

Vol 20, No. 9
1982 \$2.75

AUSTRALIAN NATURAL HISTORY

Wombats — marsupial mowers

Crocodiles — a conservation
success story

What's new in the stars
Noisy Miners — the art of
communal living

AUSTRALIAN NATURAL HISTORY

PUBLISHED QUARTERLY BY THE AUSTRALIAN MUSEUM, 6-8 COLLEGE STREET, SYDNEY

TRUST PRESIDENT, JOE BAKER MUSEUM DIRECTOR, DESMOND GRIFFIN

VOLUME 20 NUMBER 9 1982



A fine spiral galaxy, probably rather like the one which we inhabit. This object, NGC 2997, is seen almost full-faced and shows all the classical features of its type. The central yellow region is composed of old stars which have entered a stable but cool period in their evolution. Emerging from the nucleus are two spiral arms composed of much younger, bluish stars formed more recently from the red clouds of hydrogen gas which can be traced along the inner edges of the arms. All the individual stars peppering this photograph are line-of-sight objects which belong to our own Galaxy and are not connected to NGC 2997, which is many millions of light years beyond the faintest star seen here. Photo David Malin.

EDITOR
Roland Hughes

ASSISTANT EDITOR
Barbara Purse

CIRCULATION
Cathy Kerr

Annual Subscription: Australia, \$A10.00; New Zealand, \$NZ13.50; other countries, \$A12.00. Single copies Australia, \$A2.75, \$A3.40 posted; New Zealand, \$NZ3.85; other countries, \$A4.00.

For renewal or subscription please forward the appropriate cheque/money order or bankcard number and authority made payable to Australian Natural History, the Australian Museum, PO Box A285, Sydney South 2001.

New Zealand subscribers should make cheque or money order payable to the New Zealand Government Printer, Private Bag, Wellington.

Subscribers from other countries please note that moneys must be paid in Australian currency.

All material appearing in Australian Natural History is copyright. Reproduction in whole or part is not permitted without written authorisation from the Editor.

Opinions expressed by the authors are their own and do not necessarily represent the policies or views of the Australian Museum.

The editors welcome articles or photographs in any field of natural history.

CONTENTS

FROM THE INSIDE Editorial	277
WOMBATS — AMIABLE NATIVE LAWNMOWERS by Graham Brown and Greg Young	278
SEARCHING THE SOUTHERN SKIES by David Malin	285
NOISY MINERS — THE GIRLS HAVE IT MADE by Mary J. Whitmore and Douglas D. Dow	291
PARMA WALLABY, <i>Macropus parma</i> Centrefold	295
A LOOK AT THE FRESHWATER CROCODILE by Grahame Webb	299
GARDENS, GODS AND BODY LANGUAGE by Diane Losche	305
IN REVIEW	311
INFRA-RED PHOTOGRAPHY IN FOCUS	313



FROM THE INSIDE



Australian Freshwater Crocodiles were probably the most poorly known of all the world's crocodilians until the Conservation Commission of the Northern Territory undertook a research programme which began during 1978. One of the many interesting facts which emerged was that Australian Freshwater Crocodiles, *Crocodylus johnstoni*, are one of the few world crocodilians which can gallop. In fact they can reach speeds of up to 18 kilometres per hour for short distances. Photo Graham Webb.

Australians have always been proud of their distinctive flora and fauna, that recognition being supported by the placement of the kangaroo and emu on our coat of arms and the establishment of a number of native plants and animals as official emblems for the States. While fascination with these unique plants and animals continued over successive generations consideration for their environment was not widely practised.

Conservation has only recently become of interest to Australians with a dramatic rise in public awareness taking place during the past ten years. Two recent surveys on conservation issues indicate the strong community support for protection of the environment.

Results of a nationwide survey conducted by The Sydney Morning Herald and The Age during November, 1981 has shown the substantial growth in people opposed to oil drilling on the Barrier Reef over the past two and a half years. The 1981 survey shows 80 per cent of Australians are opposed to drilling on or near the Reef while only 18 per cent favour exploration and drilling. A similar survey conducted in April 1979 showed that at that time 66 per cent of Australians opposed oil drilling on the reef and 31 per cent supported it.

Another survey commissioned by the National Trust and the Australian Conservation Foundation has shown similar support for the preservation of NSW rainforests. Sixty-nine per cent of people in NSW favour preserving the State's rainforests from logging and clearing while 87½ per cent believe the Government should help timber workers find new jobs.

Obviously with such a wide base of public support Government decisions on some of the more contentious environmental issues will have to be made carefully to avoid incurring the wrath of what will be a large section of voters.

Regular readers will notice the increase in size of Australian Natural History over the last two issues. In the effort to provide more information this size has now become our standard format. Unfortunately to achieve this standard there has had to be an increase in cover price and subscription rates.

The next issue will feature an article on the Monterey Pine, *Pinus radiata*, in Australia including its history both here and in California, plans for the pine plantations in Australia and the effects these have on wildlife. Other topics will include the effects of 1080 poisoning on native fauna, a look at Western Australia's Numbat and an examination of treecreepers, mistakenly believed to be Australia's 'woodpeckers'.

Roland Hughes
Editor



WOMBATS—AMIABLE NATIVE LAWNMOWERS

by Graham Brown
and Greg Young



Wombats excavate burrows up to 20 metres in length, usually with a single entrance. These burrows may have a number of side tunnels with one or more resting chambers.

Above right, wombats have long strong claws on its handlike forepaws. They dig the earth with their forepaws pushing the dirt to one side.

Since the discovery of the Common Wombat in the late 1700s by a party of shipwrecked sailors on an uninhabited island in Bass Strait, this powerful marsupial has always held the fascination of those coming in contact with it. Famous for their large burrows, wombats are the largest burrowing herbivores in the world. Their deep and often complex tunnel systems can be up to 20 metres in length. They usually emerge from their burrows at dusk and spend a few hours 'mowing' the lawns of Australia's forests and adjacent clearings.

Graham Brown and Greg Young began working together on the Common Wombat five years ago. Based at the CSIRO Division of Wildlife Research in Canberra they are at present working in the laboratory on the thermo-regulation and energy metabolism of wombats.

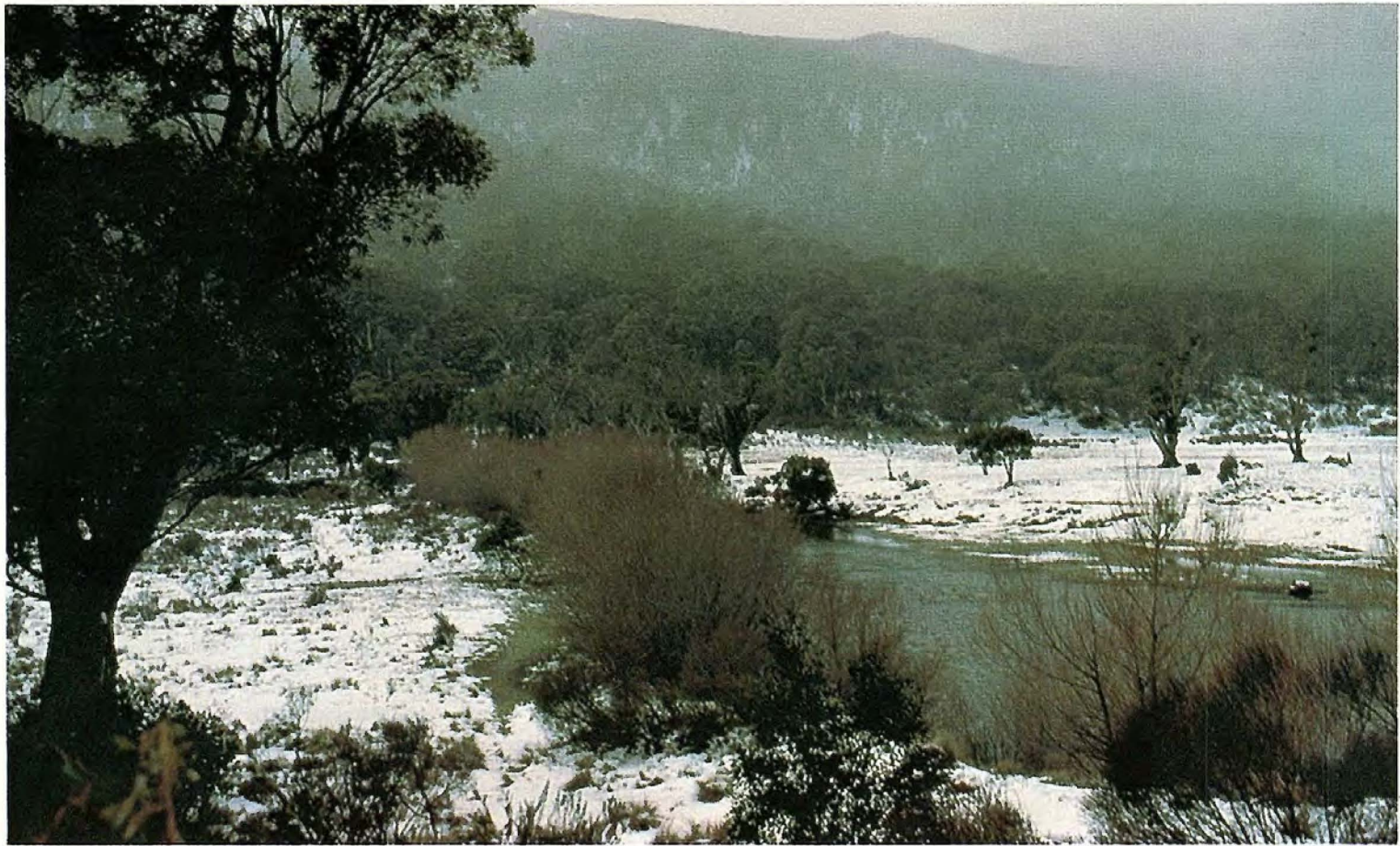
During the Pleistocene, about one million years ago, there were many large marsupials in Australia. Among these giant marsupials were the rhinoceros-sized *Diprotodon* and *Procoptodon*, the giant kangaroo, and large wombats closely related to living forms. Some of these extinct wombats, such as *Phascalonus*, exceeded 2.5 metres in length. Fossil remains of these wombats have been found in the Darling Downs region in Queensland.

In modern times, there are only three living species of wombats. The Southern Hairy-nosed Wombat, *Lasiorhinus latifrons*, from some of the more arid parts of South Australia, the Northern Hairy-nosed Wombat, *Lasiorhinus krefftii*, which is restricted to a small colony near Clermont in eastern-central Queensland and the Common Wombat,

Vombatus ursinus, the subject of this article.

The first Europeans to discover the Common Wombat were shipwrecked sailors who survived for a year on an uninhabited island in Bass Strait with wombats making up part of their diet. In 1797 the ship *Sydney Cove* was on her way from India to Sydney. During February she rounded Van Dieman's land, then believed to be connected to the Australian mainland, only to run aground on Preservation Island in the Furneaux Group.

In May of that year, some of the shipwrecked sailors from the *Sydney Cove* were picked up from a longboat on the New South Wales coast. In February 1798 Governor Hunter sent the schooner *Francis* to Bass Strait to rescue the survivors on Preservation Island. Matthew Flinders, who accompanied



Above, Thredbo diggings on the Crackenback River, Kosciusko National Park during winter. Wombats dig burrows on the banks near the river and graze on the tussock grasses in the cleared areas beside the river. Photo G. Brown.



Left, the wombat is able to regulate its body temperature and is well equipped to withstand the winter conditions experienced in the alpine parts of its range. Photo Keith Gillett.

the *Francis*, returned in July with a wombat for Governor Hunter. This specimen, together with a drawing of it, was eventually sent to Sir Joseph Banks in England. Later in 1800, Shaw described this animal as the type for a new species with the scientific name of *Didelphis ursina*.

Although this animal was the first wombat formally known to science, in January 1798 the mainland wombat had been found by a party of explorers near the present site of Bargo, its discovery being later reported in Sydney. The name wombat is derived from the aboriginal name for the species although the early settlers often referred to them as 'badgers', a name still used by country people in parts of Australia.

The Common Wombat is found in the mountainous sclerophyll forests of south-eastern and southern Australia. Its range extends from the Queensland—NSW border to southeastern South Australia, Tasmania and Flinders Island in Bass Strait. Some of the smaller islands in Bass Strait were previously inhabited by wombats but it is thought that European settlement of the islands in the late 18th and early 19th century contributed towards their extinction.

Constant tooth growth

The Common Wombat is a large animal, weighing up to 35kg and measuring 1.05 metres from the tip of the nose to the base of the tail when fully grown. They have the distinction of being the only marsupial to have continuously growing teeth similar to those of rodents. All teeth are rootless. The incisors are separated from the premolars by a wide diastema or gap. The dental formula is I:1/1, C:0/0, PM:1/1, M:4/4.

The coat of the wombat is made up of long coarse hair with little underlying fur. It has no markings and its colour may be black, various shades of dark brown, ginger or grizzled grey. Albino animals are rare and only two have been reported in the literature. Wombats have exceptionally thick skin, especially on the rump and mid-back where it may be up to 1 cm thick. This thick skin may have evolved as protection against past predators such as the thylacine.

Nowadays their only natural predators are dogs and dingoes. When chased they retreat to a burrow and block the entrance with their rump. They then raise their hindquarters wedging themselves in the burrow. It has been reported that dogs have been injured by being crushed against the roof of the burrow by a wombat.

The pouch of the Common Wombat opens towards the rear and contains two teats. This backwards opening pouch is found in only a few families of marsupials including the wombats, the bandicoots (*Peramelidae*), the koala



(*Phascolarctidae*) and a single representative of the *Didelphidae*, the South American Water Opossum, *Chironectes minimus*.

The Common Wombats from Tasmania are, on average, a little smaller than those on the mainland while those on the islands of Bass Strait are smaller still. Although in the past the wombats from Tasmania and Bass Strait were considered to be separate species, nowadays only a single species is recognized.

Common Wombats appear to prefer habitats in the forests of the higher country not too distant from watercourses, but burrows are often found on arable land, at the margins of cleared areas and in exotic pine plantations.

20 metre burrows

The whereabouts of wombats is easily recognized by the presence of their large burrows. Wombats are the largest burrowing herbivores in the world. They excavate burrows up to 20 metres in length, usually with a single entrance. These burrows may have a number of side tunnels with one or more resting chambers. There is often a sit or small excavation just outside the entrance of the larger, most frequently used burrows in which they bask in the afternoon sun.

Peter Nicholson, while a schoolboy at Timbertop in Victoria, explored a number of burrows in the rugged country near the school. He crawled into the burrows, enlarging some of the tunnels slightly and excavating spaces in which he could turn. He was able to observe wombats digging on a number of occasions. The wombat has long strong claws on its handlike forepaws. Nicholson noted that the wombats dug the earth with their forepaws

Thredbo diggings, on the Crackenback River, Kosciusko National Park. Wombats dig burrows on the banks and near the river and graze the tussock grasses in the cleared areas beside the river. Photo G. Brown.

while seated firmly on their rumps and hindlegs, pushing the dirt to one side. The loose soil was then moved out of the burrow with the front and back paws as they backed out of the burrow. The burrows are often dug in the banks of streams, rivers and swamps but in some places they are found in the sides of hills some distance from the nearest water.

Individual wombats visit between one and four burrows a night and different wombats may visit the same burrow. Although at any one time there is generally only a single animal occupying a burrow, simultaneous use has been observed. The number of burrows in an area is usually much greater than the number of wombats. Many are minor burrows only one or two metres in length which often have the entrance overgrown with grass. These burrows are more subject to flooding and are used relatively infrequently. Larger burrows in better condition are used more often. The most regularly used burrows have large, worn entrances, often show signs of recent excavation and may have more branching or interconnected tunnels than the smaller ones.

The large burrows provide the wombats with shelter during the day and in adverse weather. They also provide shelter for other mammals. Foxes and rabbits have been reported to use the burrows even when a wombat is in residence. There are also reports of dingoes whelping in disused burrows.

John McIlroy of the CSIRO Division of Wildlife Research, Canberra, has investigated the behaviour of wombats using radio-transmitters to track their movements in their natural habitat. He found that they had a home range with an area of five to 23 hectares. By following the movements of individual animals, McIlroy found that wombats remained within the same home range at least three months.

Unfortunately there have been no long term studies to investigate possible seasonal movements in which new home ranges may be established. The home ranges of different wombats may overlap with several animals living near a common grazing area and sharing some of the same burrows, but at different times.

Monitoring movements

The authors have used radio-telemetry to monitor the activity and behaviour of wombats in Kosciusko National Park. We found that on most days the wombats emerged from their burrows at about sunset and were active above ground for three to nine hours before returning to a burrow. During this time they were feeding and may have briefly visited several other burrows in their home range. After returning to a burrow at about midnight, they remain there until they emerge again the following evening. The weather may alter this pattern of behaviour. We have observed that wombats may emerge at any time during the daylight hours if the sky is overcast. In the mountains in winter, their grazing period may be interrupted by particularly bad weather, high winds, rain or snow, when they return to their burrow for several hours or for the rest of the night. While they are in their burrow they often remain completely still for many hours but short periods of activity will occur from time to time. We have not yet been able to determine when they do their chores such as cleaning out their burrow or excavating further tunnels.

McIlroy has made the only study of the diet of the wombat. In the Brindabella Mountains near Canberra, various species of tussock grasses, *Poa spp.*, are the most common items of their diet. The leaves of the Longleaf Matrush, *Lomandra longifolia*, was an important secondary food item, particularly during winter. At times they may dig over quite large areas of ground presumably to reach the roots of grasses and herbs. These disturbed areas look a little like areas in which pigs have been rooting up the soil.

Another role of the burrow is to counteract the climatic extremes encountered on the surface. Thus in summer air temperatures within the burrow rarely exceed 25°C and in winter they seldom fall below 4°C even during prolonged periods of subzero surface temperatures when the burrow may be covered with snow.



In summer the temperature regulation of the wombat is closely attuned to the maximum air temperatures recorded in the burrow. At air temperatures above 25°C the ability of the wombat to regulate its body temperature is diminished. It shows obvious signs of distress and elevated body temperatures when exposed to air temperatures of 35°C. Such high above-ground temperatures are often encountered in summer in the warmer parts of its range. It is unlikely that the wombat could tolerate those high air temperatures for long without recourse to the lower air temperatures provided by the burrow.

Winter body temperature

In the cold climates, on the other hand, the wombat is well able to regulate its body temperature and is well equipped to withstand the winter conditions experienced in the alpine parts of its range. In Kosciusko National Park we are studying the temperature regulation of free-ranging wombats using miniature radio transmitters to measure body temperature, heart rate and activity. This work has shown that in winter the wombat exhibits daily fluctuations in body temperature of up to 3°C.

At night, while they are feeding, body temperature increases steadily, following an increase in heart rate at the onset of activity. This rise in body temperature indicates the storage of heat generated by an increased rate of metabolism while they are active. This stored heat is then lost slowly during the rest of the day while it is resting in its burrow.

The wombat's burrow acts as a sanctuary from the climatic extremes encountered during winter and summer. In summer air temperatures within the burrow rarely exceed 25°C and in winter they seldom fall below 4°C. Photo Keith Gillett, courtesy of the NSW National Parks and Wildlife Service.

It is thought that by storing heat while they are active and cooling slowly while they are in the burrow, the amount of energy used for regulating their body temperature will be reduced and thus their requirements for energy or food may be lessened. This could be of special importance in winter when the pasture on which they feed grows more slowly than in other seasons and the amount of food available may be restricted.

Therefore the burrow of the wombat provides a cool retreat in summer and is somewhat warmer than the outside air temperatures in winter. The use of the burrow together with behavioural and physiological adaptations enables the wombat to tolerate the climatic extremes encountered in its habitat.

Reproduction in the Common Wombat has received little scientific attention. We have observed a mating between two captive wombats. The female showed some aggression to the male as soon as he was introduced into the pen. The female lunged at the male, biting him on the back and emitting a hissing growl. This behaviour continued for about 30 minutes. The female then allowed the male to mate.

Both animals lay on their sides, the male holding the female around the chest. They seemed to curl around each other which suggests that in the wild they may mate within the burrow. The mating lasted for about 30 minutes.

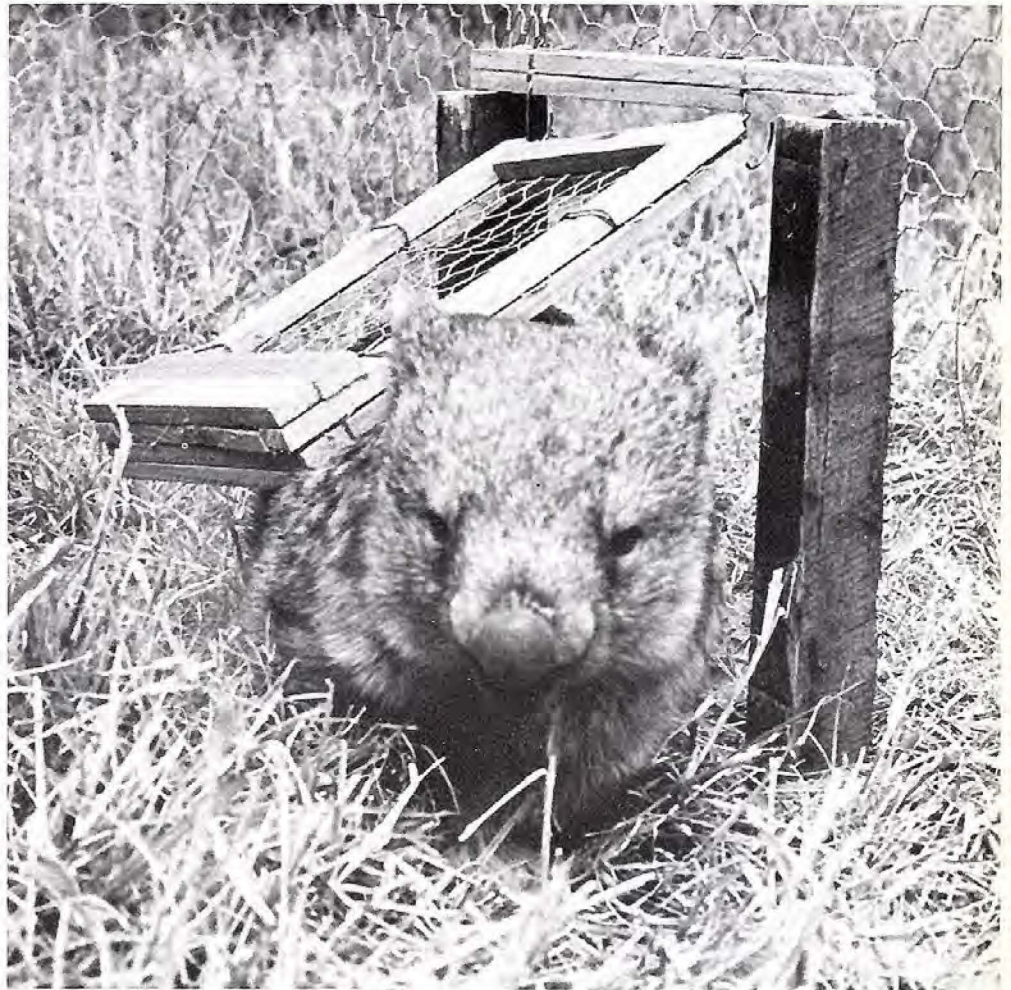
Twins at birth—myth

The gestation period is thought to be 30—35 days which is similar to that of many of the larger species of marsupials. Wombats are polyoestrous and recent studies on growth and age estimation suggest that they breed all year round. Generally only one young is born each year and, contrary to popular belief, twins have never been reported.

As with other marsupials, young wombats are born at an immature stage of development, weighing about 0.5g at birth. The newly born wombat makes its way to the pouch with the aid of its well developed forelimbs and extended claws. It then attaches to one of the two teats in the pouch.

About 200 days later it first emerges from the pouch when it is fully furred and its eyes are open. It is not known if the pouch young takes in solid food at this stage but observations of hand-reared animals indicate that they may do so. These large pouch young, weighing about 1.2kg, still return to the pouch and their mothers have been seen to lift the pouch containing the young animal while moving around and then lowering it to the ground when it stops to feed. The head and forepaws may occasionally be seen protruding from the pouch.

When the young are too large for the pouch they continue to suckle from their



mother. The mother's teat becomes very elongated and can protrude from the pouch. The young is fully weaned at an age of about 430 days. Nicholson reported that the young wombat learns tunnelling in its mother's burrow, gradually digging a small burrow within the mother's.

A wombat gate similar to that constructed by a farmer in Mittagong. He found that after installing the gate wombats within 400 metres of the original hole eventually used the swinging gate. On several occasions, four or five wombats were seen queuing to pass through the gate on their way back to their burrows. Photo Gary Steer, NSW National Parks and Wildlife Service.

Live from 15 to 20 years

Little is known of the life of the young wombat after it leaves the mother's burrow. Relatively few young, independent wombats are seen in the same areas as adults. Captive wombats have been reported to live from 15 to 20 years but there is no information on the longevity of wombats in the wild.

At times, wombats can pose a problem to foresters and farmers. By digging and pushing under vermin-proof fences, they damage the fence and allow other pests such as rabbits to get through. This has been a particular problem with young pine plantations which are especially susceptible to destruction by rabbits.

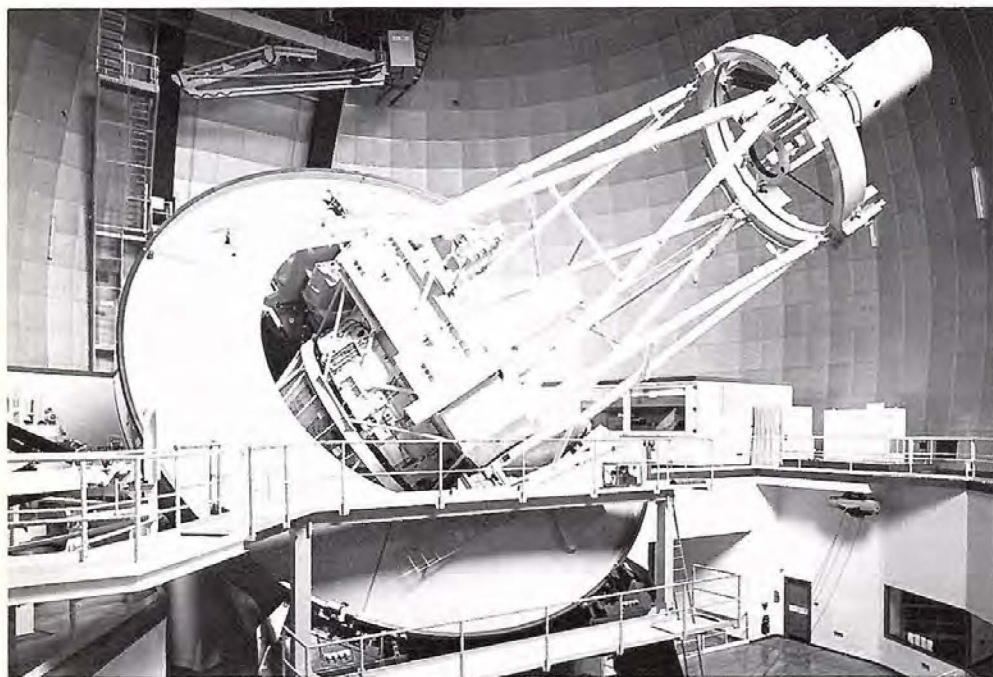
On farms, besides the damage to fences, their burrows are considered to offer a home to rabbits and foxes and possibly contribute to soil erosion. A property owner from Mittagong overcame the problem of damage to fences by

constructing a wombat gate at a well used hole in a fence. Before installing the gate the other holes in the fence were kept repaired until the wombats gradually became accustomed to using the remaining hole. The gate was swung from its upper edge and heavily weighted at its lower edge. While the wombats could push through the gate it was too heavy to allow rabbits to pass through. It was reported that all the wombats within 400 metres of the original hole eventually used the swinging gate. On several occasions, four or five wombats were seen queuing to pass through the gate on their way back to their burrows. Maintenance of the gate was easier than repairing the fence. However, the amount of economic damage caused by the wombat is very small in comparison to that caused by the large kangaroos.

The wombat is a unique marsupial about which there is relatively little scientific knowledge. While not seriously endangered at present, future conservation will depend on further research on their ecology and biology.



Wombat burrow in the northern part of the Kosciusko National Park. Photo G. Brown.



Top, the dome of the Anglo-Australian telescope dwarfs the cars which stand around it. The highest point on the revolving roof of this remarkable windowless building stands some 50m above the car park and high above the surrounding plains of north-western New South Wales. Mount Kaputar can be seen from the catwalk on the NE horizon and to the south the nearby peaks of the Warrumbungle National Park dominate the landscape. The long low building to the left houses work-shops, emergency power generator and air conditioning plant. This photo and all photos in the article are by David Malin.

Middle, the 3.9m Anglo-Australian telescope is seen here pointing low in the east. Attached to the top end is a cylinder, the prime focus 'cage' in which the astronomer rides to take photographs. In other configurations, light from the 16 tonne primary mirror, hidden in the rectangular centre section, is reflected by a second mirror attached to the top end into bulky instruments in the Cassegrain cage, partly obscured by the massive horseshoe bearing. The telescope can be directed to any point in the sky 20° above the horizon by moving the horseshoe (for an E—W motion) and declination axis (N—S movement) mounted within the horseshoe. The large horseshoe bearing is mounted at right angles to the celestial poles (about 31° from the local vertical) so that the telescope can track objects across the sky by movement of just one of its two axes.

Bottom, the power of a modern large telescope is well illustrated in this photograph of a magnificent spiral galaxy, known only by its rather undistinguished catalogue name NGC 253. It is a member of a nearby group of galaxies, which straddle the southern constellation of Sculptor at a distance of about 10 million light years and is close enough for us to see individual stars on this deep AAT photograph. (One light year is a little over 9,000,000,000,000km.) The spiral nature of the galaxy is not obvious because we see it almost edge-on and enormous dark clouds of dust obscure much of its internal structure. If the galaxy were turned to face us it would appear to be half the diameter of the full moon (though much less bright) and would be a magnificent spectacle in quite small telescopes.

SEARCHING THE SOUTHERN SKIES

Man has been a stargazer ever since the dawn of time. Prehistoric art shows us many examples of man's awareness of the stars. Even the Australian Aborigines are thought to have recorded celestial events. 'Sunbursts', carved on rocks in the vicinity of Broken Hill, NSW, are believed by some astronomers to be recordings of Vela supernovas.

In this article, which heralds the first of what will be a number of articles on astronomy in the southern hemisphere, David Malin briefly explains the tradition of astronomy in the northern hemisphere and its relatively recent start here.

In the forefront of radioastronomy with the telescopes at Parkes and Fleurs, Australia combined with Britain to build the four metre Anglo-Australian Telescope, generally acknowledged as the finest large telescope in the world.

David Malin is a research photographer at the Anglo-Australian Observatory in Sydney. His novel methods of extracting information from astronomical plates have given him a world-wide reputation. One process he has developed allows colour photographs to be made of extremely faint objects in space which is providing astronomers with a considerable amount of new information on our universe.

by David Malin



When the Anglo-Australian telescope is used as a giant camera to take photographs of faint celestial objects, the observer rides in the prime focus 'cage' at the upper end of the telescope. Generally seated with his back to the sky and using equipment illuminated only by star-light he must ensure that everything functions as it should to enable the telescope to track objects across the sky for exposures which can last for an hour or more. Here David Malin occupies a small seat attached to the walls of the cage, walls which rotate to find a (reasonably) comfortable position for the long exposures. During long winter nights special clothing is essential as temperatures hover around freezing point; in the summer short sleeves and shorts are in order. All the celestial photographs which accompany this article were made at the 'prime focus', the dark square in the centre of the cage where light from the 150 inch (four metre) mirror is focused.

Most Australians can point out the Southern Cross in the night sky. It is so distinctive that it has become part of our national flag. It therefore comes as something of a surprise to some of those who leave Australia for lands north of the equator that this group of stars is no longer visible, replaced in the sky by equally distinctive but quite unfamiliar stellar arrangements such as the Great Bear or Cassiopeia. Like so many of the changes which travellers must contend with, these manifestations are subtle yet profound.

They reflect the simple truth that star gazers in the two hemispheres look out onto different parts of the Universe. The individual naked-eye stars which make up the named constellations are our immediate neighbours in our own galaxy.

However, even the most powerful telescope, capable of reaching far beyond the Milky Way cannot scan all the sky from a fixed location. A substantial fraction of the observable Universe is always hidden by the bulk of the earth itself. Since all of the world's large telescopes were originally built well north of the equator, in California, Arizona, Europe and the USSR, the southern skies could not be examined in detail until recently.

This imbalance in no way reflects the astronomical importance of the two hemispheres, rather it is a result of the relative affluence and long astronomical traditions of the nations inhabiting the northern continents. Quite simply 90% of the world's population live north of the equator and that is where most astronomers and the funds needed to support them can be found.

This is not to say of course that astronomers are ignorant of the southern skies. Observatories in both Australia and South Africa have been active since these lands were settled by Europeans and have a long and distinguished history. However it had long been apparent to optical observers that a large telescope was needed in the south, in particular because the Magellanic Clouds, the two nearest galaxies to our own, can only be studied from southern sites and the centre of our galaxy, the brightest part of the Milky Way, passes directly over observers in Australia. Some of the best examples of globular clusters, vast spherical concentrations of stars left over from the formation of our galaxy and the several important radio galaxies are also out of the reach of northern hemisphere observatories.

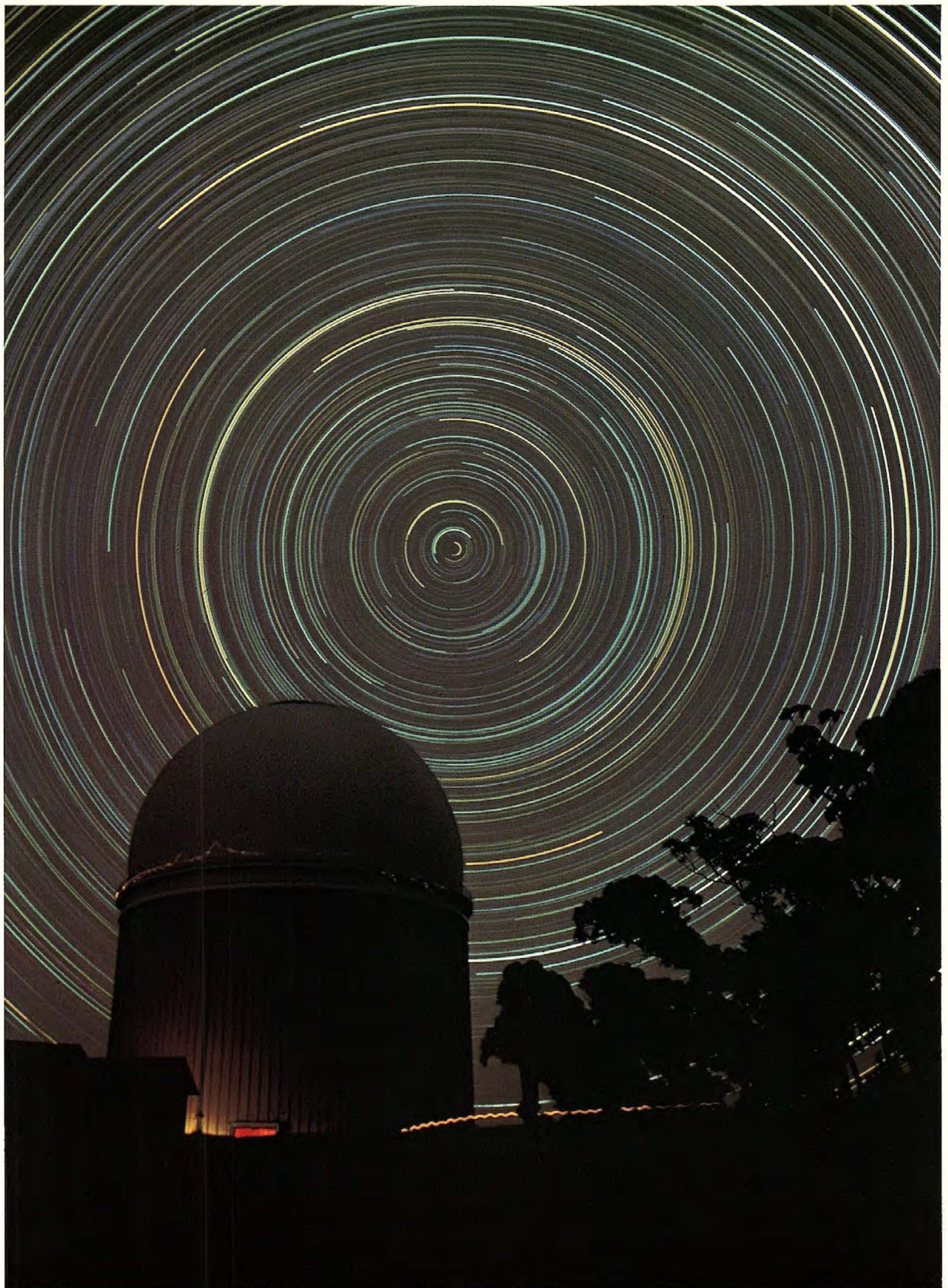
Forefront of radio astronomy

The requirement for first-rate optical facilities was made the more urgent as Australia came to the forefront of radio astronomy with the establishment of new telescopes at Parkes and Fleurs.

The first important step towards creating what is now the Anglo-Australian telescope was taken in 1967 when the Science Ministers of Britain and Australia agreed to fund the construction of a four metre telescope to be built in Australia. Construction and running costs were to be shared equally between the two countries and observing time was to be similarly divided between British and Australian astronomers.

(continued on page 288)





Photos on the preceding pages.

Top of page 286, our view of the centre of the galaxy is obscured by huge clouds of interstellar dust in the direction of the constellation of Sagittarius. The patchy nature of the obscuration can be seen from the uneven distribution of background stars across this picture. Light from bright stars within the dust produces the two blue reflection nebulae (NGC 6589, 6590) while a large cloud of hydrogen mixed with some dust, glows with a characteristic red colour over most of the field of view. (IC 1283, 1284).

Bottom of page 286, the Nebula in Orion is in our own galaxy at a distance of 1,300 light years and is the brightest nebula seen from our position in space. Since this object is also visible from the northern hemisphere it is the best studied example of a gaseous nebula and was the first ever to have been photographed. It consists of an enormous cloud of hydrogen gas, mixed with dust and stirred up by the radiation of hot bright stars recently born within it. Four of these stars, the Trapezium cluster, are just visible in the brightest part of the nebula.

This object can be seen with the keen unaided eye and is clearly visible with binoculars on a (southern hemisphere) summer evening as the central 'star' in Orion's Sword. The photograph here has been specially treated to reveal detail in the very wide range of luminosities found in many gaseous nebulae. The large scale of photographs made with the Anglo-Australian telescope is very important in the study of the fine structure of such nebulae.

On page 287, the rotation of the earth causes the sun to journey across the sky from east to west every day. Although their movement is less obvious, the stars, too, appear to move in gigantic arcs across the heavens. The position in space of the earth's axis of rotation is seen here at the centre of the hundreds of star trails captured in this 10½ hour exposure. This point is about 31° above the horizon — the geographic latitude of Siding Spring Mountain. If this long exposure were repeated at the South Pole the centre of the arcs would be directly overhead; at the equator similar photographs would show the stars tracking around two points on the horizon, one due north and the other due south of the observer.

Silhouetted against the starry background is the dome of the AAT. The ragged line at the level of the catwalk was caused by an astronomer coming out of the dome to look at the weather. As he walked around the path his torch was recorded on the photograph.



(continued from page 285)

The building of the telescope and dome was a truly remarkable international enterprise. The main mirror, a single piece of Cervit glass-ceramic, 4 metres in diameter and weighing over 16 tonnes was cast in the USA by Owens Illinois and polished to its final shape by the Sir Howard Grubb-Parsons Company in England. The telescope mounting and its drive and control systems were supplied by the Mitsubishi Electrical Corporation of Japan and the complex building and dome were constructed by the Australian companies Leighton Construction Ltd and Evans Deakin Industries.

Finest telescope in the world

The final cost of construction was close to \$16 million. HRH Prince Charles inaugurated the telescope in 1974 and regularly scheduled observations began in June 1975. The end result surpassed all expectations and the 3.9m Anglo-Australian telescope (AAT) is generally acknowledged to be the finest large telescope anywhere in the world.

Overlooking the beautiful Warrumbungle National Park in north western New South Wales the top of the glistening white dome which houses the telescope stands 50m above a prominent outcrop of Siding Spring Mountain, and is the largest building outside a metropolitan area in Australia. This remote mountain top some 500km from Sydney, was chosen for its distance from city lights and the clarity and steadiness of the atmosphere. The site is shared with telescopes run by the Australian National University and with the UK Science and Engineering Research Council's 1.2m Schmidt telescope.

NGC 2359 is the nebula produced by a single star, HD 56925, shedding a substantial fraction of its outer layers. As these are ejected from the stellar surface with velocities which can reach 2000 kilometers per second, the shell-like layers interact with the gas and dust around the star producing the cosmic bubble seen here. Such stars are rare, largely because behaviour of this kind cannot be long sustained but also because this example happens to inhabit a part of our galaxy rich in interstellar gas.

However the isolation is only relative for the observatory is fortunate to be within a 30 minute drive of Coonabarabran, a thriving settlement of some 3,500 people. Large enough to offer the amenities of a country town to the resident observatory staff, yet not so big that it poses a serious threat to the darkness of the night sky, the name is an aboriginal word meaning 'inquisitive man'. Regular commercial flights link the town with the observatory's administrative offices and laboratories in Sydney.

Like all modern reflecting telescopes the AAT can be used in a variety of configurations. In its simplest mode of operation, the observer rides in a cylinder at the upper end of the telescope operating the prime focus camera. He is sitting inside a photographic system which works at $f/3.3$, a respectable aperture for a camera lens of 100mm focal length. In the case of the AAT however the focal length is an impressive 12.7 metres. With modern photographic emulsions this 'camera' can record the feeble light of a candle at the distance of the moon and under stable atmospheric conditions would be able to resolve into two separate images a pair of candles 2km apart at a similar distance.

The top-end of the telescope can be changed by means of a gantry crane built into

the dome. Two alternative top ends carry mirrors to reflect light to the Cassegrain focus ($f/8$ or $f/15$) or to the coudé focus ($f/36$) where the focal length of the telescope is an impressive 140 metres. At these foci are attached instruments which are too heavy or bulky to carry at the prime focus. These are usually spectrographs to split the starlight into its component colours or photometers which accurately measure the feeble light of distant objects at a variety of wavelengths from the ultraviolet to the infrared.

Sensitive electronic detectors

These instruments use sensitive electronic detectors and their output is recorded via a computer onto magnetic tape for subsequent analysis. In addition, the telescope and dome are controlled by computer systems which ensure that the programme object is followed accurately as the earth's rotation carries it across the sky.

The combination of excellent optics and sophisticated computer control make the AAT an extremely efficient telescope to use. Experienced astronomers speak enthusiastically of the enormous amount they can accomplish in the short time allocated to them.

Large demand for access

Such efficiency is particularly important because demand for access to the telescope far outweighs the time available. Apart from the brief close-down necessary to replace the main mirror's aluminium surface, the telescope operates on every clear night throughout the year. Even so, on average only one in three of those who want to use the telescope are fortunate enough to be given time and often the successful astronomer receives fewer nights than he requested.

Time on the AAT is keenly sought and detailed applications from potential users are scrutinised by committees meeting regularly in both Britain and Australia. Nor is the time application committee the last hurdle. After making the journey to the telescope and preparing for the observations so carefully planned months before, the weather can have the last word. Cloudy nights mean that the allocated time is lost and the whole process must be repeated though most observers obtain some data during their stay at Siding Spring.

On the reasonable assumption that the skies will be clear the astronomer must decide how he will use his valuable telescope time. Exactly what he does and how he does it depends on the problem in hand. For example he may have an interest in a very faint source detected by radio observations. It could be a quasar, a galaxy so distant but so energetic that it appears on photographs as a star-like image (a quasi-stellar object).

To learn more about these strange objects, often near the limits of the observable



Universe, it is sometimes necessary to devote most of a night to collecting sufficient light to produce a usable spectrum of just one of them. On the other hand it is possible to record the images of thousands of faint objects, including distant galaxies and quasars with a single photographic exposure lasting little more than an hour. In this case the detailed spectral information is lost but statistical data on how the Universe appeared thousands of millions of years ago is the result. In both examples the telescope—the data acquisition system—is only the first link in a series of steps which can take months, sometimes years of analysis to produce a meaningful result.

Evolution of stars

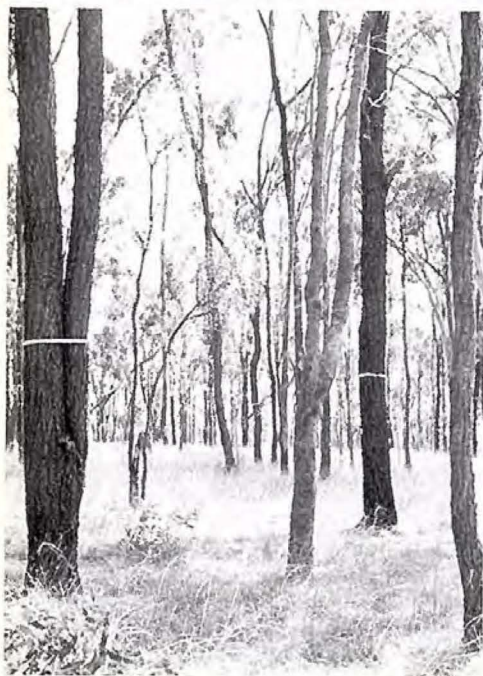
Other users of the telescope are interested in the evolution of stars in our own galaxy and those nearby. All around us we can find places where stars are being born in giant clouds of gas and dust and other regions where older stars are in their death throes. Examples of both kinds of phenomena are seen in the illustrations which accompany this article.

The modern science of astronomy is a manifestation of the insatiable curiosity of the human species and its continuance reflects the sense of wonder and awe we all feel when standing under a star-strewn sky. The practical consequences of astronomy are all around us

The Helix Nebula is the typical result of a smallish star, about twice the mass of our sun, entering its dotage. The nuclear reactions which keep a star glowing brightly for most of its life begin to falter and the delicate balance between gravity holding it together and radiation pressure blowing it apart are upset. As old age approaches the star sheds substantial amounts of its outer layers, often in the form of symmetrical shells as in this example. The remaining central star is much hotter than a normal star and radiation from it causes the tenuous shell of gas to glow with its distinctive colours. In this case, the central greenish colour is due to oxygen, the red is hydrogen, nitrogen and oxygen gas. The object derives its name from its appearance—rather like looking into a coiled spring from one end.

in our clocks and calendars and ability to navigate the globe.

It is worth recalling too that Captain Cook was on an astronomical expedition to observe a transit of Venus across the face of the sun when he charted the eastern coast of Australia in 1769. The purpose of the observations, to measure the distance of the sun, would seem to his contemporaries (and probably to some today!) to have no relevance to life on earth and yet by knowing its distance we could find the size and mass of our nearest star and better understand our place in the Universe. Cook's exploration of the coast of what is now New South Wales may have appeared equally irrelevant at the time but his work quite literally put the land of the Southern Cross firmly on the map.



Above, adult at nest with food. Often food is so small as to be completely concealed in the beak. Note also how the feathers surrounding the eye patch are fluffed to reduce its effective size. The same thing is common in encounters between certain adults.

Top, a banded adult miner resting during a bout of preening.

Middle, typical Noisy Miner nest and eggs.

Bottom, an example of the open dry sclerophyll woodland favoured by Noisy Miners in south-eastern Queensland. Marked trees indicate intersections of a grid on the study site. Top photo by M. Whitmore, all other photos by D. Dow.

NOISY MINERS—THE GIRLS HAVE IT MADE

The irrepressible Noisy Miner is one of the most enterprising Australian honeyeaters due to its ability to adapt to urban man's environment and because its tight social structure, allows it to compete successfully with other birds for the available resources.

Outnumbered three to one by male birds, individual females live with a number of males in a social group called a coterie. As a result Noisy Miners are extremely promiscuous, the female copulating with a number of males from their own and other coterie.

Mary Whitmore is a postgraduate student completing field research on the Noisy Miner at Queensland University. Douglas Dow, also based in the School of Zoology, University of Queensland, has been working on Noisy Miners for over a decade and is responsible for most of the information known concerning these dynamic birds.

by Mary J. Whitmore
and Douglas D. Dow



Adult approaching to feed fledgling. Photo D. Dow.

Mention the miner to the man mowing his suburban lawn and receive a look of scorn to last a lifetime. "Ah, yes ... those blasted mickies! Our garden is crawling with them. They frighten all the interesting birds away." Mention the miner to the woman behind the snack bar at Lone Pine Koala Sanctuary in Brisbane and she'll tell you that he's cheeky enough to visit the cordial dispensers and drink enthusiastically without leaving so much as a cent. Mention the miner to the elderly country lady and hear her recount the attack of the horrible soldier-bird that nearly killed her caged German Roller canary.

What kind of birds are these and what have they done to deserve such a reputation? Possessor of many common names, the Noisy Miner, *Manorina melanocephala*, is a robust member of the honeyeater family, Meliphagidae. Close relatives are the Yellow-throated Miner, *M. flavigula*, the Black-eared Miner, *M. melanotis*, and the Bell Miner, *M. melanophrys*, which in turn prefer drier woodland, mallee and wetter forest.

The Noisy Miner occupies a broad band of dry sclerophyll woodland in eastern Australia, from Tasmania north to tropical Queensland. Where man has thinned the woodland the miner has staked his claim and is now common in suburban parks and gardens.

As with many of Australia's birds, little was known about the social behaviour of miners until recently. In 1969 one of us (DD) fortuitously discovered their habit of breeding communally. The term communal breeding implies that individuals in addition to parents care for the young. This phenomenon is fairly common among Australian birds; to date, over seventy species in twenty families are known to do so. From the Magpie Goose, *Anseranas semipalmata*, to the Yellow-rumped Thornbill, *Acanthiza chrysorrhoa*, strategies of life history are diverse.

have continued, mainly in southern Queensland near Laidley, 72km west of Brisbane, and Meandarra, 310km west of Brisbane. By colour-banding over 400 birds and observing them at these localities, we discovered that communal breeding is not the only fascinating aspect in the life of the Noisy Miner.

Populations of these miners are sedentary, living in colonies year round. Although honeyeaters, a large proportion of their food consists of insects that they glean from foliage, bark and litter. Many other passerine birds are colonial but most of these are seed eaters or aerial foragers. Some, like miners, feed on insects and nectar and nearly all feed outside their colony.

Fiercely defensive

Within the colony, the dispersion of these other birds is quite simple, involving the defence of a small territory and nest site or a chamber within a shared nest. Noisy Miners are exceptional in several respects. First, they obtain virtually all their food within the colony and, secondly, they have a complex social system that facilitates a cooperative defence of resources.

If you were to visit a miner colony, you would immediately notice that few other species of birds live within its confines. Of 60 species of land birds expected to breed at Meandarra, only ten are known to have successfully reared young in the miner colony where we work.

The exclusion of other birds is brought about by an incredibly high level of interspecific aggression by the miners. This pugnacious disposition is a trait of many honeyeaters and may be a means of controlling a transitory food supply.

Since 1969 our studies of Noisy Miners

A high density of miners makes the exclu-

sion of other birds through flight chases, attacks and mobbings certainly more dramatic and probably more effective. But the availability of food within the colony may limit the number of miners that can reside there. We think that colony size may be nicely balanced between food supply and energy required for cooperative defence.

Although miners are sexually monomorphic, we can determine the sex of most by observing their behaviour. At both our study sites males outnumbered females about three to one. There is a concomitant deviation from the more typical spatial system of many birds, where pairs on territory are usual.

Male ranges overlap

Male miners do not defend individual territories and their ranges overlap those of other males. They associate with each other frequently, whether in the course of foraging, bathing, greeting, chasing or mobbing. We call these transitory flocks coalitions, consisting of birds whose ranges overlap at or surround the point of interaction. The membership of a coalition is fairly predictable once the ranges of resident males have been mapped. If a goanna climbs to sun on a prominent dead log or a falcon lights atop a box tree, we can guess with fair certainty which males will appear shortly. There is, in fact, no finer way to impress the uninitiated than to rattle off the colour band combinations of all the mobbing males without so much as looking through our binoculars.

While the membership of coalitions changes from point to point in the colony, a more stable social unit of males is the coterie. Males belonging to the same coterie collectively show a higher level of aggression to other individuals or coalitions. Their behaviour is seemingly territorial and there is little exchange of birds between these units.

Females outnumbered

Females play by different rules. Their ranges do not overlap, not because of battles at boundaries but instead because of mutual avoidance. A female may join coalitions of males that form near or within her range. Thus, each coalition that one sees usually contains only one or two females.

Living colonially and defending resources cooperatively, miners frequently interact and have an extensive repertoire of vocal and visual displays to communicate intentions, age, sex and social status. Most of us associate display with activity, but even an inactive miner is constantly sending messages. While perched, he may quickly and dramatically change the size of his brilliant yellow eye patches by sleeking or fluffing the feathers that surround them; large patches indicate dominance, small ones submission. The carpal joints may be strongly raised outwards by a



Two males visit and display at the nest of an incubating female. Photo D. Dow.

dominant miner, producing a gap between the wings and the sides of the body, while the wings of a submissive bird may droop ineffectually.

Even certain aspects of flight have been ritualized into a stereotypic communicative function. Long flights are made by several birds as high as 40m above the canopy. Groups travel considerable distances in this way, chattering constantly and loudly. Miners in the trees below may become agitated and fly up to join them as they pass overhead. Birds on long flights may absent themselves from their usual ranges for up to 20 minutes. Where they go and why they go often remains a mystery.

Short flights seem to be performed exclusively by males. In a series of rhythmic un-



An adult without food visits a nest. In response to the sudden gaping by three nestlings, it opens its beak in a 'trident-bill display'. Note the elevated tongue. This display is used frequently in general encounters within corroborees. Photo D. Dow.

dulations, the miner flies outward and, generally, upward over a clearing while uttering a low, whistled 'teu-teu...teu-teu'. The display conveys information about the sex and location of the performer but its exact function is still somewhat of a puzzle. Many other honeyeaters have an aerial display, often interpreted as a territorial one.

Head-up flights are associated mainly with nesting activity and are most commonly performed by females. The display varies in intensity but always involves a slower and more laboured flight and an elongation of the neck. The most conspicuous aspect is the position of the head, which is held up and back. In this way, a female advertises the location of her nest to other miners while she builds it. Later, some males also display with a head-up flight as they approach and leave the nest. The frequency and intensity of this display changes according to the phase of the nesting cycle.

Perhaps the most impressive display is the corroboree. Several birds (usually 5 to 10) converge, hunch their backs, wave their wings, rapidly open and close their bills and sometimes elevate and extend their tongues. A corroboree appears as a greeting, occurring when members of a group come together after a separation. And when miners mob other species of birds, snakes, lizards, cats, or foxes, a corroboree seems to rally the participants to an even greater level of enthusiasm, much to the chagrin of the attacked.



Driving, a persistent series of supplanting flights, is one of the most common activities observed in a miner colony. We think that only females are driven and only by males. There seems to be no stereotyped pattern of courtship among miners, but driving is the most commonly observed element. One bird supplants another by flying or jumping towards it from a distance of one or two metres. If the supplanted bird flies off, it is usually chased aggressively. If it flies to a nearby perch, however, driving usually continues.

Driving becomes most frequent as the peak of the nesting period approaches. Although clearly sexual in nature, driving does not always culminate in copulation. As the breeding season progresses, males may dispense with the preliminary sequences of behaviour and simply leap onto females. Miners at both our study sites were promiscuous, with one female copulating with more than one male and sometimes with males from different coteries. Such promiscuity may help explain some of the bizarre behaviour of males, which is described later.

The onset of breeding has no obvious ecological correlates. At Laidley and Meandarra, the main breeding season fell between

July and November. While nests outside this period were not uncommon at Laidley, they were extremely rare at Meandarra, perhaps because of the more extreme temperatures at that site.

The most obvious sign that breeding has begun is, of course, the nest, built by the female from small twigs, grasses, tendrils and rootlets and held together by strands of spiders' webs. Nests are easy to find — females not only advertise the locations of their nests with head-up flights but also do a poor job of concealing them in the surrounding foliage.

Strange behaviour by males begins while the nest is being built. They 'visit' the nests of females, singly or in groups. Stranger still, in any one day, a male may visit more than one nest. If alone, he may merely peer inside the cup and then leave. If several males arrive at the nest simultaneously a corroboree may ensue or a scuffle may erupt. Witnessing a gathering of eight male miners at a nest is an eye-opener for anyone used to the idea of breeding by pairs of birds.

Why do males come to an empty nest? By visiting it, they may familiarize themselves with

The most obvious sign that breeding has begun is, of course, the nest, built by the female from small twigs, grasses, tendrils and rootlets and held together by strands of spiders' webs. Photo Norman Chaffer, from the National Photographic Index of Australian Wildlife.

its location. Furthermore, the site may be a convenient place to encounter other males for the purposes of display and also the building female for copulation.

The female lays from two to four eggs and she alone incubates them. Visits by males continue and their displays become even more peculiar. Curiously, the same behaviour displayed to other birds in corroborees is directed towards the eggs!

Females do not chase the males away from the nest. In fact, a male may occasionally grasp the incubating female by the feathers of her nape and pull her off the nest before he displays to the eggs. We wonder if these interruptions by the complement of males visiting the nest disrupt the female's pattern of incubation and thereby lower breeding success.

If all goes well, the eggs hatch in about 16 days. At this time the behaviour of males,

simply visiting the nest and perhaps looking at or displaying to the contents, must change to the carrying of food to nestlings. Much of the food brought to the nest is, in fact, delivered by males but the female's contribution is also significant and she alone broods the young. We have never watched a nest that was attended by the female and only one male: at Laidley as many as 22 males visited a single nest of one female!

We know of no other species with an equally small brood that feeds its young at such a high rate — up to 71 times per hour. Some items are so small that they can be held almost entirely within the feeder's bill, others so large that parts of them may still protrude from a nestling's mouth several minutes after a feeding.

Danger of predation.

Nestlings begin to 'chip' soon after they emerge from the eggs. This begging call becomes louder and seemingly more insistent each day and, coupled with the comings and goings of feeders, must contribute to the conspicuousness of the nest. We never witnessed predation at a nest although losses of eggs and nestlings frequently occurred.

Young miners fledge gradually, initially venturing no further than a metre from the nest before returning to it. Because the eggs hatch asynchronously, the young are not of equal age and it is not uncommon for the oldest of a brood to fledge several days before the youngest. Once out, the fledglings tend not to move much for the first few days and depend on adults for food and protection. Their loud chips and feeding squeals may attract nearby males that have not been involved previously in their care.

Fledglings show aggression

All is not domestic bliss, however, and the dispositions of some fledglings are not as innocuous as their fluffy plumages and tiny tails might lead us to suspect. Aggression between young of the same brood may first be seen in the nest; it becomes more pronounced after fledging, but scuffles are minor and involve awkward fencing duels with the bills. Later, as mobility and coordination increase, chases and pecking attacks may become more frequent. The latter, as we learned only recently, may be fatal.

Young miners are still being fed a month after leaving the nest but threatening behaviour by adults, often the very birds who cared for them earlier, becomes more frequent and intense.

Little is known about the ontogeny of behaviour and the processes of socialization in young wild birds. The survival of most young passerines is often low, leaving the researcher with few subjects. The survivors often are



Above, male Noisy Miner in threatening attitude. Note large eye patch with feathers sleeked to maximize its size.

Right, an adult removes a faecal sac. Note the trace of pollen on this bird's crown and the irregular wear in its tail feathers. These are the clues that enable short-term identification of individuals and counting of the number of birds visiting a nest, even though they may never arrive there together. Photos D. Dow.



drably coloured, cryptic in behaviour, and generally inconspicuous in the avifauna. Young Noisy Miners are exceptional in several respects. Their plumage and coloration is quite similar to that of an adult and their behaviour is anything but cryptic.

Here, then, is a species providing an excellent opportunity to study the ways in which young are integrated into a very complex social system and this is where our current interest in miner research lies. No doubt another fascinating chapter of the miner's story is concealed there, waiting to be told.

By studying the development of young, we hope to explain why males behave as they do. Not all males visiting a nest contribute equally to the welfare of the young. A male's participation at a nest may be affected by his genetic relatedness to the female, his probability of having fathered the young, his social relationships with other visiting males and the proximity of the nest to his home range.

Regardless of these factors, all males

might benefit in the long term by caring for offspring because by increasing the population density of the colony, to some critical limit, interspecific defence becomes more effective and this reduces the competition with other species for food in the colony area. Miners are long-lived and a male, by remaining in his natal colony, may stand a good chance of becoming more dominant and ultimately successful in fertilizing females.

Our interpretations may be speculative but one cannot deny that here is a species most unusual in so many ways. Its life history is unique among birds so far studied. So the next time the talk turns to birds or behaviour utterly bizarre, we hope that you will mention the miner — with a new appreciation not only of its aggression but of its complex social life.

CENTREFOLD No. 11

Parma Wallaby *Macropus parma*

by G. Maynes



The Parma Wallaby's optimum habitat seems to be wet sclerophyll forest with a thick, shrubby understorey associated with grassy patches. Photo A.G. Wells, courtesy of the National Photographic Index of Australian Wildlife.

Pine plantations expanded during the 1960s on Kawau Island, off Auckland, New Zealand, suffered considerable damage from wallabies which had been originally brought from Australia almost a century previously. Foresters were doing their best to eliminate or control these exotic pests but in 1965 it was discovered that the population consisted of two species: the Tammar Wallaby, fairly widespread in Australia; and the Parma Wallaby, assumed to have become extinct during the nineteenth century. A stay of execution was granted while some of the Parma Wallabies were exported to zoos and research institutions in Australia and other parts of the world to establish breeding colonies from which the species might perhaps be returned to the wet forests of southern New South Wales where it had first been seen by John Gould around 1840.

It was not long, however, before this enthusiasm was found to be misdirected. A live female was taken near Gosford, NSW in 1967 and subsequent surveys have shown that it still occurs in New South Wales, at least from the Watagan Mountains north to the Gibraltar Range.

The Parma Wallaby lives in wet and dry forest and occasionally in rainforest but its optimum habitat appears to be wet sclerophyll forest with a thick, shrubby understorey associated with grassy patches. Primarily nocturnal, it takes cover among the shrubs during the day and emerges at dusk, or shortly before, to feed on grasses and herbs. When hopping, it remains close to the ground in an almost horizontal position with its forearms tucked tightly against its body. At medium pace, the tail is curved upwards in a shallow U-shape.

The male is larger than the female and has a more robust chest and arms. On Kawau Island there is a sharply defined breeding season from March to July, controlled by the nutritional state of the female. Available evidence from wild populations in Australia suggests that most births occur between February and June. In Australia, females become sexually mature when one year old but on Kawau Island maturity is not attained until two, occasionally three, years of age. Males appear to reach maturity at 20–24 months of age in both regions.

The single young is born after a gestation of about 35 days. Its first excursions from the pouch are made at the age of 23–25 weeks

and it quits the pouch when about 30 weeks old and about 750g in weight. Weaning is not completed for another 2½–3½ months, during which time the female may give birth to a second young.

The Parma Wallaby is normally solitary under natural conditions although feeding aggregations of two or, rarely, three are sometimes observed in Australia. Larger aggregations occur on Kawau Island where the population density is much higher. It appears that the effects of nutritional stress and crowding on Kawau Island has exercised some selective pressures: females are smaller than those in Australia and their captive-reared female progeny remain small even when uncrowded and well fed.

Size (Australian populations): Head and body length is 482–528mm for males and 447–527mm for females. Tail length is 489–544mm for males and 405–507mm for females. Weight is 4.1–5.9kg for males and 3.2–4.8kg for females.

Identification: Uniform greyish-brown back and shoulders, white throat and chest; dark stripe along the spine ending on the mid-back, a white stripe on the upper cheek. The tail is about the same length as the head plus the body. About 50% of the animals have a white tip to the tail. Distinctive faecal pellets are flattened, square to slightly rectangular.

Past Scientific Names: *Thylogale parma*, *Wallabia parma*

Other Common Names: White-throated Pademelon, White-throated Wallaby

Survival Status: Rare, scattered.

Subspecies: None.

FURTHER READING

Maynes, G.M. (1977). Distribution and aspects of the biology of the Parma Wallaby, *Macropus parma*, in New South Wales. *Aust. J. Wildl. Res.* 4, 109-205.

Wodzicki, K. & J.E.C. Flux (1967).

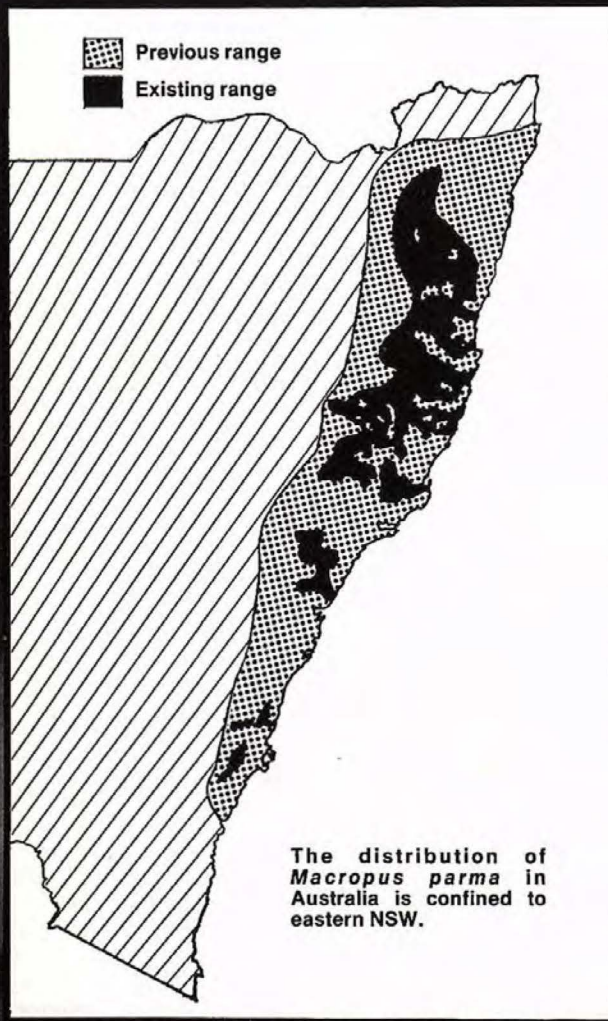
Rediscovery of the White-throated Wallaby, *Macropus parma*, Waterhouse 1846, on Kawau Island, New Zealand. *Aust. J. Sci.* 29, 429-30.

Extract from the forthcoming book, *The Mammals of Australia*, Ronald Strahan (ed.), Angus and Robertson, Sydney. This book includes an account of every species of Australian mammal and will be illustrated with colour photographs from the National Photographic Index of Australian Wildlife. Dr Gerald Maynes is an Australian authority on the Parma Wallaby and is currently working with the Papua New Guinea Division of Wildlife Research.

The Parma Wallaby, presumed extinct on the Australian mainland before the late sixties, was re-discovered near Gosford, NSW, when a live female was captured in 1967. Subsequent surveys have shown that this wallaby still occurs in New South Wales. Photo A. G. Wells.



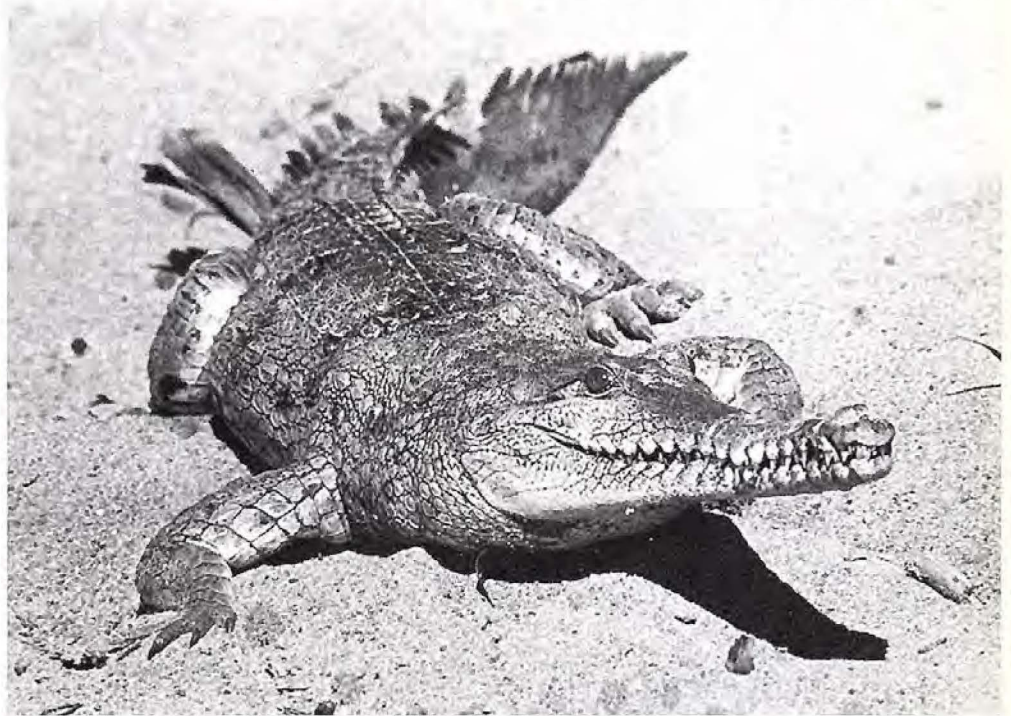




Class: Mammalia
Order: Marsupialia
Family: Macropodidae
Genus: *Macropus*
Species: *M. parma*
Common Name: Parma Wallaby



A LOOK AT THE FRESHWATER CROCODILE



by Grahame Webb



Two of the workers on the crocodile research programme retrieve a male 2.7m Freshwater Crocodile, *C. johnstoni*, caught during the previous night.

Above right, a 1.5m *C. johnstoni* sunbaking on the bank of the McKinlay river. All the photos in the article are by G. Webb.

The Australian Freshwater Crocodile was, until recently, one of the most poorly known of all the world's crocodiles. Protected in the Northern Territory since 1964, the Freshwater Crocodile occurs throughout the northern areas of Western Australia, the Northern Territory and Queensland and up to the 1970s was the subject of intensive hunting.

In 1974 the Commonwealth Government instigated a total export ban which finally gave protection to the crocodile in Queensland. Prior to that ban, poachers operated throughout the remote areas of the Northern Territory and Western Australia, shipping the hides across the border into Queensland where they could be legally sold.

Now, as a result of protection, the numbers of crocodiles are increasing to the extent that commercial utilisation, strictly controlled and properly managed, could become a viable proposition as well as playing a positive role in a total conservation strategy.

Grahame Webb, a consultant for the Conservation Commission of the Northern Territory and a Research Fellow at the University of NSW, has been studying Freshwater and Saltwater Crocodiles since 1973. The Conservation Commission's detailed research programme commenced in 1978 and in five short years is already a world leader in research on crocodiles in the wild. With crocodiles in such a precarious position as a result of over exploitation by the hide trade, this research will benefit crocodiles worldwide.

The Australian Freshwater Crocodile, *Crocodylus johnstoni*, is an endemic species which is widely distributed in the northern parts of Western Australia, the Northern Territory and Queensland. Until recently, there had been no detailed study of its biology and consequently, it was one of the most poorly known of living crocodilians.

In 1978, the Conservation Commission of the Northern Territory initiated a programme of research broadly aimed at rectifying this situation, and although these studies are still in progress, a considerable body of information has

now been gathered. *C. johnstoni* is proving an extremely interesting crocodile and very different in many respects to Australia's other crocodile, the estuarine or Salt Water Crocodile, *Crocodylus porosus*.

The Northern Territory study is centred in the McKinlay River area, approximately 130 kilometres south-east of Darwin. The area was chosen because it was logistically close to Darwin and was known to have contained large populations during the days of crocodile shooting.

The Fresh Water Crocodile was protected in the Northern Territory in 1964, after some four to five years of intensive hunting. The McKinlay River itself flows during the wet season (November to April), and breaks up into a series of isolated river pools during the dry season. It drains a large flood plain on which there are other creeks and drainage lines, most of which contain additional isolated pools during the dry season.

One of the first studies undertaken in the McKinlay River area was a survey of all pools of water in the area, to determine where the crocodiles were located. This survey, carried out in the dry season, clearly demonstrated that the crocodiles were not randomly distributed among all the pools present, but were concentrated in the larger, deeper pools.

Dry season water holes

Surveys later in the dry season indicated that many of the small shallow pools had subsequently dried, and therefore the choice of deep pools early in the dry season probably means that crocodiles select areas where there will be permanent water throughout the dry season.

One of the advantages of the McKinlay River area was the fact that the pools were mostly under 100 metres by 50 metres, which enabled more efficient netting to catch the crocodiles. Using information on the number of crocodiles caught in specific pools and the numbers sighted in those pools during the surveys, it was possible to derive a correction so that the original survey results could be amended to give actual numbers of crocodiles present. This indicated that the population in the study area was about 1,000 individuals.

Between 1978 and 1980, some 70% of *C. johnstoni* in the McKinlay River area were caught, measured, marked and released, in a study designed to determine how fast crocodiles grow. These data in turn, allow the relationship between age and size to be quantified. The preliminary results of this study have given the age structure of the population from which it appears that the survival of hatchlings in the upstream part of the study area is substantially greater than in the downstream part of the study area. The reasons for this difference are still under investigation.

The information collected on *C. johnstoni* nesting in the McKinlay River area has allowed the formation of a reasonably complete picture of their nesting biology here.

C. johnstoni nest during a discrete period in the dry season, namely the last two weeks of August and the first week of September. The nests are holes excavated in soft substrates, (70% of nests are found in soft sand) but sometimes in sand mixed with humus and, occasionally, in gravel and clay.



For at least two weeks prior to egg laying the crocodiles dig into the nesting banks, without laying eggs. The function of such digging is unknown, although they are generally considered trial nests. The ease with which a hole can be excavated appears to be only one aspect of nest site selection because, in many areas of soft substrate, there is insufficient moisture.

Most nests are excavated to a level at which the sand is damp, about 5% moisture by weight. The distance of nests from permanent water varies between 1 and 100 metres, and appears to be more a measure of the closest suitable bank rather than a reflection of any specific distance favoured by the crocodiles. If suitable banks are abundant, *C. johnstoni* usually nest within a few metres of the water's edge.

Nocturnal egg laying

Egg laying occurs mainly at night, or in the early morning and the eggs themselves are hard shelled. *C. johnstoni* eggs are on average 6.6cm long, 4.2cm wide, and weigh 68gms. The average clutch size is 13.2 ± 3.2 eggs, and when deposited and covered, the top egg is typically 20 centimetres below the surface, although this varies with substrate type. Egg sizes and clutch sizes are quite variable, and clutches of between four and twenty-one eggs have been located.

There is, however, a significant but highly variable relationship between clutch size and egg size. Large clutches tend to have large eggs and small clutches small eggs. Furthermore, there is a tendency for the larger clutches (with larger eggs) to be laid early in the nesting season, which is thought to reflect a tendency for the larger (older) females to nest before the smaller (younger) ones.

Incubation times in the field are typically $2\frac{1}{2}$ to 3 months, although this varies with nest temperature, itself a function of depth of the

A survey of the McKinlay River area carried out during the dry season showed that the crocodiles were not randomly distributed among all the pools present, but were concentrated in the larger, deeper pools.

eggs, substrate type, and aspect. As the embryos develop, metabolic heat is produced which raises clutch temperature. Temperatures measured in nests within the first week after laying are $29 \pm 1.5^\circ\text{C}$, yet at the termination of development, temperatures are about 32°C to 34°C .

When development is complete, the young crocodiles call from within the eggs, in response to which adults, presumably the females, excavate the nest. The hatchlings usually form a distinct group or crèche in the water for at least a month, and the female often remains with them. Crèches are usually positioned among debris at the water's edge rather than being in an exposed area. The time of hatching (November) coincides with the normal start of wet season rains.

In the McKinlay River area, a reasonably small proportion of the eggs laid actually develop through to hatching. The sand goanna, *Varanus gouldii*, is adept at locating nests and, in 1979, accounted for the loss of 55% of all nests in the area. Wild pigs took a further 6% and 1% were exposed by nesting females digging out the nest of another female.

In the same year 2% of nests were inundated with water from early wet season rains. In subsequent years the proportion of nests lost to such flooding has been appreciably higher and flooding could well be a major factor limiting nest success. The sand banks used by *C. johnstoni* to nest are often in creek beds, and these areas are washed out rapidly with early rains. Furthermore, the moisture level at which the eggs are deposited, is sensitive to a rise in the water table. Some nests which have not been washed out are simply inundated with ground water, drowning the embryos within their eggs.

A further loss of eggs occurs at the time of



hatching and appears to result from females excavating a nest before all hatchlings are fully developed. The partially excavated nest is exposed to the sun, which rapidly overheats the advanced embryos. The overall mortality of eggs in the McKinlay River area is thought to be about 70% each year.

Most hatchlings die

The crocodiles that do hatch have low survival rate and it is estimated that 80–90% die during the first wet season. The agents for this loss have not been identified, but large fish, birds, turtles and perhaps even *C. johnstoni* themselves are possible predators.

The wet season is very much the time of plenty for *C. johnstoni* in the McKinlay River area. Animals of all sizes appear to grow rapidly during the 'wet', whereas during the 'dry' many lose weight. The most important foods are insects, both terrestrial and aquatic, along with fish when they are abundant.

Amphibians, reptiles, birds and mammals are all represented in the diet, particularly in larger *C. johnstoni*. However, even the largest crocodiles appear to retain the ability to feed on small prey items. The most common

feeding behaviour is for crocodiles to lie in shallow water at the edge and snap sideways into the water, presumably at small disturbances.

Although there is extreme individual variation in the growth rates of *C. johnstoni*, the average McKinlay River female takes about 11 years to reach 1.5 metres, the size at which most mature. The males appear to take a few years longer to reach 1.8 metres, the size at which they mature, although some individuals form a distinct group of fast growers, and these may mature earlier.

The maximum size of *C. johnstoni* in the McKinlay river area is about 2.1 metres for females and 2.6 metres for males. Although these individuals are at least 40 years of age, their real age is unknown. Large *C. johnstoni* appear to cease growing and may exist for many years without changing in size.

The relationship between growth, age, maximum size, and feeding may be habitat specific and, even in the McKinlay River study area, there is a difference between the upstream and downstream animals. The

A 1.5m *C. johnstoni* which directed its gallop into a single bound. Freshwater Crocodiles can obtain speeds of up to 18 kilometres per hour for short distances.

downstream animals grow faster, mature at slightly larger sizes, and appear to reach greater maximum sizes.

Stunted crocodiles

In the Liverpool River, some 230 kilometres further east, the total population appears stunted relative to the McKinlay River animals. In this area, the maximum sizes appear to be 1.2 metres for females and 1.5 metres for males which is below the size at which *C. johnstoni* even mature in the McKinlay river area. These differences are thought to reflect the availability of food, but a suite of factors may be involved.

The Liverpool River population was particularly interesting because it appears that it had never been hunted. These animals were small lengthwise and quite robust individuals, mainly in good condition, however there were



a number of very thin emaciated animals. These have since been interpreted as old animals, beyond reproductive use and, if so, pristine crocodile populations may have a reasonably high proportion of old crocodiles in a population. Hunting would rapidly remove such animals and it could take many years until they once again became a recognisable segment of the population.

Same pool each year

The movement patterns of *C. johnstoni* in the McKinlay River area have not been studied in depth. Recapture results indicate that over 70% of animals use the same dry season pool year after year and that this is more so downstream in the study area than upstream. It also appears that *C. johnstoni* have a well developed homing ability. In one experiment, 16 adults were caught in a pool 75m x 25m and released in a larger pool, 39 kilometres upstream. The next year, 8 of these animals were recaptured, 7 in the pool from which they had originally come, and 1 half-way between. There were hundreds of pools between the release and recapture sites, many of which contained *C. johnstoni*.

The ability to home to a specific pool would appear to be particularly important to

Repetitive photographs of a 1.5m *C. johnstoni* at full gallop. Freshwater Crocodiles are adept at terrestrial movement. They have often been sighted moving overland between waterholes and are one of the few crocodiles in the world which have developed a true, gallop as a common form of escape behaviour.

C. johnstoni because during the wet season many of the billabongs (in which they live during the dry) become united in a single sheet of water. A minor change in location at this time could put individuals in a completely different drainage pattern, such that when the waters did recede the crocodiles could find themselves in an area which did not have permanent water for the dry season. Homing therefore allows them to return to sites with permanent water.

Nevertheless, *C. johnstoni* appear adept at terrestrial movement, and there are many instances where they have been sighted moving overland between pools. They are also one of the few world crocodilians which have developed a true gallop as a common form of escape behaviour and this, in itself, has been interpreted as a reflection of their need for efficient overland travel. The gallop allows *C. johnstoni* to obtain speeds of up to 18 kilometres per hour for short distances but it

also allows them to negotiate obstructions such as rocks and logs. The gallop is very much a bounding gait.

The McKinlay River study has given a lot of information on *C. johnstoni* from one area, and we are now trying to determine how typical of *C. johnstoni* in other areas this population is. The Liverpool River population, with its stunted animals, appears something of an extreme situation. In the long term, it is hoped that a management plan based on a firm biological foundation can be devised whereby the freshwater crocodiles of the Northern Territory are assured of a secure future, whether or not a degree of commercial utilisation be introduced.

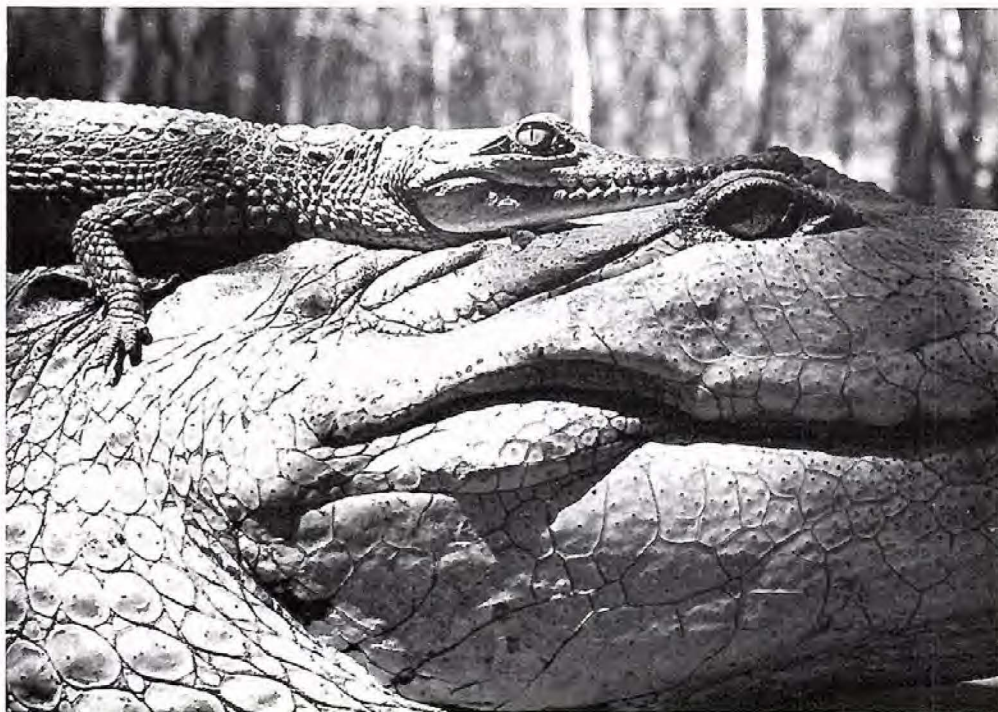
Population increasing

From a conservation viewpoint, the *C. johnstoni* populations in the Northern Territory differ from many world crocodilians as they are once again established in many areas and are not endangered. Should uncontrolled exploitation ever be allowed again, this situation would be rapidly reversed.

Commercial utilisation of crocodilians can, however, play a positive role within a total conservation strategy and the many possible

Right, a one year old Freshwater Crocodile on the head of a fully grown adult male (2.7m).

Below, a nesting bank on the edge of a billabong where 20 nests are laid annually.





strategies which could be used to achieve this, need to be investigated. The basic principle is that if crocodiles are of commercial value, the wetland habitats they occupy become an asset and their destruction a liability. Furthermore, the current world demand for crocodilian products is being supplied to a large extent from areas in which the crocodilian populations are over-exploited and where hunting cannot be controlled.

The problem lies in devising a strategy whereby recruitment in wild populations is enhanced, wetlands become a financial asset to those directly responsible for their protection and, if possible, pressure can be relieved on over-exploited populations. In Louisiana, where a very tightly controlled harvest occurs annually, the wild populations are continuing to expand.

Commercial viability

A strategy currently under investigation in the Northern Territory is an egg/hatching harvest compensated for by a return back to the wild of one-year old animals in excess of what would have survived had the eggs been left in the wild. As pointed out above the mortality rates on eggs and hatchlings are extremely high — 90—95% of all eggs laid. In its

simplest form, if all eggs were collected and incubated in captivity, the number of eggs taken could be compensated for by a 5—10% release of one-year olds. The success of such a strategy would depend on both the survival and fitness of incubated and raised animals when released back to the wild, and studies investigating this are currently under way in the McKinlay River area.

The most 'risky' part of such a management scheme, however, lies in the marketing of products. In Louisiana, when the first harvests were re-introduced, all products were exported such that no internal market was opened. This prevented the high level of poaching which could be expected if the products could be sold with ease within the State or adjoining States.

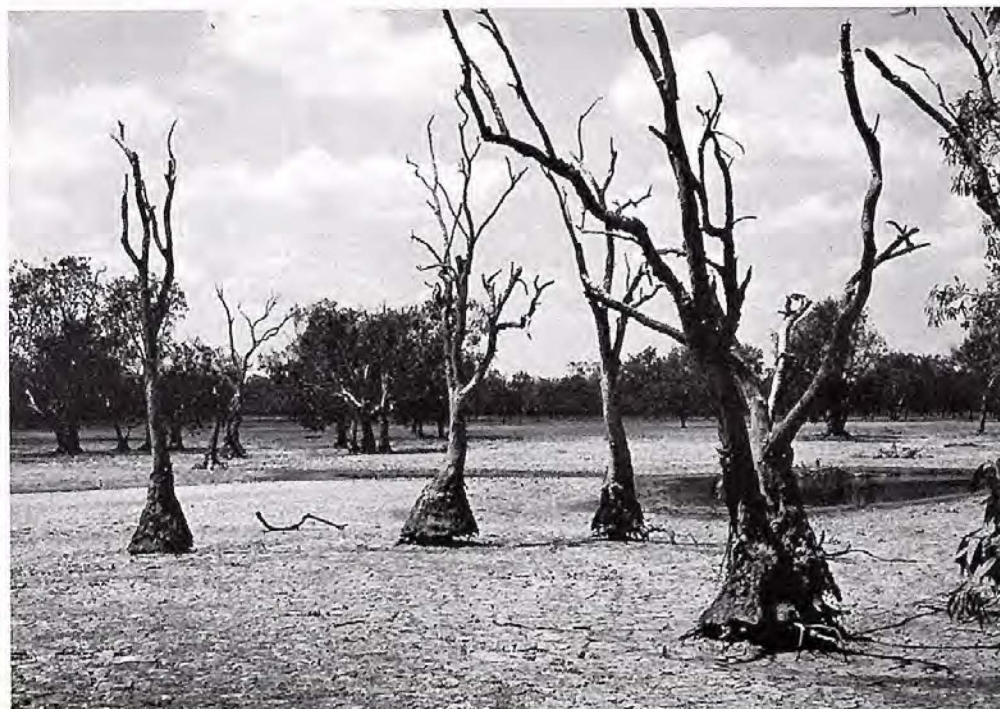
One only has to look at the history of crocodile protection in Australia to get some idea of the ramifications of a market being opened within the country prematurely. *C. johnstoni* were protected in Western Australia in 1962 and in the Northern Territory in 1964. In Queensland it was ten years later that protection was finally introduced, and then only after a total export ban had been imposed by the Commonwealth Government. Prior to

that ban, poachers operated throughout the remote areas of the Northern Territory and Western Australia, shipping the hides across the border into Queensland where they could be legally sold. The outback areas in the North of Australia are so vast that such poaching was, and still would be, extremely difficult to control if a market existed within the country.

Protection — sound strategy

Unfortunately, the problems of crocodile conservation and management are easily solved when there are few crocodiles left — blanket protection is a sound strategy. However, the results of this protection, if effective, are an increased number of crocodiles which complicates the issue somewhat. As many people simply do not like crocodiles enough to view a possible future abundance with enthusiasm.

Crocodile population management may therefore be a critical tool in their long-term conservation and a degree of commercial utilisation could be an important part of that tool. We can only hope that the overall result is acceptance of the fact that crocodiles are an integral part of our North Australian wetland fauna whose future survival should never again be in question.



Left, erosion threatens some wetlands utilised by this species of crocodile.

Below, Kites feeding on a dead Freshwater Crocodile.





The world of the Abelam unites—

by Diane Losche



A man showing some of the elaborate regalia used at the dance ending the male initiation ceremony. In the background a painted and perforated wood board with human and bird figures is attached to a bamboo pole which is tied to the man's shoulders.

Opposite, a senior man at a dance celebrating the end of male initiation into the spirit cult. His costume indicates that he is one of the group of men who prepared the carvings and painting in the spirit house for the initiates to view. All photos in this article are by Diane Losche.

GARDENS, GODS AND BODY LANGUAGE

In the autumn of 1978 two members of the staff of the Australian Museum, in Sydney, undertook a reconnaissance of Papua New Guinea.

In search of suitable anthropological material for a new exhibition Dr James Specht, Curator of Anthropology, and Mr Jeffrey Freeman, Exhibitions Officer, visited three regions and found the Abelam people of the East Sepik province to be the most suitable. The exhibition was proposed to increase the viewer's understanding and respect for other cultures and to promote a lively interest in their own culture by way of comparison with intimate details of everyday life, love and religion.

Dr Diane Losche, then a PhD student in New York University and an expert on the Abelam was invited to join the Museum staff and take charge of developing the exhibit. Under Diane's guidance field trips were organised and key personnel from the Museum took part.

No scientific, technical or promotional aspect was left to chance. Senior officers carried out conservation studies on location, not only on artifacts but on foliage and fauna — anthropological artifacts were collected and added to those already in the Museum collections, a Museum film crew recorded daily aspects of life, from the trivial to the serious, from buildings to cultivation, from mealtimes to initiation ceremonies.

Only after these exhaustive, on-site studies did construction commence in the latter part of 1980. In 1981 two senior men came to Sydney from Abelam to advise on construction of a spirit house or haus tamberan, and the presentation of Abelam village life. Meanwhile artists, artificers, preparators and volunteer workers became deeply involved in creating an authentic reproduction of an Apangai village and its daily life.

Finally, with the generous financial assistance given by Unilever Australia the gallery will open to the public in May providing an experience which Museum visitors will find exciting and satisfying.

In this article Diane Losche gives further dimension to the message of the exhibit by detailing the import of body decoration or language as a link between men and spirit.

The tradition of western art usually relegates body decoration to the position of poor cousin among the arts. Although art galleries occasionally display clothing the idea persists that the creation of body decoration is in the field of craft rather than art. Likewise jewellery, china painting and embroidery are consigned to the less elite realm of creativity.

Why are some activities given a higher status than others? From the western point of view body decoration is seen only as decorative and functional. Painting and sculpture on the other hand are thought to be most precious because they show the relationship of human beings to the universe.

The division between the lofty arts and the decorative crafts is part of the fragmentation and specialization of activities which form part of large industrialized societies. Fragmentation implies for example that we do not, or should not, bring spiritual belief to the work place, that priests, hospitals, teachers, and police perform roles that would be amalgamated in one person in smaller societies.

Body decoration has come to be seen as an expression of individual taste, the way we seek to 'stick out from the crowd', a way of becoming beautiful and desired by others, or a way of identifying with some social group

within the larger society. Pin-striped business suits identify the wearer as a professional or businessman as much as the outfits of 'bikies' transmit their group identification. Outfits however are not seen as ways of relating the wearer to the cosmos or to the spirit world.

The Abelam people of Papua New Guinea present an alternate view of these activities. Pursuing the myriad threads of art, body decoration, the world of the spirits, and the garden cycle they live with a view to life radically different from our own but, equally cohesive and powerful.

The Abelam is one of the best known art producing societies within the Sepik River region of Papua New Guinea and are a language group made up of about forty thousand people who live in an area of plains and foothills between the middle Sepik River and the Prince Alexander coastal mountains. While the Abelam share common characteristics including language, the cultivation of yams as a staple diet and an initiation complex, they are not completely homogenous in language or culture nor does the area form a common political unit.

The Abelam use a slash and burn technique of horticulture, the major crop being yams;

(continued page 308)





Photos on the preceding pages.

The photo on page 306 shows a senior woman decorated for the dance following a male initiation. Women and men wear many of the same objects in their body decoration although certain objects, such as the large bailer shell chest ornament seen on page 307, are worn only by senior men. On page 307 a senior man is decorated for the dance at male initiation.

(continued from page 305)

sago, taro and bananas are important secondary staples. Village life is organized around a seasonal cycle: the period April to October being the dry season, December to March the season of rains. Some foods, especially certain species of yams, are grown during the wet and harvested during the dry season.

The population lives in villages along the ridges of hills in the northern part of the Abelam area. Village size ranges from about 100 to 800 people. Each village, and to some extent each clan within a village, is an autonomous political unit which, prior to colonisation, had a shifting relationship of alliance and enmity with nearby villages and clans. There are no institutionalised positions of authority within the village but the elder men of clans take a more active role than others in the organization of village life.

Famous spirit houses

Within a village, people are divided into patrilineal clans which are land holding units with rights to segments of land surrounding the village. The people of a particular clan tend to live in adjacent hamlets. A series of hamlets is grouped around a central hamlet which has a cleared plaza area, called *amei*. This plaza is the centre of community life where dances, festivals and exchanges of food take place and this is where the *haus tambaran* or spirit house stands. These *korombo*, for which the Abelam are famous, have gabled A-frames and their brightly painted facades soar as high as 21 metres.

Abelam religion combines elements of magic and animism, a widespread belief where an active spirit or soul is attributed to inanimate objects and natural phenomena. The Abelam believe that phenomena such as the sun, moon, trees, and water holes, as well as ancestral-like spirits called *nggwal* contain agents whose powers can be used to make food grow, to hunt, cure the sick, kill and in general to create beneficial effects on most human endeavours.

The Abelam are known to the western world chiefly for sculpture and painting created in the context of a spirit cult. Although their body decoration is visually spectacular little is seen in museums and art galleries partly because of the fragility and ephemerality of the materials used but also because westerners appropriated Abelam material culture to their own system of value giving priority to the collection of sculpture and painting rather than to costume.



Three large carvings with a painted background of sago bark, used for the initiation ceremony in the spirit house. Two of the carvings have basket-like structures attached to their backs while the centre carving is free-standing. These carvings represent *kutagwa* and *nggwal*. In the north, they are decorated with feather and painted bark headdresses as well as with leaves, flowers, fruits, necklaces and bone daggers. These are placed on the carvings immediately before the ceremony and removed immediately after.



Abelam girl being decorated by her father for the dance following the male initiation into the spirit cult.

Prior to colonisation the Abelam wore no fabric clothing. Everyday adornment consisted of fibre, belts, large net bags for women, smaller bags for men with fibre, teeth jewellery and shell jewellery usually kept for special occasions. With these simple objects the distinctions of age, sex and male initiation status, the criterion for the most important roles in Abelam society, can be marked. Only women, for example, carry large net bags while only fully initiated men wear certain woven fibre arm bands. Today in Abelam villages people wear

skirts, blouses and short trousers for everyday wear and many enjoy wearing hats and jewellery purchased in trade stores. Although western dress has been adopted for everyday use, the Abelam continue to wear their own unique body ornaments. Like us the Abelam wear emblems of age, sex and status just as our bikies and pinstriped businessmen carry the emblems of their status and group identification. However Abelam fashion becomes more interesting when we turn to the yam and spirit cults.

The cultivation of yams and, by extension, all food is the central theme of Abelam political life, moral values, rules of behaviour ritual and myth. The Abelam have organised their very dramatic ceremonial life around the growth of one type of yam. The two major religious cults, intertwined with one another, are both concerned with yam growth. One of the cults is concerned directly with the growth of yams, the other, the spirit cult or the cult of the *nggwal*, is concerned with contacting spirits who will aid yam growth.

Food and sex taboos

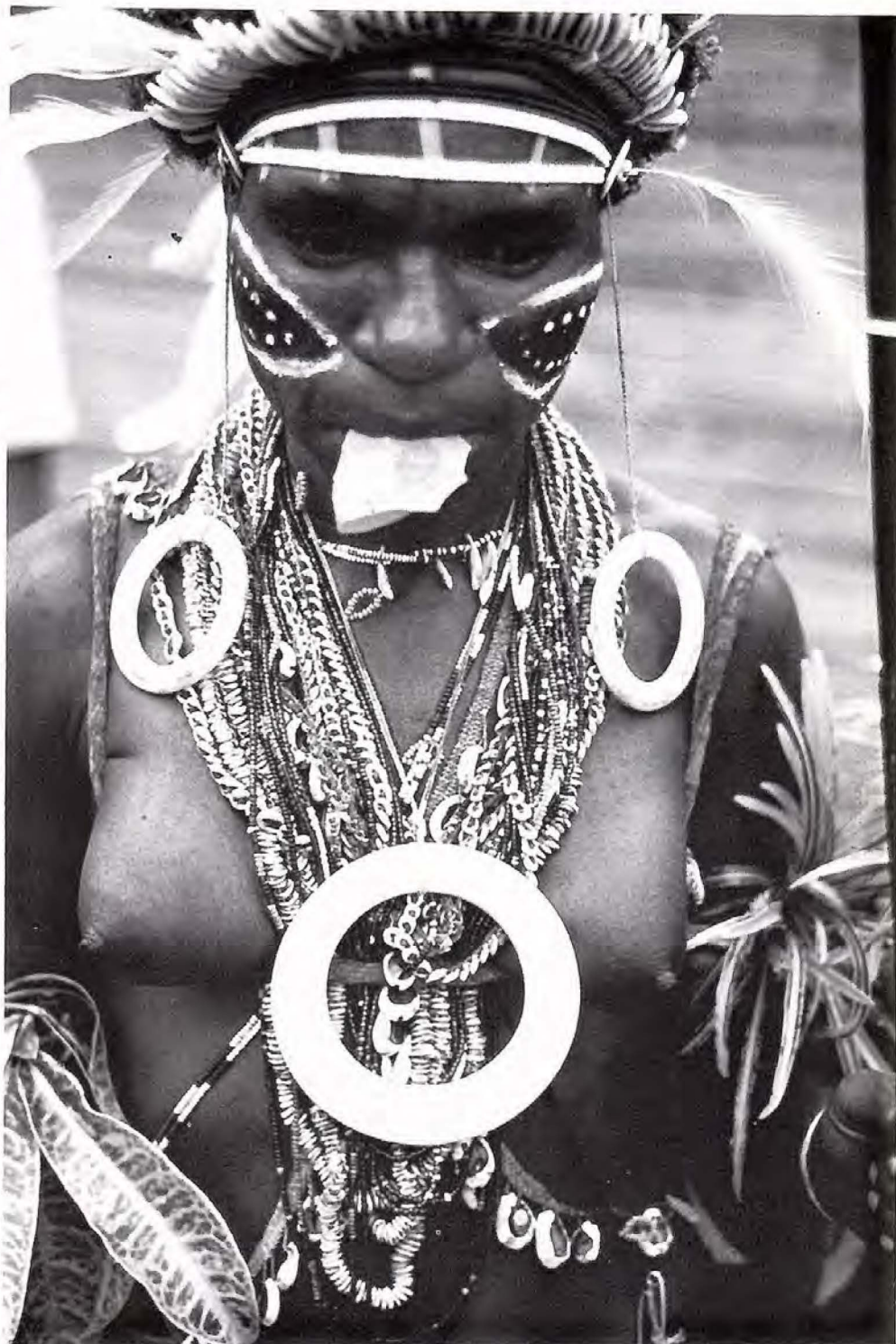
The yam cult is organized around the growth, display and exchange of these yams. Whatever variety of yam is used the general outlines of the yam cult are the same throughout the Abelam area. Only adult men grow the special variety of yam. The yam grower must obey a series of food and sex avoidance taboos if his yams are to grow large and long. Men call upon the spirits which inhabit their environment, the sun, the moon, water spirits, ghosts of the dead and ancestral spirits to help with the successful growth of these yams.

At harvest time the largest and longest of the yams grown by the men of each clan are decorated with cane or wooden masks painted in red, white yellow and black, together with bright orange inedible fruits, shell valuables, flowers and brilliantly coloured bird feathers, particularly those of the lesser Bird of Paradise. Sometimes the yam tuber itself is painted with designs. These long yams are divided into male and female types. Long thin tubers are designated male while tubers which have bifurcated during growth into a number of short tubers are designated as female.

Highest spirits

When decorated, the long yams are thought to become the most important spirits in the Abelam world, — the *nggwal*. Once the yams are displayed, the men who have grown them exchange their yams with a partner who may be from the same or from another village. To give a larger yam than you receive demonstrates your superiority over your partner. In this exchange men gain prestige vis-a-vis one another. The political and gardening world of the Abelam, where the decorated yams are central, is linked to the spirit world through a second cult, that of the *nggwal* whose activities take place in the spirit house.

Abelam men begin their initiation into this cult when they are children. There are a number of different levels in the spirit cult into which men are initiated in their life. In some areas of Abelam country there are as many as eight separate, named initiations. Each of these is connected by name to a different spirit in the Abelam world. The later stages however, are, always connected to the *nggwal*. In the context of these initiations carv-



ings and paintings are produced. These carvings and paintings are placed in the spirit house and decorated with the same materials which decorate the yams at display time. The carvings are given headdresses to which are attached bright orange fruits, red and yellow flowers and brilliant feathers, especially the plumes of birds of paradise. Like yams, the carvings are also divided into male and female and like the yams the carvings represent spirits in the Abelam world.

An adult woman, wife of one of the group of men who created the carvings and paintings at the initiation ceremony, attending the dance. The leaf she holds in her mouth is a sign of peace and well-being. She is wearing shell earrings and around her neck is a combination of shell necklaces and trade store beads. Some necklaces are simply looped once about the neck but others are criss-crossed.

Abelam initiations culminate in dances and parades of which the visually spectacular body decoration is an integral part. Through the body decoration used during such parades and dances, the gardening world, the spirit world and human society are linked through identification of human beings with yams and spirits.

During these parades and dances men and women are decorated with the same materials and in a similar fashion to that of long yams during yam festivals and spirit figures carved for initiations. In preparing for the dances the materials for creating body decoration are gathered together. As with the yams and spirits, these include leaves, red and yellow flowers, cassowary feather headdresses, bird of paradise plumes, bright orange fruits, bark and feather headdresses and varieties of shell and bead jewellery. The materials are assembled in different ways by individuals depending on taste. For example some people will use bark paintings as the centre of a headdress, others, feather-covered bark or a cane mask. Some headdresses are very elaborate, others quite simple depending on the role one plays in initiation, whether one is of a junior or a senior age grade, whether one has created the initiation or has viewed it. However the end result is not simply a beautifully decorated person, what is of greater importance and inextricably bound with the Abelam concept of beauty is the fact that the person, in taking on this body decoration, has become the spirit being celebrated in the particular initiation.

Intricate ceremony

Some men, for example the men creating a particular initiation, become *nggwal*, that is ancestral-like and powerful spirits. At other initiations the men of the initiating group will become *kutagwa*, witch-like creatures, via their costumes. At most initiations two senior men who are covered in white ash or white mud are called either *M'bau* (ash man) or *gambandu*, meaning ghost or spirit of the dead. These men observe the most stringent food and sex taboos for much longer periods than anyone else. They are considered responsible for continuing the power of the initiation via their taboo maintenance and are considered dangerous to others. Thus for the period of their taboo physical contact with them is avoided.

The point of taking on these elaborate costumes, is to channel and acquire the power of productivity and creativity of the spirit world. It is this which places Abelam body decoration at the centre of Abelam cosmology. Costumes from this point of view are not prettifying decoration but literally a channel of sacred power from the spirit world to human beings and their life-sustaining gardens. From this point of view, beauty and magical, sacred power are inextricably bound together.



This view of body decoration as a channel for power between the spirit and human world forms part of an all-encompassing and complex world view in which power is channelled from the spirit world to the human via magical means.

The animistic forces of Abelam belief, the sun, moon, water, trees and *nggwal* do not act of themselves, rather they must be channelled to human activities via the medium of divers substances, such as paint or various plants and animals as well as the recitation of verbal formulae (*manangoop*). The Abelam system of magic depends on an assumed spiritual contact between the object on which magic is performed and the person or object it is supposed to affect.

An example probably demonstrates best the system of work in Abelam life.

Although shell rings are highly valued as exchange items and objects through which one acquires wealth in pigs, shell rings are also thought to be powerful mediums of spiritual power. During the growing of long yams, senior men place a painted figure of an *nggwal* spirit against a wall inside the spirit house. A line of shell rings is extended from the figure to an imitation yam trellis and vine made for the occasion. Spiritual force from the figure is believed to travel through the line to the imitation yam vine and hence to the growing yams in the garden, causing them to grow well. Successful yams thus heighten the worldly and spiritual status of a senior man since his magical power as well as technical skill are thought to cause the proper growth of his yams.

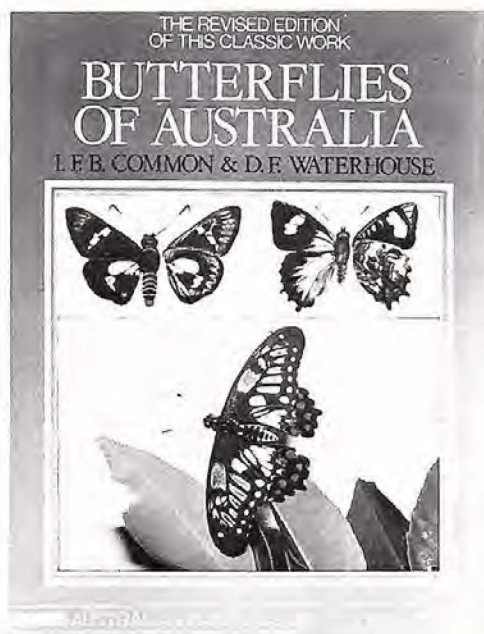
Just as spiritual power is thought to be transmitted via shell rings so also the objects

A father fixing his son's headdress for a male initiation dance. The younger man has helped create the carvings and paintings in one of the later stages of the initiation. He is wearing a forehead ornament made of painted woven material and shells with a fringe of cassowary feathers tucked inside. These ornaments belong to the older man and eventually they will be given to his son.

which men and sometimes women wear in initiations cause the transmission of spiritual substance and power to human beings. Paint, for example, is considered one of the most powerful ingredients in some types of magic. Abelam paints are vegetable dyes procured from the local environment and in certain circumstances are considered magically powerful. Men and sometimes women are covered in paint in order to gain spiritual power. The application of this substance also causes an identification between human beings, and the spirit world. Paint is the medium of spiritual force which connects people, carvings and the spirits. Other objects, such as the leaves which are tucked into arm bands, are thought to be useful in warding off sorcery. Bright red flowers, which are used on people, carvings and long yams, are associated with one of the most powerful of Abelam substances, bright red paint. Cassowary feather headdresses are associated with a mythic, bird-woman who is considered responsible for creating many cultural objects such as fire and houses. The list could go on but the point is that all the objects used in body decoration are linked as effective magical mediums in Abelam cosmology.

In this system beauty and sacred power are identical just as the use of similar objects on yams, people and carvings creates a strong triumvirate of identification. All three are linked via the medium of powerful and beautiful decorations to the world of the spirit.

IN REVIEW



Butterflies of Australia by I.F.B. Common and D.F. Waterhouse. Second Edition. Angus and Robertson, 1981, 682 pages, 28 colour and 21 half-tone plates. \$39.95.

This is easily the most authoritative and useful book on Australian butterflies to appear since G.A. Waterhouse's *What butterfly is that?* in 1932. To the present generation its usefulness exceeds that of the 1932 book, not only because of its updating to include the greater amount of information now available, but because of the additional illustrations.

The early chapters of the book include explanations or at least discussion of such topics as mimicry, eye-spot patterns, association with ants, courtship patterns and migration. Despite the general accuracy of these chapters, chapter 6 commences with a quite erroneous definition of natural selection. The definitions of species given on page 32 and particularly on page 77 and the interbreeding test mentioned on the former page will tend to reinforce the still widespread belief that distinct species are necessarily intersterile or at least that the F1 hybrids are sterile. This situation, 44 years after the first publication of Dobzhansky's *Genetics and the Origin of Species*, I find discouraging.

Some space is given to discussing the geographic subspecies of the sword-grass brown, *Tisiphone abeona*. This is the best documented case of intraspecific variation in an Australian butterfly and should help the beginner to understand the subspecies system so extensively used by butterfly workers, who tend to ignore, rather than answer, critics of the system.

After a short chapter on methods of classification and nomenclature, one reaches the section of over 500 pages devoted to descriptive and other information on the individual butterfly units of classification including the species. This section is of prime importance to serious students of the butterflies not only in informing them of the status of knowledge that has been reached for each species, but as an aid to identification of the species and genera. Butterflies, like any other large group of animals, have difficult groups of species where accurate identifications are made only after careful examination of inconspicuous details. Often the text includes statements which will help in identification when a glance at the illustrations does not. Unfortunately there are cases where this is not so, and I feel that the provision of taxonomic keys to genera and species would have provided clarification in many places, even if not absolutely necessary throughout. Among the satyrine genera, Browns, the distinguishing characters of *Argynnina* (p. 330) are the same as those given for *Nesoxenica* (p. 352). Also,

the differences between the species of *Oreixenica*, silver xenicas etc, all but one of which could be regarded as difficult, are not stated, and a key seems essential.

Keeping abreast of the times in classification and nomenclature is difficult in a book of this nature on several counts, one of which is deciding which recently published revision to follow. Dr Common has wisely adopted a moderately conservative course and in a number of cases has avoided the excessive splitting of genera, such as *Danaus*, *Vanessa* and *Candalides*, advocated by some authors. On the other hand he has now made the change from *Argynnis* to *Argyreus* for the fritillary, a necessity long apparent to some. The general use of scientific names, with common names appearing only in sub-headings, if at all, may be daunting to some would-be readers, but is inevitable. No system of common names yet proposed is adequate for even the species-level identification of such a complex fauna as our butterflies.

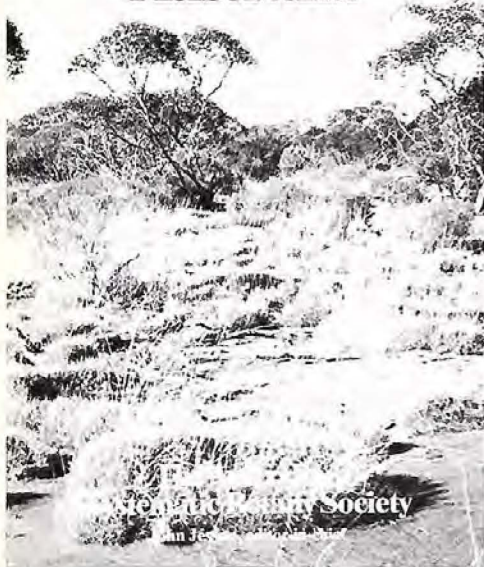
The descriptive section is that which owes most to the late G.A. Waterhouse, and the authors freely acknowledge their debt. Many passages, if not exact quotes from the 1932 book, *What Butterfly is that?*, at least appear to be paraphrased from it.

The very extensive illustrations are the most helpful section of the book for those making identifications, yet in some ways they do not live up to expectations. This is largely due to their long and varied history. All but three of the colour plates of adult butterflies were prepared by Neville W. Cayley for *What Butterfly is that?*. In that book some of the colour reproduction was not very accurate and some figures were too small to do justice to the subject matter. For the new edition the Cayley originals have been extensively retouched by Dr Common and a third new colour plate is added. Unfortunately the new blocks for these are almost as small as those for *What Butterfly is that?* and the colouring is often too dark, especially in the brown and reddish tones, so there is some loss of detail.

Captions to the illustrations include a factor for determining natural size of the adults, but not, strangely, of the larvae and pupae. It might be better to have some measurements in millimetres in the descriptive text. I noted one case, *Charaxes latona*, plate 45, figure 8, where the size factor is incorrect.

Because *Butterflies of Australia* is such an excellent summary of what is known, it enables one to evaluate the progress of butterfly science in Australia. — David McAlpine, Curator of Entomology, the Australian Museum.

Flora of Central Australia



Flora of Central Australia by the Australian Systematic Botany Society, A.H. & A.W. Reed, 537 pages, \$35.00.

It gives cold comfort to realise that approximately half of the Australian continent possesses a vegetation practically undisturbed by man. Floristically the coastal plains and tableland areas have been mauled and muddled to such an extent that it is becoming difficult to determine natural vegetation. This is especially true in alpine areas, the fast disappearing rainforests and coastal sand-dune areas, the broad sweeps of the Darling Downs, the fertile plains of south-western Victoria and the Western Australian wheat-belt. The extensive and continuing urbanisation which our society now requires is rapidly replacing the natural vegetation in less fertile areas. In this context the *Flora of Central Australia* has made a timely arrival helping to inform, and make us aware of what is really involved in the flora of this vast area.

Produced by the Australian Systematic Botany Society, the book is a great credit to the members of that dynamic organisation and especially to its Editorial Committee and its Editor-in-Chief, John Jessop. Containing contributions from over 70 writers, *Flora of Central Australia*, draws on an inordinately immense range of material which would probably not have been published if left to the labours of one author.

The committee has chosen to illustrate and describe the flora of a 'central' Australia which consists of what John Beard calls 'the central core of the Australian Arid Zone'. This zone is much more extensive than that area of the Northern Territory usually identified as central Australia. Here it includes a large part of Western Australia and considerable areas in south-western Queensland, north-western New South Wales and northern South Australia.

The introductory section explains the aims of the committee and their approach to the problems of accomplishing their self-inflicted task within a period of three years. It was desired that publication coincide with the XIII International Botanical Congress. That it was completed so quickly and at such a generally high standard disarms the critic of minor detail.

The historical section, presented by J.H. Willis, is an informed account of the discoveries made in this inhospitable country. Willis recites not only the efforts of the collectors who traversed the land, but he also provides interesting information on the disposition of their collections. The general account of the vegetation by J.S. Beard, accompanied by beautiful illustrations, is full of information germane to an understanding of the distribution and grouping of plant species in this huge region.

The format of the main section is that of a conventional Flora, presenting a most satisfactory selection of data for a one-volume work. It is in botanical order, each plant group is preceded by a key and each family, genus and species is concisely described. Synonymy is minimal, and common names restricted to those in general use. The notes of distribution and field-occurrence are succinct but informative. This is not a rich flora, having less than 2,000 species, but it is varied and of considerable scientific significance. Its origins are probably relatively recent but the history of many of its elements has yet to be elucidated.

For the lay reader this book presupposes some familiarity with the working of botanical keys and interpretation of a stylised format. Allowing for that requirement the book provides a rare opportunity, — any reader, with the aid of the extensive and illustrated glossary and the clear and informative line-drawings, can feel confident of being able to identify the plant he has found.

The general appearance of *Flora of Central Australia* is pleasing. The print is clear, the text well set-out and the drawings uncluttered. The printer has not been kind to the coloured illustrations and has been haphazard about type face in places, but these discrepancies are minimal compared with the botanical value of the work. To have this synthesis of current taxonomic opinion about so many groups from an area of such interest and so ripe for further study, and to have it in such a pleasant and transportable form is a credit to all concerned.

There is no doubt that the political and economic development of these regions will cause the environment to feel the bruising hand of man within the next few decades. It is to be hoped that this book will long remain a guide and illumination, rather than a monument, to the flora of Central Australia. — Joy Thompson, *Botanist, Royal Botanic Gardens, Sydney.*

Whitley Awards

The Rodents of Australia by C.H.S. Watts and H.J. Aslin, published by Angus and Robertson has won the 1981 Whitley Medal.

Presented annually by the Royal Zoological Society of New South Wales, the awards are given for books on the natural history of Australian animals.

Whitley Medal Winner — *The Rodents of Australia* by C.H.S. Watts & H.J. Aslin. Published by Angus & Robertson.

An Outstanding Publication — *Australian Parrots* by Joseph Forshaw, illustrated by William Cooper. Published by Lansdowne Editions.

Best Field Guide — *A Field Guide to the Birds of Australia* by Graham Pizzey. Published by William Collins.

Best Children's Book — *The Friends of Burramys* by June Epstein. Published by Oxford University Press.

Best Environmental Book for Children — *Looking at the Wild* by Harry Butler, illustrated by Tony Oliver. Published by Hodder & Stoughton.

Best Illustrated Book — *Birds of Australian Gardens* by Tess Kloot and Ellen McColloch, illustrated by Peter Trusler. Published by Rigby.

Best Limited Edition — *Nocturnal Birds of Australia* by Richard Schodde and Ian Mason, illustrated by Jeremy Boot. Published by Lansdowne Editions.

INFRA-RED PHOTOGRAPHY IN FOCUS

Amazing colour effects can be obtained from colour infra-red (CIR) aerial photography as shown by these examples from the Forestry Commission of New South Wales. The CIR film gives spectacular colour contrasts as healthy vegetation reflects the infra-red radiation while artificial surfaces and open, clear water areas act as strong absorbers.

Scientists working with vegetation have successfully employed this film for the detection of stress in the growth of plants. Prime users have been people working with agricultural crops, but foresters have also suc-

cessfully used CIR film. In Western Australian forests the film is used for surveying and detecting the onset of Jarrah 'dieback' (banksia species are first affected by the dieback fungus and gradually turn yellow). Again in WA and in New South Wales, CIR film is being used for detecting the effects of prescribed burning operations in State Forests.

The examples pictured here demonstrate the sorts of situations where this film can have an added value over normal film. It must be recognised that the colour range is purely ar-

tificial—different colour dyes have been arbitrarily assigned to each of the three sensitive layers of the film. Healthy vegetation in these pictures is dark red and not the conventional green. Dying foliage or vegetation can be various tones of straw colours, and dead vegetation (or burnt) tends to be greenish or blueish tones. Some colour differences can be the result of differences in vegetation type and this is of value in botanical identification.

Fire damage in the heath along the Budawang Range, NSW





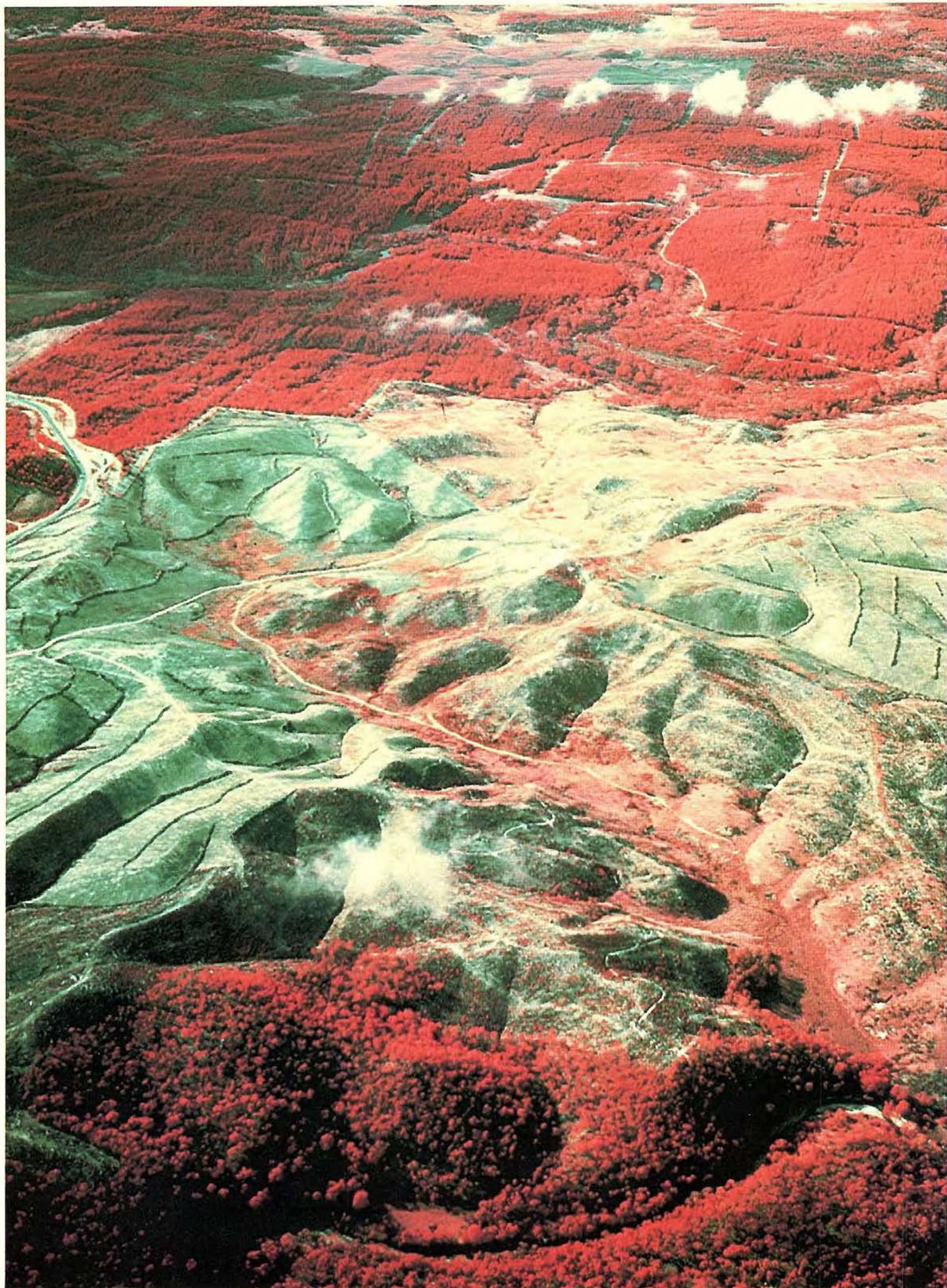
Top, swamp near Moruya Airport.

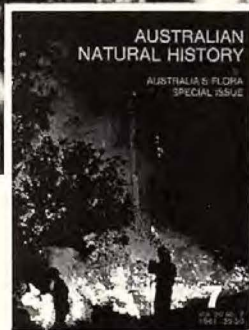
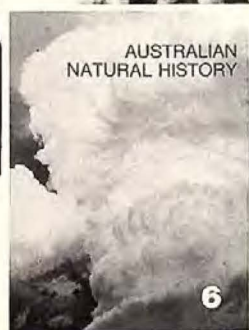
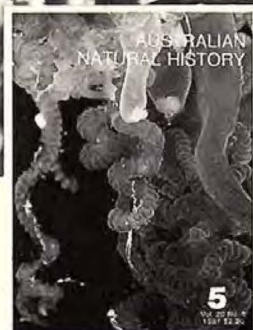
Left, Nerriga private pine plantations on the Shoalhaven River.

Opposite, the lower Clyde River looking east from Nelligen towards Bateman's Bay.

On page 316, a recently cleared area near the Shoalhaven River.







THE WORLD OF AUSTRALIAN NATURAL HISTORY

No. 5 Venomous Australian Animals. All you need to know about stingers, biters and scratchers. Plus turtles, and cuttlefish.

No. 6 Dingoes — Friends or Foe? An intensive study of this controversial dog. Plus Native Orchids.

No. 7 Australia's Flora — Special experts write about Australian native plants — pollination by birds, bees and possums — continental drift and the origin of Australian plants. Mans effect on native flora.

No. 8 Funnel Web Spiders — the facts and myths — antivenene and treatment. Plus the woodchip controversy and the future of Terania Creek, Australia's best known rainforest.

Backnumbers available now

(at the cover price plus a \$A1.00 service charge)
Fill in the subscription form provided specifying issue of interest.

COVER

The Common Wombat, *Vombatus ursinus*, is one of three species of wombats occurring in Australia. Found in the mountainous sclerophyll forests of southeastern and southern Australia, the Common Wombat's only natural predators are dogs and dingoes. Photo Keith Gillett.