards the purely documentary and failing to go beyond the clear presentation of the subject matter. Although these 'record shots' are often necessary they are seldom soul-satisfying. In my own photography I strive to capture the inherent beauty or 'character' of my subject by finding compositions which produce strong graphic images — these I hope are images which capture the attention and can stand repeated viewing!

"I'm very keen to attract people to natural history and to encourage an interest in the plants and animals around us, no matter how common; if photography is a way towards this then great. Australia is a paradise for me, I'll never get over how incredibly beautiful many of the most common plants and animals are here."

6

1. Lizard: the Jacky Lizard *(Amphibolurus muricatus)* is very common in the Royal National Park at Bundeena. This one is sunning itself in the branches of a *Casuarina* (She Oak) bush.

2. Preying Mantis: a young Preying Mantis photographed in silhouette, about 1cm long. Even at this young age they have a voracious appetite actively hunting for other insects to eat.

3. Red Tentacles: the caterpillar of the Orchard Butterfly *(Papilio aegeus)* is very common in city gardens feeding on citrus trees throughout Australia. When alarmed it rears up and extends a pair of red 'tentacles' (osmeterium) which also produces a strong citrus odour; to me the caterpillar looks a bit like a bishop praying!

4. Crickets in Brick: juvenile garden Bush Crickets *(Pteropotrechus)* usually moult in the safety of a rolled leaf which is sealed with a meshwork of 'silk'. These two chose to seal themselves in a brick!

5. Barley: I've always found barley particularly beautiful. Here it's the Shield Bug straddling the spines that completes the image.

6. Bug on Sundew: the highly unusual and specialised Mirid bugs are unique because they are quite safe amongst the sticky tentacles of Sundews where they suck the juices from other insects as they are trapped by the Sundew. This Sundew *(Drosera binata)* and an as yet unidentified Miria bug was photographed in the Blue Mountains.

1.

SULAWESI!

Roger Kitching describes the complex ecosystem protected by Sulawesi's Dumoga-Bone National Park and how conservation fits Indonesia's Third World economy and philosophy. This park also protects the Sulawesi 'Specials' — three endemic species — of which two are endangered. The pig-like Babirusa is threatened: living in the Dumoga-Bone and at least one other park, its numbers are unknown. Colin Groves' report of the Sulawesi 'Specials' shows the island's importance for the animal world. In 1863, zoogeographer Alfred Wallace drew an imaginary line through the Malay archipelago, representing the meeting of Australian and Asian faunas. Today's understanding is that such a line should run right through Sulawesi.

RAINFOREST PROTECTION IN THE THIRD WORLD

If you were to ask a zoogeographer — someone interested in the geographical distribution of animals — what three places, say, are the most interesting on the face of the Earth, I would be prepared to bet he or she would say the Galapagos, Madagascar and the Celebes. The Galapagos earns its place in the list as the place of Darwin's inspiration — here the dynamic processes of selection and isolation which led Darwin to his formulation of the theory of evolution can still be seen in action as well if not better than anywhere else. In Madagascar the zoologist can study a 'predecessor' fauna, a slice of the Africa before the one we know today — of lemurs instead of apes, of insectivores not rodents, of fossas and teyras rather then cats and civets. The Celebes — or Sulawesi as it is now known — earns its spot on the list as the place the other originator of the theory of evolution, Alfred Russell Wallace, noted as the point at which two of the world's great faunas come together and mix — just!

2.

It is only in Sulawesi that a natural mix of marsupials and large placental mammals can be found, where cuscus live in the same forests as the celebrated Sulawesi 'specials' — the Celebes black ape, the dwarf forest ox or anoa and the enormous pig-like babirusa with its two pairs of recurved tusks distinguishing it from all other pigs. Here, zoologically speaking, Asia and Australasia meet. Indeed, we now believe that the contorted land mass of Sulawesi, sitting like a Rorschach ink-blot at 100 kilometres east of Borneo, is the point of collision between two (or more) of the massive continental plates which move slowly but inexorably over the Earth's molten core. The island's mountain ranges and active volcanoes are evidence of this ongoing impact between Asia and Australasia (possibly with an additional participant in the form of the so-called Philippine sub-plate).

In January 1985 the Royal Entomological Society of London launched a major research expedition to investigate the insects of the Dumoga-Bone National Park in northern Sulawesi, following in the footsteps of the Society's distinguished past President, Alfred Russell Wallace. This year-long exercise, named "Project Wallace", involves over 150 scientists from 17 countries and is examining the ecology and fauna of the primary rainforest of the park and the adjacent agricultural and urban areas.

The rainforest of northern Sulawesi is a study in green and brown — but of every conceivable variety and shape. As in our familiar Australian rainforests a great variety of broad-leaved trees soar skywards creating the moist gloom in which an enormous diversity of animals

3.

1. Expanding agriculture eats away at the edge of the Sulawesi rainforest. Photo: Roger Kitching.

2. 'Stilt roots' are characteristic of trees in many rainforests. Photo: Roger Kitching.

3. The fruiting body of a bracket fungus. Photo: Roger Kitching.

and lesser plants thrive. The rainforest is one of the most complex places there is, even when viewed, by necessity, from ground level.

Lianes loop from the canopy or hang loose like vast pendulums; trunks and branches are clothed in creepers, ferns, mosses and lichens whereas high in the canopy the true epiphytes, orchids and ferns of every shape and size create miniforests on the larger branches of the trees themselves. On the ground, amid the contorted plank buttresses of the trees, is the canopy-in-waiting — elegantly formed and delicately coloured seedlings awaiting their moment to shoot lightwards and replace their parents. Nowhere else are the basic processes of life and death so apparent as in these forests. Birth and growth is everywhere not just in the seedlings but in the sprays of new leaves and fronds, often russet coloured in contrast with the greens of the older foliage.

The rainforest is a vast edifice of plant tissue with a greater mass of living material on any given area than in any other terrestrial ecosystem. But if the plants are the buildings, the animals are surely the architects. Walking through the forest the naturalist's attention is diverted by movement and contact which provide the key to these burgeoning animal/plant interactions.

The Sulawesi forests are incredibly thorny places. Palms and canes, ferns and creepers, shrubs and trees are, more often than not, covered in spines of every shape and size ranging from a dense pile of hair-like projections, to massive nails three or four centimetres in length which will penetrate leather and canvas as easily as flesh. Rattan cane, when stripped of its spines as raw material is famous for the manufacture of furniture and has a particularly ferocious armoury, perhaps as a defence against grazing animals, as well as being useful for hitching a lift up into the canopy by dint of scrambling along the trunks and branches of others. Different plants adopt different anti-herbivore defences — tough or even poisonous leaves are common. Yet there is no shortage of successful herbivores in the forest and the results of their depradations are to be seen everywhere. Here, a pile of nuts is stripped from the trees by apes and utilised, secondarily, as a source of high protein food by the very common ground squirrels; there, neat circular pieces of leaves are incised from the edges of leaves by leaf-cutter bees. The air literally rings with the calls of cicada and cricket, coucal and hornbill, ape and parakeet. Plants are chewed, bored, mined, sucked and gnawed. Leaves, fruits, stems, flowers and roots all have their specialists: insects, birds, mammals or molluscs.

The rainforest supports a diversity of decomposers such as this millipede among the rich growth on tree branches. Photo: Roger Kitching.

There is a degree of evolutionary tuning which is characteristic of the rainforest where a long history and predictably equable climate have allowed finer and finer division of resources as more and more species pack into the variety of habitats the forest provides. Of course, the immense diversity of herbivores and an equally diverse set of decomposers such as termites, millipedes, springtails and worms themselves are a resource for others. A wide range of predators and parasites exhibit a greater or lesser degree of specialisation in their reliance on the other animals of the forest as food. There is an amazing range and number of robber flies — aerial wolves which snatch butterflies and moths out of the air as they pass. Brilliant red and blue dragon and damsel flies make similar depradations on flower-feeding insects. Mantids lurking on flowers and spiders are everywhere. The forest floor is the hunting ground of the many hued skinks, relentlessly pursuing smaller fry and, in turn, themselves pursued by the snakes. Brilliant yellow Chinese orioles and acrobatic drongos are perhaps the most visible of the many insectivorous birds and the noisy departures of mammal and bird-eating hawks are common sounds as one walks through the forest.

How does a vast area of virgin forest fit into the economy, philosophy and day-to-day life of the fifth most populous nation on Earth? The Dumoga-Bone National Park was established as part of a regional development program in northern Sulawesi supported by the World Bank. The area itself represents the water-catchment area of much of the Province and the growing population of farmers downstream depend on the water for both irrigation and drinking purposes.

The small towns and villages of the region, situated as they are on deep, rich black volcanic soil, well watered by year-round rainfall, present a prosperous and pleasant appearance. Canna lilies and bougainvillaea are planted along the road verges and I even saw lush tropical lawns maintained by painstaking work with the sickle. The small holdings behind the flowers are packed with corn and cassava, mangos and pawpaws with peculiar skeletal kapok trees and sweet smelling clove bushes to remind us that it is not just food that these people glean from the soil (the cloves are incorporated into cigarettes!).

Unlike the jam-packed populations of Java, here in northern Sulawesi the carrying capacity of the land for people is not exceeded, and forested hilltops and national parks can be tolerated. But the writing is on the wall. For every elderly person one sees five to ten young adults and for every adult, three to four children. The age structure of the population represents an environmental timebomb for the region. Sulawesi, like other less crowded areas of Indonesia, is also one of the receiving places for the government transmigration program which resettles Javanese and Balinese peasant farmers in an attempt to alleviate the horrendous pressures on land and amenities in their home islands. Transmigrant rice farmers establish paddy fields and push cultivation up the hillsides, clearing the forest as they go.

What arguments can a group of tourist scientists adduce to persuade, not the distant government in Jakarta, but the local people that their national park is an essential and priceless heirloom to be preserved for ever? The maintenance of water quality is an obvious beginning. The forest acts as a combination of still and sponge, collecting, refining and replenishing the river waters on which productivity depends.

Interconnected with the water economy of the region are the soil dynamics. With steep slopes and fre-

Babirusa in its natural jungle ▶ environment. Painting by Sue Oakes.

quent torrential rain, even the rich soils of Sulawesi are at risk if the stabilising and restraining role of the forests is removed. It is usual for us to think of national parks as inviolate places in which "nothing is left but footprints; nothing taken but photographs". However for a park in a developing country this may be an inappropriate idea. As a low-tech source of additional protein (bush rats are a favourite dish in northern Sulawesi), medicinal plants and wild fruits, the forest can remain an integral part of the life of the people.

And then there is tourism — a much applauded but little executed concept in northern Sulawesi but, nevertheless, a substantial potential source of income in a cash-starved local economy.

Lastly, and hardest to explain to pragmatic locals, is that the forest is a source of information — genetic, scientific and aesthetic — which can never be replaced if destroyed. In my experience there was a certain feeling of awe, even apprehension, concerning the forest among the local people which, with just a little education (and universal primary education is one of the real achievements of modern Indonesia) could be turned into appreciation and admiration of this most wonderful of ecosystems. □

– Roger Kitching
Environmental Studies,
Griffith University

THE SULAWESI 'SPECIALS'
ARCHAIC, STRANGE, ENDEMIC

What would you think if you saw a fight between two barrel-bodied, but thin-legged, pig-like animals, their four pairs of tusks — yes, tusks — interlocked? You might blink, then count the tusks, or you could be forgiven for looking skyward to check that one of the weird looking creatures was not flying above.

You would, to say the least, be surprised. Unless you are familiar with one of the three species unique to Sulawesi.

Three of Sulawesi's mammals have become more famous than the rest: they are a group of monkeys, a couple of dwarf buffalo, and a weird beast that is best described as a thin pig.

For a long time the received wisdom was that there were two kinds of monkey on Sulawesi (or Celebes as it used to be called): the Moor Macaque and the Celebes Black Ape. Macaques are the ordinary brown monkeys of Asia, with about twelve species ranging from the small, long-tailed Crab-eating Macaque of the temples of Bali to the giant Tibetan Macaque of the snows of Sichuan in China. The Moor Macaque attracted little attention. But the Black Ape was at first considered an extraordinary monkey. As its name indicates it has no tail ("ape" is a loosely applied term, meaning any primate without a tail); it is jet black, and has a long dog-like face resembling the snout of a baboon, an African monkey.

The American zoologist Jack Fooden took another look at these two monkeys in 1970. To everyone's surprise he found that what everyone had been happily calling "the" Moor Macaque was in fact three separate species (or sub species), living in different parts of the southern and south eastern peninsulas of Sulawesi; and "the" Black Ape was similarly two separate species (or sub species), inhabiting different parts of the northern peninsula. Moreover, there were two kinds of monkey of intermediate form in the centre of the island. This made everything clear: they were all in fact macaques! They all have common features: all tend to have rather long snouts and short tails and are mostly some blackish tone rather than brown. The one in the south-west, the true Moor Macaque *(Macaca maura)*, is the most like "normal" (non-Sulawesi) macaques. The one in the far north east, furthest from the Asian mainland, the Black Ape *(Macaca nigra)*, is the most different.

In 1975 I went to Sulawesi to examine whether these seven kinds of macaque were really distinct species or not. The definition of a species is that it is reproductively isolated from other species: that is to say, under natural conditions (and this is important: in captivity all the rules can be flouted) they do not interbreed with each other, or at least there is no hybrid population. I found that in South Sulawesi there is a sharp border between the Moor Macaque *(M. maura)* and its neighbour, the Tonkean Macaque *(M. tonkeana)*. At the 'neck' of the northern peninsula there is a wide zone of interbreeding between the Tonkean Macaque and its neighbour, Heck's Macaque *(M. hecki)*. Near Gorontalo there was another sharp zone bordering between *M. hecki* and Temminck's Macaque, *M. nigrescens*. And along the Onggak Dumoga River *M. nigrescens* interbred with the Black Ape *(M. nigra)*. Because people like to keep monkeys as pets, it was possible to examine quite a lot of monkeys at close quarters to see if they had characteristics intermediate between two forms as hybrids should.

So I concluded that the Tonkean Macaque should be called *Macaca tonkeana tonkeana* and Heck's Macaque *M. tonkeana hecki*. The Black Ape should be called *M. nigra nigra* and Temminck's Macaque *M. nigra nigrescens*.

In the same forests where the macaques run through the trees, down in the undergrowth moves another of Sulawesi's famous trio: a dwarf buffalo, the anoa. Anoas, under a metre in height, have short horns that point straight back in the plane of the face, rather like the young of water-buffalo. They have a fearsome reputation. I have vivid memories of a pair in Jakarta Zoo trying heads down, to spear me, through the wire netting. In captivity anoas have been known to kill each other and any hapless deer they have been caged with. To my surprise, however, in Palu, the capital of Central Sulawesi province, I was shown a pet anoa which would sit and lie down on command, but would not be touched.

Anoas are true buffalo, and like water-buffalo belong to the genus *Bubalus*. There are in fact at least two species: one in the lowlands and one in the mountains. The Lowland Anoa *(Bubalus depressicornis)* is larger, about 90 centimetres high, and jet black, always with white forelegs; the hair is short and sparse, and is often rubbed off with age leaving parts of the body bald. The Mountain Anoa *(Bubalus quarlesi)* is only 70 centimetres high, with a more woolly, black or brown coat.

Of the Sulawesi 'Specials', the most remarkable is a slenderly built, thin-legged pig-like animal with a long thin snout and — in the male alone — nature's more extraordinary tusks. It is known as the Babirusa (lit-

◀The Lowland Anoa *(Bubalus depressicornis)*. Both the highland and lowland forms are close relatives of true water-buffalo. Photo: M. Lyster, World Wildlife Fund Photolibrary.

erally *babi*, pig, and *rusa*, deer). This species *Babyrousa babyrussa*, is in fact the most divergent member of the family Suidae, the family which also contains true pigs and warthogs. Newborn Babirusa have no tusks. With growth, males erupt a pair in either jaw, which are at first simple pointed teeth like normal canines. Then the socket of the upper pair turn upwards and the upper tusks begin to grow upwards: through the skin of the snout, up, back and round again in a spiral. The lower tusks grow up and slightly backward.

A local legend in North Sulawesi has it that the male uses his curly tusks to hang himself up on a branch and wait for the female to come by.

It was not until John McKinnon studied the wear patterns on the tusks and Victoria Selmier described how they were used in practice that their real function was understood.

What appears to happen is that when a female is in heat males fight one another for the right to mate with her. First they stand side-on, pushing with their shoulders. They then retreat, facing each other and rear on their hindlegs, their front hoofs flailing, their lower tusks thrusting upwards as they try to gore each other. Here, the spiral upper tusks come into play. Blows are caught and deflected by the tusks, protecting both the eyes and the maxillary nerve, which runs along the top of the snout. Sometimes one male's lower tusk gets caught in the spiral of the other's upper tusk, and is so rendered harmless. Whatever the course of the fight, one male gradually presses down on the other, pushing him back onto all fours. The winner then mounts the loser, and they walk around together in this way for several minutes. The winner has thus achieved dominance, and his rights to copulation will not be interfered with by the loser.

Babirusa appear to be crepuscular, i.e. most active around dawn and dusk. They love to wallow in mud, and swim well. In the Togian islands they have been seen swimming a kilometre or more between small islands. Unlike true pigs, they are unable to dig deeply, because their snouts are not as strong and the rooting disc at the end is not as developed. They do not eat deep lying roots, but grasses, fallen fruit, mushrooms, and grubs which they gnaw from rotten wood.

A final curiosity about the Babirusa is the possibility that it may be the origin of a figure prominent in Balinese art. The *Raksasa* is a kind of devil, half-human, half-animal; the animal part of his nature is shown in art by the tusks emerging from his cheeks!

Although this young Black Ape was orphaned by poachers, Sulawesi macaques are probably not endangered while their forest habitat endures. Photo: Michele Depraz, World Wildlife Fund Photolibrary.

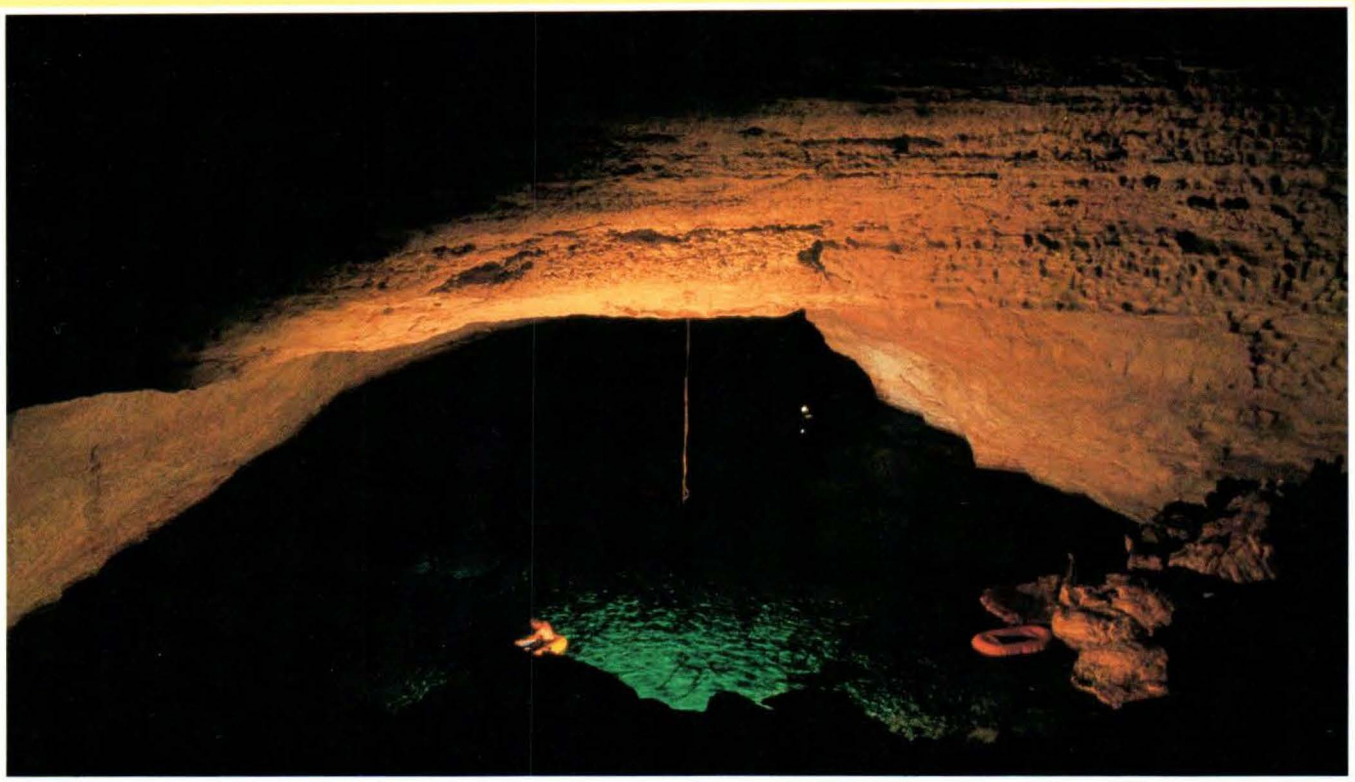
Babirusa recently achieved momentary fame in the United States recently as the purported 'kosher pig'. Its stomach is more complex than that of other members of the pig family, and someone leapt to the conclusion that this means it ruminates. An animal that divides the hoof (as the Suidae do, like cows and sheep) and chews the cud would be clean in Mosaic law, so Jews and Moslems could eat it. Farm them! Sell their meat! Good idea to conserve them and make money too! The idea was firmly squashed, almost as soon as it hit the headlines, by Victoria Selmier. Just because it has a fairly complex stomach, she pointed out, does not by any means guarantee that it chews the cud: in fact, other evidence is all against it. If it were declared ritually clean, it would be far more likely to be hunted by people than farmed, thus endangering species' existence. Besides, who are we to meddle with other people's belief systems and tell them what is clean and what is not? A Moslem theologian who was consulted expressed extreme skepticism that it was clean.

That is not to say that there is no conservation problem on Sulawesi. The monkeys are probably not endangered as long as their forests endure. But both anoa and Babirusa are hunted by non-Moslems, the former for its skin (very useful to make hard-wearing bags) and the latter for its meat. The Babirusa is also hunted for sport because it is reputedly very dangerous. The Dumoga-Bone National Park shelters Babirusa and at least one species of anoa, as well as Temminck's Macaque. Let us tread lightly in the footsteps of Wallace, and we will see something precious, something wonderful.

– Colin Groves
Prehistory and Anthropology
Australian National University

Nudging the Limits 'neath the Nullarbor

by Christine Deacon



▲The main lake in Weebubbie Cave. The pipe seen in the centre is the means by which water was extracted from the cave and piped 13 kilometres to the Eucla Roadhouse. The pipe and pump have since been removed. Photo: Norm Poulter.

The Nullarbor Plain is centred on the South Australian/ Western Australian border. Peppered with saltbush and bluebush, plants that have adapted to the highly saline conditions, it stretches as far as the eye can see, from the sheer 90 metre cliffs where it drops into the Southern Ocean, inland tor 250 kilometres.

This limestone region formed beneath the sea during the Tertiary Period, approximately 20 to 25 million years ago. It was later uplifted and exposed to the effects of weathering. Rain percolated through cracks in the limestone, joining slow-moving water. The water dissolved the limestone, creating passages where the water flowed. These dissolved passages became so extensive that the roof collapsed into them. The large caves on the Nullarbor are mostly these collapsed-formed passages floored by a jumble of broken blocks of limestone. In Cocklebiddy most of this collapsed passage was flooded when the water table rose with the rise in sea level following the last Glacial period, about 40 million years ago.

Aborigines knew the caves well. The Kukuda, Mirning and Pindini peoples lived here long before Europeans. At Koonalda Cave they quarried flint and scratched abstract designs in the soft limestone. The climate was milder and wetter and the vegetation, and animal life it supported, more varied. The Aboriginal art at Koonalda is in a prohibited area of the cave known as the Art Passage.

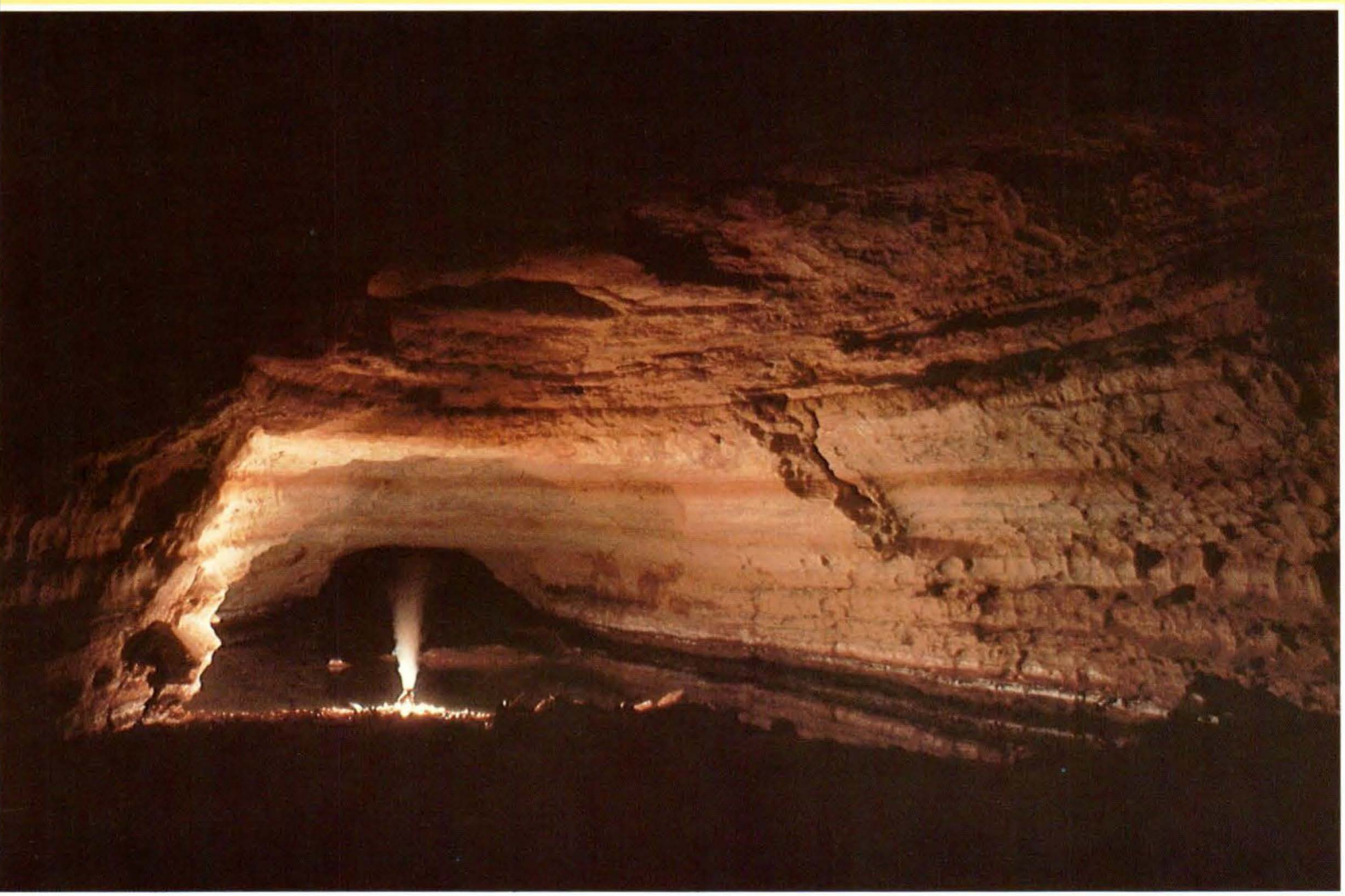
Other caves on the Nullarbor have been explored. Eleven of them contain water — shallow lakes or long water leads. They were first discovered by pastoralists in 1901 and the water, although salty and needing desalination, was pumped for stock and even domestic use. Two of the caves, Weebubbie and Cocklebiddy, have become famous for their size. This fact would certainly have surprised the first explorer of the caves, Captain J. Maitland Thomson, who ventured into Weebubbie Cave in a three metre wooden dinghy in 1951.

In the 1960s divers began to explore the caves, at first snorkeling the lakes, then penetrating the underwater passages with scuba. The remoteness of the area and the need for sophisticated diving equipment and techniques had kept the inner nature of the caves a secret from even the most adventurous explorers.

In 1972 however, 71 years after they were first discovered, Ian Lewis organised a major expedition. He was a member of the Cave Exploration Group of South Australia and played an active part in exploring and mapping the underwater sections of the South Australian Mount Gambier caves. He pioneered new techniques for the safe exploration of underwater cave systems. The

Time exposure of the helmet lights indicates the frantic preparation needed for the push from Cocklebiddy Cave's entrance to the rockpile.▶ Photo: Barrie Heard.

The entrance to Cocklebiddy Cave appears as a huge hole on the Nullarbor Plain. Exploration equipment must be lowered into the cave using rock climbing techniques. Photo: Alan Jolliffe.▼



▲Cocklebiddy Cave illuminated by a magnesium burning device specially developed for photography in the very large chambers of the Nullarbor caves. Photo: Norm Poulter.

team consisted of six divers and 30 cave explorers. All the diving gear had to be carried or lowered into the caves (a feat in itself), then carried over boulders and rough ground before reaching the water. Cocklebiddy Cave drops 90 metres over just 200 metres of surface. Other caves have a long, sheer drop into the entrance chamber and abseiling and other rock climbing gear must be used to lower equipment. During this expedition and another two years later, all the known water caves in the Nullarbor area had been superficially explored.

Cocklebiddy Cave is long and shallow and, by 1973, had been explored underwater to a point 554 metres from the underground lake in the main chamber. The following year a joint South Australian/Western Australian team organised another major expedition. Using sophisticated equipment such as submersible radio direction finders, which enabled accurate pinpointing of sections of the cave, as well as high-powered wet cell and gel cell rechargeable lighting, the cave limits were extended. High pressure copper tubing was laid from the cave mouth into the main chamber, enabling scuba tanks to be filled without the difficult and time consuming task of hauling them to the surface. They reached a point one kilometre by underwater tunnel from the entrance lake. Here a rock fall blocked the water passage, but left a dome-shaped air-filled chamber above. Divers had to carry their equipment over the rocks into the inner chamber where they again explored the water passage for a further 150 metres.

In 1977, divers managed to penetrate two kilometres from the cave entrance. The dive was made possible by the use of "triple" (three linked) scuba tanks on each diver and 16 spare tanks, which were taken to the inner chamber by underwater sled. The base party at the rockpile were connected to the world by a telephone cable. In sealed containers, food, sleeping bags, batteries and clothes were swum in for the long wait for the lead party's return.

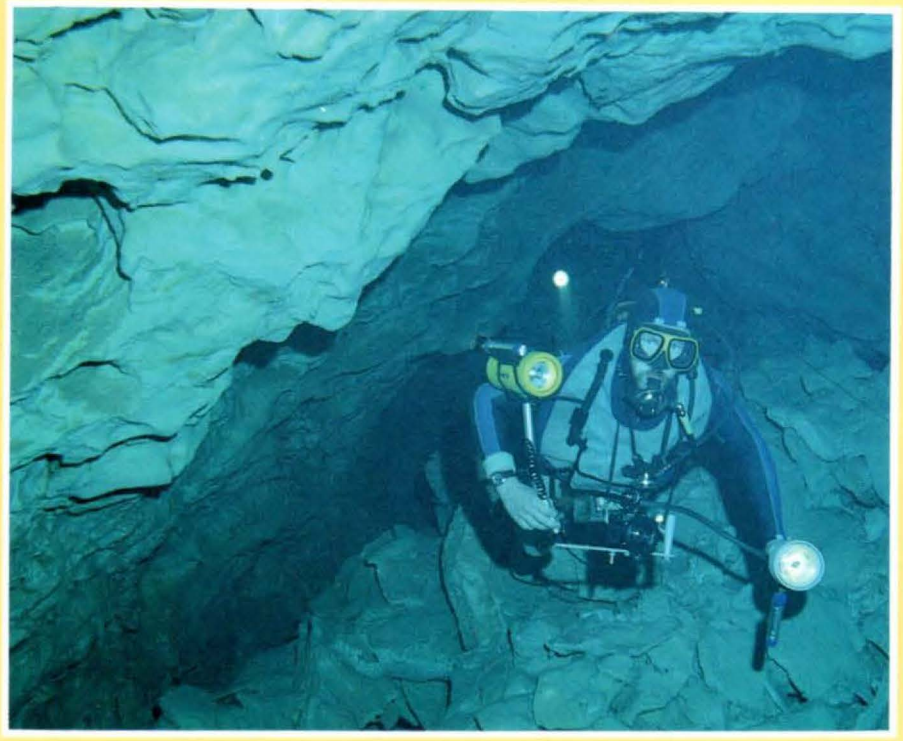
Two Australian expeditions followed in 1979, one reaching three kilometres distance from the entrance. This amounted to a five hour dive by a team of nine divers with 58 scuba tanks and three high pressure compressors. For Hugh Morrison and his team, it established a new world record and, for Australia, the longest submerged cave dive in the world.

One would think that after this enormous effort they would be content to rest on their laurels. Yet the temptation of the unknown limits of the cave was too great. Hugh Morrison organised another expedition in 1982. High pressure air and 240-volt lighting were available at the water's edge. An underwater sled transported 15 scuba tanks to the rockpile, which again formed the base camp. After disassembling the sled and carrying it and all the tanks to the far side of the rockpile, three divers entered the water at 8 pm.

The dive plan utilised the "one third rule" of cave diving: one third of the air supply to go in, one third to go back, and one third reserved for emergencies. At 1,800 metres, Hugh Morrison had used a third of his air and the sled was left, its bouyancy keeping it against the roof of the underwater cave. They pushed on past the previous penetration limit and discovered another underground air chamber, three and a half kilometres from the entrance. They named it Toad Hall. After a three and a quarter hour swim from the rockpile, they rested for an hour, then, concerned that the others waiting at the rockpile would think they had run out of air, they began the return journey. They had still not reached the limits of the cave. The total dive time was seven hours. Each diver had swum seven kilometres and physical and mental fatigue was evident as they emerged from the cave to a Nullarbor dawn.

Francis LeGuen, a French explorer, was the next to organise a major Cocklebiddy expedition. This was to form the basis of a full length feature film for French TV. The base camp on the dusty Nullarbor Plain was transported in a truck carrying

The topic of underwater caving is covered more comprehensively in a forthcoming book called Australia Down Under, by Christine Deacon to be published by Doubleday Australia Pty. Ltd.



Underwater view of Tommy Graham's Cave showing limestone sculpturing on the roof. This is a common feature of many underwater limestone caves. Photo: Alan Jolliffe.

half a tonne of fresh water, a tonne of food and three tonnes of equipment. Ultra high pressure fibreglass scuba tanks were specially manufactured for the expedition and diver propulsion vehicles (underwater scooters), weighing 150 kilograms each, allowed the divers to advance at 30 metres per minute. The two women in the team swam to the rockpile, taking one hour, and set up another base camp. Francis and his brother Eric scooted, in half the time taken to swim past the rockpile, in the direction of Toad Hall.

The second leg to Toad Hall took them an hour and 50 minutes. The rear diver switched off his lights to save the battery power on his diver propulsion vehicle. They were equipped with dry suits and wore thermolachyln underwear beneath their suits. On reaching Toad Hall, they slept in their underwear between survival blankets for four hours. Only Francis made the final push of three hours and 30 minutes, while his brother waited at Toad Hall. This lone dive disregarded the rules of safety. Before the 47 hour dive was complete, in which six kilometres were penetrated and a new world record set, they began to suffer hallucinations. When they returned to the rockpile, food was ready, and the record-breakers were able to rest before the last kilometre swim.

The Australians, led by Hugh Morrison, not to be outdone, organised another major expedition in 1983. Ron Allan, Peter Rogers and Hugh Morrison reached a point where the tunnel narrows. It was here that Francis LeGuen discovered limestone skeletons of a group of bats, which disintegrated as he touched them, and a new crystalline type of flowstone, which, he reports, shimmered like gold as it flowed through his fingers. About one and a half kilometres from Toad Hall the three divers changed over from triple to single scuba tanks so that they could squeeze along the tunnel for another one and a half kilometres. At that point, Hugh Morrison took the tank off his back and, extending it in front of him, squeezed into a thin tunnel for a further 240 metres. He reports that at that stage he was psychologically unable to go any further. Fear of the dark and being crushed in the bowels of the Earth encouraged him to back out and begin the long swim home.

It is heartening to know that the adventurous drive which led our forefathers to this country is still alive and well. As long as there are challenges to their physical and mental capacities, men and women will face them and the spirit of adventure will take us all to the unknown limits of human endurance. □

SAND-BUBBLERS

Sand-bubblers: Crabs that Breathe with their Legs (but of course!)

by Pamela and David Maitland

▲The gas-windows (air-breathing membranes) on the legs of this male *Scopimera intermedia*, a common Malaysian species not found in Australia, are a bright red colour. The crab is in a defense posture used to ward off intruders on its feeding area.

Beaches usually bring to mind sun, sand and surf — the stuff of which summer holidays are made. But this is only one type of beach and one that, biologically at least, is the sea's answer to a desert. At the other end of the beach scale is the mud flat — where the much weaker waves, instead of carving into the shoreline and carrying away all but the largest grains of sand, actually deposit fine mineral and organic sediment. This continual influx of organic matter (food for many animals) builds up and with each laboured, squelching footstep comes the whiff of rotten eggs — the gaseous product of organic decay. The sun-worshipper would never dream of basking in this oozing black mud, but to the fisherman, the crabs, worms, clams and shrimps, it is a great attraction.

Somewhere between these two extremes lies a wealth of lesser known intertidal habitats, each with it own appeal. The sand-bubbler crabs, *Scopimera* and *Dotilla*, are examples of animals that thrive in vast numbers on one such habitat — sheltered sandy beaches throughout the Indo-Pacific. They live in burrows within the intertidal zone and are only active when the tide is out. Sand-bubblers are spidery-looking crabs, with small round bodies (about 1cm across) and long thin legs.

Australia's only representative, *Scopimera inflata*, is endemic and found along the coast of Queensland and northern New South Wales. Beaches where they live are often covered with sand balls forming beaded tendrils radiating out from central holes. These holes are the burrow openings and the sand balls are tangible evidence of their feeding activities.

The sand-bubbler spends most of its time feeding on the top layer of sand, creating shallow feeding paths as it moves sideways. The powerful crushing claws usually associated with crabs are hardly the thing for the manipulation of loose, wet sand. The sand-bubblers have, instead, a pair of delicate claws that they use to rake over the sand surface. The mouthparts open up like barn doors to receive the incoming sand at the bottom and it is their rapid and continual side-to-mouth motion that scrapes the sand clean. Special spoon-tipped hairs lining the mouthparts aid this process by acting like bristles on a scrubbing brush. Water taken from the gill chambers on either side of the crab's body is used to separate the lighter, edible material from the heavier, inedible sand and is essential for this method of feeding. Once processed, the waste sand collects as a ball at the top of the mouthparts and, on reaching a critical size, is wiped away with a flourish by one or other of the claws.

The sand-bubbler then scuttles the pellet backwards underneath its body with its legs and advances a little to feed on fresh sand. By feeding in this well-organised manner, the sand-bubblers not only avoid

▲This sand-bubbler crab, *Dotilla myctiroides*, another common Malaysian species, has daintily raised its last pair of walking legs to increase the effects of air-cooling. The surface temperatures of the sand flats where these crabs are found can go up to 50°C.

covering fresh food-laden sand, but also maintain a clear path along which they can run quickly back to their holes and out of danger.

As mentioned before, the sand-bubbler uses water in its gill chambers to feed. But where does the water come from after the tide has gone out, the pools have dried up and the supply in the gill chambers is exhausted?

Both *Scopimera* and *Dotilla* have special hairs (between the legs and on the abdomen respectively) that are used to absorb the water coating the sand grains — the interstitial water. When feeding, *Scopimera* periodically wiggles one side of its body into the sand. This pushes the special hairs located between the second and third pairs of walking legs into the sand so that the interstitial water can be drawn up between them and into the gill chamber through a special conducting channel. Once enough water is collected the sand-bubbler lifts itself up and continues feeding. Two paddle-like structures near the mouth beat in such a way that they help to suck up the water. These structures, called bailers, are used in aquatic crabs to circulate water past the gills for breathing.

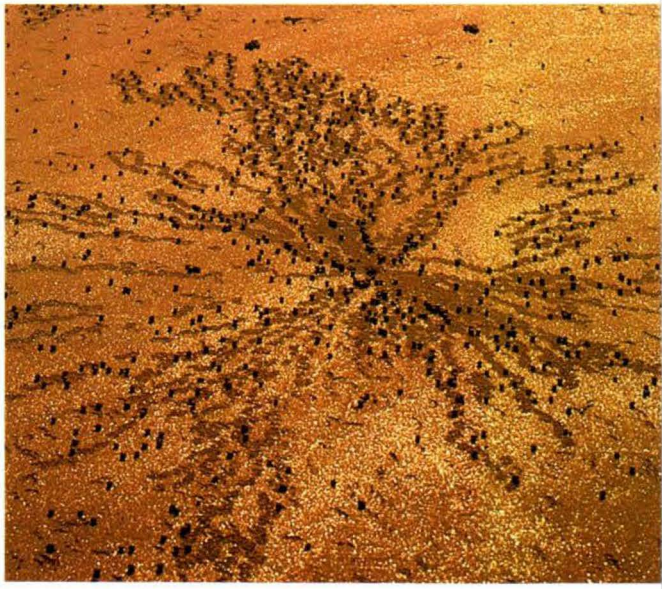
Although the water used for feeding could also be used in breathing, sand-bubblers, in actual fact, extract most of their oxygen from the air. Other air-breathing crabs such as ghost crabs, soldier crabs and fiddler crabs, have expanded gill chambers with an air cavity located above the gills. The lining of this chamber is richly supplied with blood vessels and forms the lungs of these crabs. The sand-bubblers are most unusual, however, in that, instead, they breathe air using structures on their legs! These shiny, membraneous structures (located on their "thighs" — the leg segments closest to the body) are quite unmistakable. In some species they are brightly coloured, e.g. bright red in *Scopimera intermedia*. *Scopimera* means "thighs with windows on them", and the leg membranes have been called gas-windows.

The gas-window membranes are very thin (half a thousandth of a millimetre) and are stretched across the curved frame of the leg, one on

each side of the thigh. Directly beneath these membranes lies an intricate meshwork of blood spaces that spreads the returning venous (deoxygenated) blood evenly beneath the gas-window membrane. Once oxygenated, the blood is collected at the top of the leg and returned to the body.

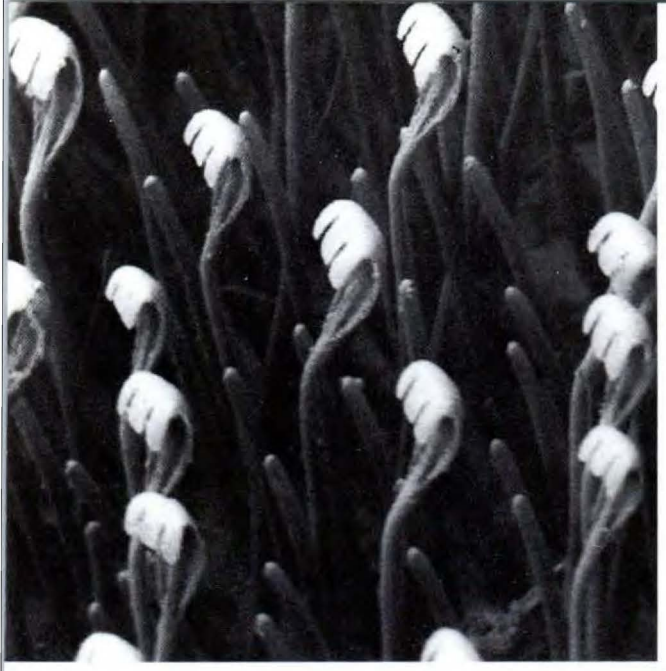
Several behavioural mechanisms have been adopted to avoid damage to these highly vulnerable and conspicuous leg membranes. Sand-bubblers, being deposit feeders, do not have to grapple with large, struggling prey which might otherwise harm them. Also, the way these crabs assert dominance over mates, burrows or feeding areas is highly ritualized and the risk of physical injury is reduced. If one sand-bubbler intrudes on another's feeding area, what looks to us a ridiculous and ineffectual waving of

▲This is a typical intertidal sand flat near Townsville where the Australian sand-bubbler crab, *Scopimera inflata*, lives. It is on such sheltered sandy beaches throughout the tropical and sub-tropical Indo-Pacific (eastern Africa, Asia, Japan, and Australia) where sand-bubblers are found. Photo: D. P. Maitland.



The beautiful star-like patterns of▶ sand balls are made by the Australian sand-bubbler crabs as they feed on the food that the last ebb tide has left behind on the top layers of the sand.

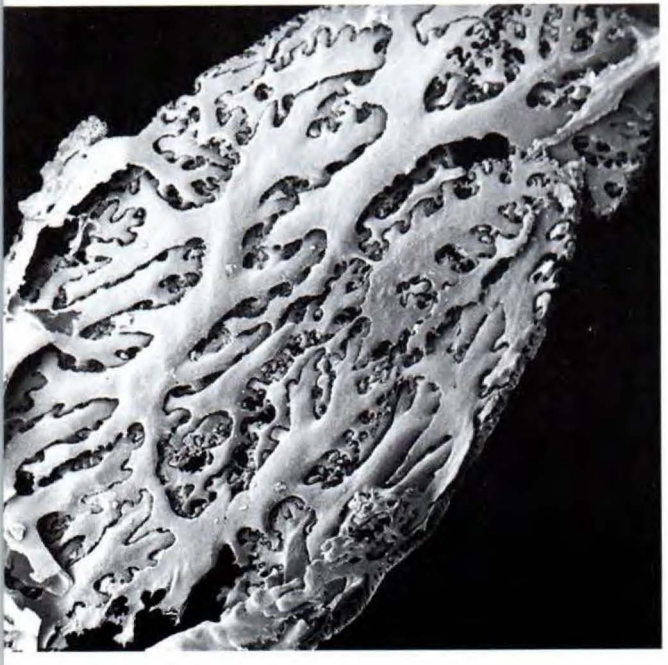
The male Australian sand-bubbler crab is brightly coloured. The huge mouthparts take up most of the crab's face and they open up like barn doors to receive the food-rich sand spooned up to them by the ▼claws.



◀This is a scanning electron micrograph (SEM) of the lining of the mouthparts of the Australian sand-bubbler crab showing the beautifully shaped spoon-tipped hairs. Together with the side to side motion of the mouthparts, these tiny "back-scratchers" help scrape the food off the sand particles.

While the sand-bubbler crab feeds it uses water from its gill chambers (located at either side of its shell), which, together with the motion of the mouthparts, washes the food off the sand. To obtain more water, the Malaysain sand-bubbler crab, *Scopimera intermedia*, tilts one side of its body over, pushing hairs between its legs into the wet sand which draw ▼water up them and into the gill chambers.

◀This SEM is of a gas-window of the Australian sand-bubbler crab showing how it is stretched tightly across the oval frame of the thigh. The membrane is remarkably thin — only half of a thousandth of a millimeter (0.5μm)! Oxygen can diffuse easily across this thin membrane to the blood vessels lying directly below.



◀In order for the gas-windows to function as breathing organs there must be a well organised blood supply to and from them. Plastic casts were made of the blood vessels in the legs of a sand-bubbler crab and as this SEM shows, there is indeed a highly organised blood system beneath the gas-window membranes.

the claws is often enough to send the trespasser on his way. A similar waving behaviour is used by males to attract females. If, however, the intruder persists, then the two crabs will grip each other's claws, arms stretched wide apart, and push and shove until one of them gives up — usually the smaller. The walking legs are rarely involved in such encounters and the gas-windows are safe.

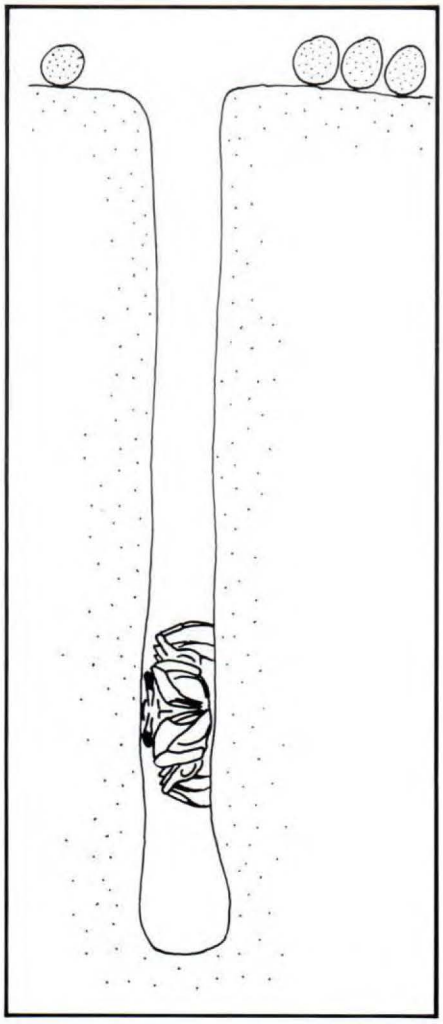
Only within the last year was it realised that these gas-windows had a respiratory function. Previously, these membranes were thought to have been hearing organs (reminiscent of grasshoppers' and crickets' eardrums) and, since the 1890s, have always been referred to as "tympana". Now that it is quite clear that they are not auditory organs but, instead, are involved in breathing, some of the descriptions in the old literature seem quite amusing.

Biology is like economics and political science. Outcomes can usually be explained easily in retrospect, but the prediction of trends is often a very unsuccessful business indeed. There is so much interplay between so many variables that it is very difficult to generalise and derive any hard and fast rules that can be applied to specific problems. Something new, unaccountable or, even worse, overlooked, is bound to crop up and have untold influence on a given outcome. The expected does not always happen. Truman beat Dewey in the 1948 elections, the economies of post World War II Japan and Germany grew at an unprecedented rate, and the sand-bubbler crabs not only breathe air, but do so with their legs instead of the more conventional crab lung. It is only after it has been realised how, why and what happened in a particular situation that the biologist, economist or political scientist fetches a resounding slap to the forehead and cries, "But of course!". In the case of the sand-bubbler crab, when its ecology was studied in a new light, it was realised

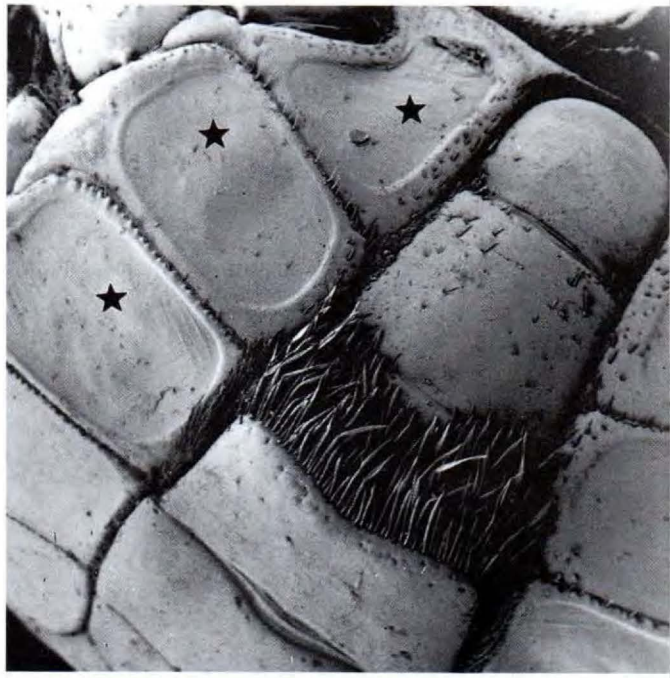
The sand-bubbler crab gets its ▶ name from the way in which it feeds. The cleaned sand collecting at the top of the mouthparts looks like a bubble balanced between the eyes — hence the name sand-bubbler. Photo: David Maitland.

Once the sand bubble, or feeding ▶ pellet, reaches a certain size it is swept off the mouthparts by one of the claws and is brought to the walking legs which, as seen here, scuttle it backwards behind the crab. As the sand-bubbler crab moves along sideways these feeding pellets come to line the feeding path. Photo: David Maitland.

Sand-bubblers live down burrows within the intertidal zone and only become active when the tide is out. The burrow it digs for itself is a straight shaft about 15 cm deep. As the tide advances up the beach the crab crawls into its burrow and plugs the entrance with sand so that no water can get in. It sits out high ▼tide in this air-filled retreat.



Remarkably, in three species of ▶ *Dotilla*, gas-windows are also found on the lower side of the body (sternum) as well as the legs. This SEM photograph shows the sternal gas-windows (stars) of *Dotilla mycti-roides*. The abdomen is tucked into a cavity in the sternum, and bears a broad tuft of hairs which is used to absorb water from the sand. This water is led to the gill chambers, and from there is drawn upon as the crab feeds.

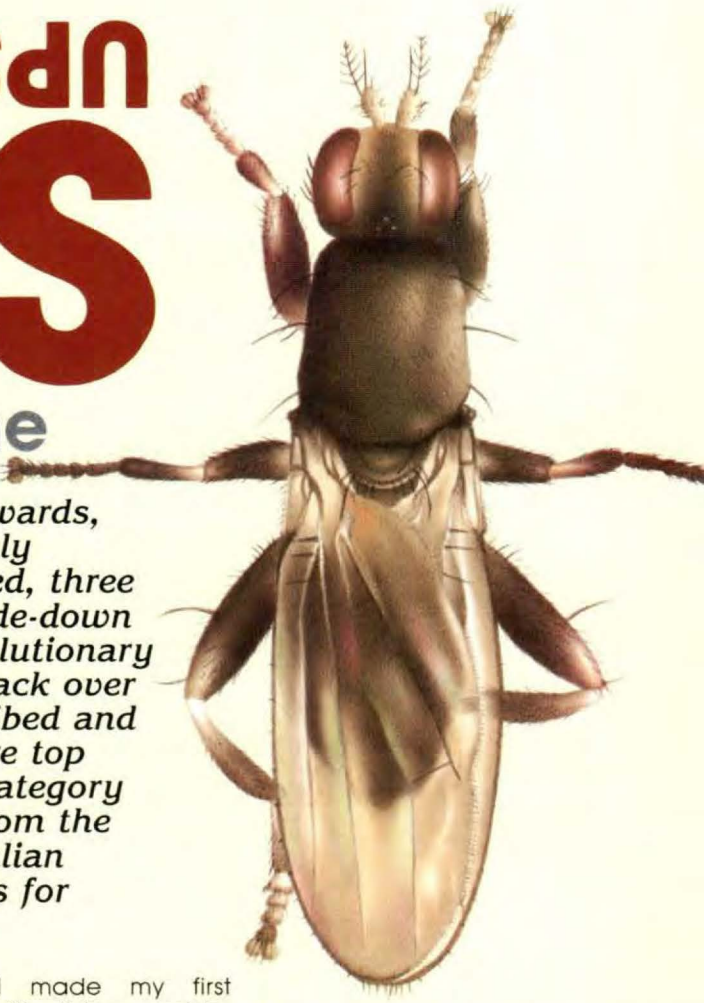


that it must breathe air, yet it had no lungs; and soon it was obvious that, in fact, it was breathing air with its "ears". But of course! □

We greatfully acknowledge the facilities and assistance of the Zoology Department, U.N.S.W., the Australian Institute of Marine Sciences, Townsville and the A.R.G.S. for their support of the original research.

UPSIDE-DOWN FLIES

by David McAlpine



What runs backwards to move upwards, sideways to move horizontally and only fowards to go downhill? The fairy-sized, three millimetre-long and aptly-named upside-down fly. Despite its diminutive size, its evolutionary history is far from short. Extending back over 40 million years and being first described and named as fossils, upside-down flies are top contenders for that rather ill-defined category of "living fossils". David McAlpine, from the Entomology Department of the Australian Museum, has been studying these flies for nearly 30 years.

The Australian Upside-down Fly, (*Neurochaeta inversa*), is about three millimetres long with a rather slender and distinctly flattened body. Each of the long wings has three erect bristles. Painting: Wayne Fogden.

Australia's native mammals have received much publicity because so many of them are widely different from those of other continents. That many of the insects and other small animals are equally distinctive is not generally realised. Although upside-down flies are by no means peculiar to Australia, the Australian species is the only member of the family whose lifestyle has been studied. The other species are only known as museum specimens or fossils. If any form of animal is to be placed in that ill-defined category of "living fossil" the upside-down flies should be top contenders, as possibly the first ones to be named and described were fossils.

I first encountered upside-down flies in the 1950s when museum specimens were sent to me for study and identification from the University of Queensland and the South Australian Museum. At this time, however, no-one could identify them because they did not fit any of the published descriptions of Australian species of flies; nor did they seem related to anything known from overseas.

In 1961, on a cunjevoi (*Allocasia macrorrhiza*) in a rainforest remnant at Bellingen in northeastern New South Wales, I made my first acquaintance with living upside-down flies. It was then that the strange head-downwards behaviour (described below) was noted and the insects were dubbed their common name.

Subsequently I was able to find the flies in many rainforest localities from the Atherton Tableland in northern Queensland to just north of the Hunter River in New South Wales. It was also possible to observe their habits and to find the larvae and pupae.

In 1965 the late Professor Willi Hennig of Stuttgart (West Germany) published an important illustrated work on flies fossilised in Baltic amber. Amber, the fossilised resin of coniferous trees, often includes the bodies of insects and other organic objects that became stuck and were then enclosed when the resin was in its fresh, liquid state. The Baltic amber of northern Europe is considered to belong to the early Oligocene or late Eocene Periods, that is, it is about 40 million years old or more. Hennig named one of these amber flies *Anthoclusia gephyrea*, the generic name indicating an unusual combination of characters of flies of two different families (Anthomyzidae and Clusiidae) and the specific name indicating its association with amber (L. *gephyreus* = pertaining to amber). Hennig later found a second species of *Anthoclusia* in the Baltic amber and indicated that the genus could not be placed in any family of living flies then known.

After studying Hennig's detailed descriptions and illustrations, I realised our upside-down fly was closely related to the fossil *Anthoclusia* — so closely, in fact, that they must be placed in the same family. There is also a possibility that the fossil fly is the direct ancestor of the modern Australian one. I later examined a specimen of *Anthoclusia* embedded in fairly clear amber and made a comparison with the upside-down fly, thus confirming my earlier thoughts.

The next development was the discovery of another two modern species of upside-down flies in the collection of the Natal Museum, Pietermaritzburg. They were both originally found in the African region —one from Zimbabwe, the other from Madagascar. The Zimbabwe species proved particularly interesting, being intermediate in many ways between the Australian and the fossil species, and thus strengthened the case for grouping them into the one family.

A new genus, *Neurochaeta,* comprising the three modern species, and a new family, Neurochaetidae, comprising this modern genus and the fossil *Anthoclusia,* were established.

The Australian Upside-down Fly (*Neurochaeta inversa*) is about three millimetres long, with a rather slender and distinctly flattened body, and the hind legs longer than the other two pairs. The colouring is greyish-brown and dull cream. Under the microscope, each of the rather long wings is seen to have three erect bristles arising from near the middle of the basal half, a feature that distinguishes the species from all other Australian flies.

In life no magnification is needed to identify the insect for its behaviour is distinctive enough. If resting on a vertical or inclined surface the fly is always positioned with the head pointing downwards. The insect can run rather rapidly, for its size, in any direction but it does this without turning its body from the head-downwards position. Thus it must run backwards to go upwards, sideways to go horizontally and forwards only if going downhill. Of course if it is on a horizontal surface these rules do not apply, the insect's body simply being parallel to the surface, and when it flies it goes head first in the normal horizontal position. An interesting experiment is to place a number of upside-down flies in a small jar or stoppered glass tube. All those on the vertical glass surface will then have their heads directed downwards. When the container is inverted, each fly immediately turns to restore its original position.

The life of the upside-down fly is closely dependent on its host plant, the cunjevoi. The winged adult flies are found running over the large leaves and their rapid zigzag movements probably help them locate food by covering a large area in a short time. Their food may consist of honey-dew (a secretion from certain insects) and fresh bird droppings. When weather conditions are unfavourable the flies shelter in the hollow base of the cunjevoi leaf-stalk (petiole). In winter all the flies of any small cunjevoi patch may congregate together in a single leaf-stalk of one of the larger plants, so that none can be found elsewhere. This appears to be due to a greater tendency of the flies to settle on such a plant in bad weather and to a reduction of restless activity in the individual when in contact with others of its species. On a mild day they often emerge onto the leaf surface and apparently bask in the sun.

The cunjevoi, being of the arum or calla lily family (Araceae), has its minute flowers crowded on a rod-like spadix. The female (seed-producing) flowers are on the lower part of the spadix, which is loosely enclosed by the leaf-like spathe. The female fly lays eggs on the female flowers and the newly hatched larvae live among the little green fruits that develop from the flowers. By this time the lower part of the spathe has formed a sealed chamber in which both fruits and larvae can develop in protection from the outside world. As the larva does not eat or penetrate the young fruits, it probably eats microscopic organisms living in the moist chamber. Like other typical flies, the larva does not shed its skin when about to pupate but the larval skin hardens to form a puparium, enclosing the delicate pupa. When the fruit are ripe and red, the spathe splits open and the adult fly, now emerging from the pupa, can escape.

Cunjevois flower in summer in New South Wales, so that breeding and development of the upside-down flies are restricted to this season. The period from egg-laying to emergence of adult flies possibly takes five to six weeks but, like many aspects of the life of the upside-down fly, this needs further study.

Studies of the neurochaetid family are still far from complete. As recently as 1978 the nature photographers Densey Clyne and Jim Frazier, on a visit to Sabah (North Borneo), discovered a fourth species of *Neurochaeta,* living on the same type of plant as the Australian species and with similar upside-down habits. Still another species of the genus, collected in the Philippines, was recently identified in the collections of the Museum of Comparative Zoology, Harvard University, U.S.A.

Another Australian fly, *Nothoasteia platycephala,* which has remained an enigma because of its extreme rarity in collections, now seems possibly related to the upside-down flies. John R. Malloch, a Scotsman who settled in America and made a monumental contribution to the knowledge of flies (including the naming and description of about 1,000 Australian species), first described this species in 1936. This minute, flat-headed fly had been collected at Brisbane, but the only known specimen disintegrated in the mail when Malloch was returning it to Australia. The pieces, however, are still preserved. I was therefore very excited when I received, for identification, a specimen of *Nothoasteia,* collected near Dwellingup in southwestern Australia. It proved to belong to a distinct species, different from Malloch's Brisbane specimen.

The new specimen reveals a most unexpected trait perhaps unique among all Australian fly species — the absence of functional claws at the tips of the feet. It has, however, well-developed pads

The life of the upside-down fly is closely dependent on its host plant, the cunjevoi (*Allocasia macrorrhiza*). Photo: David McAlpine.

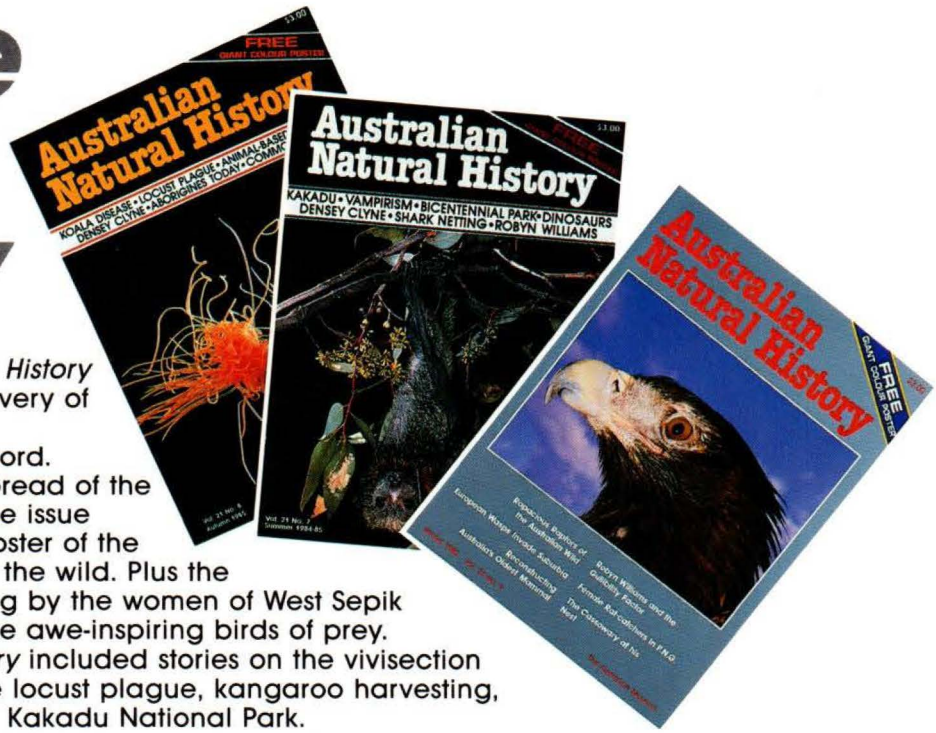
(pulvilli) like those used by the house fly to cling to window panes. Perhaps this fly is adapted to cling to smooth, hard surfaces where claws would be useless in obtaining a grip. The sticky microscopic hairs of the pad would provide enough support for its minute body weight.

A detailed study of *Nothoasteia,* however, requires more specimens. A preliminary study suggests a relationship to *Anthoclusia* and *Neurochaeta* but not so close as that between these latter two genera. Hence, while *Neurochaeta* probably evolved from *Anthoclusia* or its near ancestor, the *Nothoasteia* lineage may have separated from this same stock at an earlier stage. It could perhaps be classified as a third genus of the family Neurochaetidae.

The upside-down habits of these flies have only been recorded in the Australian *Neurochaeta inversa* and a closely related Bornean species. The other species of the family are only known as museum specimens (including fossils). Observations of all species of living upside-down flies are needed to find out if these habits are shared by only a few similar species or by all living representatives of the family.□

LAST PHOTO:
POSSUM HANDS: Like most possums, the Eastern Pygmy Possum is nocturnal spending the day hidden from view — except in this case for its hands! The Possum was hiding in a hollow log at the University of New South Wales field station at Cowan. This is the last *Australian Natural History* for editor Rob Cameron. He leaves the magazine in good shape.

Read the Natural Authority



The winter issue of *Australian Natural History* (Vol. 21 No. 9) looked at the recent discovery of Australia's oldest mammal fossil and its importance for the palaeontological record. Another timely article reported on the spread of the European Wasp within Australia. The same issue covered another Australian first with a poster of the male Australian Cassowary at his nest in the wild. Plus the painful stings of Bulldog Ants, rat-catching by the women of West Sepik Province in Papua New Guinea and those awe-inspiring birds of prey.

Past issues of *Australian Natural History* included stories on the vivisection debate, koala disease, the impact of the locust plague, kangaroo harvesting, shark-netting and a critique of tourism in Kakadu National Park.

WATCH OUT IN COMING ISSUES . . .

THE SALTWATER CROC: Conservation strategies in northern Australian waters.

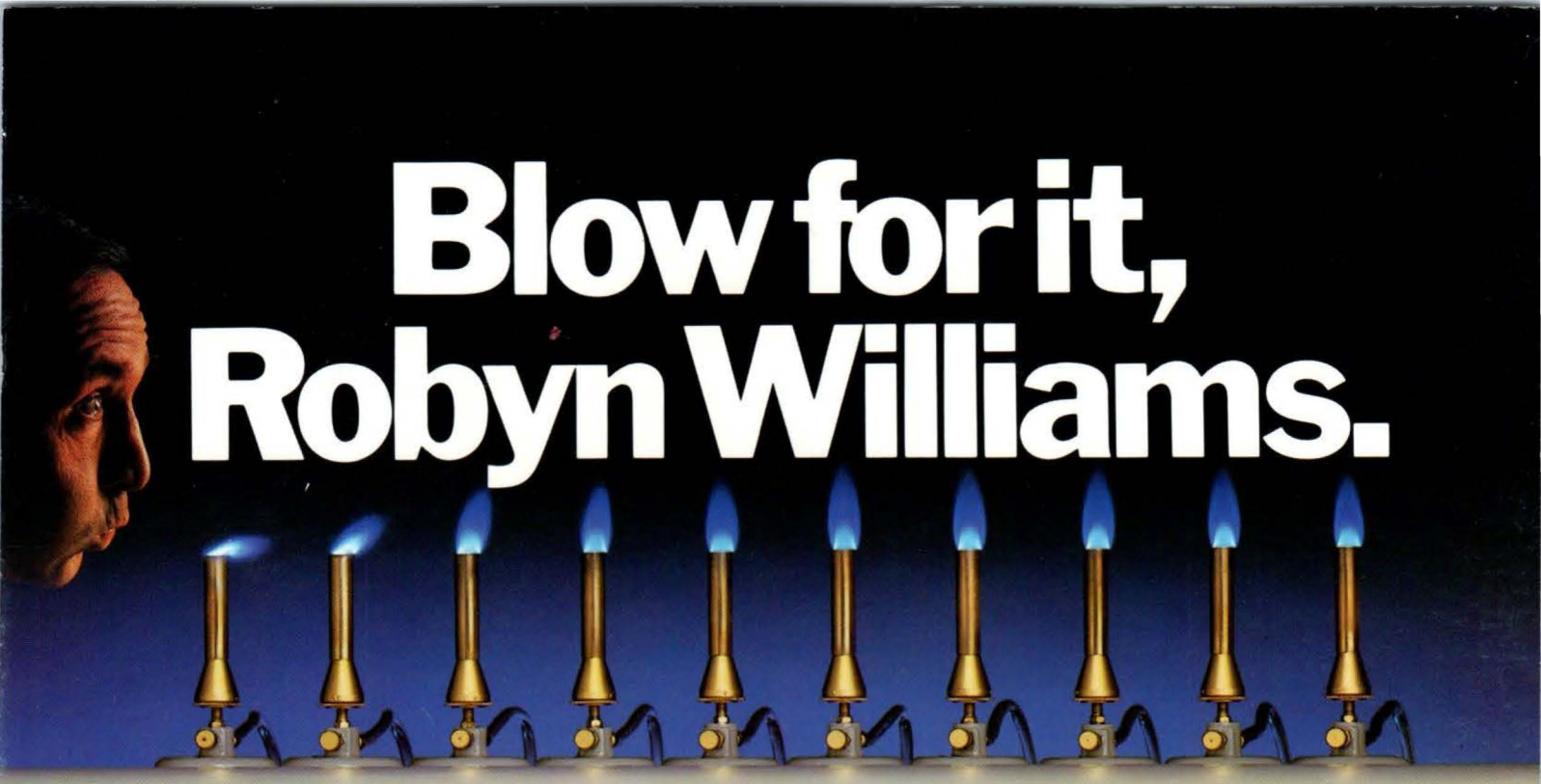
WUVULU: The history and culture of a people living on an underwater mountain.

AUSTRALIAN DESERT CRABS: Remarkable adaptations to our hostile interior.

AQUATIC INSECTS: Strange insect antics.

TERRACOTTA ICONS: The ritual and significance of possessing icons for two tribes in the Mewar region of India.

Australian Natural History



Happy birthday, ABC Science Show.

Now 10 years old, the Show's "proud Dad," producer, presenter, creator and sometime roving reporter, Robyn Williams, has seen his "baby" grow from the mewling and puking age, to its now irrefutable shining morning face.

So much so that all ABC Shops have put a selection of the programs in books and cassettes which have sold well over 100,000 copies.

Also, the esteemed British Journal, "Nature," has described ABC Radio's science programs as "Australia's most vivid source of news about science."

Happy Birthday, ABC Science Show, and many happy returns.

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