# Australian Natural History

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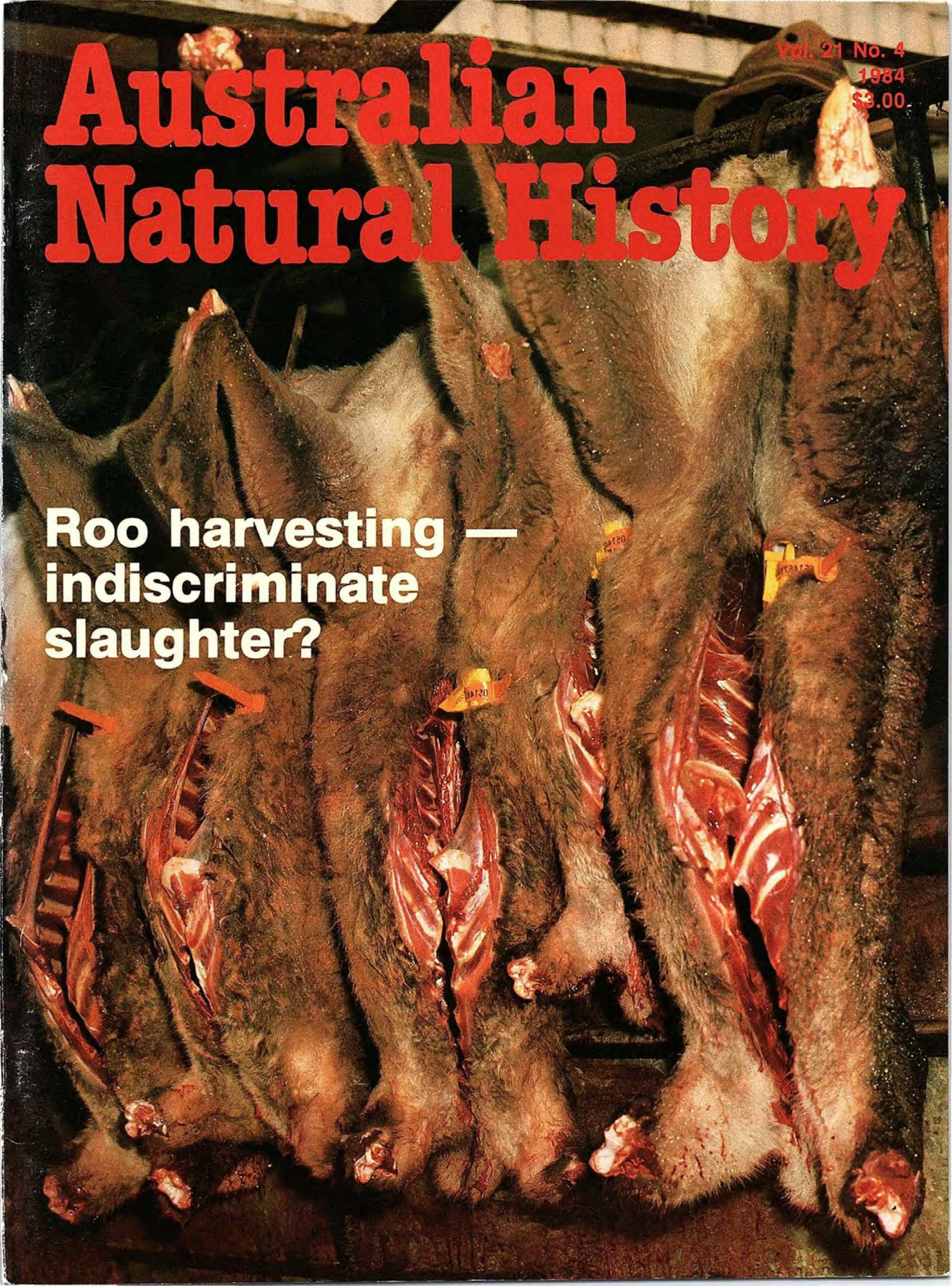

## Roo harvesting — indiscriminate slaughter?

# Australian Natural History

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*A close-up of the male antennae of the Australian Atlas or Hercules Moth,* Coscinoscera hercules *— the subject of this issue's centrefold. Photo Densey Clyne.*

*When the female Malleefowl arrives at the mound ready to lay an egg, her mate uncovers the egg chamber and after each egg is laid, he replaces the cover. He repeats the process again and again until he has moved three to four cubic metres of soil and leaf litter. Photo H. J. Pollock (NPIAW).*

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**Cover**
*Tagged kangaroo carcasses hanging from a shooter's vehicle awaiting transport to a chiller. The tags are attached to each carcass to prove the animals are legally obtained. Photo Pardos Xavier.*

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# from the INSIDE

*The Red Kangaroo is a grazing animal and includes in its diet, grasses and green plant herbage. Photo R. Miller (NPIAW).*

Over the last three years *Australian Natural History* has tackled a number of important subjects revealing important, new facts concerning the wildlife and environment for our unique continent. However, none of these is as controversial or probably of such interest to Australians as our feature article in this issue of the magazine, 'Roo harvesting — are kangaroos really under threat?'

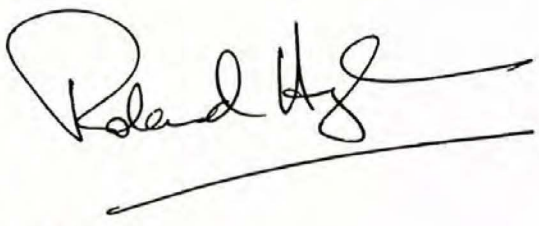
In recent months false and misleading statements have been widely reported in the media by individuals and conservation groups. These claims include the distortion that kangaroo harvesting is "leading us along a path similar to that traversed by the American buffalo" and senstional headlines such as "Killing a kangaroo every ten seconds: Is our national conscience extinct?" are being used to stop the kangaroo industry in Australia.

Not confined to the media the campaign is presently being aggressively waged against Federal and State Governments alike and the biologists and wildlife experts they employ. Letters to this magazine have included statements such as "... I find it depressing that the editor of the journal of a major scientific institution is unaware of a real ethical change taking place in Australian thinking regarding wildlife."

*Australian Natural History* does not deal in emotive ravings, exaggeration or ill-informed arguments — the magazine has always presented the facts. Our articles are exhaustively researched by experts and major issues (such as the Franklin Dam dispute covered in the last issue) thoroughly investigated by the editorial team before they are published.

The facts are that the Federal Minister for Home Affairs and the Environment, Barry Cohen, after promising to investigate kangaroo harvesting supports the harvesting programme on Red, Western and Eastern Grey Kangaroos. Every Australian must now make up his or her own mind.

This issue will be my last as editor of *Australian Natural History*. I would like to thank all our 75,000 readers both in Australia and overseas for your consistent and enthusiastic support of the magazine.



Roland Hughes.
Editor

# 'ROO HARVESTING

## ARE KANGAROOS REALLY UNDER THREAT?

by Gordon Grigg

**Are Australia's three large kangaroos under threat? Is harvesting wiping out Australia's best known native mammals? Kangaroo protectionists say so. Lobby groups including the Australian Conservation Foundation, Greenpeace and Animal Liberation are presently waging a campaign to stop the kangaroo industry in Australia.**
**However, Federal and State Government biologists and wildlife ecologists argue that controlled harvesting of the three main species of kangaroos will not affect their survival in the open ranges.**
**In order to discover what the real story is, *Australian Natural History* approached Gordon Grigg, Associate Professor of Biology and Head of the School of Biological Sciences at Sydney University. While his main interest is the physiological adaptations of animals to their environment, he has also been heavily involved in monitoring kangaroo populations across Australia since 1974. He has a keen interest in seeing that our national symbol is properly protected now and in the future.**

The commercial harvesting of kangaroos is a hotly debated and emotionally charged issue. At the centre of the debate are the three largest Macropods — the Red Kangaroo, *Macropus rufus,* Western Grey, *Macropus fuliginosus,* and the Eastern Grey, *Macropus giganteus,* which draw commercial interest.

Kangaroos* would feature on anyone's list of the world's most spectacular and exciting animals. Further, as our national symbol, they are of great significance to Australians, and the conservation of abundant and widespread populations of kangaroos is a clear and important national responsibility.

To farmers and graziers, however, kangaroos are sometimes pests, for they damage crops and fences, as well as compete with sheep and cattle for feed in times of drought. Also they are a valuable source of meat and leather.

As a result, kangaroos have been shot as pests and for commercial purposes over the last hundred years, and until comparatively recently this shooting went unregulated in most places.

Most conservation groups accept that some pest control is needed, and State Governments harness the activities of the kangaroo meat and leather industry to the needs of pest control. However, there is considerable controversy about the rights and wrongs of such a policy. Fears are voiced that kangaroo populations will be threatened by a commercial industry and that, when quotas are set, the needs of the industry will carry more weight than those of kangaroo conservation.

Even stronger opposition comes from people who believe it is unethical to benefit commercially from wildlife, and also from animal liberation groups who are opposed to any killing at all.

So kangaroos have become an emotional issue, with many graziers crying 'plague proportions' on the one hand, and protectionists 'brutal slaughter' on the other. Somewhere in the middle ground, and often under fire from both sides, State Governments try to match

**used in this article to denote the three large species collectively.*

*New South Wales is estimated to contain 25 per cent of all Eastern Grey Kangaroos and in areas where both Eastern and Western Greys overlap Eastern outnumber Western four times. Photo above, Andrew Smith, right, John McCann (NPIAW).*

industry quotas to pest-control needs and at the same time monitor kangaroo populations.

It is clearly important to establish how many there are, where they live, and to identify the factors affecting the density of kangaroo populations.

Those opposed to the industry, for whatever reason, often present it as a major threat to the survival of our kangaroo species. But is this so?

While populations of most Macropods are difficult to assess, aerial surveys allow a cheap and easy estimate of kangaroo populations. Hence it is possible to follow changes in kangaroo populations, and identify what forces cause such changes.

A knowledge of population trends is usually just as valuable as exact information about real numbers when trying to come to grips with the forces influencing population changes. To assess these changes accurately it is important to have a standardised survey method which can be used over a wide area to give a good index of population trends and allow comparisons between years, different areas and different survey teams.

A suitable method was developed by Graeme Caughley, now at the CSIRO Division of Wildlife and Rangelands Research in Canberra.

The survey method is simple. A small, high-wing aircraft such as a Cessna 182 or 206 is flown at 76 metres above ground-level along a series of predetermined flight lines ('transects') within a particular survey 'block'. Two trained observers, one on either side of the aircraft, each scan a 200 metre-wide strip of ground as it slides past the window. The outer edge of each strip being scanned is marked by a cord streaming back from the wing strut.

At a speed of 100 knots, the aircraft covers five kilometres in 97 seconds, during which each observer scans one square kilometre of ground, counting any kangaroos seen.

In a typical session, some 200 square kilometres are scanned as the pilot maintains a constant height and speed over the ground.

The intensity of the sampling can be modified by choosing an appropriate distance between transects.

In a survey of several National Parks in Victoria carried out since 1981, transects have been put as close as two kilometres apart, giving a sampling intensity of 20 per cent. Usually, however, larger areas are surveyed using four transects for each degree of latitude, giving a sampling intensity of about 1.5 per cent.

The next step is to scale the raw figures obtained by the survey, taking in a correction factor for sightability. This

## Is there room for any expansion of the kangaroo industry? The answer is probably yes...

correction factor is needed because even in grassland a trained observer will miss at least half the 'roos', and in densely covered country even more.

Accordingly, we use a series of habitat-related correction factors, the largest being for mallee, to estimate the total number of animals in the survey area.

The correction factor allows what would otherwise be an index of density to be scaled to an estimate of total numbers.

It is now becoming accepted that the correction factors currently in use are too low, especially for Greys, so the method underestimates real numbers. This matters little; underestimates are on the safe side, and the discrepancy does not detract from the value of the method in tracking population trends.

Trained observers are needed for survey work, and it is no mean task to learn to develop a search image for Reds and Greys and learn to reject Euros, which are normally not counted. It also

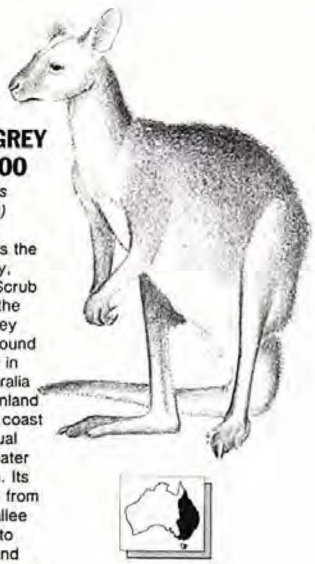
- *Colour can be from red through sandy to blue-grey. In Eastern Australia males usually are red. Females are usually blue-grey.*
- *Blunt, dog-like claws.*
- *Tail light-tipped.*
- *Legs light-coloured.*

**RED KANGAROO**
*(Macropus rufus)*

Largest of the kangaroos, the Red Kangaroo is found throughout most of central Australia, in areas with less than 500mm mean annual rainfall. Its range includes Mulga and mallee scrub, shrubland, grassland and desert, but it prefers open-plain country.



- *Tend to be lighter in colour than Western Greys.*
- *Light silver fleck on fur on top of head.*
- *Base of tail has silver flecked fur of Western Greys.*
- *Very difficult to distinguish between Eastern and Western Greys.*

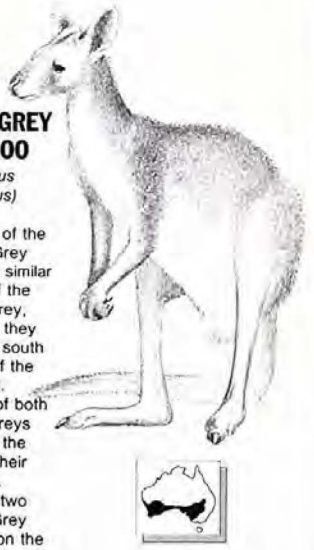


**EASTERN GREY KANGAROO**
*(Macropus giganteus)*

Also known as the Great Grey, Forester, or Scrub Kangaroo, the Eastern Grey Kangaroo is found extensively in eastern Australia between the inland plains and the coast where annual rainfall is greater than 250mm. Its habitats range from semi-arid mallee scrubland to woodland and forests. Of these, it prefers woodlands.



- *No obvious colour differences between sexes. Usually dark brown colour.*
- *Often very dark down centre of back.*
- *Sharp, cat-like claws.*
- *Dark-tipped tail.*
- *Dark-tipped feet.*



**WESTERN GREY KANGAROO**
*(Macropus fuliginosus)*

The habitats of the Western Grey Kangaroo are similar to those of the Eastern Grey, except that they occur in the south and west of the country. Populations of both types of Greys overlap at the edges of their ranges. There are two Western Grey subspecies on the mainland, and a further discrete one on Kangaroo Island, in South Australia.



takes time to learn to work in a noisy, often hot and bumpy aircraft. It usually takes a new observer about 50 hours to get used to the discomfort, maintain a steady high level of concentration and identify, sort and store separately the images he or she identifies as Red or Grey Kangaroos.

An observer in training sits on the same side of the aircraft as an experienced observer, both scanning the same strip. At the beginning, the novice may see about 50 per cent or less of the trained observer's score. This gradually improves over many sessions and the scores eventually stabilise. Luckily, most people seem to show similar skills, but a separate correction factor can be calculated for any observer whose performance is consistently different from the rest. Not surprisingly some people prove unsuitable; observing is a very demanding task and requires a high level of concentration and dedication.

At present two extensive surveys (the South Australian Pastoral Zone since 1978 and the western plains of New South Wales since 1975—76) and two intensive surveys (Kinchega National Park in New South Wales since 1969 and several Victorian parks since 1981) are undertaken regularly.

New South Wales populations are surveyed by the National Parks and Wildlife Service. Surveys of the South Australian Pastoral Zone, an area of 207,000 square kilometres encompassing almost all the kangaroos in that State, are made each year as part of a continuing research project by a team from the University of Sydney. Data from the surveys in South Australia and New South Wales are used as a basis for setting harvesting quotas.

New South Wales and South Australia are estimated to contain approximately 70 per cent of all Western Greys, 50 per cent of all Reds and 25 per cent of all Eastern Greys, so a comparatively high proportion of the populations is monitored regularly.

Additionally, most of Queensland was surveyed in 1980, northwestern Victoria in 1981 and Western Australia later. Subsequently, the gaps were filled so that by the end of 1982 most of the distributions of all three species had been surveyed, except in the eastern highlands where the terrain makes low-flying difficult.

Now, for the first time, an all-Australia estimate was possible.

By including data from 1980—81 surveys of South Australia and New South Wales, a quantitative picture was built up of the relative density of the three largest kangaroos throughout their ranges.

In areas where the ranges of Eastern and Western Greys overlap, ground-survey ratios of Western to Eastern Greys enabled Greys counted in the aerial surveys to be assigned proportionally to Western and Eastern Grey totals. Estimates of 1.8 million Western Greys, nine million Eastern Greys and 8.4 million Reds were reported — an all-around total of about 19 million. However, due to a succession of good breeding seasons in the eastern states and South Australia before 1981—82, populations at the time of the surveys were probably higher than the long-term average.

**The figures give no indication that the shooting of kangaroos makes much impact on kangaroo population densities.**

As well as producing statistics, the six or more years of regular surveys in South Australia and New South Wales combined with one 'Australia-wide' survey, numerous smaller surveys and other data have enabled a number of observations to be made.

- As expected, most of the kangaroos inhabit pastoral regions, within the dingo-proof fences, coin-

ciding with Australia's sheep country. It is interesting to speculate on why this may be so. The answer is undoubtedly complex and it would be an over-simplification to assume that the high numbers derive only from pastoral activities. For example, sheep and kangaroos have broadly similar climatic preferences. Also, water and pasture management in pastoral zones probably benefits kangaroos, while outside the dog-fence, kangaroos are more likely to fall prey to dingoes.

- There may be enormous fluctuations in populations from year to year which are clearly caused by rainfall and drought. Widespread rainfall leads to large and rapid population increases. In good conditions an annual rate of increase of at least 25 per cent can be maintained. Drought may drastically reduce the population density. In South Australia, the recent drought, believed by many to be one of the worst on record, reduced Western Grey 1982 numbers by 44 per cent and Reds by 38 per cent. In a similar period in New South Wales, falls of 45 and 41 per cent were recorded. If these falls can be regarded as typical of the overall population, a 1983 estimate of 11—12 million seems reasonable for the whole country, although this does not allow for increases which probably occurred in Western Australia after the drought-breaking rains of 1980.

Such vast fluctuations are completely different from what is seen in human populations. This may account for many misunderstandings about

**...singling out the kangaroo harvest as a threat to the survival of the commercial species represents a misjudgement of the real situation.**

kangaroos. The idea of a population losing 40—50 per cent, or even more, of its members may seem horrific, but it must be remembered that kangaroos have been coping with drought for thousands of years.

One of their many specialisations for dealing with drought is a very high reproductive rate. Even if only a small group survives a drought, its numbers will increase rapidly once conditions improve. Mobility is also important, and the history of kangaroos has been partly characterised by groups of kangaroos re-colonising areas previously made unsuitable by drought.

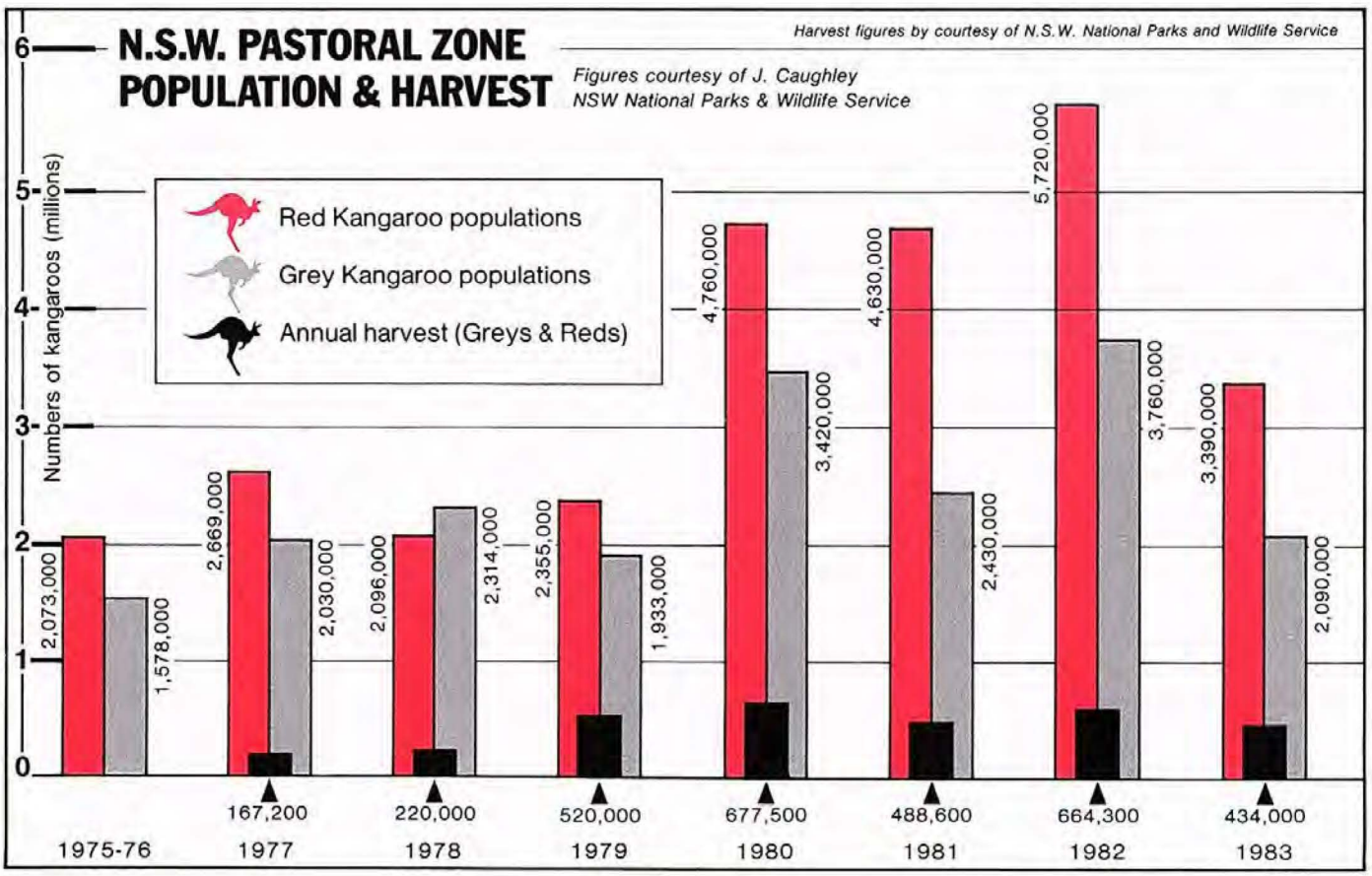
- The figures give no indication that the shooting of kangaroos makes much impact on kangaroo population densities. Although common sense dictates that pest control in a particular area can cause a decline in local numbers, this appears to be quite lost in the overall picture. In a run of good seasons from 1978 to about 1981, numbers throughout most of South Australia increased continuously despite annual legal harvests of 100,000—200,000 animals and an illegal kill of unknown size.

Even without the survey data, the facts speak for themselves on this point. Over the last 50 years, official records show that the average annual export has been about one million kangaroo skins. As this is only part of the kill, the annual total harvest must have been much larger, yet there has been no sign of any diminution.

- Since 1982 the drought has wrought a massive drop in numbers, but it is worth noting that numbers now are not very much lower in South Australia than they were in 1978 when aerial surveys began. In 1978 there was little concern about kangaroos being threatened — quite the reverse. Aerial surveys were instigated partly in response to graziers' claims that kangaroos in that State were in 'plague proportions'. Shooting then did not exceed the kangaroos' ability to increase, and there is no reason to suggest that it will now.

The nature of kangaroo shooting is such that it is economic only while kangaroos are abundant. When numbers fall, many shooters either move elsewhere, select other targets or take up other work. As a result, economic constraints provide a strong intrinsic regulation of the industry, and will continue to do so unless the market value of kangaroo products increases very significantly.

- Increased watering points and grassland in the pastoral zones are thought to have benefited rather than



disadvantaged kangaroos. In contrast, wheat-farming areas carry very low densities. In northwestern Victoria, for example, most of the kangaroos are found in a few National Parks such as Hattah-Kulkyne, which stand out as islands in a sea of agriculture.

What the numbers were in Victoria before farming, nobody knows, though mallee is known not to support high densities. Wherever wheat and kangaroos come into conflict, kangaroos seem to lose out. This may be a response to the intensity of land-use combined with wheat-farmers being less tolerant of kangaroos than sheep-graziers.

Some new wheatlands and cotton fields are being opened up, but it is unlikely that this agricultural expansion will affect the commercial species more than by causing some localised extinctions. Whether or not this matters when so many thrive elsewhere is an important subject for debate.

In summary, we now have quite a lot of information about the size and distribution of the total populations and the marked fluctuations that occur. Rainfall and drought are clearly identified as the most significant agents of short-term changes in population density, while habitat changes have probably been beneficial in the pastoral zone but harmful in farmlands. Shooting does not appear to be a major factor and in the foreseeable future it seems unlikely that a regulated industry will pose a threat to the maintenance of abundant and widespread populations of these three kangaroo species.

**As a result of the emotional attention given to kangaroos... other Macropods and conservation issues are being ignored.**

There is considerable opposition to the kangaroo industry on moral grounds — because of cruelty, the morality of basing an industry on the killing of wildlife, or opposition to the killing of any animal. Proponents of the last argument are usually vegetarians who avoid leather and feather products; they are consistent but are very much in the minority.

As to cruelty, the RSPCA has no major concern regarding professional shooters. Indeed, one could argue that the slaughter of kangaroos is more humane than the slaughter of sheep and cattle, on the grounds that kangaroos lead their normal existence as wild creatures until the last instant. On the other hand cattle and sheep are herded together, jostled onto trucks and often transported long distances in hot conditions before eventually being killed.

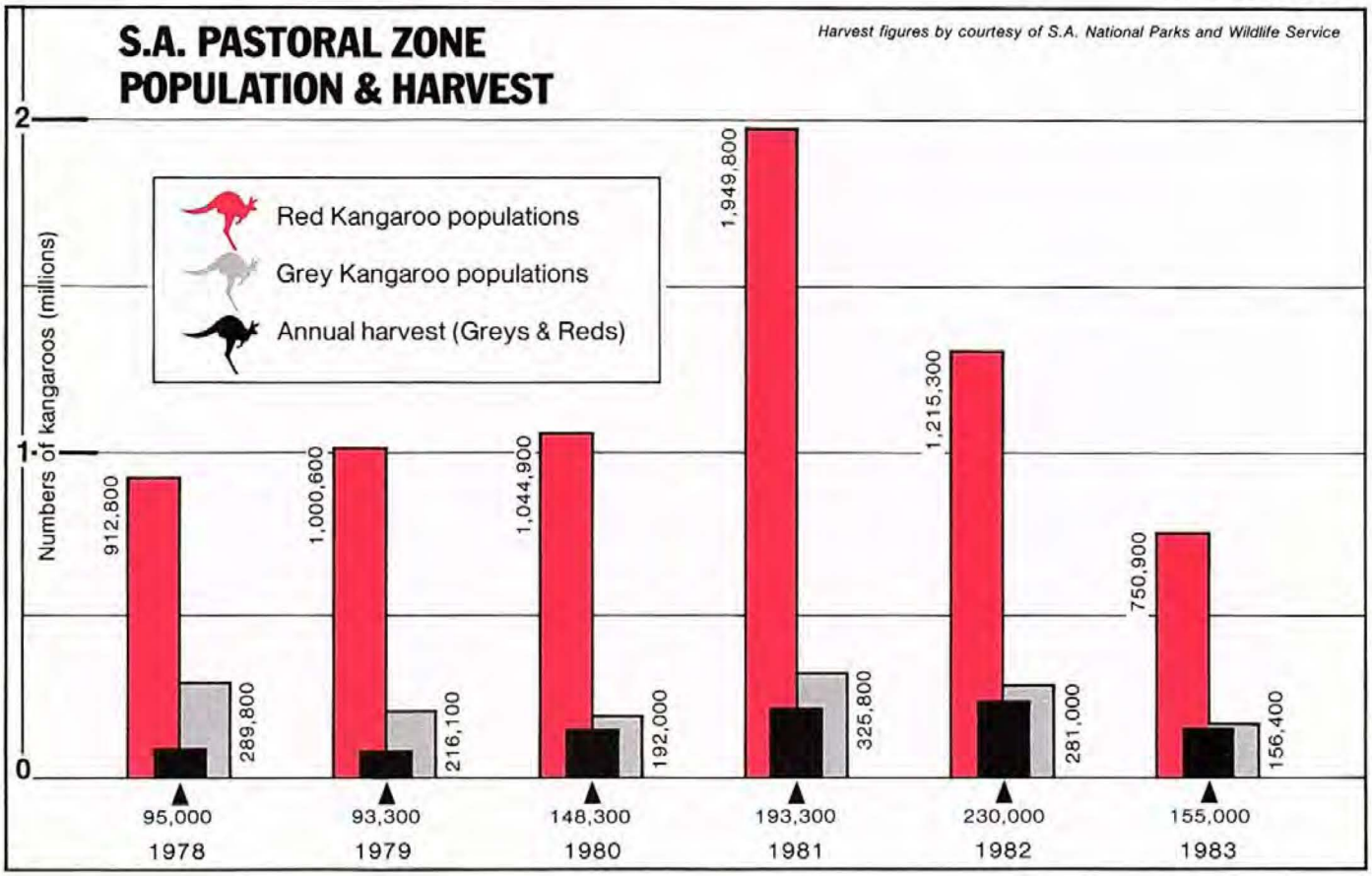
The 'kangaroos are wildlife' issue is more interesting. Is the difference between wildlife and domesticated animals more than just conceptual? Is killing a sheep or a cow any different from killing a kangaroo as far as the victim is concerned?

The killing of **any** animal is an unpleasant business, yet most of the community willingly accept killing domestic animals. Why should it be any less ethical to kill a kangaroo than a sheep? Surely it is only prejudices and definitions that conspire to construe those deaths differently? Is it inconsistent to make sacred cows out of kangaroos yet eat beef?

The justification usually given for the industry is largely that it performs a self-supporting pest-control function, avoids the needless waste of leaving carcasses to rot in the paddocks, and minimises those infamous 'kangaroo drives' by disgruntled graziers. However, why shouldn't the justification be that kangaroos are abundant and widespread animals, beautifully adapted to the Australian environment, which give excellent meat and fine leather and can be harvested without endangering the species? Is this not a good reason by itself to make careful use of a renewable resource? If a spin-off from that activity can bring about pest-control in some areas, then so much the better.

It is interesting to speculate on what our country would be like now if, instead of preserving their European tradition of eating cattle and sheep, our colonising forefathers had turned more to the local herbivores as a source of protein and leather. Ungulates graze at the expense of most of the surface of this continent. Kangaroos have evolved here, and maybe with their soft feet the land would have been much less degraded. However, the practicalities of

*(continued page 129)*



# The harvesting process

by Roland Hughes

Ever since 1978 the Commonwealth Government has set an annual harvest quota for each state after consulting the various states' wildlife experts. The annual harvest varies from year to year depending on the estimated number of kangaroos that occupy a harvesting area. Factors such as the potential rate of increase of particular populations are evaluated so proper management decisions can be made.

In New South Wales the kangaroo harvest is mainly based on a 'pet-food carcass' which includes both meat and skin. The harvesting of skins alone is prevented by the 1974 National Parks and Wildlife Act. Only a few specially endorsed licences are given to trappers to harvest for skins alone and they are closely monitored by the National Parks Service.


**1** Most harvesting is undertaken by professional kangaroo shooters.

**2** Shooters are required to keep detailed records of their kills.

**3** The kangaroo carcasses are weighed as soon as they are unloaded.

**4** Kangaroos shot for human consumption must be placed in chillers before daybreak following a night of shooting.

**5** Skinned kangaroo carcasses hanging in a boning room await processing as pet food.

**6** Bags of kangaroo meat awaiting delivery to pet-food retailers.

*(continued from page 127)*

**The Red, Eastern and Western Grey Kangaroos are probably the most abundant and secure of all the kangaroos...**

kangaroo farming would have demanded radical new approaches to livestock management.

Kangaroos need not end up only as dog's meat, yet only in South Australia is 'roo meat on sale for human consumption. Nobody seems to find it unethical that Aboriginal Australians have been eating kangaroo for thousands of years.

Is there room for any expansion of the kangaroo industry? The answer is probably yes, because the industry takes very few animals compared with losses that are sustained in droughts. Furthermore, harvesting could be intensified in high-density areas to reduce overpopulation and minimise the number of deaths from starvation. However, the economic return is probably not great enough to sustain an industry capable of such flexibility, so boom-and-bust kangaroo populations are likely to be the continuing pattern.

In the future, the possible threat of disease to kangaroo populations cannot be overlooked. Although little is known about kangaroo diseases they are more likely to strike, if patterns typical of other mammals apply, in times of stress (such as in droughts), and at high population densities. This may be an argument in favour of reducing numbers in localised areas, particularly in droughts, but as yet not enough is known.

A more tangible threat which has recently emerged is the growing interest in and advocacy of the use of electric fences to 'control' kangaroos, instead of shooting them. If every grazier fenced out kangaroos with an electric fence, there would soon be none left to shoot except those comparatively few beyond the dingo-fences and in reserves. Reds and Western Greys move between land systems to feed, so even a low usage of electric fencing may prohibit such movements, rendering kangaroos more vulnerable to the effects of drought.

If the market value of kangaroos were to rise very significantly the present situation could change. There seems to be no prospect of this in the foreseeable future. However, if it does happen, a better understanding of kangaroo biology, combined with the community's increasing sympathy towards conservation, should enable and encourage an effective regulatory response from government.

The conservation of kangaroos should be a major national responsibility and conservation-oriented individuals and societies should remind governments of their responsibility. However, singling out the kangaroo harvest as a threat to the survival of the commercial species represents a misjudgment of the real situation. If on the other hand the attack on the industry is based on moral grounds, then it should be put as such, not as an argument about numbers.

As a result of the emotional attention given to kangaroos, and the frequent confusion between conservation and animal liberation, other Macropods and conservation issues are being ignored. A large proportion of the research resources of National Parks organisations is diverted to 'managing' the large kangaroos which seem to be doing very nicely **despite** everything that has been thrown at them so far.

The Red, Eastern and Western Grey Kangaroos are probably the most abundant and secure of all the kangaroos but comparatively little is known about the other forty or so members of the Macropodidae, and the threats they face. If these other Macropods are considered important, then the public's urging (and money) would in the long run be better spent if it were directed towards more critical situations and away from this preoccupation with only three species of kangaroo.

It will be to Australia's credit if we can match pride in our national symbol with wise and long-term use of this resilient and renewable resource.

*Western Grey Kangaroos. Photo C. A. Henley (NPIAW).*

# On the hop

by David Priddel

**A thorough knowledge of kangaroo movement is an essential ingredient in the formulation of any proper conservation strategy for these remarkable marsupials. The largest study yet completed of kangaroo movement was a joint project undertaken by the New South Wales National Parks and Wildlife Service, the CSIRO and the University of Sydney, and it found that, contrary to popular belief, most kangaroos are not nomadic. By tracking individual animals with radio transmitters biologists were able to confirm that most of the three large species of kangaroo do not move out of a home range of ten square kilometres.**

**David Priddel, now a Research Officer at the New South Wales National Parks and Wildlife Service, was involved in the three-year study programme while he was a postgraduate student at the University of Sydney. Presently he is working on animal radio-tracking and will soon be commencing a research project on the mallee fowl.**

*An Eastern Grey Kangaroo on the hop. Grey Kangaroos have a wide and almost continuous distribution between the inland plains and the coast where annual rainfall is more than 250mm, in habitats ranging from semi-arid mallee scrub through woodland to forest. Photo A. Young (NPIAW).*

Four species of large kangaroo inhabit the inland plains of New South Wales — the Red Kangaroo, *Macropus rufus,* Western Grey Kangaroo, *Macropus fuliginosus,* Eastern Grey Kangaroo, *Macropus giganteus,* and the Euro, Wallaroo or Hill Kangaroo, *Macropus robustus.* These species are common in pastoral areas of New South Wales where they are often regarded as pests. As well as damaging crops and fences these kangaroos are a hazard to motorists and during drought compete with domestic stock for water and pasture.

Although all kangaroos are protected, a number of Reds and Greys are harvested legally for meat and hides. The quota of Red and Grey Kangaroos culled in New South Wales is set by the State National Parks and Wildlife Service and is based on annual estimates of their numbers in areas open to commercial harvesting. Aerial surveys indicate that, in spite of this exploitation, populations of Red and Grey Kangaroos increased substantially during the 1970s. In August 1981 there were approximately four million Reds and three million Greys on the inland plains of New South Wales. The drought which recently enveloped most of the eastern states has since caused the number of kangaroos to decline considerably.

The number of kangaroos inhabiting Australia before European settlement is not known. Anecdotal evidence suggests that overall their numbers were much lower than they are today. Prior to European settlement kangaroos were probably restricted to areas near natural water courses. Although kangaroos can obtain most of their requirements for water from the food they eat, during prolonged periods of hot dry weather they need to drink regularly. The provision of permanent watering places for domestic stock and the need for farmers to channel water for the irrigation of crops in pastoral areas has resulted in an increase in the numbers of kangaroos in many areas away from natural water courses. In addition, clearing of extensive tracts of land and subsequent grazing by domestic stock appear to have modified the pastures beneficially for kangaroos.

One feature of the semi-arid which has not been altered by man is the occurrence of drought. Although many bores, earth tanks, irrigation channels and some natural water courses retain water during drought, many pastures

wither and die, imposing a severe shortage of food on kangaroos and domestic stock alike.

Red Kangaroos are notable for their ability to survive the harsh dry environment of inland Australia. One of the major factors contributing to their survival is believed to be their mobility — kangaroos are generally thought to be highly nomadic, regularly moving hundreds of kilometres in search of greener pastures. Some graziers claim that mass seasonal migrations of kangaroos occur between the southern and eastern states of Australia. These graziers eagerly relate anecdotal accounts of mobs of thousands of kangaroos moving headlong across the moonlit skyline.

Studies have shown that Euros and Eastern Grey Kangaroos are not nomadic — these animals rarely move more than a few kilometres even under drought conditions. The mobility of the Red Kangaroo is more confusing in that observations are conflicting. While movements of over 200 kilometres have been recorded for some individuals, others have remained in the same area for several years. Little is known of the mobility of the Western Grey Kangaroo.

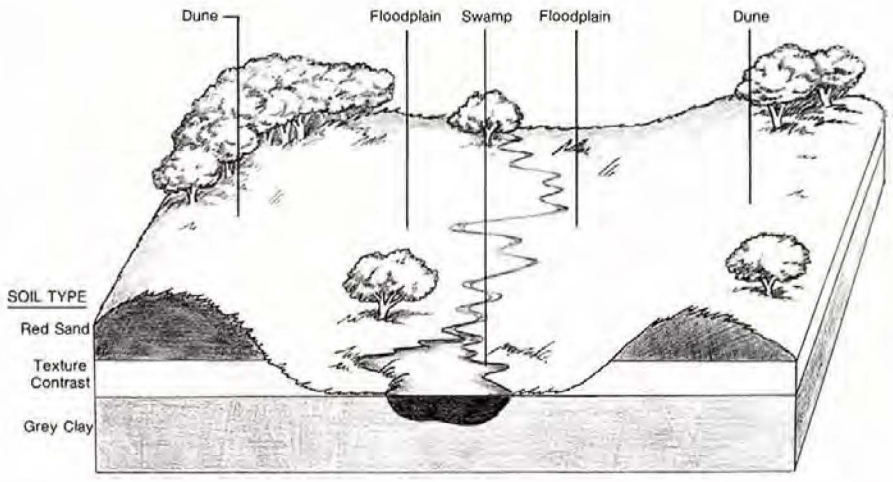
To bridge these gaps in our knowledge, a study of the mobility of Red and Western Grey Kangaroos was undertaken. This study was centred on Kinchega National Park and on 'Tandou', a large pastoral property which adjoins the southern boundary of Kinchega. Being a National Park, Kinchega differs from the surrounding properties in that there is no grazing by domestic stock nor commercial kangaroo harvesting. Kinchega is also unique in that it is encircled by a 1.8 metre high 'kangaroo-proof' fence. Comparison of the mobility of kangaroos on and off the Park was a significant component of the study.

Both Kinchega and Tandou abut the Darling River, south-west of the township of Menindee, about 120 kilometres south-east of Broken Hill. This area, like much of western New South Wales, has been grazed by domestic stock for more than a century. It was once part of the sprawling Kinchega Station — one of the first pastoral settlements established along the Darling River in the early 1850s. By 1884 Kinchega was running 143,000 sheep and covered more than half a million hectares. In 1967 the area of land that now comprises Kinchega was formally dedicated as a National Park.

Kinchega and Tandou contain extensive areas of low-lying river floodplain and swamps comprising grey and black heavy-textured clay soils. These areas are interspersed with elevated areas of sandplains and dunefields comprising red well-drained sandy soils. These two discrete soil types form a mosaic, usually with distinct boundaries between them. Alternatively, the two soil types may merge to form areas of texture-contrast soils which vary between red sands and grey clays. The different soil types each occur at different heights in a catena formation (connected series) of undulating dunes and plains. The low parallel east-west dunes may span three kilometres and be up to 10 metres high.

**In the past, movements of hundreds of kilometres by kangaroos have tended to be accepted as the norm rather than the exception.**

*Ranging over most of the central part of Australia in areas having less than 500mm mean annual rainfall, Red Kangaroos are one of the largest living marsupials. Photo H. & J. Beste (NPIAW).*

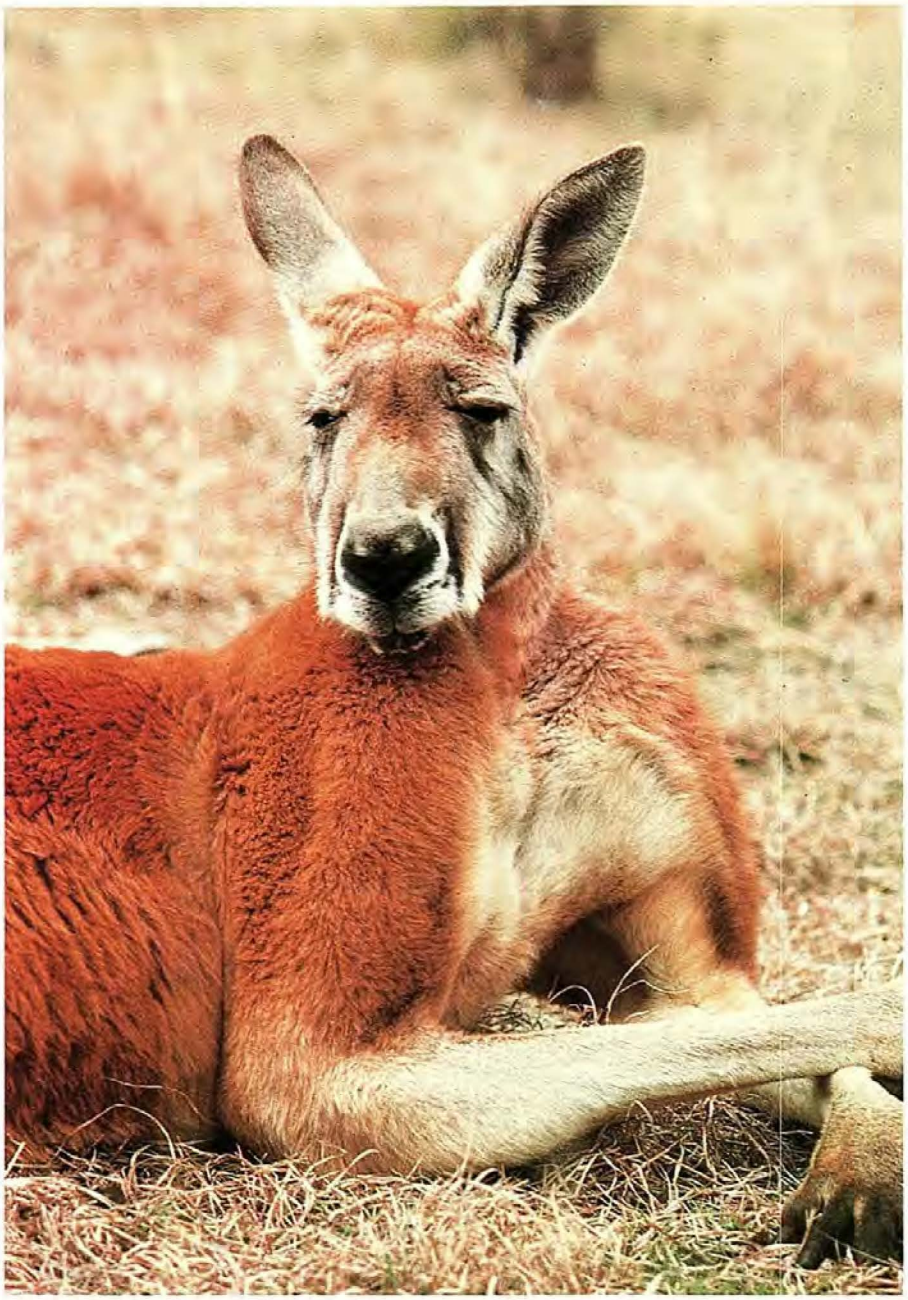



*Each different soil type occurs at different heights in each dune and plain formation. Both Red and Western Kangaroos moved up and down the soil formation in response to different pasture growth and soil type.*

Each soil type supports a different range of vegetation communities, consequently boundaries between soil types are accentuated by an abrupt discontinuity in vegetation types. Pastures on each of the various soil types are composed of different species, each responding differently (in terms of germination, growth and survival) to rainfall and weather.

Following rain, pastures on the light-textured red sands germinate more quickly than those on the heavy textured grey clays. As the environment becomes drier, pastures on the moisture-retaining grey clays persist longer than those on the well-drained red sandy soils, especially in areas adjacent to creeks, billabongs and depressions.

Throughout Kinchega and Tandou 261 Red and 170 Western Grey Kangaroos were caught, tagged individually and released. Over three years almost 2000 sightings of these tagged kangaroos were recorded by scientists, graziers and kangaroo shooters. An additional 24 Reds and 24 Western Greys were caught, fitted with radio transmitters and released. Half these animals were caught and released within Kinchega and the other half were



*After rain Red Kangaroos move onto the red sandy soils of the upper catena to graze on the emergent herbs. Photo T. & P. Gardner (NPIAW).*

**However, evidence shows most Red and Western Grey Kangaroos are confined to relatively small home ranges.**

caught and released in Tandou. During the following 20 months, the movements of the radio-tagged kangaroos were traced by intensive radiotracking from both ground-based tracking stations and aircraft.

The information obtained indicated that despite the fence and the differences in land use on and off the Park, the mobility of kangaroos in Kinchega was similar to that of kangaroos in areas adjacent to the Darling River outside the Park. Most Reds and Western Greys were confined to small home ranges of less than 10 square kilometres. In both Kinchega and Tandou, a few individuals were nomadic and extremely mobile — six kangaroos moved more than 40 kilometres during the study. The largest recorded movement was 85 kilometres by a Western Grey male. There was no predominant direction of movement of kangaroos away from the study area, and those individuals that were highly mobile at any one time did not necessarily remain so. Many of the animals that moved long distances (over 20 kilometres) were confined to small home ranges of less than eight square kilometres prior to this movement. On average, Western Greys were less mobile than Reds, and females were less mobile than males.

The proportion of the kangaroo population which was nomadic increased during summer as the environment became drier. In other words, as the local pastures withered the number of nomadic kangaroos increased (within limits), and correspondingly the number of relatively sedentary animals decreased.

Aerial surveys of kangaroos indicated substantial changes in their dispersion. Usually kangaroos were widely dispersed, but when pastures were scarce kangaroos aggregated at the edges of receding water and on areas receiving localised rainstorms.

In arid and semi-arid areas of Australia the distribution of rainfall is so patchy that while one area may receive no rain, another area one kilometre away may receive enough rain to germinate the dormant seeds of native pastures. When pastures grew in these sodden areas large mobs of kangaroos aggregated on the green feed.

These aggregations were predominantly kangaroos that had moved only a few kilometres and whose established home ranges overlapped part of this sodden area. Movements of kangaroos to isolated patches of green pasture from more than 10 kilometres away were uncommon.

Within their established home ranges Red and Western Grey Kangaroos both moved up and down the soil catena in response to the different growth of pastures on each soil type. When there was rapid growth of pastures following rain, Red Kangaroos moved onto the red sandy soils of the upper catena to graze on the emergent herbs.

As these pastures matured, Western Greys followed the Reds onto the red sands presumably to graze the mature herbs or the emergent slower growing grasses. Then, as new growth ceased, both species descended the catena onto texture-contrast soils.

As the environment became drier, and pastures continued to wither, Western Greys descended the catena further onto the low-lying grey clays to graze the last remnants of dry pasture.

Red kangaroos generally occupied a higher position on the catena than did Western Greys, and favoured areas of fresh green herbage. Western Greys tended to remain and survive in areas of woody or withered vegetation. These differences in foraging behaviour reflect differences in the digestive physiology of these species. The digestive system of Western Greys is adapted to digest a coarser diet with a higher fibre content than that of Red Kangaroos.

How applicable the findings of this particular study are to other areas of Australia can only be surmised. In remote arid deserts where man has not constructed abundant artificial water supplies the distribution of kangaroos is often restricted to areas near permanent water. Only following infrequent rains do kangaroos occur in large numbers thoughout the deserts. The movements of kangaroos about persistent sources of water in the arid deserts may be quite different to kangaroo movement in the pastoral zones.

Movements of kangaroos in relation to a catenary soil sequence are not confined to riverine areas in New South Wales. Such movements by Red Kangaroos have been reported from central Australia, suggesting that the occurrence of these movements is widespread.

If kangaroos move up and down the soil catena according to the rate of pasture growth, then the most beneficial home range for a kangaroo should contain areas of red sands interspersed with areas of grey clays. Such a home range would enable kangaroos to graze the residual pasture from the grey soil as the environment becomes drier, and enable them to take full advantage of any emergent growth of pastures on red sands immediately following drought-breaking rains. All the radiotracked kangaroos had home ranges which included areas of both red sands and grey clays.

If areas are to be set aside for the protection and conservation of kangaroos, then these areas should contain a range of habitats and soil types. Movement of individual kangaroos between different habitats within a small home range should provide continual access to reasonable forage except during prolonged periods of drought.

In the past, movements of hundreds of kilometres by kangaroos have tended to be accepted as the norm rather than the exception. Such high mobility of kangaroos has consistently been used to account for the marked changes in their dispersion. However, evidence shows most Red and Western Grey Kangaroos are confined to relatively small home ranges. Only a few individuals are highly mobile or nomadic. Furthermore, high mobility of kangaroos is not necessary to explain the large changes in the dispersion of kangaroos. Local aggregation, limited immigration and emigration, recruitment and high mortality are sufficient to account for these changes.

As extensive areas become denuded of vegetation during a prolonged drought, kangaroos aggregate on local areas of remnant pasture, increasing their density in these areas many fold and thereby creating a false impression of very high population levels. The limited increase in the number of nomadic individuals results in limited emigration from some areas and immigration into others.

*Eastern Grey Kangaroos will congregate on local areas of remnant pasture during prolonged droughts. Photo G. B. Baker (NPIAW).*

However, many kangaroos deprived of sufficient food in areas denuded of pasture have depleted fat reserves and poor body condition. These animals would find it a severe strain on their already emaciated bodies to move hundreds of kilometres to areas of green feed. Most kangaroos remain, and of these, many perish. When the density of kangaroos in an area drops suddenly, a mass exodus of animals from the area is usually assumed. Seemingly always overlooked is the possibility that this large drop in density could be caused by natural mortality. In addition to drought, very high temperatures during summer can also inflict high mortality on kangaroo populations. While the exact cause of death is unknown, the corpses of those animals affected are usually severely dehydrated, often despite being within easy range of water.

Although kangaroos do not move hundreds of kilometres in mass migration as folklore would suggest, their mobility is important to their survival, particularly during drought. Their ability to move between landsystems and through or over stock fences gives them access to alternative watering sites should one dry up, and enables them to feed on any remaining pastures nearby.

Farmers have no reason to fear thousands of marauding kangaroos descending onto their properties from hundreds of kilometres around. It is more likely that during drought when pastures are scarce, local kangaroos (those within a 10 kilometre radius) would form dense aggregations by converging on crops and isolated areas of remnant pastures. Unfortunately, whatever the origin of these kangaroos, their effects on the farmer's hard-won crops or valuable pastures can be devastating.

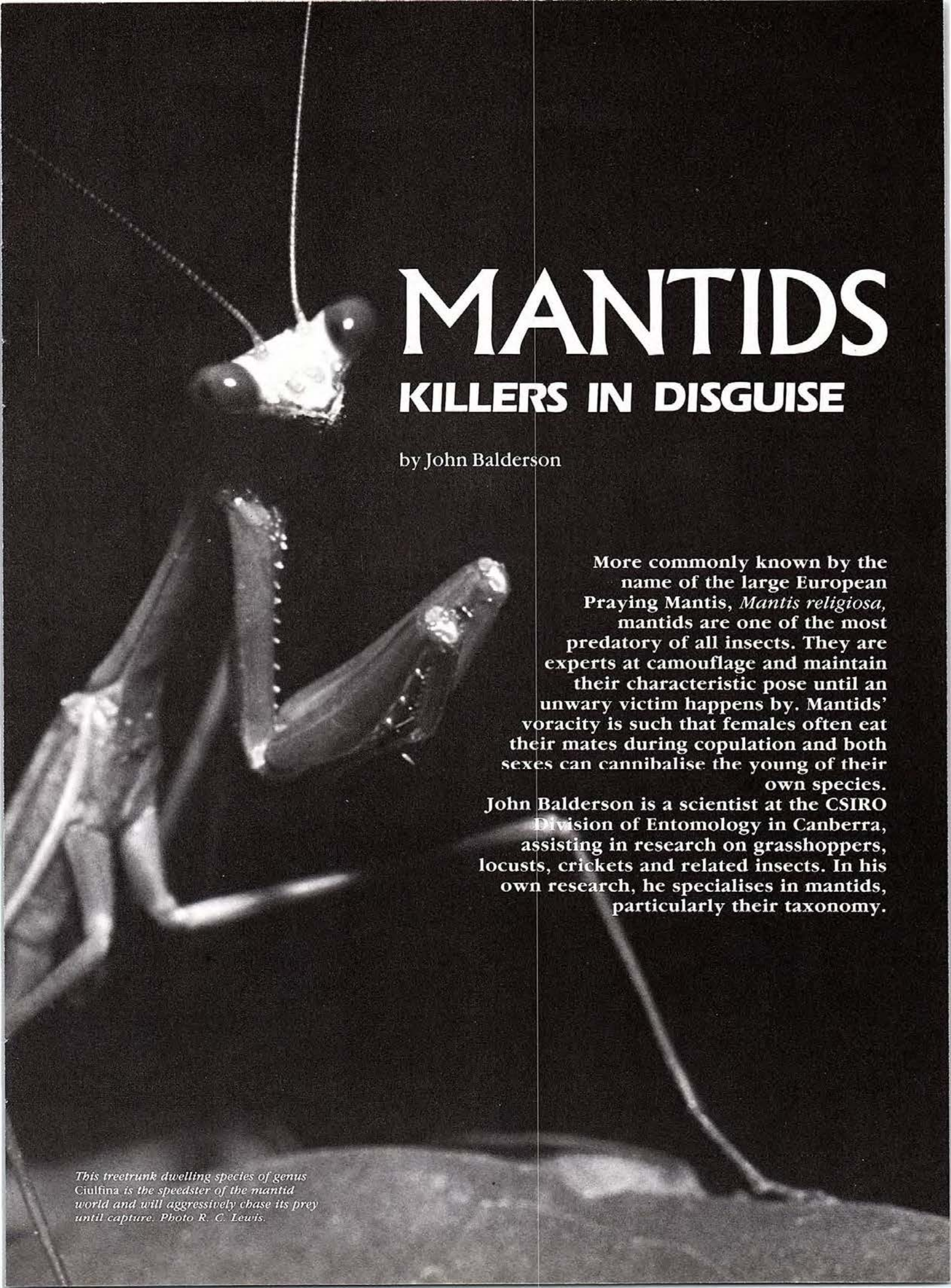
# MANTIDS

## KILLERS IN DISGUISE

by John Balderson

**More commonly known by the name of the large European Praying Mantis, *Mantis religiosa,* mantids are one of the most predatory of all insects. They are experts at camouflage and maintain their characteristic pose until an unwary victim happens by. Mantids' voracity is such that females often eat their mates during copulation and both sexes can cannibalise the young of their own species.**

**John Balderson is a scientist at the CSIRO Division of Entomology in Canberra, assisting in research on grasshoppers, locusts, crickets and related insects. In his own research, he specialises in mantids, particularly their taxonomy.**



*This treetrunk dwelling species of genus* Ciulfina *is the speedster of the mantid world and will aggressively chase its prey until capture. Photo R. C. Lewis.*

Standing motionless or swaying gently, with forelegs raised 'folded in prayer', mantids have long been revered as gods, manifestations of deities, or soothsayers in a wide variety of societies.

The bird-fly or mantis god of the ancient Egyptians was charged with conducting the souls of the dead to the great divine spirits. To the Bushmen of southwest Africa, mantids are a manifestation of their supreme deity Kagen, while in the West Indies they are known as 'god-horses'. 'Mantis', the name given to them by Linnaeus, is Greek for 'soothsayer', or 'prophet'.

Although they are often known as 'praying' mantids because of their habitual posture, a far more appropriate description of these voracious, pugnacious, carnivorous insects is 'preying'.

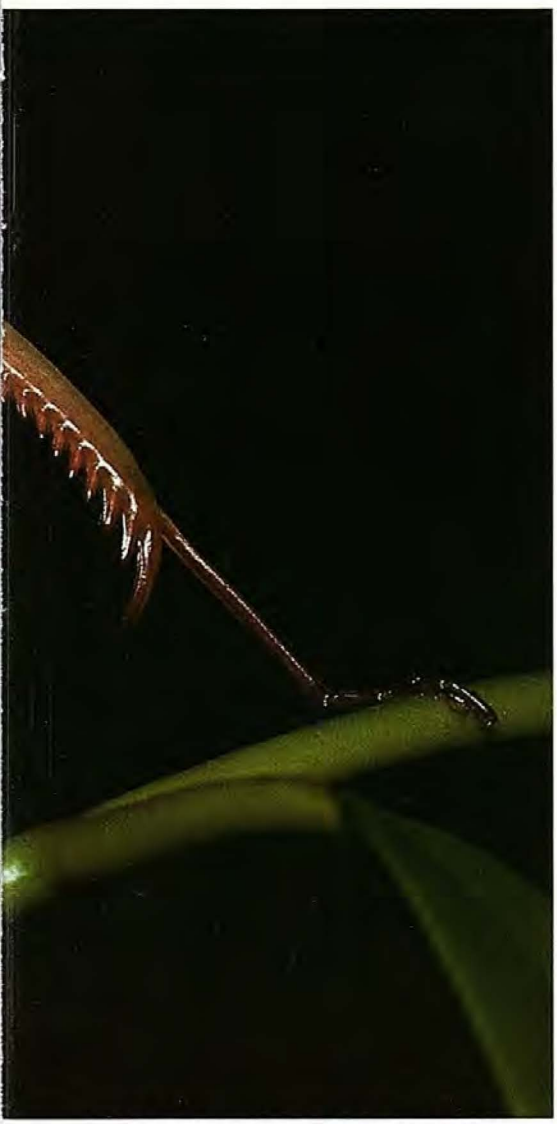
The basic morphology and lifestyle of these insects centres on their ability to catch prey. Many mantid species will stalk prey if they have been without food for a long time and some long-legged, fast-moving species will even join in a chase. In general, however, the shape and colour of a mantid's body, together with its 'praying' stance, enable it to remain undetected until an unsuspecting victim comes close enough to be caught by a lightning-fast strike of the forelegs.

These forelegs, which are the mantid's most distinctive characteristic, are highly efficient mechanisms for catching prey. The femur (upper part) of each leg is lined with two rows of sharp spines, the tibia (lower part) is edged with one or two rows of shorter spines, and ends in a long, sharp, curving hook. The unsuspecting victim is caught in a strike so swift it has no time to react — about one twentieth of a second — by the meshing of the spines when the leg is closed. The spines interlock neatly when the limb is closed, rather like a penknife, and the large hook fits into a deep groove on the femur. Once caught in this mesh, the hapless victim has little chance of escape and is eaten alive at the mantid's leisure. Hungry mantids have occasionally been seen eating a fly from one foreleg and at the same time catching and holding another fly in the other foreleg.

The strength of the spined legs is attested by the large green mantid, *Hierodula werneri,* in the Northern Territory, which catches and eats frogs and geckoes. There are also reports of mantids catching small birds but usually their diet is restricted to insects, which may include members of their own species.

To aid their hunting technique, many mantids are shaped and coloured for camouflage. The basic shape of a mantid is long and thin, but spectacular variations exist, particularly in warm areas. Some species have protuberances on their heads, others leaf-like expansions on legs and abdomen. The thorax of *Hierodula atricoxis,* from Cape York, is widened into a rather flattened oval plate and the abdomen of the wingless females of the widespread genus *Paraoxypilus* is knobbly and semispherical. In Asia such modifications are taken to the extreme by floral simulators whose bizarre shape and bright colours are a remarkably close imitation of the flowers in which they sit awaiting prey.

Camouflage works to mantids' advantage as a means of protection against predators. Even within the same species colour may vary, green and brown forms being the most common. In monsoon areas these variations may be associated with the dry and wet seasons. To be brown while vegetation is drying out would clearly be an advantage, whereas green is of more value in the verdant colours of the wet season.



*Mantids are often the subject of many superstitions among more primitive cultures. A member of the mantid family displays its peculiar 'praying' stance. Photo D. Clyne.*

Mantis ostospilota *uses a startle display to deter a potential predator. Photo C. F. Rentz.*

*Left, the very large eyes of a mantid are set far apart on its head.* Pseudomantis albofimbriata, *like all other members of the mantid family, can judge distances very accurately and know whether or not prey is within easy range. Photo D. Clyne.*

The colours of treetrunk-dwelling species of the genus *Gyromantis* in Australia are well adapted to the insects' habitat. Individuals found on paperbark melaleucas tend to be a pale sandy or yellow colour, whereas those on stringybark eucalypts are usually grey, and on fire-blackened trees they may be blackish.

As well as camouflage, overseas research indicates that mantids have a number of other basic defence mechanisms when under threat, although no comprehensive study on defensive behaviour has been undertaken in Australia.

Species of *Ciulfina, Ima* and *Gyromantis* can flatten themselves against tree-trunks so that they throw no shadow, and no marked irregularity on the tree-trunk can be detected from the side.

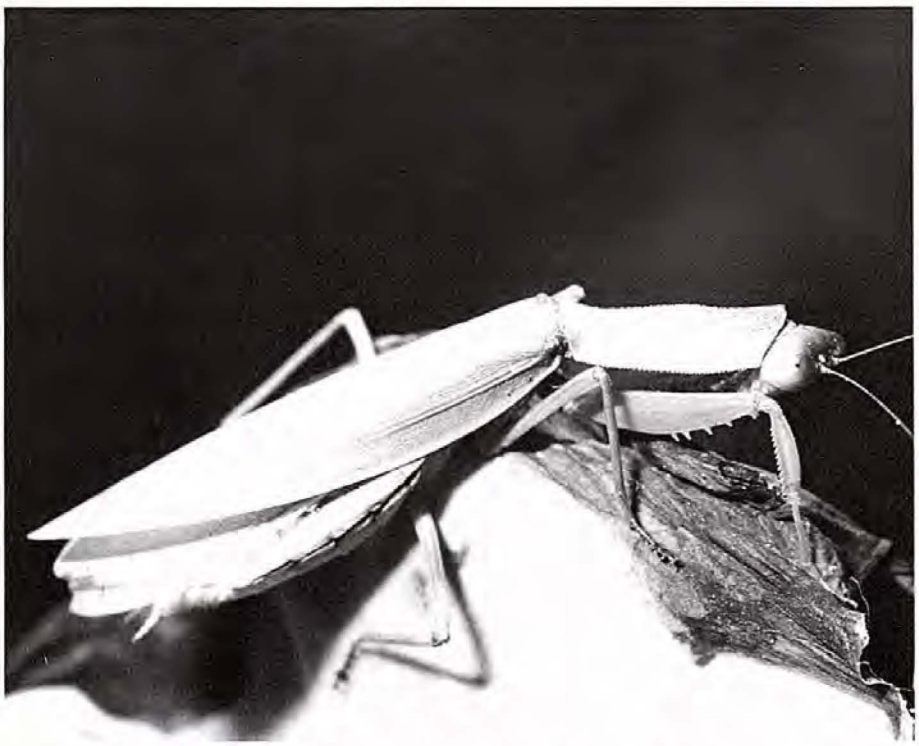
The many green, leaf-shaped species derive protection from their close resemblance to the foliage in which they live. Even large, heavy-bodied species such as *Hierodula werneri,* can be difficult to detect when sitting in a leafy shrub. Still more leaf-like is the small *Neomantis australis,* which has broad oval upper wings of delicate apple-green.

Grass and stick mimicry is also common. Grass mimics have long, thin bodies and very long, thin legs; in Australia the genus *Rhodomantis* is the best example of this. *Rhodomantis* females have very short wings and live in the low grasses and spinifex of the arid and semi-arid regions. When surprised in the open, they stretch out low, with middle and hindlegs widely splayed and front legs stretched forward as an extension of the body. If disturbed in grass, the insect freezes, often in a semi-vertical position among the stems where it can be extremely difficult to detect.

There are numerous recorded instances of very young mantids in some parts of the world mimicking ants and the same behaviour may be found in the young of the Australian genera *Pseudomantis* and *Sphodropoda.* However, this type of mimicry is probably best developed in the young and adult females of an unnamed genus of mantids found in northern Australia and the Western District of Papua New Guinea. These little mantids run freely with ants of the genus *Rhytidoponera,* generally on red lateritic soil surfaces. They are not only much the same size, shape and colour as the ants but they also run in short, sharp bursts and flicker their antennae when they stop, in the same way as the ants. It is uncertain at this stage whether the mantid is solely obtaining protection by mimicking a distasteful and possibly dangerous ant or whether it is using its disguise in order to prey upon the ants.

Most mantids will resort to one or more secondary mechanisms if the primary defence fails. These include escape by running, jumping or flying, thanatosis (death-feigning), startle or frightening displays, chemical defence (regurgitation of fluids) and, as a last resort, overt attack upon being seized.

The young of many mantids are very active and will run or jump surprisingly quickly to avoid capture. The various species of *Ciulfina,* once their



*Above,* Orthodera ministralis *enjoys a meal of honey bee. A mantid's appetite is so indiscriminate that it will readily devour members of its own species.*
*Photo D. Clyne.*

*Left, geologically speaking mantids are modern animals; earliest known examples date back 65 million years. Today there are about 1500 species found mainly in warm countries. Photo K. Atkinson.*

disguise has been penetrated, run exceptionally quickly up the tree-trunk on which they live and around to the side opposite to the potential danger.

Although many small species, such as *Kongobatha* and *Neomantis,* have flimsy wings which mainly serve to bring the sexes together, others, such as *Tenodera* in the grasslands of northern Australia, will readily take wing and are quite strong fliers. Under such conditions they can easily be mistaken for strong, flying grasshoppers.

Thanatosis is common when a mantid drops or jumps from a shrub to the ground. By lying perfectly still among the litter, often on its back with its legs spread out, it can avoid detection until danger has passed.

Startle display is well documented for many overseas species but little has been recorded on this behaviour in Australia, even though it is used frequently and can easily be induced by teasing a mantid with a finger or a stick. It usually entails the insect suddenly revealing vivid wing or body colours that were previously concealed, and at the same time rearing up and spreading wings and forelegs, to increase its apparent body size. The whole action may be accompanied by a hissing sound caused by the wings rubbing against each other or against the abdomen.

As a result drab females of *Rhodomantis* merge into their grass background but will lift their hindwing covers when hard-pressed and raise their small but startlingly bright blue-black underwings. Even the common little Green Garden Mantid, *Orthodera ministralis,* widespread over most of Australia, can be teased into rearing back on its middle and hind legs and will lift the front half of its body and raise its forelegs to the side of the head. In this stance it exposes bright purple-blue leg-patches to the attacker. Many species at the same time turn their bodies side-on to the source of danger and in this position raise brightly coloured underwings. In the case of *Mantis octospilota,* black markings are revealed along the side of the abdomen.

Mantids are also seen 'boxing', using their front two legs either together or alternately. Females of *Paraoxypilus* expose a leg-marking of a bright purple spot on a black background during such displays. However, it is believed that boxing is not so much a defence mechanism as a territorial spacing signal among members of the species. Therefore it is usual to find only one specimen of *Paraoxypilus* on each tree trunk and this is probably the maximum number that can be maintained by the food resources of this niche.

There are about 1,500 mantid species worldwide, about 130 of which are known in Australia. Although many of the genera occurring in Australia are found in other parts of the world, most of the species are endemic — our Black Barred Mantid, *Mantis octospilota,* is closely related to the widespread European Mantid, *Mantis religiosa.*

Sizes range from the one centimetre long *Bolbe pygmaea* to some females of *Archimantis latistyla* which reach 12 centimetres.

Apart from general bodyshape and size, the major differences between mantid species are the arrangement of spines on the femur of the front legs, the position of the groove into which the hook-like claw fits, the number of rows of spines on the tibia of the front legs, colour splashes on the inside of the front legs or the underside of the thorax, the shape and size of the cerci (the small jointed appendages at the end of the abdomen), and males' genitalia.

Female mantids tend to be larger and heavier bodied than males. Also, they are generally short-winged or wingless, whereas males can be quite strong fliers. Indeed, it can often be difficult to associate the two sexes as members of the same species unless they are found copulating. The easiest way to distinguish the sexes is by the last few segments of the abdomen. In males the dorsal and ventral segments are slightly flattened or spoon-shaped, often with the hardened genital organs visible between them, while in females the ventral segment is shaped rather like the prow of a boat.

The sexes do not generally court one another. Males of some overseas species do indulge in a form of 'semaphoring' using brightly coloured foreleg markings, and there is evidence to suggest that females do produce a sex scent or pheromone to attract males. But otherwise courtship is limited to a cautious approach by the male, usually from the rear, culminating in a short dash or leap on to the female's back. Any carelessness on the part of the male will prompt the female to strike as if at prey.

Numerous instances are known of females eating males, not only before or after mating, but also during copulation. The nerve centre that controls copulation is situated towards the rear of the insect, so the male can lose its head and

*Above,* Sphodropoda tristis *senses danger and rears back to adopt a threatening pose. Photo C.F. Rentz.*

*Left, leaflike expansions and the mottled grey colour of Borneo's 'Dead Leaf' Mantid provide it with a superb camouflage. Photo D. Clyne.*

thorax but continue to mate.

Such voraciousness on the part of the female is probably due to her need for protein in order to produce eggs. Once inseminated, she will produce six or more egg-cases over several weeks.

The eggs are laid in line inside the cases, which are formed from a frothy material produced by the female's glands. This material hardens rapidly on exposure to air, forming a protective cover around the eggs. Each egg-case generally contains 100—200 eggs, although up to 400 have been known.

Often the eggs are parasitized, particularly by chalcidoid wasps (tiny parasitic wasps), whose larvae will eat the mantid eggs and then occupy the egg-cases themselves. Also, ants and dermestid beetles (a group which includes carpet beetles) are known to burrow into the case to prey on the eggs.

Each species lays its own characteristic egg-case but some generalisations can be drawn. Those produced by *Archimantis* and *Tenodera* are large semi-spherical frothy masses which are generally attached to twigs or grass stems. *Orthodera's* are smaller, horny capsules and can be found tightly fastened to branches, treetrunks or fences. Tree-trunk-frequenting mantids such as *Gyromantis* form long, thin capsules generally with a short whip-like extension left at the completion of laying. Two species, *Sphodropoda tristis* and *Rhodomantis pulchella,* have been observed laying their egg-cases in sandy soil.

Like their nearest relatives, the cockroaches, young mantids are miniature versions of adults when they emerge from their egg-cases, except that their wings and genitalia are still only rudimentary. When newly emerged, they are particularly vulnerable to predators, even by others of their own kind, and comparatively few survive to adulthood.

In southern Australia the lifecycle of mantids is usually attuned to the seasons. The egg-stage takes place in winter, the young emerge in spring and become adult between January and March, when mating occurs and the next season's egg-cases are laid. In northern Australia the lifecycle is nowhere near as seasonal; all stages can be found at the same time.

These highly specialised daylight hunters benefit agriculture for they prey on pest species, although they do not occur in large enough numbers to be of major economic significance. Perhaps just as important is the fascination and reward of observing them in the garden or their more natural habitats.

# Simmering in the Simpson

by Rosemary Purdie

**To some people the Simpson Desert is just a name on a map, or less. To others, it draws immediate excitement, evoking visions of red sand dunes with bare crests and spinifex-covered slopes — an arid wilderness to visit if ever the chance arises. It is a place where wildfires may burn unhindered over thousands of square kilometres, and where camels, donkeys and rabbits replace sheep and cattle as visible reminders of the European occupants of Australia.**

**Having written for *Australian Natural History* before, Rosemary Purdie wrote this article after visiting the Simpson Desert for the Australian Heritage Commission to assess whether it should be included on the National Estate Register. During the six week trip the expedition first penetrated the Desert from the north along the Hay and Hale Rivers, journeyed through the southern dunefields until reaching Lake Eyre North, then finally crossed the Desert from west to east at about latitude 26 deg S. Rosemary Purdie is a botanist with the Bureau of Flora and Fauna in Canberra.**

The Desert covers an area of about 170,000 square kilometres in the general region where South Australia, Queensland and the Northern Territory adjoin, and is bounded by the Mulligan and Diamantina Rivers to the east, Macumba and Finke Rivers to the west, Warburton River and Lake Eyre North to the south, and the Macdonnell Ranges and an un-named sandplain to the north. It consists of thousands of longitudinal dunes, composed of siliceous sand, running parallel to each other for hundreds of kilometres in a NNW-SSE direction at an average spacing of about 500 metres. The dunes may be from 20 to more than 200 kilometres long and up to 30 metres high. In cross section they are mostly asymmetrical, with a gentle western slope of about 12 degrees giving way to a steep eastern slope of about 20 degrees which makes vehicular crossing of the Desert from east to west virtually impossible.

The first European entry of the Desert was in 1845, when Charles Sturt penetrated some 200 kilometres into the eastern dunefields, in what is now Queensland, in search of an inland sea. However, the region was not named until 84 years later, despite continued intermittent exploration in the intervening period. In 1929 C. T. Madigan called it the Simpson Desert after A. A. Simpson, the then President of the South Australian Branch of the Royal Geographical Society of Australasia, who did much to encourage exploration of the arid dunefields.

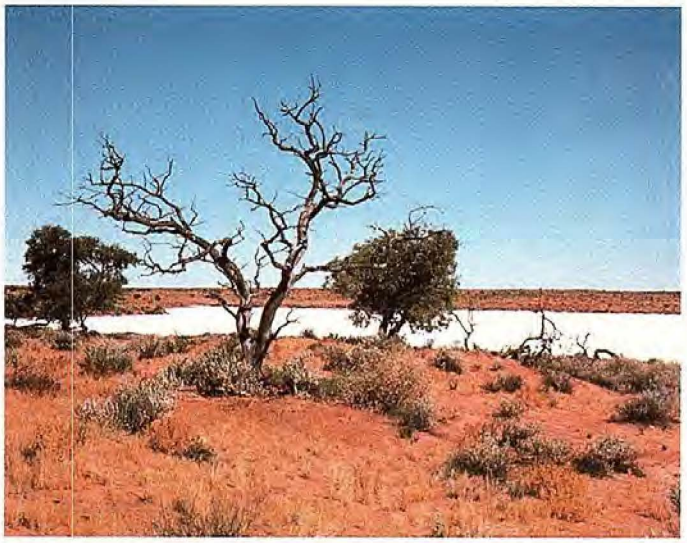
The first recorded west-east crossing was made in 1936 by E. A. Colson and an Aborigine, using five camels for transport along a route roughly following the 26 degree south parallel. Three years later, Madigan led a scientific expedition across the Desert on a more northerly route and for the first time scientifically accurate descriptions were obtained of the dunes, their vegetation and much of the fauna. While early exploration relied on camels for transport, it was not until the search for oil and gas opened up the Desert with seismic tracks in the 1960s, that ready vehicle access became possible for scientist and tourist alike.

Contrary to the popular image of the desert being a place of monotonous uniformity, there is a great deal of variation in the dunefields and their vegetation. Much of this is evident while crossing the Simpson along the main west-east route which lies just south of the Northern Territory-South Australia border. Reaching the dunefields however first involves a long, slow, dusty, bone-shaking drive over gibber-covered undulating plains and low hills, bare except for scattered tussocks of grass and low shrubs, with acacias and occasional eucalypts along rocky creek beds. These eventually give way to a waste, usually dry swamp on the floodplain of the Finke River, densely covered with low shrubs and with sparse lines of trees tracing the meandering route of the shallow river channels. Then finally, reddish sandy rises covered in grey, rounded grass hummocks indicate the first of the thousand or so dunes to be crossed during a west-east traverse of the Desert.

The dunes in this western region are short and have many cross connections. From the air, the pattern is not one of parallel longitudinal dunes but of a disorganised dune network. The dunes are mostly less than 10 metres high and their crests usually lie less than 200 metres apart. On the ground, the reticulate nature of the dunefield is less obvious, and while travelling in vehicles the dominating feature is a regular crest-sandy corridor-crest sequence. The vegetation of these western dunes is typical of that which occurs over much of the northern Desert. It is dominated by hummock grasses — Sandhill Canegrass, *Zygochloa paradoxa,* on the crests were the sand is loose and mobile and the nutrient status low, and Spinifex, *Triodia basedowii,* on more stable and fertile slopes and sandy interdune corridors. Shrubs are present and dominated by species of *Acacia, Grevillea* and *Eremophila.*

The density of shrubs on the dunes and in the corridors is greatly affected by rainfall. Shrubs may be rare after prolonged drought, but present in high densities following mass regeneration

*Dunes in the eastern Simpson Desert can reach 30 metres in height and frequently have mobile crests which are sculptured by the wind. All photos in the article by Rosemary Purdie.*



*Left, Poached-egg Daisies,* Myriocephalus stuartii, *carpet dunes after winter rainfall while saltlakes are interspersed between dunes (above).*

after abnormally wet years, such as occurred in 1973-1976. When such contemporaneous populations later die *en masse,* either due to drought or the natural end of their life span, the vegetation reverts to a more open structure.

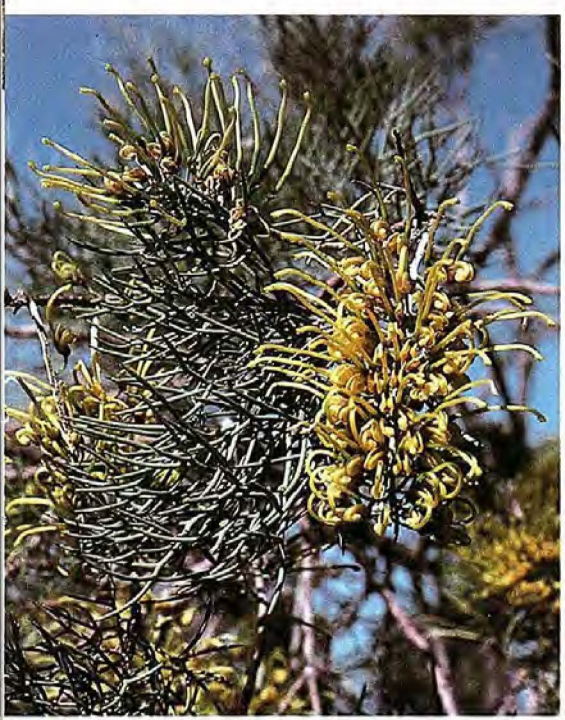
In dry seasons, the sand between the grass hummocks is bare except for windblown ripples, and animal tracks and dung but after winter rainfall it can become carpeted with a great variety of colourful ephemeral plants. These quickly die as the soil dries out, leaving their seeds alive in the sand to germinate when conditions once more become favourable. This may be within 12 months or not for several years, as the climate is one where the rainfall is low, less than 160 millimetres per year on average in the southern portions of the Desert and extremely erratic in both its yearly and seasonal occurrence.

After a run of good seasons when there is much dry herbage between the grass hummocks, wildfires started by lightning may burn out vast areas. These are clearly visible on LANDSAT satellite photographs. The hummock grasses and most of the shrub species recover after the fires, often by a combination of seed germination and vegetative regrowth but for the first few years there is little ground cover. Sudden changes from dense spinifex to bare sand may be the result of past wildfires. These are indicated by the occasional charred remains of root stumps. Although wildfires and episodic rainfall events have long-lasting effects on the vegetation it is easy to overlook the time-dimension of vegetation change which they initiate.

After crossing the first 300 or so dunes (about 80 kilometres of travelling) a different type of dune system becomes apparent. The dunes are parallel to each other, have relatively few cross connections, are up to 20 metres high and have an average spacing of 300-500 metres. On the ground, the dunefield consists of groups of closely spaced crests of loose sand separated by wide, firm, sandy-loam corridors. In places the pattern reverts to a regular crest-corridor-crest sequence but the dune heights and inter-dune distances are much greater and the corridors less sandy, than in the western reticulate dune system.

In these wide, sandy-loam corridors, Spinifex is replaced by low open shrubland of Saltbush, *Atriplex vesicaria,* or short-grasses and scattered shrubs such as *Eremophila longifolia, Cassia nemophila* and *Rhagodia spinescens.* Although the shrub and hummock grass densities are much lower than for the western-most dunes, the crest-slope zonation of Sandhill Cane-grass-Spinifex is still present and duplicated by some of the shrub and herb species.

About two-thirds of the way across the Desert its character changes again, quite suddenly. From dune crests dark groves of trees or startling whiteness may be seen in corridors ahead. The dunes themselves are frequently a jumbled mass of mobile crests which are 20 metres or more above the wide, loamy corridors. The sand of the dunes is a pale reddish colour instead of the previous deep red-brown and on the slopes, Spinifex is replaced by Sandhill Cane-grass. This region is the northern tip of a huge wedge-shaped area of desert, extending from an apex north of Poeppel Corner to a base of Lake Eyre and the Warburton River, where dry, elongated salt lakes (salinas) interspersed with longitudinal dunes characterise the dune system.



*Many desert plants grow in specific habitats.* Hakea eyreana, *in this case, occurs in the less sandy corridors between the dunes.*

The southern part of this wedge is a stark, bleached landscape of white, disorganised dunes covered in grey Sandhill Cane-grass, or, in more saline areas, with Nitre Bush, *Nitraria billardieri.* The dunes contain a high proportion of clay particles with sand and their lower slopes are frequently eroded into deep gullies. Along dry river courses, drifts of white sand engulf Coolibah trees, *Eucalyptus microtheca,* once associated with active floodplains. Permanent waterholes occur in this area, on the Kallakoopah Creek, Warburton River, and the lower reaches of the Macumba river, all of which wind their way through the dunefields to Lake Eyre North, into which they discharge water in exceptionally wet years. Birds abound, and the tracks of dingoes and camels are far more common than in the waterless areas to the north.

The salinas vary in size, the largest being up to 70 kilometres long or to 15 kilometres wide but all are miniature versions of Lake Eyre. Because of the high salinity and gypsum content of their soil, a unique assemblage of plant species tolerant of these conditions is associated with them. Succulent Samphires, *Halosarcia* spp, form open

# Simmering in the Simpson

shrublands around their margins, while species of *Frankenia, Lawrencia* and *Scaevola* grow among gypsum crystals protruding from the powdery brown soil. On the higher ground upslope from the salinas, gnarled, stunted Georgina Gidgee trees, *Acacia georginae,* form low open woodlands, sometimes with a shrubby understorey of Saltbush, at other times with only sparse short-grasses and forbs below.

About 50 dunes east of the cement post at Poeppel Corner which marks the junction of the Queensland, Northern Territory and South Australian borders, the region of salinas is left behind. Moving east, another system is entered where the dunes are single-crested, up to 75 kilometres long with few cross connections, and run parallel to each other at an average spacing of one to two crests per kilometre. The dunes are up to 25 metres high and frequently have mobile crests with westward-facing slip-faces.

The vegetation on the dunes is sparse, consisting of scattered Sandhill Cane-grass hummocks and low shrubs. The wide corridors support groves of Georgina Gidgee trees, until the soil abruptly changes from sandy-loam to cracking clay where Coolibah trees, Lignum shrubs, *Muehlenbeckia cunninghamii,* Oldman Saltbush, *Atriplex nummularia* and Bluebush, *Chenopodium auricomum,* occur. This transition marks the start of the 15 kilometre wide floodplain of Eyre Creek, which is overlain here by some 20 dunes. In extremely wet years, floodwaters form a swathe between the dunes from the vicinity of Muncoonie Lakes, where the Mulligan River and Eyre Creek adjoin, south to where Eyre Creek meets the Diamantina River. Usually, however, the floods soak into the desert long before reaching the latter. After the water subsides the clay plains of the corridors become covered with scented ephemeral herbfields composed of a large number of species unable to grow in the sand of the adjacent dunes. Such floods are often derived from rainfall in the river catchments which lie far outside the Desert. As a result, the corridors may be carpeted with flowers while the dunes are totally devoid of ephemeral vegetation, unless rain has also fallen locally.

East of the Eyre Creek floodplain the inter-dune corridors are dominated by scattered Whitewood trees, *Atalaya hemiglauca,* Bloodwoods, *Eucalyptus terminalis,* and shrubs of species such as *Hakea eyreana, Acacia tetragonophylla* and *Cassia* spp. On the dunes, the crests and slopes are once more delineated by zones of Sandhill Cane-grass and Spinifex. The species of shrubs dominant on the dunes are similar to those found on the western dunefields, although the density of plants is much lower.

Near the eastern margin of the Simpson Desert in far western Queensland, yet another distinct dune system occurs. Although conforming to a simple crest-corridor-crest pattern, the dunes sometimes exceed 30 metres in height and their crests may lie a kilometre or more apart. Unlike the previous dune systems, the corridors are covered with polished gibber stones whose colour changes with the angle of the light from orangy-brown to deep purple. The gibbers form a dense pavement over the powdery desert-loam soil except along graded tracks, where clouds of bulldust mark the passage of vehicles.

In all, the dunefields of the Simpson Desert can be divided into some eleven distinct dune systems based on the type of dunes, their height, length and spacing, and the types of soil and vegetation which occur on both dunes and corridors. The diversity of the vegetation throughout the Desert is largely associated with changing soil factors and the effects of fire, drought, floods and seasons of high rainfall. However in addition to this natural variation is that induced by introduced grazing animals.

On the Desert margins, particularly where permanent water is available from either natural waterholes on rivers or man-made bores, the effects of cattle are seen in the lack of ground herbage, the trampled dune soil between the hummock grasses and the presence of distinct browse lines on the foliage of taller shrubs. The most widespread grazing effects however are due to rabbits. These animals occur throughout the southern half of the Simpson Desert, surviving in areas where surface water is absent. During a west-east crossing of the Desert in 1982, rabbit droppings were common along the entire traverse. The large numbers of empty warrens attested to the size of populations which must have been present during previous good seasons, while the numbers of defoliated and debarked shrubs of certain species indicated a reasonably high current rabbit grazing pressure. One could not help but wonder how quickly the rabbit populations will build up with the next run of good seasons and to what extent their grazing will affect the regeneration of the vegetation. It seems probable that species composition of the vegetation has already altered and will continue to be changed, by the selective grazing habits of these animals. This, in turn, has ramifications for the native fauna, whose habitats may be destroyed as a consequence.

Despite its remoteness and the extremes of its climate, the Simpson Desert has been invaluable for scientific endeavours to understand the geomorphological mechanisms of dunefield formation and has provided important clues to the climate of Australia millions of years ago in the Quaternary and late Tertiary periods. Although the landforms and flora of the dune systems are not in themselves unique, the Simpson Desert never-the-less is considered to be a classic area of dunefields within the Australian continent, and as such, deserves a recognised place as part of our national heritage.


*Poeppel corner lies in a region where salt lakes are interspersed between the dunes and where Georgina Gidgee Trees and saltbush shrubs are common along the corridors.*

# CENTREFOLD 4

## Hercules Moth

*Coscinocera hercules*

It wouldn't be hard to mistake the caterpillar of the giant Australian Atlas Moth, or Hercules Moth, for a modernist painting, so spectacular are its colours. Or the moth itself, with its 20-centimetre wingspan, large body and strong flight, for a medium-sized bird.

This is one of the largest and most spectacular moths in the world. Apart from its enormous size, it is noted for the transparent triangular windows in the wings and for the very long tails on the hindwings of the males.

Found throughout Papua New Guinea, in the Louisiade and Bismarck Archipelagos, and in north Queensland, where it lives in rainforests and monsoon forests from Cape York south to Paluma, the Australian Atlas Moth belongs to the family Saturniidae. Among its relatives are many other beautiful species including the well-known, giant Atlas Moth, *Attacus Atlas,* of India and Southeast Asia, and the Emperor Gum Moth, *Antheraea eucalypti,* familiar for its sleek, chestnut-brown colouring. This family also contains some of the moths used to produce silk, although not the familiar silkworm, *Bombyx mori.*

When the Australian Atlas Moth was first discovered on Cape York in the nineteenth century, scientists named it *Attacus hercules,* but have since placed it in a genus by itself, designating it *Coscinocera hercules.*

Males reach a wingspan of over 22 centimetres and their long tails are often eight centimetres long. Females are even longer, their typical wingspan being 23 centimetres, but they have shorter, broader tails. The males also have broad, comb-like antennae, important for detecting the pheromones (sex-scents) produced by the females to attract them.

A female produces up to 230 large, smooth, oval eggs which hatch in about 12 days. When first hatched, the caterpillars are white and covered with a white waxy powder. They grow rapidly, feeding on a variety of tropical plants. By the time they are fully grown they are pale bluish green, with yellow tubercles, red spiracles (air-holes) and a large brownish black patch on its anal prolegs. They reach a length of about 10 centimetres, and throughout their life need plenty of water droplets to drink.

Caterpillars hatching in late December produce cocoons in late February. From these, adults emerge in April and a few during the dry season, but most remain in the cocoon until the following wet season. Enclosed in a leaf of the foodplant, the grey silk cocoons hang by a long stalk from twigs. The cocoon itself is about nine centimetres long and the stalk is usually a bit shorter.

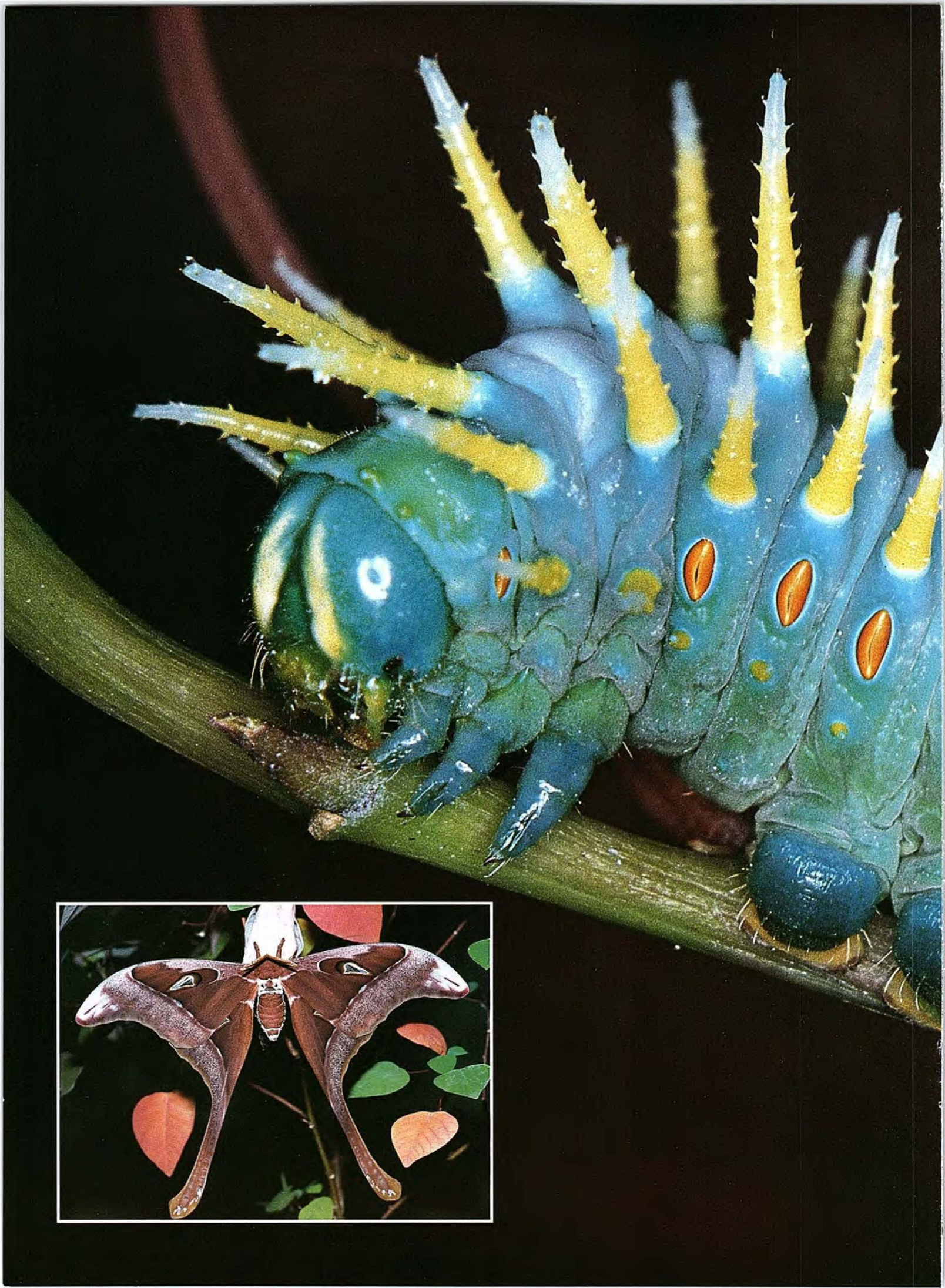
Adult moths have no proboscis and are unable to feed or drink, and so probably live no longer than about a week. Attracted to light, they are most commonly seen during the wet season (January to April), but some may be found during winter and the dry season.

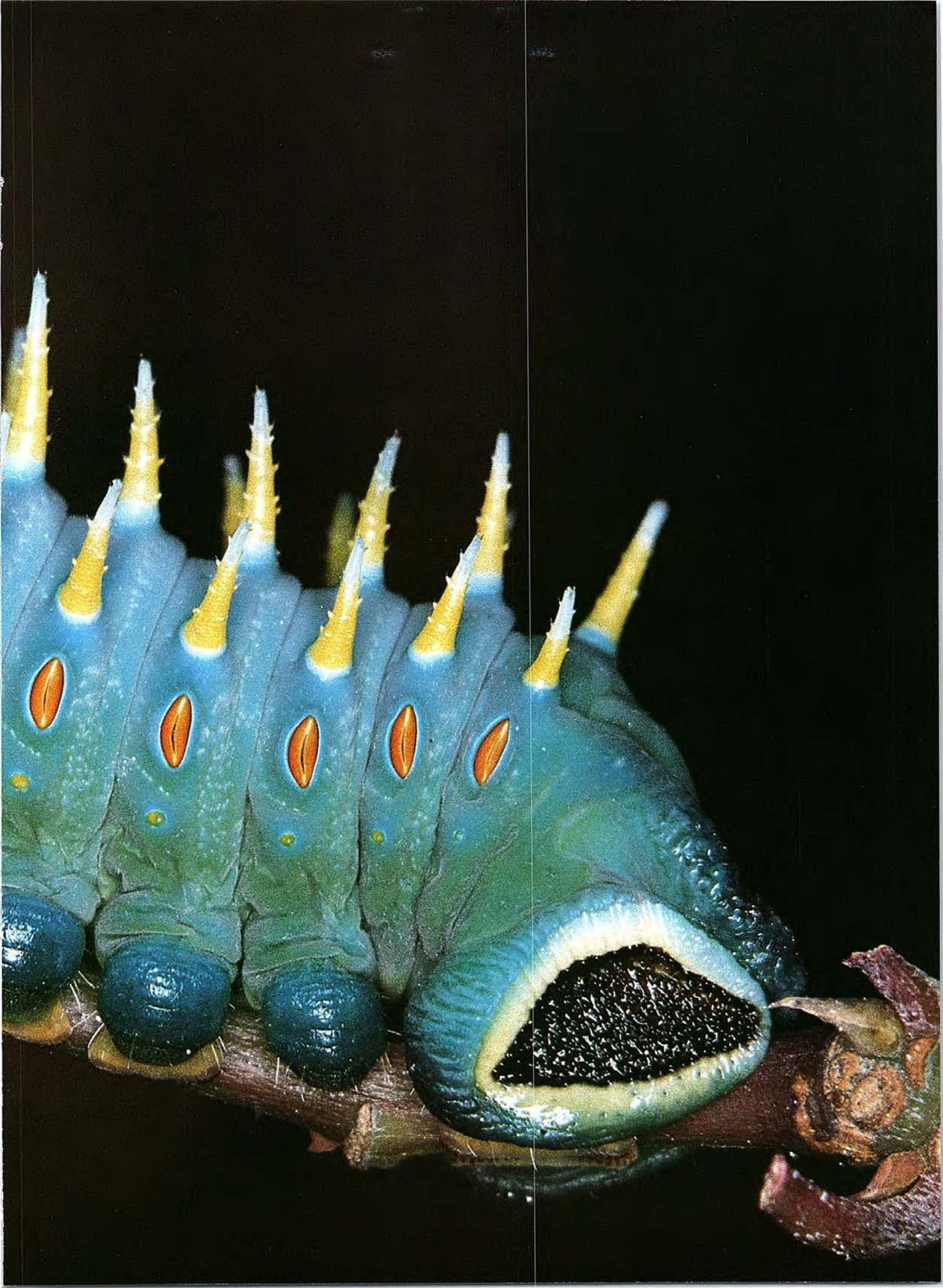
*Ted Edwards, Entomologist, CSIRO.*

*Above, a female Australian Atlas Moth,* Coscinoscera hercules, *newly emerged from its cocoon. All photos by Densey Clyne.*

*Centrefold, brilliantly coloured caterpillar of the Atlas or Hercules Moth. This species has a wing area of 300 square centimetres.*

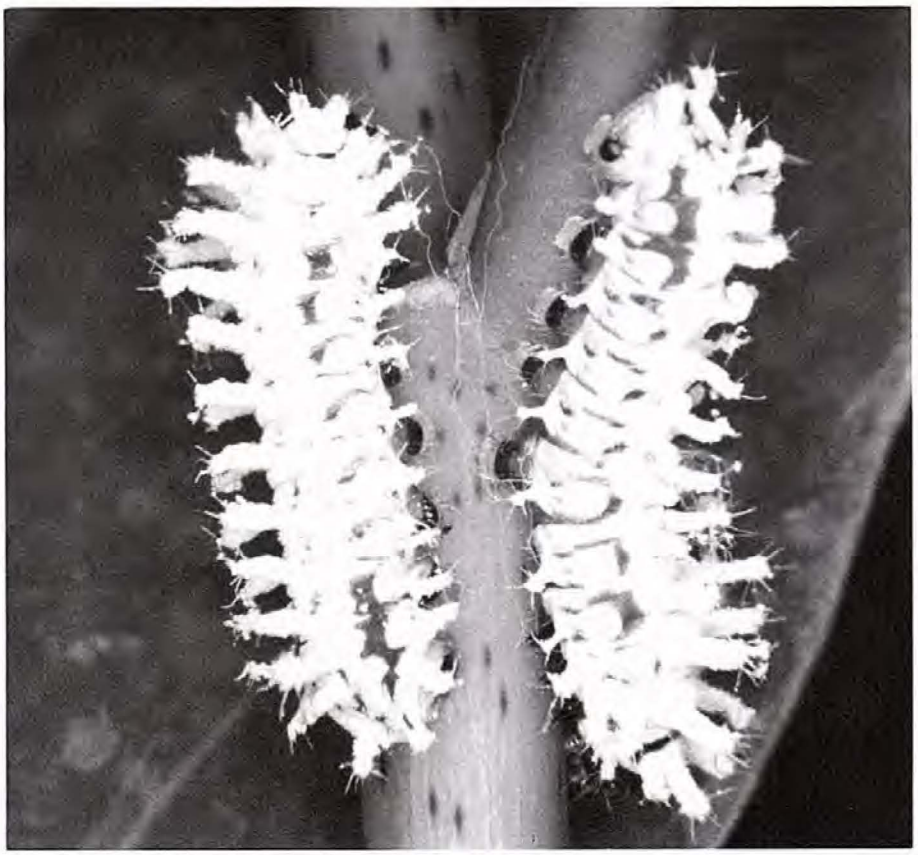
*Insert overleaf, the hindwings of the Australian Atlas Moth are extended into long 'tails' and there are transparent, window-like areas in the wings. These moths are strong fliers and have large, heavily built hairy bodies.*





*Above,* Coscinoscera hercules ***hatching.***

*Right, spiky, white hatchlings or instars of the Australian Atlas Moth during early days.*



*The Australian Atlas Moth's colourful caterpillar sheds its skin.*

## MOTHS IN THE MOVIES

Caterpillars have always fascinated me, from the first time I watched a Looper looping, and poked a Woolly-bear to see it curl up.

The more I learned about the character and habits of moth larvae the more the fascination grew. I can't remember ever having windows clear of casemoth ladders, or kitchen benches without Chinese Junks and others chomping gum-leaves.

This year my house-guests have been more exotic and certainly bigger than anything you'd find around our southern cities. Star performers in a film my colleague Jim Frazier and I are making about Australian moths are the larvae of *Coscinocera hercules,* the giant Australian Atlas Moth of Papua New Guinea and far north Queensland.

Writing a natural history film-script is one thing; finding the cast is quite another. There was no certainty of obtaining any of the moths. Even in normal seasons they're rarely seen, and our scouts in north Queensland said the weather was against us, with an erratic rainy season.

We cheered when a batch of eggs eventually arrived from the north; eggs were essential as the entire life-cycle was to be filmed. To rear a large tropical species in Sydney's climate might seem a daunting task, but one thing was in our favour. Although the moth itself is restricted to the tropics, one of its larval food trees extends south into the wetter parts of Sydney's bushland.

This is the small evergreen *Omalanthus populifolius,* or native bleeding-heart, whose heart-shaped leaves, ageing to red, make it an attractive garden tree.

Apart from a few casualties, the spiky white hatchlings did very well on a small potted *Omalanthus* tree in our film studio, supplemented with fresh branches from suburban gullies. But after a few weeks we found ourselves faced with a lot of insatiable, four-inch-long, blue-green monsters — and a sudden dearth of food-plants. The drought, of course.

Jim searched the gullies far and wide while I phoned native nurseries and friends with bush-gardens. We met the demand, but only just.

There were certain hazards to keeping the larvae on branches in bottles. I found one of them floating head-down in water one day. What do you do with a half-drowned caterpillar? Hold it in the sunshine, mop it carefully with tissues, and apply mouth-to-spiracle resuscitation, of course. With all those breathing holes, giving the kiss of life to a giant, unconscious caterpillar is rather like playing a rubber mouth organ. But it worked.

At five inches long, the caterpillars pupated, hanging from the branches in their cocoons of leaves and silk. We placed them for the winter in a plastic chamber with temperature and humidity controls.

So far, filming the various stages of development had not been difficult. The emergence of a moth from the cocoon, though, would not be easy. Other moths, such as Emperors, give you plenty of warning and time to set up the camera. They scratch away for hours inside their rock-hard cocoons like a mouse gnawing on wood. But the Australian Atlas larva spins a flimsier cocoon.

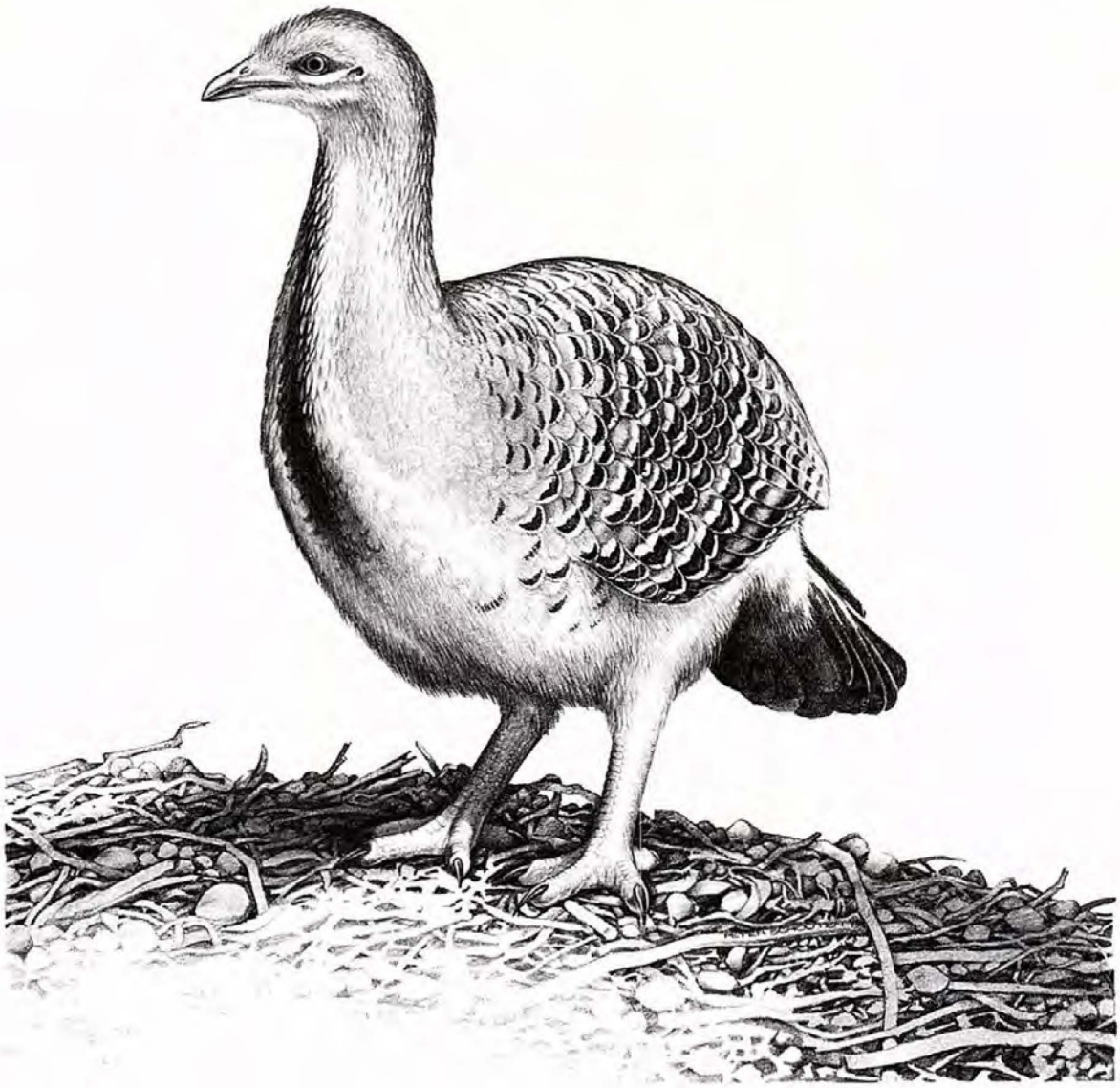
So Jim rigged up an early warning system — a tiny microphone fixed to each cocoon, leading to a loudspeaker in my bedroom. At the sound of scraping I was to leap out of bed, check the cocoons, telephone Jim, and keep the moth from emerging until his arrival.

The system worked so well we had to abandon it. The loudspeaker crackled every time a pupa turned over in its sleep, which, it seemed to me, they all did several times a night.

Well, we haven't filmed an emergence yet, but we do have a fine male and female out of their cocoons and eyeing each other across the studio. So it's two down and five to go.

With a bit of luck and a lot of patience, our moths should soon be in the can. In a manner of speaking.

*Densey Clyne, Wildlife Film-maker.*



# Malleefowl

## A remarkable bird with an uncertain future

by John Brickhill

**White man's settlement of Australia has caused the decline of many of our medium-sized mammals, in some cases until they were threatened with extinction. The malleefowl, although a relatively large bird, is a similar size to those theatened mammals and for many of the same reasons, suffers a similar fate.**
**John Brickhill is a naturalist with the New South Wales National Parks and Wildlife Service and has studied the habits and distribution of the malleefowl for the past eight years. In this article he describes the life history of the remarkable malleefowl and outlines the reasons why it was placed on the endangered fauna list in New South Wales.**

Malleefowl, at various times and places also known as mallee hens, native pheasants, gnow, and lowan, were named by John Gould *Leipoa ocellata*. They are one of Australia's three members of the family Megapodiidae which only contains 12 species. Although this family is named for the great size of its feet, its most remarkable feature is the strange method of incubating the eggs. Similar to many reptiles, the megapodes lay eggs in a warm place, after which they pay them little further attention. These warm places can be in a pile of rotting vegetable matter collected by the male, in beach sands warmed by the sun, or in ash beds warmed by geothermal action. Gould's name *Leipoa* meaning 'egg leaver' neatly characterises this behaviour.

The megapode family is largely confined to moist tropical forests in Australasia and the Philippines, with the malleefowl being the only member to occur in arid and semi-arid habitats. Tropical forests have an abundance of leaf litter which can easily be collected to make suitable warm moist microclimates for egg laying. In arid and semi-arid southern Australia, however, the sparse *Eucalyptus* or *Acacia* canopy produces small litter layers which are dried by solar radiation. That extreme summer radiation penetrating the canopy is in fact far in excess of the amount needed for egg incubation.

These climatic and habitat constraints have required the unique behaviour of nest mound temperature regulation found only in the malleefowl to evolve. This complex activity confused many naturalists until carefully studied by H. J. Frith in the 1950s. He experimented with man-made mounds and some nests artificially heated with electrically powered heating elements at a study site near Griffith in mid-western New South Wales.

Frith discovered that the male malleefowl involves himself with the nest for up to 11 months of the year and controls the temperature while the eggs are in it. The male malleefowl collects leaf litter, consisting of leaves, bark, twigs and small branches during winter, raking it for up to 50 metres into the nest, which is a crater shape about three metres in diameter and one metre deep. The litter is dampened by late winter rains until August when a small depression, acting as an egg chamber, is formed in the top. The litter pile is then covered by a layer of sand or soil, which retains heat released from the decaying leaf litter. Both birds monitor the temperature, and when it reaches 30 degrees Celsius in the egg chamber, the first egg is laid. This usually occurs between mid-September and mid-October near Griffith. The litter temperature is controlled by its moisture content — it must not be too wet, so well-drained sites are an advantage in most seasons. Most nests are found on sandy or well-drained soils.

Depending on the food supply, and other factors such as the age of the individual female, eggs can be laid at a rate of one every four to eight days until the full heat of summer halts the egg-laying period. In most years a clutch of 15—24 eggs will be laid, each egg averaging 187 grams, about 11 per cent of the female's body weight. Eggs take seven to eight weeks to hatch, when the young dig themselves out of the mound and are independent.

While the female faces the task of finding sufficient food for a clutch of large eggs weighing two or three times her own weight, the male must feed himself and control the nest temperature by manipulating the sandy soil cover over the eggs. In spring the decaying organic matter releases more heat than is required by the eggs, but there is little heat from the sun. Each morning, before sunrise, the male opens the mound to within 100 millimetres of the eggs to allow the excess heat to escape, then refills it immediately. Later in spring and early summer, there is less heat from the drier organic matter. The mound only has to be opened for cooling every few days and, as there is more heat in the sun's rays, the soil does not have to be replaced so quickly.

In summer, the male bird's main efforts are to cool the nest from the summer sun. A thick layer of sand is placed over the eggs by raking sand from around the mound. This is periodically cooled by digging out the whole mound before sunrise, spreading the sand to cool and then replacing it in the mound. This may take three hours, continuous work. By autumn, when no more heat comes from the organic matter, the nest is warmed by the sun. Almost every day the birds open the nest at 10—11am and spread it out so it forms a saucer shape. Sand warmed by the sun is replaced over the eggs at intervals throughout the day until by late afternoon the mound is restored and heat retained through the night. By late autumn, the nest temperature cannot be maintained with the large daily temperature fluctuations and the nest is then abandoned. The male digs it out to a crater shape, ignoring any eggs that may remain. The male bird controls the temperature regulation work throughout the season, although the female will assist, especially after the last egg has been laid.

During his study near Griffith, Frith also watched tame birds feeding, and so could score the frequency for various items taken. Food consists of invertebrates, herbs and buds, flowers, fruit and seeds of shrubs including many legumes. Near Griffith *Cassia eremophila, Acacia spp* and *Beyeria opaca* were fed on for 58 percent of the observation periods. Herbs are important in autumn, winter and spring, buds in winter and spring, flowers in spring and early summer, seeds in summer and autumn. Insects are taken whenever

available (availability being greatest in spring) and accounting for 17 percent of observations. These observations on food plant species are not sufficient to show the nutritional importance of various food items, but they do show the malleefowl to be an omnivore with no specialised food requirements. Frith's study site near Griffith was one of the highest rainfall mallee sites in New South Wales with a rich diversity of shrubs. The food preferences may be biased to herbs and shrubs at such a site and insects may be more important in more arid places.

With the male bird needing to work regularly on the nest mound for nine to eleven months of the year (and during the early autumn period that work consists of visiting the nest almost at hourly intervals throughout the day) the male is restricted to a feeding territory immediately around the nest. As a result,

*A male malleefowl digs at the nesting mound of sand, sticks and leaves. The female will lay between 15 and 24 eggs which will take seven to eight weeks to hatch. Photo L. Robinson (NPIAW).*

nest attention limits breeding habitat to areas where there is a reasonably drained nest site, and sufficient food can be obtained from within the male's breeding territory — in other words those woodlands and shrublands with an abundance and diversity of seed-bearing shrubs, as well as herb growth and sufficient leaf litter to support insect life.

Habitats which fit the malleefowl's requirements are the shrubby *Eucalyptus, Callitris* and *Acacia* woodlands and open woodlands and mallee eucalypt shrublands and some dry coastal heaths. They are found generally in southern inland Australia, westwards from the gentle western slopes of New South Wales through South Australia and southern Northern Territory to the West Australian coast and include north-western Victoria but none of Queensland. In New South Wales this distribution reaches as far east as the Pilliga scrub, where it meets the western end of the range of the brush turkey, the megapode which inhabits the moist forests of the coast and ranges.

In many places, the malleefowl habitats are amid good agricultural land. Clearing of these lands for crops especially since World War II has eliminated much of the good habitat, and poorer habitats are occupied by grazing properties. Frith surveyed various grazed and ungrazed areas of mallee and found that the densities of malleefowl in grazed mallee were 10—20 percent of those in ungrazed areas. The decline in mallee areas led to concern for malleefowl and other mallee birds, so they were added to the endangered fauna list in New South Wales and other states, and some special mallee nature reserves were created.

However, the malleefowl's own behaviour may have prevented earlier recognition that the species was in greater danger. Although malleefowl are generally solitary, their large size and sedentary behaviour and the male's devotion to nest sites meant that bird-watchers could make regular sightings at 'traditional' small patches of habitat such as Pulletop Nature Reserve, the last small remnant of Frith's study site near Griffith. The reliability of sighting there and at similar sites in Victoria and South Australia, coupled with the myth of Australia's vast areas untouched by man contributed to a lack of concern over the real position of the malleefowl

population. The existence of scattered reserves in South Australia where malleefowl were known to regularly breed meant that in the 1970s they were considered threatened but not endangered, and a similar position existed in Victoria.

In New South Wales concern began to rise with the granting of clearing permits on Western Lands Leases adjoining Round Hill Nature Reserve, near Lake Cargelligo. Clearing would isolate the reserve from adjoining mallee lands to the west as had already happened to the north. Clearing was already occurring on Western Lands Leases between Balranald and Wentworth but these were not known for their malleefowl habitat. There was no estimate of the size of the malleefowl population at Round Hill but it was assumed to be similar to a density found in surveys in similar country by Frith in the 1950s.

A survey to estimate the current population was initiated as a first step in assessing the viability of the reserve to conserve malleefowl. The best way to estimate and monitor the population density of a solitary, slow-moving, ground-dwelling bird with such large nests was to count the nests annually. With large areas of monotonous mallee vegetation broken by only a few roads, and relatively low densities of nests expected, an aerial survey samples a large area effectively. At Round Hill, the surveys are conducted by helicopter which allows slow low-level flying and the ability to examine carefully any nest seen. As each nest mound is located it is marked by a numbered conical white marker 75cm in diameter which is highly visible. These markers are permanent (except for removal by bushfire) and enable the nest to be more easily relocated.

Aerial surveys were made early in the breeding seasons in 1977 until 1980 when nests prepared for breeding were filled with litter, making them more visible from the air. A second series of flights later in summer relocated the marked nests. Scratching by the malleefowl on the pile of soft earth covering the eggs is easily seen from low level and confirms the nest's breeding condition.

The surveys over several years at Round Hill resulted in 183 nest mounds being marked, but the majority of these were very old nests, and only three nests were used by breeding birds in 1979 and 1980. The survey was not conducted in 1981 and no breeding nests were found in the severe drought of 1982. To correct the air survey for mounds not seen from the air, a ground search was conducted in May 1981, using student volunteers. A sample of 1400 hectares of the 20,000 hectares surveyed from the air was covered in five days by ten people walking in line 20—25 metres apart. The results of the ground search showed the aerial survey had found only half the malleefowl nests present. The ground search also confirmed that the aerial survey method was an efficient method of estimating the density of breeding malleefowl nests when they were at very low density.

Combination of aerial and ground survey data revealed a population of 7.2 breeding pairs (or 0.03 pairs per square kilometre) at Round Hill. Frith's estimate for such habitat was 0.15—1.54 pairs per square kilometre, suggesting a decline in the malleefowl population has occurred. The large ratio of non-breeding to breeding nest mounds also indicates a decline and confirms local anecdotal information.

The decline of the malleefowl population in apparently good habitat, securely conserved in a Nature Reserve, stimulated further research into malleefowl by the New South Wales National Parks and Wildlife Service. Another ground search of higher quality mallee habitats at Weethalle and West Wyalong in September 1982 found that malleefowl were relatively dense but restricted to minute patches of habitat surrounded by wheatfields. One area of freehold land at Weethalle had ten pairs in 330 hectares, the highest density of malleefowl presently known in New South Wales.

Interestingly, Blue Mallee leaf has been regularly harvested from this land for eucalyptus oil production. The leaf is cut by traditional methods by hand cutting coppice growth near ground level. Not all the mallee is cut, as there are some areas of Green Mallee, Broombush and Ironbark on the low ridges, and the Blue Mallee is cut in small areas on a three to five year rotation. Nearby, another small area of 290 hectares with similar soil and plant species has only one or two pairs of malleefowl, but this area has not been disturbed by cutting or fire for over thirty years.

**... an understanding of habitat ... and population ... is the most pressing need of research.**

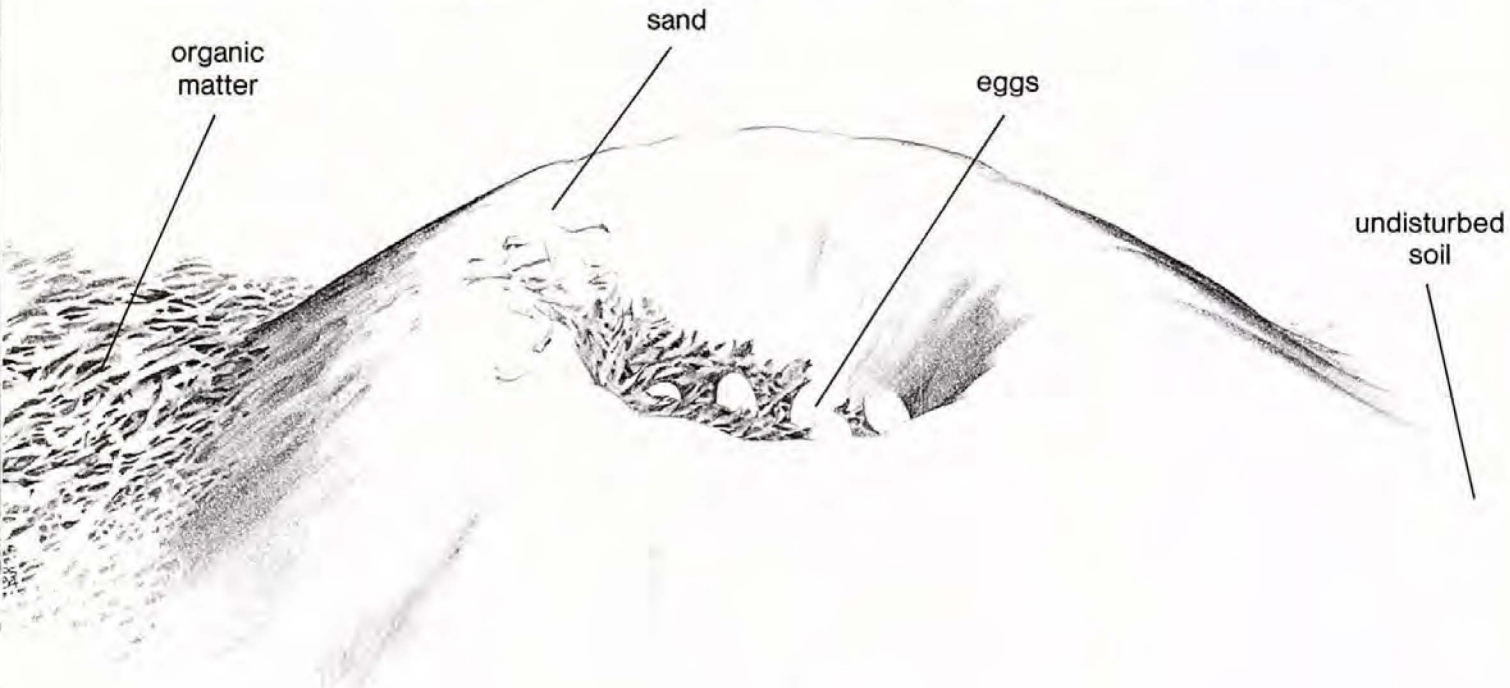
As part of any research programme on endangered fauna the basic distribution of the remaining animals should be known. The rich Weethalle site was discovered by chance and some locations of malleefowl were known from the literature but there was a need for detailed information on the malleefowl distribution, and the dates of decline from various districts. Distribution is being surveyed by sending letters and questionnaires to property owners and government land managers. Letters explaining the survey and describing the malleefowl and their nests are accompanied by a survey card which can be returned by business reply post. Questions on the card ask recipients to place their sightings of malleefowl in either pre-1940 or time periods of a decade from the 1940s onwards, and for detailed locations. To date about 2000 questionnaires have been sent and there has been a high return rate. Returns have been divided into three time periods and mapped in a method similar to that of the Royal Australasian Ornithologists Union Atlas data. Malleefowl are still very widespread with little contraction in their overall range in New South Wales, but their distribution has contracted into tiny refuge areas where clearing has occurred. Many of the refuges are State Forests or Nature Reserves but there are some pockets of private lands where malleefowl have survived. General comments on the questionnaire returns also indicate a population decline in western parts of the State that remain uncleared but grazed.

The combination of data on distribution and abundance highlights the problems to be faced in conserving malleefowl. There are a number of small pockets of land with better habitats

# The mound builders

Male malleefowls spend up to eleven months of the year maintaining and regulating the temperature of their breeding mounds.

1. In winter the male rakes all surrounding leaves, bark and twigs from a 50 metre radius and forms a crater-shaped nest (usually three metres in diameter and one metre deep).
2. After the winter rains he digs an egg chamber in the top of the litter pile and covers it with a layer of soil. Inside the eggs incubate by heat produced from fermentation of decaying vegetable matter and the heat of the sun.
3. When the egg chamber reaches 30 degrees celsius the female starts laying her eggs.
4. Between 15 and 24 eggs are laid at intervals varying from two days in good seasons to 17 days in very dry ones.
5. Incubation time is about 49 days, but is affected by the temperature of the mound.
6. The males' task is to balance the heat of fermentation against the heat of the sun so the egg chamber maintains a constant temperature of 33 degrees Celsius. He achieved this by testing the mound every morning with his beak. The male malleefowl pushes its beak into the soil and measures temperature with the lining of his mouth or tongue.
7. In spring when fermentation is intense he removes soil from above the egg chamber to release excess heat. In summer when the sun's heat is greatest the height of the mound is increased for insulation. Often the mound has to be dug out and the soil cooled during the early morning before being scraped back on.




where malleefowl densities are high but the small size of the area severely limits the number of birds they can hold. As well there are some larger areas with poor quality habitats where densities are quite low. Progeny from birds in high quality sites are unable to survive in competition with existing territory holders and they cannot colonise the low quality sites as they are isolated by large areas of cropland.

At very low densities, any malleefowl surviving to adult age may even have trouble finding mates as well as suitable breeding habitat.

Any conservation programme must face this problem of low densities in most habitats, but an understanding of the habitat requirements and population dynamics of the birds is the most pressing need of research. The decline in apparently suitable habitat cannot be rectified by malleefowl reintroduction until the reasons for the decline can be determined. The surveys at the Weethalle sites have shown that malleefowl survive well in areas disturbed regularly which appear unsuitable at first sight, whereas similar areas undisturbed have seen a decline. Work on the habitat requirements and use is planned for these sites.

Population parameters are another factor which must be examined before considering malleefowl conservation. Frith's work near Griffith showed that foxes were important predators of eggs but they possibly only replaced the predation of dingoes and Aborigines. Cats are efficient feral predators but nothing is known of their predation in mallee country. Other basic questions still unanswered are the mortality of young malleefowl chicks, as well as lifespan and age at first breeding.

It will be a combination of the work on habitat requirements, population parameters and predation by introduced predators that will be the basis of any future strategy for conservation. Once these are known, the acquisition and management of suitable reserves or management of other lands can be directed towards the long-term conservation of one of Australia's remarkable birds.

# FORUM

## The 'conservation ethic' in practice

by Harry Recher,
*Head of the Ecology Group, The Australian Museum.*

In an earlier Forum, Professor Mulvaney wrote of the changed attitudes of many Australians towards their environment. He spoke of the concern felt about the impact of growth and development and the increasing number of people who belong to conservation groups. Slowly we are evolving a 'conservation ethic' in which we not only recognise our own selfish dependence on a clean and healthy environment, but one which embodies a concern for the rights of other organisms to share this planet with us. Professor Mulvaney also identified the gap that has developed between the growth of a national environmental conscience and the development of administrative procedures to protect, conserve and enhance our environment. Leadership is coming from the conservation groups and not from government, nor with rare exceptions is it provided by the scientific and academic community. As exemplified by the recent National Conservation Strategy meetings and reports, these groups have been content to talk and not to act. Too often the lack of action has been divisive and the past 10 to 15 years could be described as an era of confrontation politics between environmentalists on one side and the established order on the other.

Nowhere has the division and acrimony been more intense than in the debate concerning the preservation and management of forests. The development of a national conservation consciousness coincided with major changes in the management of Australian forests. During the 1960s and 70s forestry became big business with emphasis on intensive harvesting and tree farming. Broad area prescribed burning was adopted as a means of protecting timber resources from wildfire.

As Australia entered the 1970s more than half of its original forests had been cleared for agriculture and relatively little was reserved as national park or nature reserve. To conservationists the advent of woodchipping, the clearing of native forest for pine plantations, and logging of rainforest spelled the end of those forests that remained. As a result conservationists began a vigorous campaign to protect forests from intensive harvesting or conversion to plantations, agitating to reserve large areas as parks. Foresters and the timber industry resisted the reservation of state forests as parks and supported woodchipping, plantation forestry and the harvest of rainforest timbers.

Advocates on either side were strong-willed people with a deep personal commitment to their goals. Very often they saw their opponents as ratbags, uninformed or dishonest, greedy or naive. Conservationists accused foresters of working too closely with industry and not giving fair consideration to forest values other than timber production. Foresters argued that if it hadn't been for their actions earlier in the century there would be no forests and that timber production was compatible with wildlife conservation and most recreation. It was hardly an atmosphere designed to engender goodwill and rational debate. A stage was reached where neither side trusted nor respected the other.

**...they saw their opponents as ratbags, uninformed or dishonest, greedy or naive.**

The controversy that developed was not helped by the lack of information about our forests, their ecology and wildlife, and the impact of logging on water quality, soils, plants and animals. Some conservationists confused the lack of information with 'secrecy' and the withholding of information by forestry authorities. Unfortunately this view was reinforced by the normal practices of Australian bureaucracies which have traditionally withheld information from the public. The Land Conservation Study Group which I chaired for the New South Wales State Government in 1977 identified the lack of open government as the most important cause of environmental conflict in New South Wales. Secrecy creates mistrust and suspicion; withholding information does not necessarily lead to good government nor to rational debate. The conflict over forestry matters was made worse by efforts to censure or suppress the involvement of scientists in public discussion.

Professor Mulvaney expressed regret that few scientists were prepared to offer an opinion publicly on the need to protect Tasmania's Southwest from development. I have also regretted the failure and unwillingness of Australian scientists to become involved in conservation issues. To understand why they haven't, one needs to understand how scientists are trained in Australia and be aware of the fact that 90 per cent of research scientists are government employees. As government employees they are bound by various rules and regulations which prevent them from releasing information or being critical of other government authorities. People who ignore these rules risk their jobs and careers. In addition scientific training in Australia is exceedingly conservative. Individuals specialise very early in their university training and are not encouraged to challenge whatever dogma their professor worships. Can we therefore expect them to question the dogma of their employers or to have the confidence to discuss issues outside their narrow area of expertise?

Too often the few scientists who have spoken out on forestry issues have been the subject of personal attack, or have been reprimanded with at least the implied threat of dismissal or demotion. Others have been denied research opportunities. As a scientist who has regularly participated in the public discussion of forestry issues, I speak from personal experience. How many scientists decline to comment on issues because they honestly lack the expertise and how many are simply afraid for their careers? While we should not force individuals to participate in debates where they sincerely believe they lack the necessary knowledge, we should not have an environment in which scientists are afraid to present an opinion **or** to release data for public discussion.

Partly because of the detachment

# FORUM

of the scientific community, the controversy surrounding forests and forestry has not necessarily led to the best decisions on how to conserve or manage Australia's forests. Money spent on lengthy enquiries and legal fees would have been better used for research on forest ecology and the effects of logging. The conservationists have been successful in influencing governments to declare large areas of forest reserved as parks, but were the right areas preserved? Are they large enough or representative of forest ecosystems as a whole? How should they be managed? Should more forest be reserved?

By themselves most forest parks are too small. The long-term survival of forests and forest wildlife requires the evolution of new communities and the adaptation of populations to changing conditions — whether the changes are climatic, or the result of the introduction of new species and the extinction of old ones, forest wildlife must be able to adapt. Adaptation in an evolutionary sense requires large populations for experiment and change. It also requires habitats with sufficient continuity for individuals to move between otherwise separated populations.

Inspection of a map showing just parks and nature conservation areas in Australia reveals the fragmented nature of our parks system and shows how isolated parks are from each other. A comparison of this map with one showing the distribution of forests will demonstrate that the park system is not only fragmented, but many types of forest are not sampled or sampled poorly. Tropical rainforests in Queensland, monsoon forests in the Northern Territory, Red Gum forests along the Murray River, Salmon Gum woodlands in Western Australia, and Alpine Ash forests in Victoria are just a few of the more glaring omissions from the parks system. Areas of these and other forests and woodlands need to be reserved as parks so that samples of forest free from logging and agriculture are available for enjoyment as well as scientific and educational reference. All forests and woodlands should be protected from clearing whether this is for farming or pine plantations. Yet it is also necessary to ensure that enough forest is kept or put into production to provide the nation's need for timber and other forest products.

There should be no basic conflict in these twin goals. Both require the conservation and management of forests and both would benefit from the reafforestation of lands already cleared for agriculture. It is a ground on which environmentalists and industry can meet and agree as they already have in jointly proposing to the New South Wales Government that it reafforest large areas of abandoned farmlands in the northeastern part of the state with native trees. It is the basis on which to begin discussion and resolve conflict.

If for no other reason than that only a small area of Australia is suitable for forests, parks will remain small and isolated. The conservation of forests and forest wildlife will therefore depend on how all other forest lands are managed and what steps are taken to conserve wildlife in these. State Forests and private lands alike will need to provide the continuity of habitats between reserves required for the movement of individuals and to accommodate the migrations of birds and insects. They are also necessary to ensure the survival of animals which occur at low densities and which require large areas of forest in which to find all their requirements for food and shelter. Examples are owls, birds of prey and some of the large parrots. Commercial forests will, as a result of logging, also provide the younger age classes of forest which may disappear from parks as the forests reserved for nature conservation mature and are protected against natural disturbances such as fire. As such, commercial forests may need to accommodate a range of plants and animals absent from or uncommon in the maturing forests on reserves.

**Too often... scientists who have spoken out on forestry issues have been the subject of personal attack.**

Regardless of how divisive the controversy over forests has been, we must not allow that to prevent the management of all forests as a whole. Integrated management is possible. An example of this is given in the following article describing the wildlife management procedures adopted by the Forestry Commission of New South Wales for the Eden woodchip concession. The procedures are based on recommendations developed during a joint Forestry Commission-Australian Museum research programme. An outline of the research, its findings and major recommendations were published by the Commission in 1980.

Inevitably the multiple use management of forests is a trade-off between competing values. At Eden the priority is on pulpwood and sawlog production, but steps are taken to ensure the survival of wildlife and maintain water quality. In doing this the visual impact of logging is reduced and recreational opportunities are enhanced. The system of corridors and the retention of mature forest along creeks and in gullies also increases the viability of the region's national parks and nature reserves by providing continuity of habitat between them. Admittedly there will be changes to the wildlife communities at Eden and the area has lost whatever wilderness values it once possessed. In turn wildlife management prescriptions will reduce the amount of wood available for logging.

As an individual who has been deeply involved with the research at Eden, I've been pleased with the response to recommendations and the willingness of the Forestry Commission to make these public. No doubt more could be done, and it remains to be seen whether the research on wildlife needed to monitor the impact of logging and test the efficiency of existing management guidelines will be carried out. However, I think there is a **prima facie** case for allowing the foresters at Eden to demonstrate their commitment to wildlife conservation and to do so in an atmosphere of constructive debate.

Eden provides a special opportunity for foresters and conservationists to learn to work

*(continued over page)* 153

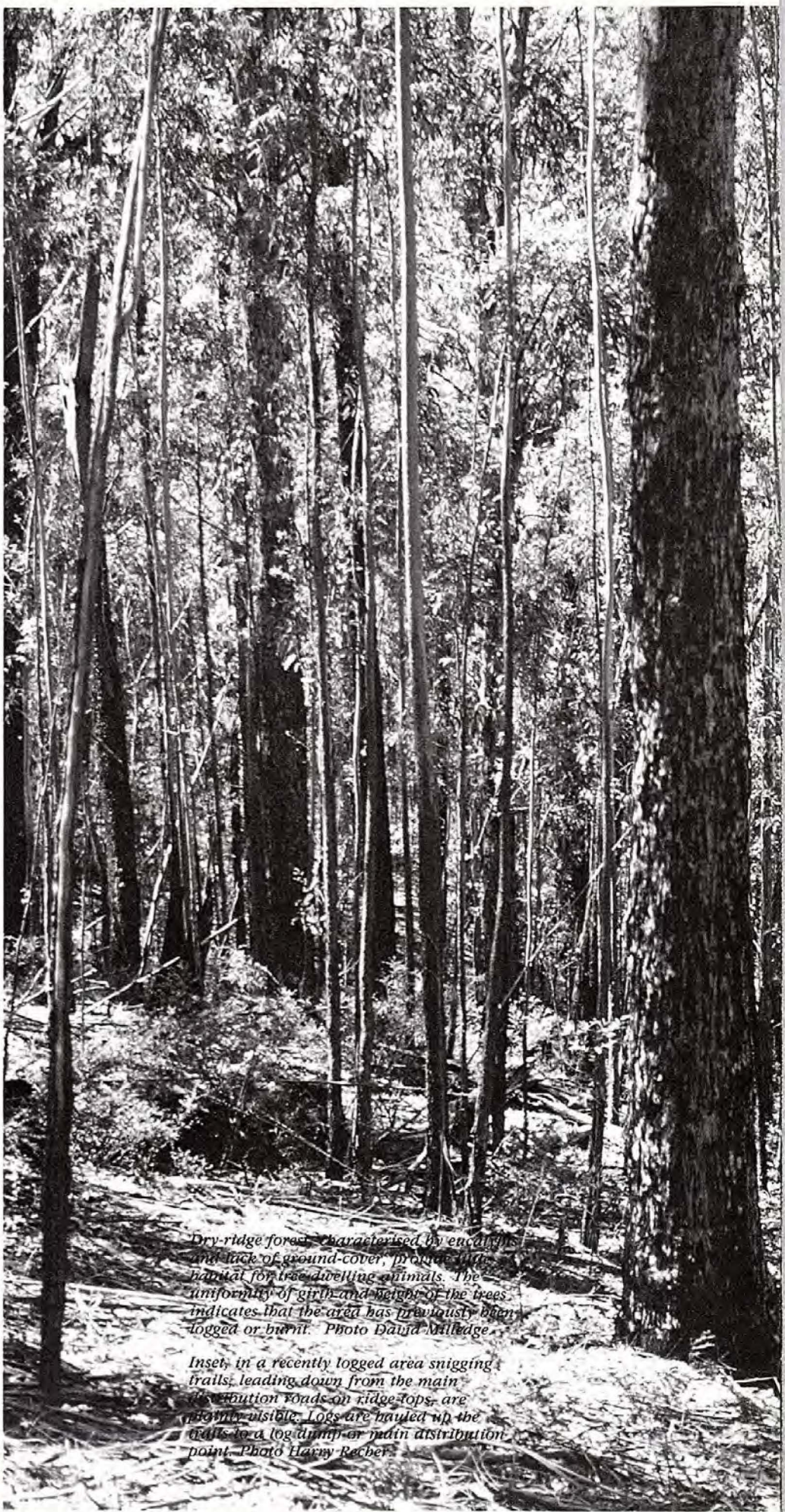
together. Indeed, Eden is a model system in which to work and develop new approaches to forest management. An important reason for this is that apart from the early 70s when integrated logging for pulpwood and saw timber began, the Eden woodchip industry has been remarkably free from controversy. It is instructive to consider why this has been so and to see if things done at Eden might not be useful in resolving or preventing other conflicts over forest management.

There are a number of reasons for the lack of continuing conflict at Eden, but three are especially important.

Firstly, open government was practised. Research results and recommendations were published and made available to the public. The local foresters listened to divergent views and while not always agreeing did not attempt to hide or deny their mistakes. Secondly, although the Eden operation began with insufficient information about the region's resources and the likely effects of integrated logging, research was initiated immediately to resolve this problem. Importantly the research initiated was a co-operative effort involving scientists from other government departments, the Australian Museum and the CSIRO. The involvement of so many institutions was important as the work could not be seen (by any reasonable person) as a whitewash by the Forestry Commission. Thirdly, as problems developed and the results of research became available, logging methods were changed and conservation procedures adopted. If the public could see the errors, they could also see that efforts were made to resolve these.

Not everyone is going to be happy with the Eden woodchip industry and no matter what is achieved there in integrating other forest values with an intensive logging operation, it should not be taken as an excuse to extend woodchipping to other forests.

For the future it would help if foresters could begin to think of commercial forests as national parks where logging was permitted. There is no question in my mind that the primary objective of management on all Crown forest lands should be the conservation of Australia's unique flora and fauna. Timber production and other forest products are secondary objectives contingent upon the success of conservation goals. It would also help if conservationists would realise that national parks do not guarantee the survival of forests or forest wildlife and that foresters and forestry play an important role in conserving forests and forest values. Australia's forests must be managed as a whole and not divided piecemeal between conflicting interests.



*Dry-ridge forest, characterised by eucalypts and lack of ground-cover, provides little habitat for tree-dwelling animals. The uniformity of girth and height of the trees indicates that the area has previously been logged or burnt. Photo David Milledge.*

*Inset, in a recently logged area snigging trails, leading down from the main distribution roads on ridge tops, are clearly visible. Logs are hauled up the trails to a log dump or main distribution point. Photo Harry Recher.*

# Keeping the options open

## The forestry ethic in practice in Eden

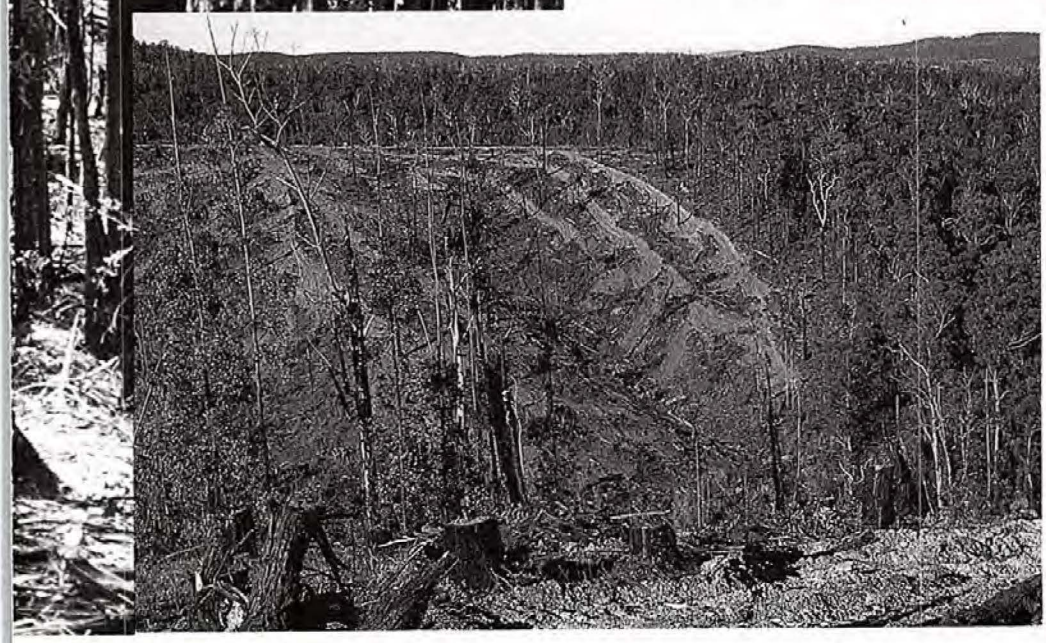
by David Ryan

**Always at the centre of heated controversy, the woodchip industry's most recent disturbance surrounds the proposal to establish a woodchip operation in Victoria's East Gippsland and the Otways.**

**The Eden woodchip concession is without doubt the most studied woodchip operation in Australia. It was systematically examined over the past eight years by a joint team of wildlife ecologists from the Australian Museum, the NSW Forestry Commission, NSW National Parks and Wildlife Service and the CSIRO. This research has given foresters at Eden a better understanding of the forest ecosystem and the effects of woodchipping.**

**David Ryan's article specifically relates how Eden foresters are applying this new knowledge in a region under intensive logging. Until recently, he held the Deputy Regional Forester's position at Eden for five and a half years. A major part of his time was spent in the day to day management of the Eden region.**

**Readers will recall our previous examinations of forestry practice in 'Woodchips or Wildlife?' (Vol 20 No 8) and 'Pinus radiata — a million hectare miscalculation?' (Vol 20 No 10) of *Australian Natural History*. Both articles are vital to a full understanding of the controversies that have plagued forestry in Australia.**



Compared to most other areas of the State, forestry activities in the Eden Forestry Region of New South Wales are intensive. The Eden region is the centre of the State's largest eucalypt pulpwood operation and contains one of its major plantations of *Pinus radiata*.

Hardwood production management is carried out over some 290,000 hectares of mixed eucalypt coastal and tableland forests and all of this area is State-owned. Pine plantations are eventually expected to cover 20,000 hectares, much of which is purchased freehold country.

The region's forests were first logged when Europeans began to settle in the area during the early 1800s. Since then, logging has extended to virtually all land now managed by the Forestry Commission. In the past native eucalypts and planted pines have yielded a large variety of products, including sawn timber, railway sleepers, pit-

props, fence-posts, poles and firewood. Now they also provide pulpwood for paper manufacture.

The pulpwood industry began operations in 1969. Until then, usually only scattered, trees were harvested for sawlogs or railway sleepers. As a result forests remained reasonably mature and native animals were barely affected by forestry practices.

After the pulpwood market developed, it was possible to harvest a wider variety of trees. As well as straight, tall trees taken for sawn timber many others, irrespective of size, are harvested, to be broken down for pulp. Logging for pulpwood and sawlogs is called integrated logging. With the advent of this type of logging, biologists and forest managers realised that such intensive harvesting would have a greater impact on forest wildlife than past logging practices.

As a result, in 1970 a number of measures were incorporated into forest management practice. Immediately areas of natural forest which could not be disturbed had to be identified. These included National Parks and Nature Reserves — a total area of about 80,000 hectares. All either adjoined or were surrounded by State Forest.

In addition, there were areas within State Forests which were not to be disturbed, including flora reserves, swamps and rocky, steep terrain.

These undisturbed areas were linked by a network of 'corridors' of natural vegetation throughout the State Forests. This network ensured no undisturbed areas were isolated and sufficient animals survived to recolonise logged areas.

Initially, corridors were established in areas unsuitable for logging, such as swamps, and scenic reserves.

After the first two years of pulpwood harvesting the logging pattern changed. Harvesting areas were reduced in size from 800 to 200 hectares and the practice of logging alternate areas of forest was introduced. The new procedure meant that half the forest would be logged during the first 20 years and the other half during the following 20 years. Each new harvesting area or 'compartment' was bounded by natural features of varying shapes and sizes. These provided continuous belts of unlogged country and meant corridors were no longer necessary to link reserves and unlogged areas. However, even to this day, many are still in existence.

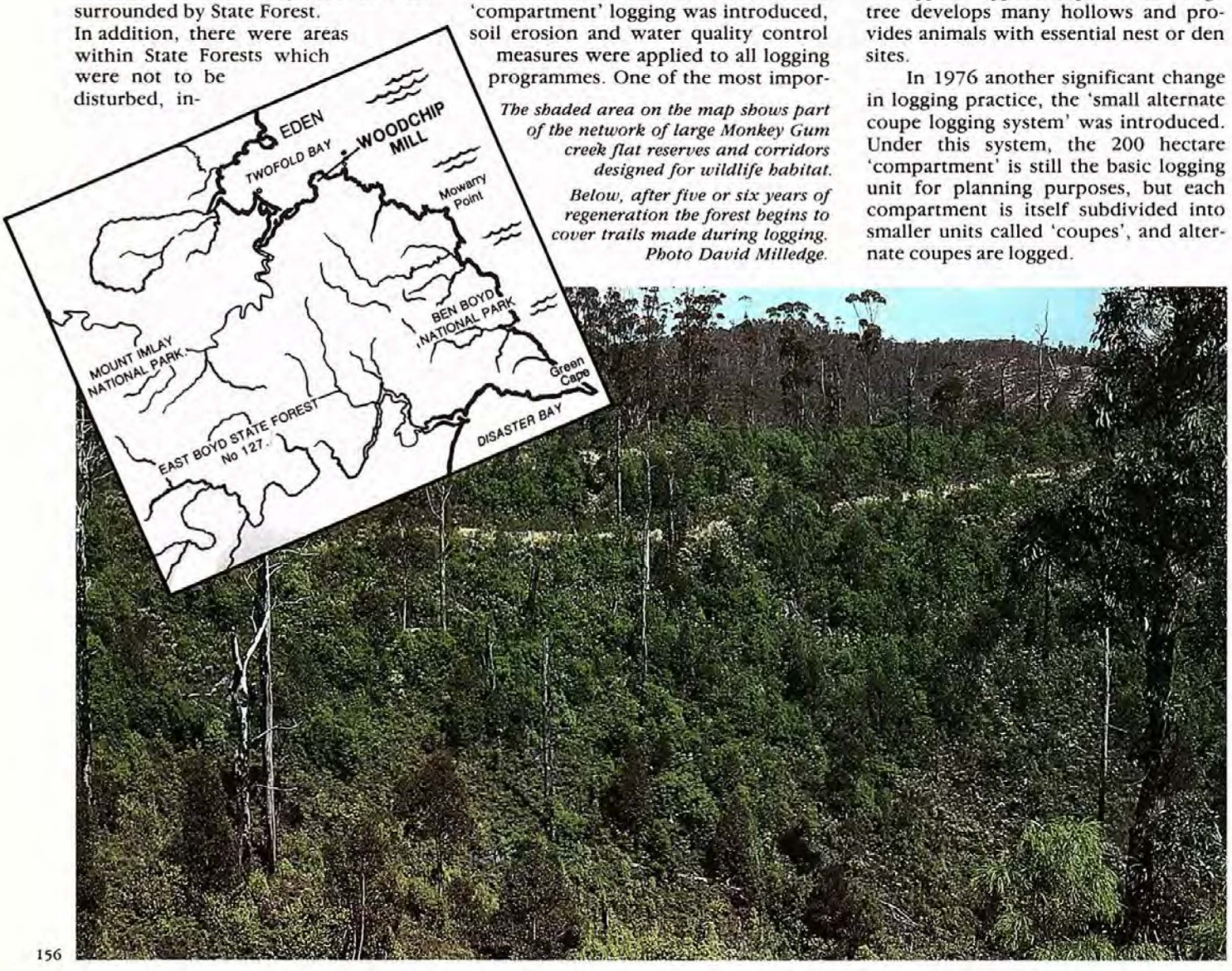
At much the same time as alternate 'compartment' logging was introduced, soil erosion and water quality control measures were applied to all logging programmes. One of the most important was the introduction of 80 metre wide strips of untouched forest running along all creeks and rivers.

In 1975 wildlife research commenced in the Eden State Forests. It initially aimed at determining the numbers and range of forest animals in southeastern New South Wales. Further work concentrated on the effects logging was having on wildlife so that effective management plans could be adopted.

As a result of this work researchers were able to identify the birds and animals which depended on mature forest for their survival. In the Eden region these include the tree-dwelling mammals — Sugar Glider, Yellow-bellied Glider, Greater Glider, Feathertail Glider, Eastern Pygmy-possum and Mountain Brushtail Possum and birds such as cockatoos, lorikeets, owls, parrots, Owlet Nightjars, kingfishers and treecreepers.

The study showed tree-dwelling mammals in coastal areas rarely occurred on dry ridges, but could nearly all be found in gullies containing moist forest. The most important tree species growing in these gullies is the Monkey Gum, *Eucalyptus cypellocarpa*. This large tree develops many hollows and provides animals with essential nest or den sites.

In 1976 another significant change in logging practice, the 'small alternate coupe logging system' was introduced. Under this system, the 200 hectare 'compartment' is still the basic logging unit for planning purposes, but each compartment is itself subdivided into smaller units called 'coupes', and alternate coupes are logged.




*The shaded area on the map shows part of the network of large Monkey Gum creek flat reserves and corridors designed for wildlife habitat.*

*Below, after five or six years of regeneration the forest begins to cover trails made during logging. Photo David Milledge.*

# TREES AS HABITATS

What is a habitat tree? Habitat tree is a term that foresters, wildlife biologists and conservationists use to describe trees which have special value for forest animals. Habitat trees are large, mature individuals which have developed hollows and cavities.

It is the hollows and cavities which distinguish habitat trees. They provide nesting places for birds, roost sites for bats and dens for mammals, such as possums and gliders.

Hollows are formed when branches break off because of fire, wind or termite damage, leaving the central core of the branch or trunk exposed, to be eaten out by termites or fungus. At first the hole may be quite small, the entrance only a few square centimetres in area, but this is large enough to accomodate a Feathertail Glider or the tiny carnivorous marsupial, Antechinus. As age and use enlarges it, a succession of animals make it their home. By the time the entrance is three square centimetres, lorikeets will probably nest in the hollow.

Gliders prefer dry hollows fairly high up in a tree, building nests of leaves and twigs. Lorikeets tend to nest on the bare wood floor of horizontal hollows while treecreepers use shredded bark or dry grass in vertical or slanting hollows. King Parrots seek deep hollows and shallow cavities are usually preferred by wood ducks.

Tree hollows are a critical resource in eucalypt forests. About 40 to 50 Australian land birds and ducks use tree hollows for nesting. With the exception of the Ringtail Possum all the arboreal mammals use hollows as well. These birds and mammals are considered to be fauna whose survival depends on mature forests.

In every forest there are a few species of eucalypts which are especially good habitat trees. At Eden on the far south coast of New South Wales, Monkey Gum, *Eucalyptus cypellocarpa,* Bloodwood, *E. gummifera,* and Prickly Ash, *E. consideniana* are among this forest's best habitat trees. In the Five Forests near Bega just north of Eden, Monkey Gum, Woollybutt, *E. longiflora,* and Coastal Grey Box, *E. boistoniana,* are excellent as habitat trees. The tree on this page is a Greybox from the Five Forests. At higher altitudes near Bombala, Mountain Gum, *E. dalrympleana,* Messmate Stringybark, *E. obliqua,* Brown Barrel, *E. fastigata* as well as Monkey Gum are the important sources of hollows for forest fauna. Along the Murray and Darling Rivers, River Red Gum, *E. camaldulensis* and in Western Australia, Wandoo, *E. wandoo* and Salmon Gum, *E. salmonophloia* are examples of important habitat trees in more arid regions.

Hollows are more common in some eucalypts than others. Eucalypts themselves are unique because of the large number of hollows which occur naturally in living trees. On other continents it is the animals which create the hollows. In North America and Europe, hollows are normally established by woodpeckers which excavate nest sites into the living tree. In the absence of woodpeckers hollows develop slowly in eucalypts. Research has shown that hollows suitable for birds and mammals first begin to appear when the tree reaches 100 years of age. Large hollows may not develop until the tree is 150 to 200 years old.

In forests where past logging or clearing has removed habitat trees, it is possible to provide artificial nest and den sites. Studies by wildlife biologists in Victoria have shown that nest boxes can be used successfully by native birds and mammals.

Nest boxes built to particular shapes and sizes will encourage certain kinds of animals to make them their homes. Nest boxes with small openings are favoured by treecreepers while boxes with larger openings encourage parrots. Although the provision of artificial nest boxes is impractical except in the most limited circumstances, such as a state forest or national park, it can be a very effective form of wildlife management for an individual who wants to encourage dependent fauna on his farm or rural property.

Hollows in dead trees are also useful for wildlife. In the Mountain Ash forests of Victoria which have regenerated since the 1939 wildfires dead trees provide habitats for Leadbeater's Possum. Although this rare animal finds an abundance of food in the young Mountain Ash trees it needs the hollows in the still-standing mature trees killed by fires to survive.

Biologists have expressed concern that as the dead trees are inevitably blown over the critical habitat for this endangered possum will no longer exist.

This is a case where it may be necessary to supplement hollows with nest boxes until some of the young trees mature and develop hollows in their own right. Then the challenge to forest managers is to maintain the correct mix of habitat trees and young regeneration providing both the food and nesting sites for this rare and endangered animal.

In an undisturbed forest, trees of all ages are represented and hollows are probably abundant enough for the forest animals that need them. When a forest is managed for timber or wood production, mature and over-mature trees are logged or removed. This results in a young and vigorously growing forest which is excellent for timber production but lack the dens and nest sites required by birds and mammals dependent on mature trees and their hollows.

In managing forests for timber production it is therefore necessary to ensure that habitat trees are retained. Provision must also be made for young trees to mature and grow old if the wildlife which depends upon tree hollows is to be conserved.

There are a number of ways to achieve this. As in the Eden district, many habitat trees are protected in stream-side reserves and wildlife corridors. Away from the creeks and gullies known habitat trees are not logged. In an intensively logged area where most of the trees are removed a habitat tree standing on its own may not be useful for wildlife as a tree which is retained as part of a small clump or group of trees.

As a part of a clump the habitat tree is sheltered and better cover is provided for the animals using it as a den or nest site. One or more of the younger trees in the clump can then be encouraged to mature as habitat trees in their own right.

Biologists from the Australian Museum have recommended that habitat trees be retained as part of a clump and that a group of trees be selected to include some of the strongest and most vigorously growing trees.

By retaining these as habitat trees the forest benefits as well. These healthy individuals can provide an important source of seed for the regeneration of a logged forest and may well represent the best genetic material for the establishment of a new generation of trees. — *Harry Recher.*

By 1978 a considerable amount of information on both wildlife and soil and water requirements was available, and new logging specifications to better manage forests were introduced.

A major task was to identify and map all moist forest types carrying Monkey Gum in coastal areas and classify them as 'wildlife areas'. Logging was not excluded from these areas but was only carried out in a modified form so that the essential features of tall, mature Monkey Gum stands were retained.

It was not until 1978 that researchers realised the alternate coupe logging system only haphazardly linked unlogged forest with wildlife areas and other reserves. To ensure links were maintained, a system of corridors covering the whole of the region was planned and mapped.

By designating all areas of Monkey Gum forest as wildlife areas, the habitat of the main coastal forest wildlife populations was now protected. On the tablelands, however, the situation was not so clear-cut. At these higher altitudes, moist forest areas are much more widespread and forests rich in wildlife are not confined to gullies or creek flats.

Despite the differences between the coastal and tableland forests, the corridor system was considered essential for both forest types and is used throughout the region. However, additional information and measures are required so effective wildlife conservation can be adopted in the higher country.

Since 1978, research efforts have concentrated on the tablelands, in an attempt to obtain a more detailed picture of the animal life and the habitats they are found in. This information enables forest managers to predict the type and size of wildlife populations.

Recent research has revealed that a number of factors influence the distribution of tree-dwelling mammals. For example, studies in areas supporting large populations of Greater Gliders found that these animals were unevenly distributed. There was no shortage of tree-hollows and correlations were found between high Greater Glider densities and gently sloping topography. It was considered that changes in the quality of leaves eaten by gliders within the forest were important factors affecting their numbers. Research found a strong relationship between the density and diversity of tree-dwelling mammal species and the level of nutrients in eucalypt leaves, particularly potassium and nitrogen. Other important factors were flat to undulating topography, diversity of plant-life and time elapsed since wildfire. Forests most favourable to tree-dwelling mammals appear to be those with large amounts of one or more of the following tree species: Manna Gum, *Eucalyptus viminalis;* Mountain Gum, *E. dalrympleana;* Swamp Gum, *E. ovata;* Maiden's Gum, *E. maidenii;* Candlebark, *E. rubida;* Monkey Gum, *E. cypellocarpa; and the* Peppermints *E. radiata, dives* and *elata.* Such forests also support an abun-

# FOREST WILDLIFE

*From left, Mountain Brushtail Possum, Greater Glider, Musk Lorikeet, Eastern Pygmy-possum, and their habitat, Monkey Gum forest.*

dance of birds and reptiles.

Seasonal changes in food supplies, such as periods of major flowering and new leaf growth also affect the distribution of tree-dwelling mammals. Animals congregate on the best food supplies.

However, the distribution and relative abundance of tree-dwelling mammals in the Eden Forestry region are now predictable. The animals' prefferred habitats can be mapped, using aerial photographs and field checking.

An attempt is now being made to classify forest types on the tablelands according to the wildlife they support. When this is completed, the various management options will be considered and current logging prescriptions varied if necessary.

The intensive logging required by large industries to operate most economically does have some effect on wildlife. The biggest and hardest decision for forest managers is what value to assign to the two forest products, wildlife and timber. Individuals have different values for each and it seems almost inevitable that some people will not be satisfied with management procedures being used at Eden. It is not possible to do everything for wildlife and maintain a viable pulpwood industry. What is essential is that the forest manager ensures all options are kept open.

Fortunately animals requiring mature forest concentrate in relatively small areas of particularly favourable habitat — moist Monkey Gum forest, the wet areas of the coastal section and a high quality mixed eucalypt forest of the tablelands.

Using the system of creekside and gully reserves, corridors linking unlogged forests and by modifying logging practices to retain the resources required by the animals, the forest manager has the opportunity to maximise the benefits for wildlife while minimising the impact on timber or pulpwood production.

The wildlife research that has been carried out since 1975 has provided valuable information for those who manage the forest. It provides the basis for developing forest management plans which account for the needs of wildlife. So long as the research continues, this process will continue and the benefit to wildlife will increase.

# Black Snake Bridges

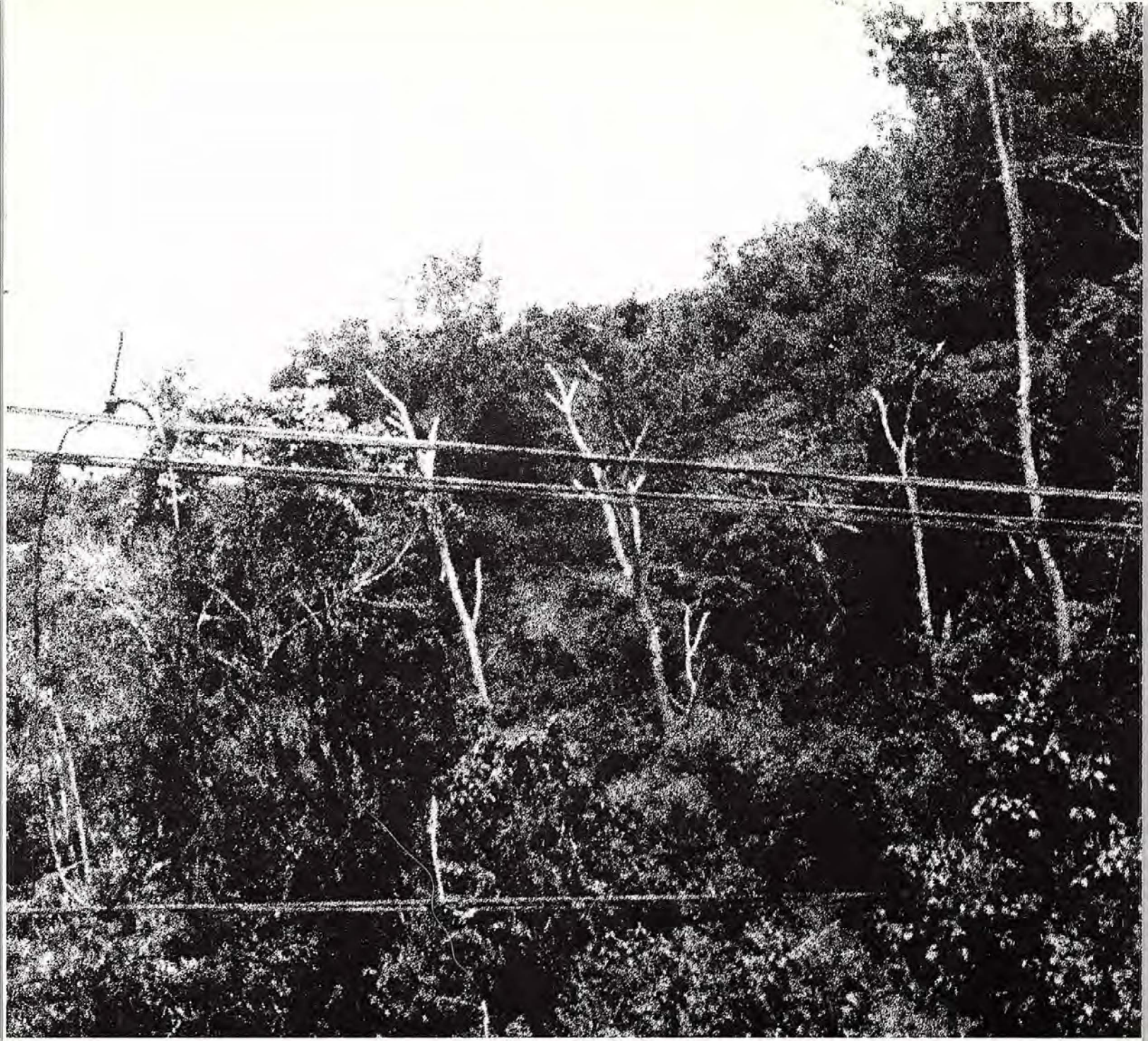
by Paul Sillitoe

**Crossing a swaying suspension bridge with white water thundering metres below can be one of the most heart-stopping experiences imaginable. Made entirely from vines, these bridges which appear dubious to our eyes, are the only means for the people of highland Papua New Guinea to cross boiling watercourses.**

**One group of people from the Southern Highlands Province, the Wola, have several large rivers flowing through their region and rely on vine suspension bridges every day. While not actually building many new bridges they must constantly maintain those constructed by their ancestors years ago.**

**The Wola attribute their specialised knowledge of bridge construction to some mythical happening centuries earlier.**

*An early stage in building a vine bridge requires a precarious journey across the river, a task few men dare to undertake. Even when the bridge is finished, Highlanders still cross them with care, for a slip may be fatal. All photos by Paul Sillitoe.*



*Long ago a man called Maegai lived at Haelaelinja and one day he saw curling up into the sky on the other side of the Was River at Nombra the smoke from fires lit by someone to burn off a new garden. His curiosity aroused, he decided to go and investigate. He walked down to the Was River but couldn't cross for there was no bridge across it at that time. As he wandered up and down the bank wondering how he might contrive to reach the other side, a large black snake appeared and arched itself across the river, over the steep sided cleft where Pelem bridge is situated today, and Maegai walked over.*

*On the other side of the river at Nombra, Maegai had a number of adventures with a man called Kondiyp who lived there. He found that the latter had a pile of birds and marsupials at his house which he burned as firewood, and he put these to cook together with a variety of vegetables in an earth oven. After this he went to find Kondiyp clearing the garden from which he had seen the smoke and found him using his leg as a cutting block against which to chop cane grass. This was causing him considerable pain and Maegai showed him how to use a log as a chopping block, after which they returned to the house where he had put the food to cook. Kondiyp ate until he was bloated but it turned out that he had no anus and was unable to defecate, throwing up his food instead. This prompted Maegai to erect a frame of rotten wood where Kondiyp customarily went to sick up with a sharpened stake concealed underneath, such that when he sat on it, it collapsed and the stake pierced his rear so that he could defecate.*

*After their meal Maegai returned home, but when he came to the Was River the snake had gone and he was again unable to cross. While he walked along the bank trying to think of a way to reach the other side, the large snake came back and stretched itself over the cleft with the river boiling below so that Maegai could cross. It occurred to him on his way over that he would wish to cross the river in future to visit Kondiyp to share meals with him, having learnt about his bountiful supply of food, and he set about erecting a vine suspension bridge. The snake remained arched across the chasm throughout, allowing him to pass*

*back and forth, "showing" him, as reciters of the story say, the way to build a bridge. When he had completed it the snake disappeared.*

*Following this, whenever Maegai saw smoke rising up into the sky from Nombra, indicating that Kondiyp was preparing an oven to cook food, he crossed the river and joined him at his meal. After a while Kondiyp tired of this and determined to put a stop to Maegai's uninvited visits. He went to a high place where he caught cloud in some* wolahaeriy *bamboo tubes, and returning to Nombra he released it. Maegai fell for his trick: thinking that it was the smoke of a fire he crossed the river anticipating a meal, only to find that Kondiyp had disappeared forever. But the bridge he built at Pelem is still there today.*

Indeed certain bridges, like the one featuring in this myth, hang in such precipitous and difficult locations that people today doubt they could be replaced if they fell into complete disrepair.

However there is little chance that bridges on popular thoroughfares will collapse through neglect, as users will add a few lengths of new vine where necessary to replace old and rotten pieces as they cross. The high volume of traffic ensures maintenance, with relatively little effort on the part of any one person, despite a considerable number of bridges being available in heavily populated areas. Along twenty-three kilometres of the Was River, for example, there is one bridge site every 2.3 kilometres.

The casual upkeep of bridges is the usual mode of repair unless someone intends to convey a number of pigs to the other side. In this case they may first carry out extensive repairs on a bridge ensuring that it is strong enough to support them and their loads.

Occasionally, though, men have cause to build an entirely new bridge from scratch. This may be to open a new route to gardens established in a previously uncultivated region or to replace a bridge swept away by a flooding river. The first task facing those involved in building or 'staking' a new bridge is the erection of two stages, one on either bank facing each other across the river. These stages, called *pok,* serve as the footings for the new bridge, anchoring it firmly to either bank. A *pok* stage consists of heavy stakes, some two or three metres long, driven into the bank in two parallel rows about a metre apart. Each row consists of three or four stakes running back from the bank in a line set at about 90 degrees to it. The two stakes near the water's edge are the longest and have two horizontal spars called *wilis* lashed across them, one near the top and the other a metre or so below it. The latter is set at a level corresponding to the walkway of the finished bridge. Each row has its tops guyed together in series to give added strength. Sometimes they have a sapling lashed to them as well, serving as a handrail. Finally, lashed to the lower *wilis* cross-member of the first two stakes is a ladder-like construction usually of three or four rungs, which gives access to the suspension bridge. The Wola use only the hardest woods available in the construction of *pok* stages so they can withstand the wet environment without rotting rapidly

When they have constructed *pok* stages, the men erect the suspension bridge. First a line is cast across the river. A thin vine provides a light and easily cast line, to which a stick is sometimes added acting as a weight.

This is then hurled across the river. The men on the opposite bank often cut down long branches or saplings to hold out over the water in an attempt to snare the cast line. Regardless of these ploys, it invariably takes many casts to land the line successfully over the wide, fast-flowing rivers.

When they have the first line across, the men use it to haul over several lengths of stout vine. After dragging across eight or so lengths, the builders tighten them securely into three bundles between the *pok* stages. Two trusses of vine are stretched between the upper *wilis* spars and one vine cable connects the middle of the lower *wilis* spars. Viewed across the river from the *pok* stage, the vine cables, called *puw,* describe points of an inverted isosceles triangle. The upper two bundles of vine, with others added subsequently, serve as hand lines and the lower one as a foot line to the completed bridge.

Once *puw* cables are in position, a man may cross the river with the aid of two loops of vine tied around them,

*The Wola build their bridges with local vines, the most efficient species being a rattan,* Calamus fuscus, *which is split and tied to the main supports to form a V-shaped cradle.*


*Suspension bridge at Pelem, which was built with the aid of a black snake in the mythical past. The shape of the bridges resembles a snake's ribcage.*

called *luwsilay*. He works his way across by sliding these before him. Only a few men have the nerve to attempt this precarious method of crossing rivers. Someone working on a bridge may haul over several lengths of vine by this method to add to the *puw* cables. Or alternatively the builders may take a vine previously dragged across the river and use it to haul over further lengths.

When those 'staking' a bridge judge they have sufficient lengths of vine in place for the *puw* cables, they tie short lengths of vine, called *porol,* to the two hand lines passing them under the foot line. This establishes the V-shaped cradle that characterises the walkway of highland suspension bridges giving them a form similar to a snake's rib cage.

Initially the men use *luwsilay* loops, until they have sufficient *porol* slings in place to hold the cables together. They then discard these and proceed to fill in the gaps with further slings until sufficient span the structure.

While the men are tying the numerous *porol* slings in position, others rig up guy lines from the *puw* hand cables to the branches of nearby trees overhanging the river. These vine guys they call *tomb*. They serve to support the centre of the bridge, preventing it from swinging violently from side to side, or worse, twisting around and tipping those on it into the river.

When they have sufficient rib slings in position and guys rigged, men cut a few saplings, trim off their leaves and lay them along the cradle formed by the *porol* ribs.

Only certain vines, according to the Wola, are suitable for constructing suspension bridges. The strongest is a rattan, *Calamus fuscus,* which they use in preference to any other.

However, while the bridge construction appears to be involved, the collection of raw materials is more time consuming. The time it takes to amass sufficient materials varies according to the bridge's location, availability of suitable vine and timber, number of men collecting them and the rate they work. It took six men with about a two hour walk to a plentiful source of vine, between two and three weeks working spasmodically to collect sufficient vine to replace a bridge swept away in a flood. Whereas in another case one man, working constantly, desperate to connect his house to the other side of the river, amassed sufficient for a new bridge within a week.

Although bridges are a public utility, rarely do more than half a dozen or so men co-operate to erect them and they will only be those who urgently require access to both sides of rivers. Others will not be interested nor lend a hand, though they may find the bridge convenient when completed and use it freely, sometimes to the indignation of the builders.

While vine bridges have served Highlanders for many generations, they do so at some risk to human life. The Wola are wary of all bridges. New bridges are especially feared, because men frequently skimp on their rib slings and guys. It is not until some time has elapsed that people cross with confidence, others having added vine piecemeal in the interval to give a sturdy structure. Even so, they cross established and well-maintained bridges with care, for a slip may prove fatal and tragic accidents sometimes occur. Bridges falling into disrepair are extremely dangerous and prompt provincial governments in highland regions to substitute wooden planked structures suspended from hawsers for some of the traditional 'snake's skeleton' bridges.

*Paul Sillitoe is a lecturer of Anthropology at Latrobe University, Melbourne. He makes regular visits to the southern highlands of Papua New Guinea where he lives with the Wola people and studies at first hand their economy, social organisation and relationship with their environment.*

AUSVENTURE

# CONCEPTS OF RECREATION

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We established Ausventure in 1965 as a natural evolution from long experience in major expeditions and recreational work with young people.

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*Interview by Meg Thornton of Warwick and Antonia Deacock, directors of Ausventure.*

***Warwick Deacock:*** *Fellow of the Royal Geographical Society, expeditions to Alaska, Lapland, sub-Antarctic. Far East, Karakoram and the Himalayas, first permanent director of the Australian Outward Bound School, first Executive Secretary of the Australian Conservation Foundation, broadcaster and film-maker, Honorary Royal Consul General of Nepal in Australia.*

***Antonia Deacock:*** *Dip. Architecture (Wits), expeditioner and author.*

*They are to be joined this year by son Nicholas who has just completed two years of experience in the field in Nepal and India.*

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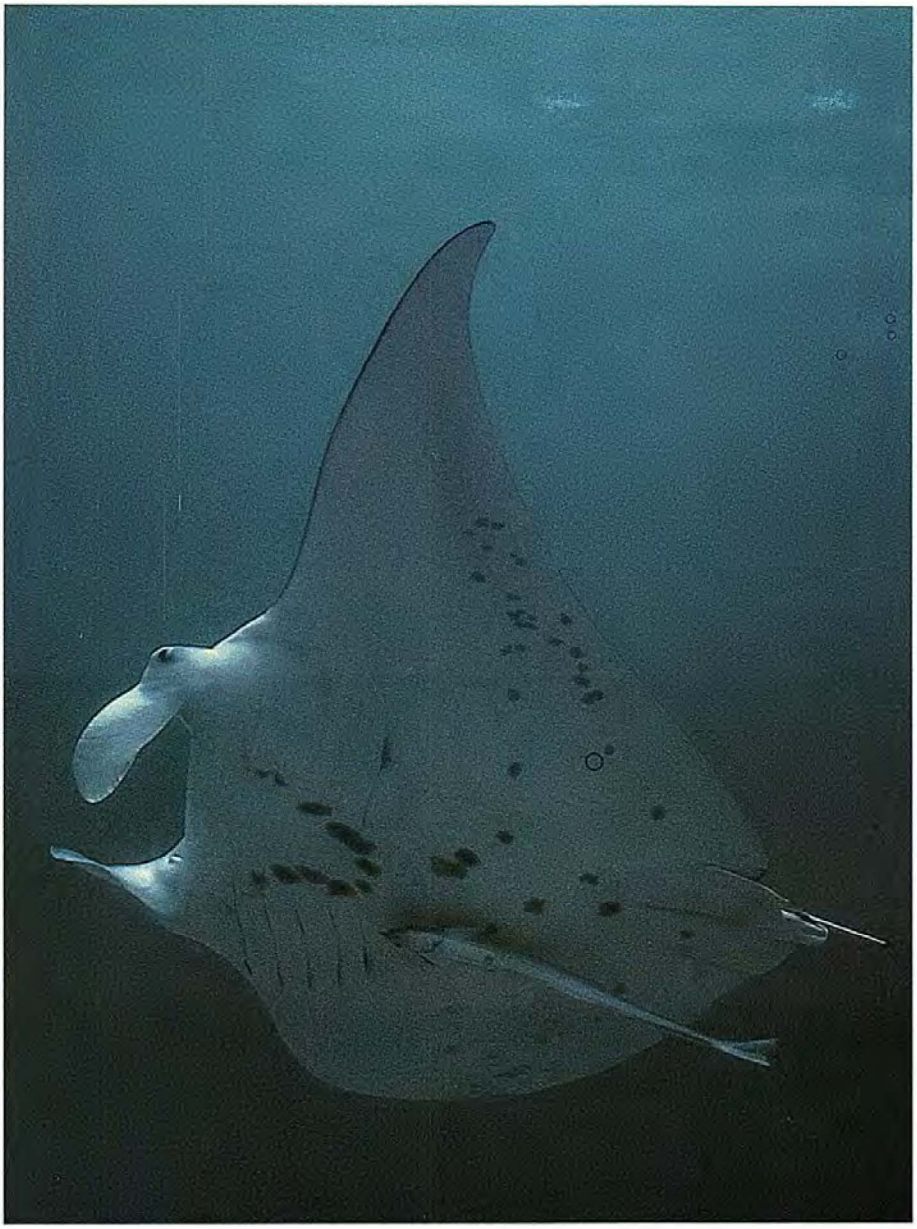


*Manta rays, awe-inspiring but completely harmless monsters, can have a wingspan of over six metres and weigh up to two tonnes. Their short tails have no spines and their enormous mouths are filled with thousands of tiny teeth. Mantas are coloured black on the back and white on the belly. All photos by Ron and Valerie Taylor.*

# The not so demonic 'Devilfish'

*by Denise Rennis*

There are about 35 different species of rays in Australian waters and while very few are dangerous, some reach an enormous size. Perhaps the most exciting are the Manta (or Devil) Rays, a group containing one of the largest fishes in the world.

Manta Rays derive their name from the Spanish word for cloak ('manta'), obviously because of their great body width. They are closely allied to Eagle Rays and Stingrays, but differ from these in several ways, most notably by their horn-like cephalic fins (the fins which extend forward from either side of the head). It is these fins which prompted the name 'devil fish'.

There are approximately 10 species of Manta Rays worldwide, two of which inhabit Australian waters — the Smaller Devil Ray, *Mobula diabolis,* and the Australian Devil Ray, *Manta alfredi.* Very little is known about the Australian Devil Ray, but marine biologists suspect it is similar to the Giant Devil Ray, *Manta birostris,* of circumtropical and subtropical regions.

As well as being one of the largest fishes, Manta Rays are probably best known for their remarkable ability to leap. The Giant Devil Ray, *Manta birostris,* can launch itself up to one and a half metres out of the water, falling back with a resounding crash. It may jump several times in rapid succession, much to the consternation of anyone passing nearby in a small boat.

The reason for this aerial activity, apart from play, remains a mystery. Marine biologists believe that the ray may be attempting to rid itself of parasites, or remoras, in its mouth and on its cephalic fins.

However, it is the size of these large rays, rather than their startling leaps, which has more than once led to tales of disaster. In one instance a diver working in waters off Thursday Island was swept off his feet when a Devil Ray wrapped its fins around his lifeline and airtube, cutting off his oxygen supply. By the time the crew of his tender vessel could disentangle the line, the man was dead. Another incident involved a military deserter, who is believed to have disappeared while swimming from

*One of the most memorable underwater experiences a skin diver can ever have is the sight of a school of manta rays performing their playful 'submarine ballet'. Their huge pectoral fins beat very slowly, and they will turn somersaults backwards, in slow motion.*

his ship when a Devil Ray threw a fin over him. Pearl-divers have many tales — some exaggerated — of Manta Rays drowning divers, beating them unconscious with their large pectoral fins or enveloping them in their cephalic fins.

The credibility of these stories is extremely doubtful, as people working with Manta Rays report their grasping power is quite weak. However, the cephalic fins do seem to close automatically on anything that touches the head between the fins. Reports of the bows of small boats being held in this manner and of shoals of rays becoming 'attached' to fence posts extending into the water are well documented. In one particular incident, a Manta became entangled with an anchor line and sped off with both anchor and boat in tow — much to the amazement of the crew.

One of the main differences between the two Australian Manta species is the position of the mouth. The mouth of the Australian Devil Ray is set at the front of the head while the Smaller Devil Ray has its mouth on the underside. The respiratory apertures, or spiracles, of both rays are small, indicating that the large mouth is the principle means of taking in respiratory water. This is unlike Eagle Rays and Stingrays which, being bottom-dwellers, use their large respiratory apertures for their main intake of water.

Manta Rays, like the Basking Shark, *Cetorhinus maximus,* and the Whale Shark, *Rhincodon typus,* feed on small shoal fish and plankton. Swimming open-mouthed through schools of plankton, these giant fish funnel food into their mouths with their cephalic fins. Once the food is in the mouth, a specialised branchial apparatus on the gill arches strains out the smaller particles, which are then eaten.

As their food is of such small size, Mantas do not need large, developed teeth for chewing. Up to 2,000 small feeble teeth, in a solid, narrow band, occupy the Australian Devil Ray's lower jaw, while the Smaller Devil Ray has 30—80 rows of about 10 teeth in each jaw.

Both Australian rays' notable characteristic is their cephalic fins, used for feeding and steering. With astonishing flexibility these fins are curled into a cylindrical roll while the Manta is swimming, and then unrolled and curved inward to act as a funnel during feeding.

The Smaller Devil Ray is found in tropical waters throughout the Indian and Pacific Oceans. Its range in Australian waters stretches from Cape York to as far south as Sydney, and it is common on the Barrier Reef. While the Smaller Devil Ray grows no more than a metre wide off the Queensland coast, it reaches 1.7 metres in width and 52 kilograms near the South African coast and 3.4 to 3.7 metres in width in Malayan waters.

The larger Australian Devil Ray occurs in the South Pacific as well as off Western Australia, Queensland and, occasionally, New South Wales. It generally reaches a width of approximately 4.5 metres. In comparison, the Giant Devil Ray can be over seven metres wide and weigh more than 1,350 kilograms.

Mantas are occasionally seen in the oceans, but are more common in coastal waters, often entering bays and inlets. Although usually alone, in pairs or sometimes small groups, they tend to cluster in schools of 10 or more during the mating season.



It is commonly believed that, unlike other rays — which are bottom-dwelling — Mantas spend most of their time basking on the water surface or leaping from the water. It is just as likely, though, that they spend most of their time on the sea-bottom, otherwise sightings of these large fish would be far more common.

Mantas swim using a flapping motion of their pectoral fins which resembles the movement of birds' wings in flight and cruise along slowly with one or both tips of the pectoral fins showing above the water surface.

Another remarkable Manta activity is rolling or somersaulting. This involves the Manta lifting its head and part of its body out of the water and then revolving so that one pectoral fin

emerges as the other sinks. As is the case for leaping, there is no explanation for this action.

Many aspects of Mantas' life history remain unknown, including its reproductive process.

The Smaller Devil Ray reaches sexual maturity while still relatively small — males are less than a metre wide and weigh about 13 kilograms, while females are about 1.18 metres wide and weigh less than 20 kilograms. All that is known of courtship behaviour is that the male pursues the female, mating eventually taking place on the ocean bottom.

The eggs of the Mantas, having been released from the ovaries, are fertilised and then hatch within the uterus where the embryo continues to develop. A milky fluid is discharged from the uterine wall to nourish the embryo. Only one embryo is produced at a time.

After reaching 60 centimetres, the embryo of the Giant Devil Ray resembles its parent but may continue to grow inside the mother until it weighs as much as nine kilograms and measures 1.3 metres in width.

While the natural birth process has never been seen by biologists, a fisherman has witnessed a pup's birth while its mother leapt out of the sea.

His account tells how "an embryo was violently ejected to a distance of about four feet. The embryo appeared tail first, folded in cylindrical form, but it instantly unfolded and its pectorals, moving in a bird manner, retarded its descent". This is probably the description of a premature birth of a pup, most likely caused when the pregnant female, startled by the boat, suddenly panicked.

Although Mantas have little commercial value, the liver oil and the skin of the Giant Devil Ray have been used, the latter as an abrasive. Manta flesh is eaten, but its acceptability as a food item varies around the world. Islanders in the Laccadive Archipelago relish Manta while Pacific Islanders claim that those who eat it sleep with the devil.

Mantas are commercially more important as game fish, and exaggerated descriptions of the ray's endurance are numerous. Texas, in the USA, claims the record for the number of boats towed by a manta. Apparently a harpooned Giant Ray swam 15 kilometres out to sea after being impaled by 10 harpoons, towing the harpooner's boat as well as 14 others, before finally breaking free. Another harpooned Manta, again off Texas, reportedly towed an eight-metre motor boat over 15 kilometres with its anchor dragging along the bottom most of the time. After five hours, the Manta was still alive despite four harpoons and several rifle bullets embedded in its body. While the accuracy of some of these stories is questionable, the great size of some rays could easily present problems to small boats.

To date, Mantas' large size has protected them from exploitation and, with luck, marine biologists will have time to discover more about these giant creatures of the ocean before any commercial use is found for them.

*Denise Rennis is a technical officer in the Department of Fishes at the Australian Museum where she works on the taxonomy of some of Australia's smallest fishes.*

# There's no arguing with a blue-tongue

*Found all over Australia, from central deserts and arid grasslands to rainforests and coastal islands, bluetongues though not the commonest are certainly the best known of all Australian lizards. They are the large members of the skink family and have smooth, shiny scales.*
*Photo K. Atkinson.*

by Virginia Richmond

**Bluff, a brilliant blue tongue and bloated body keep this lizard out of trouble. While snails, insects and other small animals always come off second best in an argument, avid gardeners have no need to worry and the bluetongue is a welcome guest.**

The body of the Common Bluetongue or *Tiliqua scinoides* is squat and usually a greyish-brown with darker crossbands. Its large head is wedge-shaped and tail, fat. The bluetongue's diminutive legs seem scarcely strong or big enough to hoist its stout frame above the ground. Despite the odd proportions and this lizard's size — it can grow to 60 centimetres in length — it is able to move quite fast for short distances with a scuttling action.

Bluetongues belong to the skink family of lizards. In this diverse group about 150 species are known throughout Australia. There is no single common characteristic which distinguishes a skink from the other lizard families. Generally, most have smooth and shining body scales and usually four legs with five toes but some species show the loss of legs and toes and some look like snakes.

There are six Australian species of the bluetongue lizard — the Eastern or Common *(Tiliqua scinoides),* Southern or Blotched *(T. nigrolutea),* Western *(T. occipitalis),* Centralian *(T. multifasciata)* and Adelaide *T. adelaidensis)* bluetongues and the Shingleback *(T. rugosa).* They occur in most habitats but prefer to rest in dense grass, deep leaf litter or among sheets of tin.

It is a well known fact that most reptiles lay eggs, but surprisingly all species of the bluetongue lizard give birth to live and active young. Females even form a primitive placenta. Litter size varies according to species — the Common Bluetongue bears from five to 18 young lizards at one time, although the others give birth to only five and the Shingleback even fewer, usually two.

Found in wet eucalypt forests and rainforests of the east coast, the Pinktongue lizard or *Tiliqua gerrardii* is related to the bluetongue though it looks very different. The size of the pinktongue's newborn family can be enormous as litters can number 67 young.

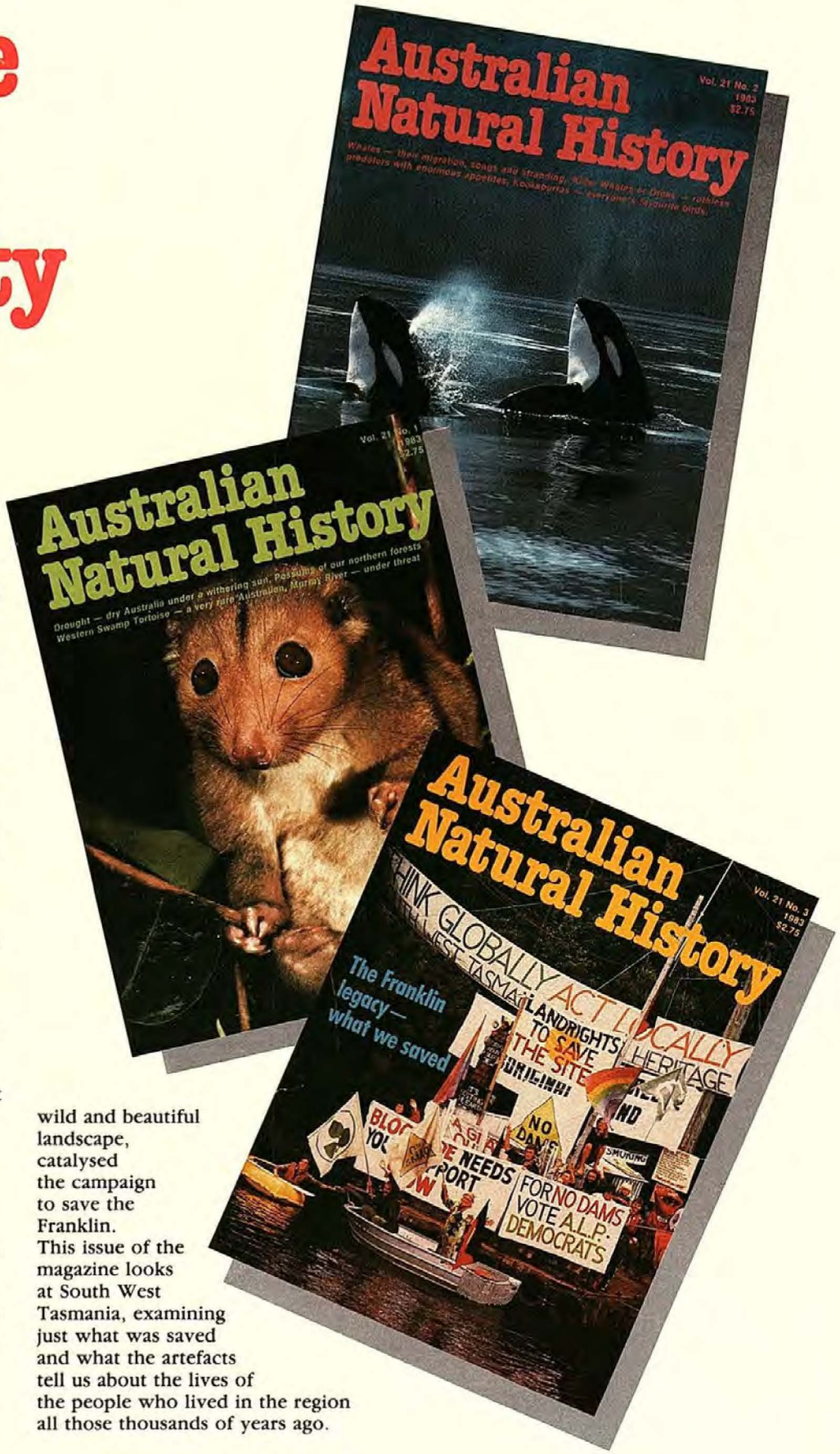
Occurring throughout eastern and northern Australia, the Common Bluetongue mates during the month of October and its young are born over 100 days later. The newborn lizards are able to fend for themselves from birth and they grow rapidly. Bluetongues kept as pets have been known to produce their first offspring when only two years old. No one really knows how long the Bluetongue lives though there are records of the lizard living for up to 20 years, and it is commonly reported to survive for at least ten years in captivity.

Snails are a bluetongue's delight, their shells are easily crushed and broken by the blunt teeth and strong jaw muscles of this forager. Bluetongues are omnivorous and will eat anything that moves slowly enough for them to catch. Their diet ranges from fruit to insects and other small animals. As pets in gardens they will thrive on wild food plus milk, bananas, raw meat, and eggs.

The bluetongue's fearsome threat display begins with the lizard filling its large lungs with air and puffing out its body which is flattened and turned side-on to the enemy. As it opens its mouth a vivid blue tongue is revealed. The lizard then exhales in a loud hiss, lunging towards the threat. If a predator is not frightened away by the bluetongue's menacing pose, it will bite hard. The lizard's teeth are not sharp but it will twist its head from side to side making a painful bite.

A human hand is bitten only if it is literally thrust into a bluetongue's mouth. If a bluetongue does bite, don't panic and don't pull. Wait until the startled lizard opens its mouth and remove your hand. You will find that there is no break in the skin.

# Read the Natural Authority




**Vol. 21 No. 1.** Earlier this year rain was on a lot of Australians' minds as the country's most severe drought moved into its fifth disastrous year. As a result *Australian Natural History* approached the experts and this issue features all you ever wanted to know about droughts. Also featured is part two of Possums in Australia, *Possums of the north,* and an interesting article on Australia's most deadly land snake and its unusual relationship with a rat.

**Vol. 21 No. 2.** This issue of *Australian Natural History* (a whale mini-special) concentrates on some of the peculiarities of whales in Australian waters. As well as covering whale stranding, intelligence (are they really smarter than man?) and migration, the mini-special explores the mysteries of whales' enchanting songs and deals with that most famous of all cetaceans, the Killer Whale or Orca.
There are also articles on the Kookaburra, a bird which has come to epitomise the Australian bush, prehistoric animals of Australia, Sydney's famous Grey-headed Fruit Bat colony and the Middleton and Elizabeth Reefs — Australia's lonely atolls.'

**Vol. 21 No. 3.** In March, 1981, a small party of archaeologists from the Tasmanian National Parks and Wildlife Service and Australian National University's Department of Prehistory returned to a cave, then known as F34 or Fraser Cave. Intensive investigation revealed it to be one of the most important discoveries ever made of man's earliest history. This discovery, together with South West Tasmania's wild and beautiful landscape, catalysed the campaign to save the Franklin.
This issue of the magazine looks at South West Tasmania, examining just what was saved and what the artefacts tell us about the lives of the people who lived in the region all those thousands of years ago.

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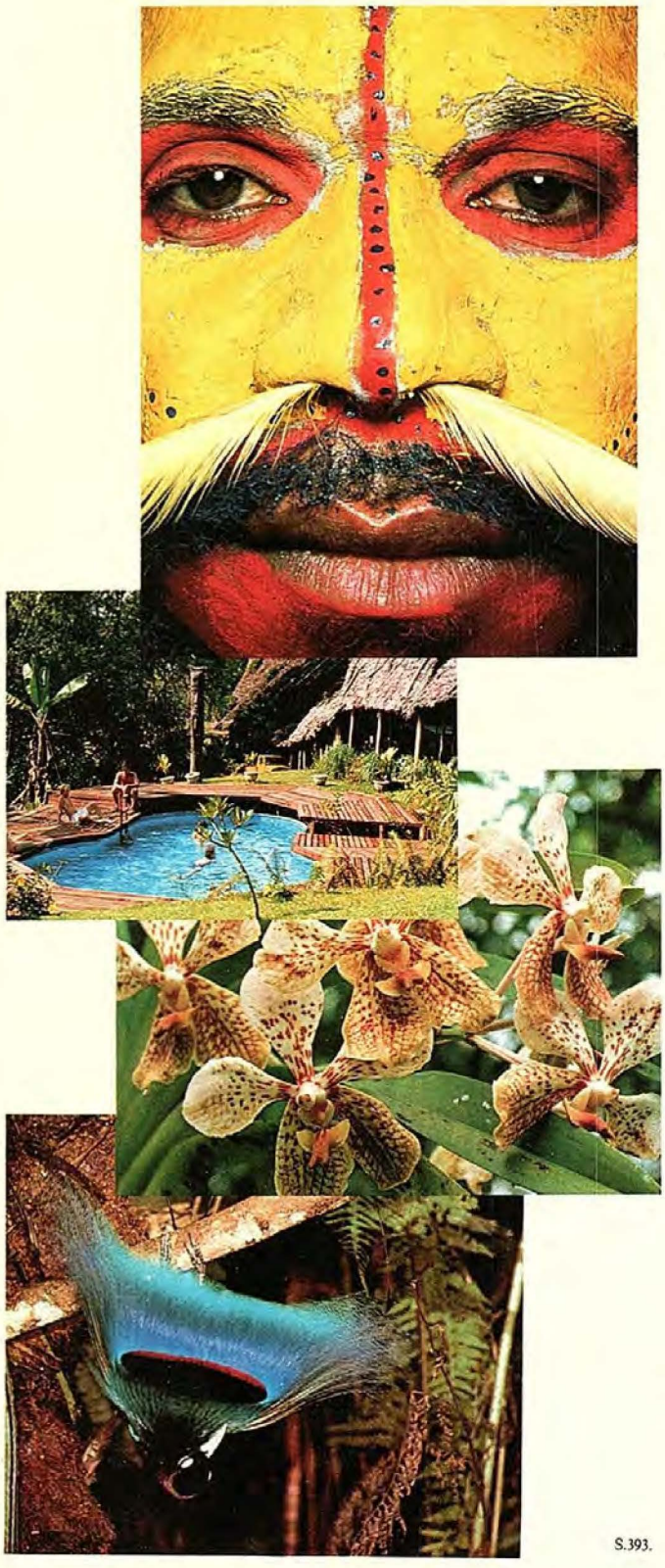

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