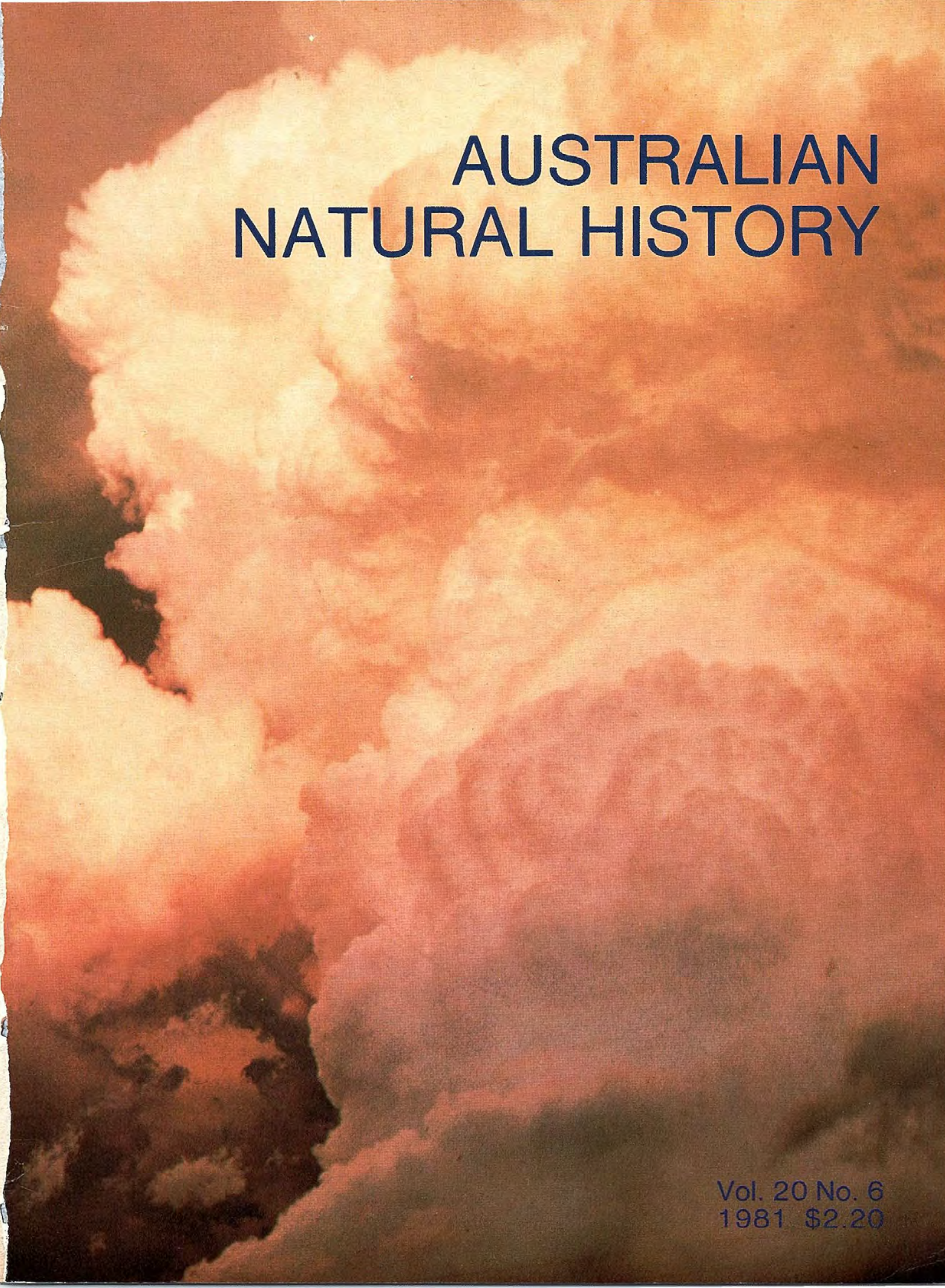

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This sun orchid, known as *Thelymitra truncata*, is thought to be a natural hybrid between two commoner species, *T. ixioides* and *T. pauciflora* (or *T. nuda*). Obviously hybridisation is an uncommon or local phenomenon, or the parent species would lose their distinctness. Photo D. McAlpine.

Altocumulus developed from a sheet of altostratus provided this memorable dawn near Mt Watt, Central Australia. Photo Robert Jones.

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Roland Hughes

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CIRCULATION
Bruce Colbey

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

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FROM THE INSIDE

A dingo inspecting the carcass of a water buffalo in western NSW. Dingoes have been regarded as pests by farmers and graziers ever since the start of European settlement and the development of a large pastoral industry. As a result of their occasional attacks on stock a militant campaign was initiated to eradicate them. Photo E. Slater.

With the opening of a new Australian mammal's gallery in September (article on page 185 of this issue) attention is focused on the effects of European man's impact on native Australian fauna during the relatively short period since colonisation.

As one proceeds through the gallery a number of startling statistics on the problems faced by terrestrial mammals soon becomes apparent. Already 17 species are extinct, 25 are in serious danger of extinction and a further 72 known species suffer a major decline in distribution and numbers. One of the main reasons for this rapid decline is the policy which promotes the continual clearing of natural habitats containing diverse natural ecosystems.

This on-going devastation has been highlighted recently by the bitter dispute raging over certain areas of rainforest in northern NSW. With tropical and sub-tropical rainforests supporting 49 species of native mammals stretching from Cape York in northern Queensland through to the rainy west coast of Tasmania, the importance of these areas as habitats becomes clearly evident.

Far removed from the scene of the controversy but deeply effected by the outcome, Australians generally could be forgiven for being a little confused over the battle taking place between the loggers and conservationists. The argument is a bitter one with the sawmillers using the fear of unemployment as their banner and the conservationists specifically using rainforests as the last examples of 'true wilderness areas'.

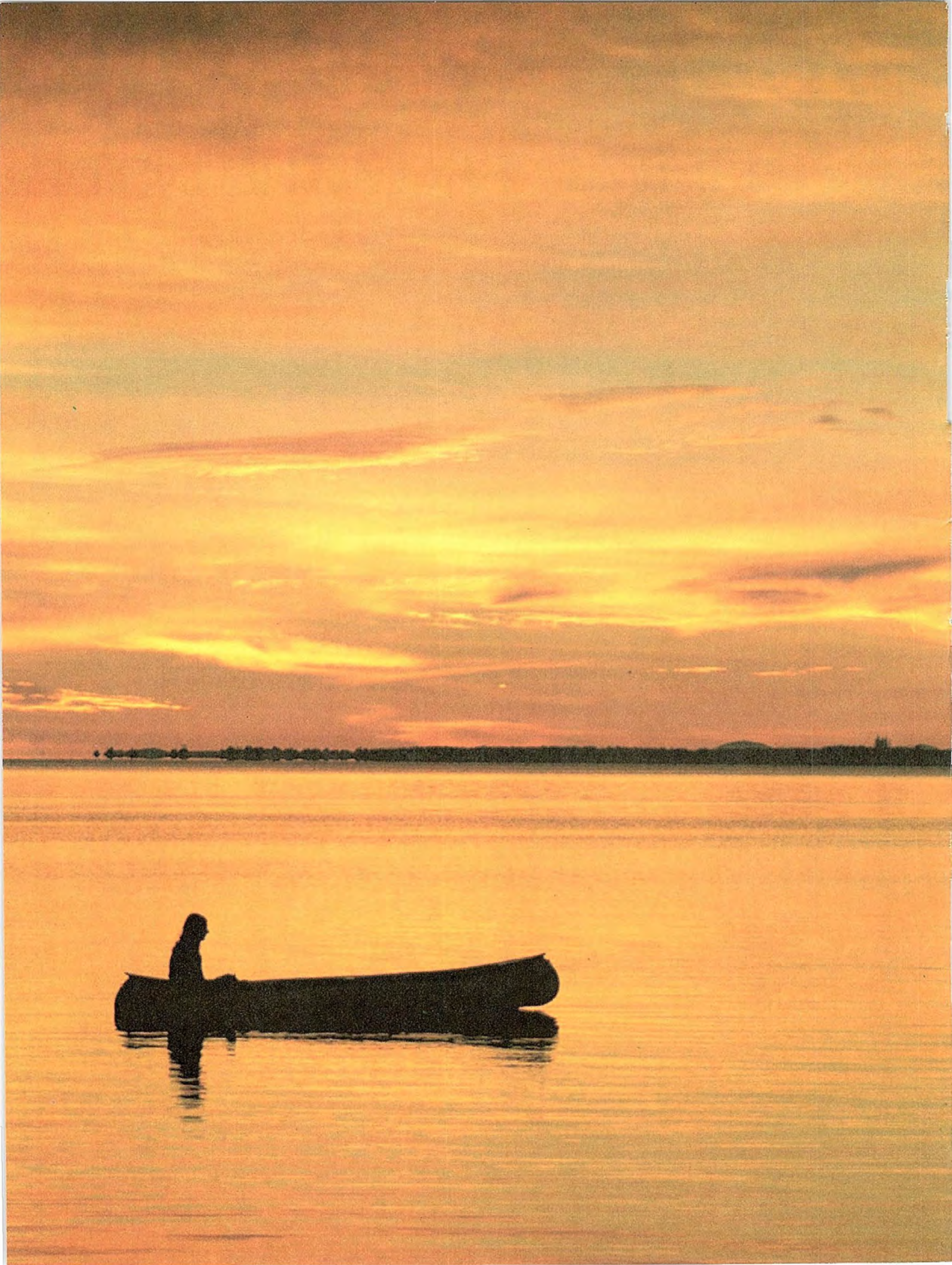
In the Washpool dispute in northern NSW, the loggers and conservationists agree in principle to a number of alternatives, primarily the use of other timbers such as certain eucalpyt species, poplars and radiata pine, to supplement rainforest timber. Two other plausible solutions include the re-afforestation of marginal, over-cleared agricultural land on the northern NSW coast and for rainforest mills to change over to regrowth logs from the State forests.

While rainforest originally covered one per cent or approximately eight million hectares of Australia before 1788, today it covers less than two million hectares and is the ever-decreasing home of a number of mammals restricted to these habitats.

Regrettably our knowledge of rainforests is slight and only a few of the animal species occurring in rainforests have been studied. As Australia is a rich nation which can well afford to temporarily suspend rainforest logging, the immediate solution is to call a halt until more information is gathered.

The next issue of Australian Natural History will be the annual special issue and with Sydney playing host to the 13th International Botanical Congress during the last half of August, the issue will treat some aspects of Australian flora. Topics covered will include the characteristic plants of Australia, pollination and evolution, Australian flora and continental drift, and the effects of fire, climate and man on flora.

Roland Hughes
Editor



PAGEANTRY IN THE SKIES

Clouds with their varying shape and appearance have always held man's interest and aroused speculation. Recently the long-standing drought, which covered most of eastern Australia, focused people's attention on clouds and their potential as rain producers. Now, with satellite photography of cloud cover appearing nightly on television weather forecasts, the public can gain an appreciation of large-scale weather circulation systems and their significance in weather forecasting. Julian Hollis is well-known to readers as a regular contributor to Australian Natural History. Apart from his specialisation in mineralogy he takes an interest in a number of other topics, one of which includes the reading of clouds.

by Julian D. Hollis

Above, medium-height cumulus on a hot afternoon in outback Australia. Vertical growth of these clouds is insufficient to produce storms and the sky can be expected to clear at sunset. Photo courtesy of the Bureau of Meteorology.

Left, a tranquil sunrise at Port Stephens, NSW, featuring a fine display of the high-level ice clouds cirrus and cirrostratus. Photo Robert Jones.

Clouds can be a major source of fascination and pleasure, with their constantly changing patterns and moods. Their passing succession of forms range from the delicate to the violently spectacular. Even a grey, rainy day is seldom entirely monotonous. Clouds are not only an interesting feature to everyday life but they also provide the means of controlling the very water supply on which life depends. Some clouds contribute to the great dramas that few can ignore, as in the thunderstorm or the sheer beauty of a sunset.

The seemingly interminable 1979-81 drought over much of eastern Australia has heightened many people's appreciation of clouds and their significance as rain-producers or otherwise. Indeed, a keen and experienced observer of local weather can forecast with remarkable accuracy, by watching the behaviour and movements of clouds. The advent of regular satellite photography of cloud cover has led to a new appreciation of large-scale weather circulation systems and their significance in weather forecasting.

In 1803, Luke Howard, a London pharmacist, proposed a system for identifying the different cloud types. He differentiated between layered forms (stratus), heaped forms (cumulus) and hairlike forms (cirrus). He termed a rain-cloud 'nimbus', a term no longer used on its own. His system has been developed to the current classification scheme, which is fairly close to the original.

Clouds are formed when air containing water vapour is cooled or moistened beyond its saturation point. The cooler the air becomes, the less water it can hold, until visible, suspended droplets appear. In the atmosphere air-masses are cooled either by contact with cold surfaces or when air is expanded by lateral or vertical movement into regions of lower pressure. Vertical development of clouds is limited to the lowest few kilometres of the atmosphere, termed the troposphere. Only a few exceptionally vigorous storm clouds briefly penetrate above the troposphere into the stratosphere. (There are stratospheric clouds composed of faint streaks of water vapour and dust particles, comprising noctilucent and mother-of-pearl clouds, but these are very rare curiosities.)

There are five major modes of cloud formation which may act in conjunction with each other:

Orographic or forced ascent. There is a greater chance of air being raised to saturation over mountain ranges. Even small relief features such as a cliff or island may provide sufficient uplift in a moist airstream to generate cloud.

Convectional. Solar heating of land surfaces generates low-level parcels of air that are warmer than their environs. These are buoyant and rise to condensation level and develop cumulus clouds. In a deep, 'unstable' atmosphere, one that shows a large decrease in temperature with height, large cumulonimbus clouds may result, giving showers and thunderstorms.

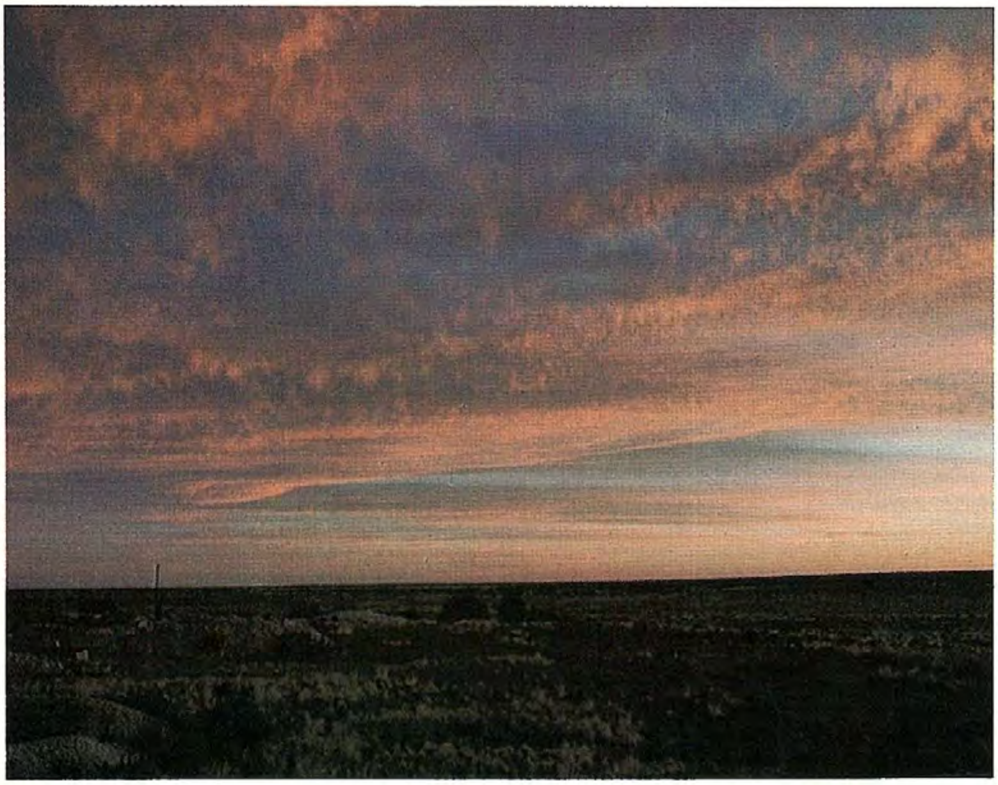
Advectional. Cold, moist air flowing across warmer water frequently generates cloud. If the cold air is shallow, extensive layer cloud or fog results, but a deep airmass can produce major instability with rain and storms. Conversely, sea fog can develop when relatively warm, moist air is forced to cool during its passage over cold water.

Frontal. Lifting of airmasses is effected by the invasion of air having different temperature and moisture characteristics. Along cold fronts, cooler air wedges beneath warmer air result in cloud bands that give a large proportion of the precipitation in the southern states. In spring, when the temperature contrast between airmasses is greatest, cold fronts can produce vigorous lines of thunderstorms.

Cyclonic. Areas of relatively low atmospheric pressure are sites of clockwise-spiralling air in the southern hemisphere. As the air streams towards lower pressure, it expands and condenses, generating deep clouds and rain.

The study of cloud physics now provides us with a good understanding of the main processes embodied in cloud formation and propagation. Instead of forming ice crystals, most cloud droplets remain in a liquid state at temperatures well below freezing point and are thus 'super-cooled'. Minute particles, such as dust or sodium chloride, are required as nuclei before freezing will occur. Even at −10°C only one out of every million cloud droplets is likely to be frozen and at −30°C there may be only a few hundred.

Once frozen, a crystal will act as a catalyst and freeze droplets on collision. Below −40°C 'glaciation' or total freezing of a cloud may take but a few minutes. Ice crystals accumulate and freeze cloud droplets so that they become larger. Branching arms from the ice crystals are shed, providing a fallout of ice splinters that provide new centres for growth.



Above, a group of small cumulonimbus clouds with showers over Maralinga, SA. These clouds grew from towering cumulus, their tops being converted to spreads of ice-crystals. Photo courtesy of the Bureau of Meteorology, Melbourne.

Left, dawn over White Cliffs, NSW. Snow crystals falling from a layer of cirrostratus are slowly evaporating in the clear air, resulting in festoon formations. Photo Robert Jones.

Below, altocumulus showing lenticular forms often seen during warm, windy weather near hilly country. Middle-level clouds of this type may form some hours ahead of a cooler wind change. Photo courtesy of the Bureau of Meteorology, Melbourne.

At temperatures below $-40°C$ crystals can grow in saturated air without active nucleii and trails of snowflakes may be shed in their wake, as in some cirrus clouds. Evaporation of ice clouds is slower than for water clouds so that they survive long after lower level clouds have disappeared. They are also capable of mixing with the surrounding air and becoming very diffuse.

Rain falls only after many thousands of cloud droplets aggregate around suitable nuclei forming drops of at least 0.1mm diameter. Sodium chloride and various dust particles typically provide these active nuclei, but their numbers are critical in determining whether raindrops of sufficient size to fall out of the clouds, will form. In drought conditions, there may be too many nuclei and not enough water vapour, hence the resulting drops will be too small to survive the fall to earth.

Often, large and thick clouds, notably cumulus and orographic formations, lack sufficient nuclei for precipitation development. Rain may be initiated or increased by artificial 'seeding' of clouds with frozen carbon dioxide or silver iodide crystals to act as nuclei for droplet formation. Seeding of a major storm cloud can lead to premature glaciation and prevent the formation of large hailstones. Many small ice crystals form rather than a few damaging lumps of ice.

Cirrus, cirrostratus and cirrocumulus are all ice clouds, typically occurring at heights of 7 to 10km in the middle latitudes. They are easily recognisable by their fibrous to diffuse formations that often have a silvery-cream appearance when compared to lower clouds. Cirrus develops delicate whisps, often with curved and drawn-out tails of ice crystals. Cirrostratus forms a featureless, diffuse cover, through which the sun appears as through ground glass, often having a halo. Cirrocumulus develops as exquisite small heaps and turrets, often finely patterned.

The cirrus group tell the observer what winds are like at high levels in the troposphere, as their directions of movement and translations of form are often clearly visible. They frequently provide useful warning of approaching fronts up to a day or more in advance, although isolated patches and transient cloudlets usually mean little. When these clouds increase and thicken steadily from the north-west, significant rain often follows. In drought situations, however, cirrus movement is often from the south-west and this is a good sign that the next frontal passage will be dry.

Layered to small-scale heaped clouds at levels between about 3 and 7km are mostly composed of super-cooled water droplets. They are a frequent feature of summer, especially altocumulus which indicates developing instability. Altostratus forms a dense overcast that obliterates the sun. This

Above right, cirrocumulus form some of the most delicate cloud features resulting from the small-scale sprouting of a cirrus layer.

Right, altocumulus in small turreted cloudlets constitute the variety called floccus and form in unstable middle levels. Photos courtesy of the Bureau of Meteorology, Melbourne.

Cloud Classification

	High	Medium	Low
Streak (Hair-like)	**Cirrus**	—	—
Sheet (Layered)	**Cirrostratus**	**Altostratus**	**Stratocumulus Stratus**
Heaped	**Cirrocumulus**	**Altocumulus**	**Cumulus**
Rainclouds (High, medium and low)	**Cumulonimbus (showers and thunderstorms) Nimbostratus (raining layer cloud)**		

As with most classifications, this system is not completely satisfactory and all kinds of overlaps and combinations occur. Various prefixes and qualifying terms are added, where necessary; for example, fracto- to indicate a ragged formation and mammatus to describe pouch-like protruberences on the undersurface of a cloud.

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Thunderstorm imminent—prepare to take cover! This series of photos show the characteristic development ahead of a severe thunderstorm. 1. Heavy cumulonimbus releases a gush of intense precipitation. 2. Cold air is dragged down to spread laterally as a violent squall beneath a menacing arch of racing cloud. 3. When the storm is slow-moving the squall cloud spreads away from the observer forming a high 'vault' between the squall and the rain gush, in this case with well formed mammatus. 4. Such extreme turbulence precedes a hailstorm and rarely a tornado. All photos courtesy of the Bureau of Meteorology, Melbourne, except photo 1. by Howard Hughes, the Australian Museum.

often develops from the lowering of a cirrostratus layer ahead of an approaching front. Such a layer may produce rain, at which stage the cloud is known as nimbostratus. Altocumulus assumes a wide range of lenticular and sprouting forms that often develop as waves. These wave developments are typical in the lee of highland areas during strong north-westerly winds. Those warm and windy days of winter and spring that are common in Melbourne and Sydney often see the formation of these deep lee-wave clouds that develop in place and remain until the frontal south-westerly change passes.

When altocumulus assumes groups and lines of strongly sprouting cloudlets (the varieties castellanus, in banks and floccus when separate) unstable middle level conditions are indicated. These frequently warn of approaching thundery weather especially if the lower levels are moist. Sometimes altocumulus castellanus will form deep banks and glaciate to form small but electrically violent thunderstorms. Little rain falls and these storms are responsible for starting many bushfires.

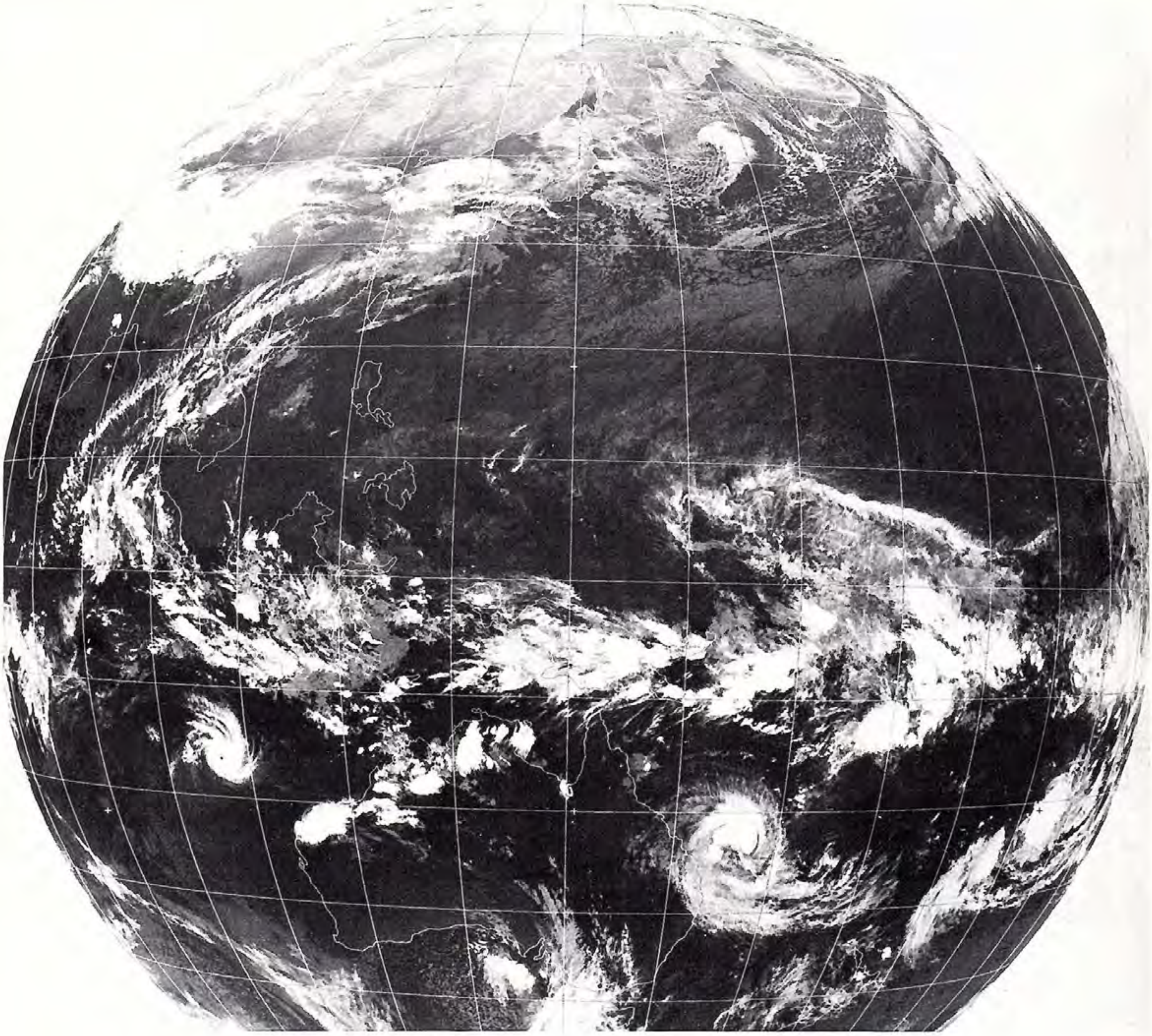
Clouds occupying the lowest 3km of the atmosphere are by far the most abundant. Stratiform types can occur as complete covers for long periods when the air near ground is moist and an inversion is established. Sheets of stratocumulus are a common feature across the southern marginal areas of Australia, especially in late autumn and winter when inversions are associated with strong anticyclones. Although the sky may look drab and rainy, stratocumulus is too thin and low to give more than a little drizzle. Stratus is a featureless layer cloud that is based within 300 metres of the surface. It develops from saturated air between spells of rain and also in valleys during still nights. Over highlands it produces the typical 'mountain mist'

Diurnal heating in the lower levels produces the small, heaped cumulus, which usually have their size and vertical growth limited by stable or dry air aloft. Individual cloudlets form and decay as successive parcels of warm air rise. When the atmosphere is unstable below a warmer layer (inversion), the cumulus will grow strongly and then spread to areas of stratocumulus. Thus a sunny morning under these conditions will be transformed to an overcast afternoon.

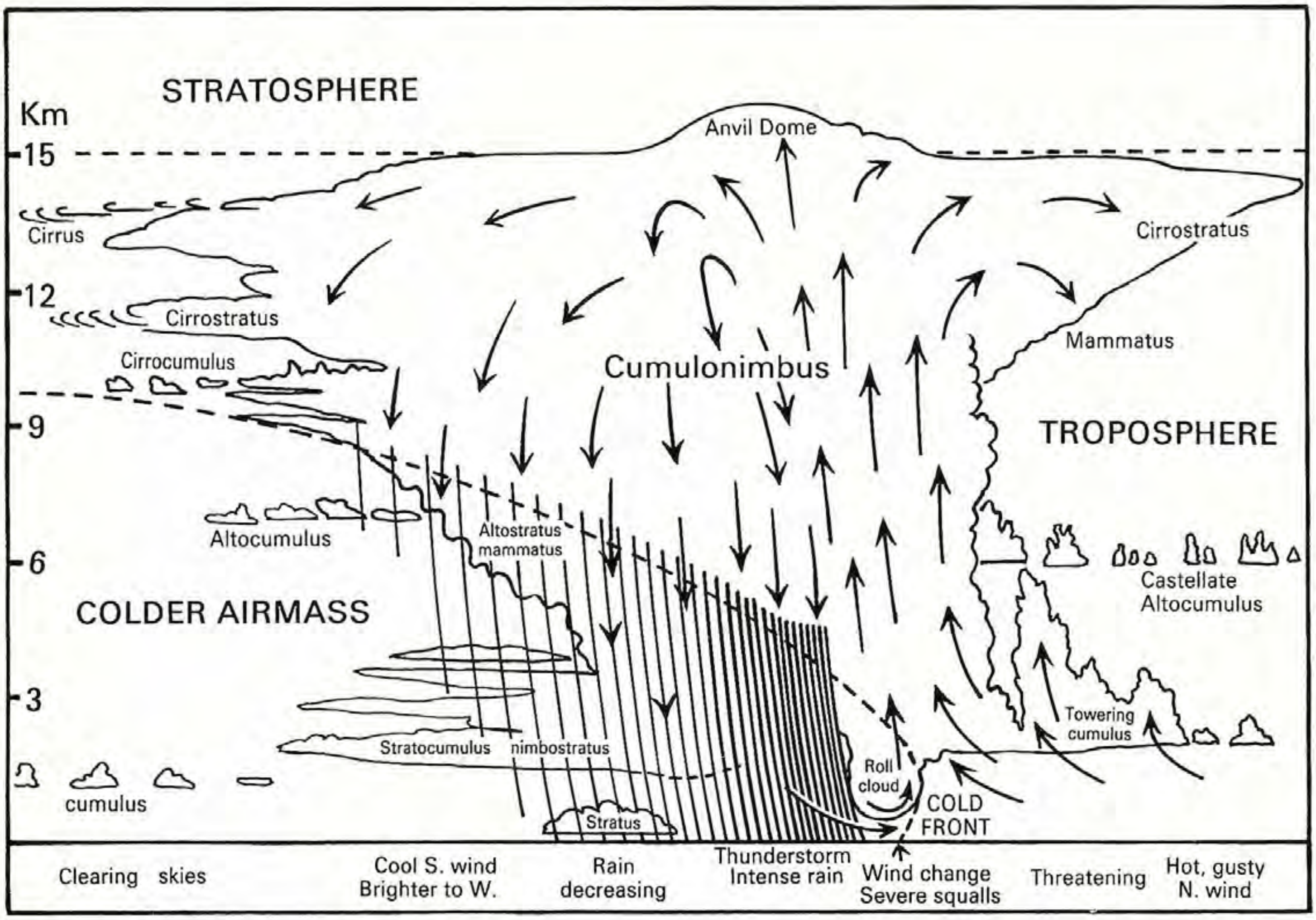
Storm clouds are notable for their great vertical extent, encompassing development at all levels of the troposphere. They are generated when large depths of the atmosphere become unstable, being triggered by convection and sometimes enhanced by orographic and frontal ascent. At heights of over about 7km the cloud tops glaciate and seeding of super-cooled cloud droplets by the falling ice crystals generates a massive precipitation.

A typical scenario for a diurnal thunderstorm over the hot inland starts with an abundant supply of moisture and an atmospheric temperature profile that shows continuous cooling with height. As surface heating increases, small cumulus appear and then tend to clump in towering groups. Often by midday, a first cumulonimbus appears with its fleecy cirrus top formed by glaciation. Shortly before this stage, there will be a very local fall of large raindrops beneath the cloud. These initial shower clouds often break up quickly, leaving a detached cirrus top to slowly evaporate. However, the stage is set for progressively larger and more vigorous cumulonimbus to develop, particularly in the vicinity of the first shower. By mid-afternoon the first enormous thunderstorm-cumulonimbus will appear.

A large cumulonimbus is one of the most impressive sights in the sky, with its massive anvil-shaped spreading canopy of dense ice-cloud above a billowing mass of rapidly rising



A satellite's view of the earth with its cloud cover at 12 noon GMT on the 18th February, 1981. The Australian region shows many of the typical weather systems associated with summer, notably the cyclonic swirls of two tropical cyclones, monsoonal thunderstorms in northern and north-western Australia and in the southern areas, bands of clouds developed along cold fronts. Speckled cloud in the Bight indicates cold, showery air. A wide band of dense cloud patches just south of the equator marks the inter-tropical convergence zone (ITCZ). Extensive cloud cover in the northern hemisphere typifies winter circulations with organised frontal bands produced by the interaction between temperate and polar airstreams. Photo courtesy of the Bureau of Meteorology, Melbourne.



cumulus. Sometimes the strongest uplift area forms a dome near the centre of the anvil, penetrating the tropopause for about a kilometre. Intense rain and sometimes large hail falls as a gush. The precipitation drags down cold air which spreads out ahead, and to a lesser extent to the sides of the storm. Rarely, a tubular vortex cloud—the dreaded tornado—will descend. The mini-cold front generated by the downdraft may generate a sinister black roll-cloud of its own, known as arcus, which is heeded by yachtsmen as a warning of imminent severe squalls.

Once well established, a thunderstorm may be regenerated by fresh cloud growth for several hours after sunset, but the systems degenerate from then on. Decaying cumulonimbus develop a fine array of clouds at many levels—cirrus and cirrostratus from the anvil region, sprouting altocumulus and altostratus layers in the middle regions and relict cumulus and fractostratus from the mixing of air having different moisture and temperature characteristics nearer the ground.

Cumulonimbus clouds are also generated by the passage of cold air over warm seas, as is a common autumn feature off the eastern Australian coasts. The temperature contrast between the southerly air of polar origin and water of tropical characteristics leads to great instability. For this reason an otherwise dry cold front may sweep seawards to be followed by almost explosive cumulonimbus generation offshore. Rarely, clouds can grow to almost 20km and produce vivid lightning displays.

The undercutting action of an invading colder airmass can also generate cumulonimbus; often along a well-marked band. These cold fronts are then experienced as a line squall or 'southerly buster'. They cause havoc for the unobservant yachtsman, structural damage on land and attendant flash flooding, hail damage and lightning strikes from violent thunderstorms. Line squalls are most common along the coasts of the southern states during the spring. A well-developed line squall system shows all the characteristics of a strong diurnal thunderstorm, except that the cloud systems contract with the movement of the cold front. Movement is often rapid and less than an hour's warning can often be given for such storms. The appearance of low and threatening clouds to the south-west on a hot day must always be regarded with suspicion, especially when radio reception is bugged by 'sferics', the crackling noises produced by lightning flashes. A rapidly advancing line of very dark rolling 'arcus' cloud is the sure sign to batten down immediately and enjoy a fine atmospheric show of fury.

The cross-section through a vigorous cold front (southerly buster) which has an approximate width of 200km. The cold frontal surface is marked as the lower dashed line and relative vertical movements are arrowed.

Every area has its own local weather peculiarities, due to microscale features of topography, the proximity relative to highlands, water and vegetation, which modify the types of cloud and their behaviour. Bearing in mind the main cloud characteristics, a regular check on the skies will not only reward one with some indication of likely future weather but also a whole constantly changing dimension of natural experience.

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AMAZING ORCHIDS OF SOUTHERN AUSTRALIA

Orchids, one of the largest and most varied families of flowering plants, are particularly interesting for their adaptation to the environment and the intricate mechanisms by which the flowers are pollinated. David McAlpine, as Curator of Entomology, is particularly interested in this aspect of orchids and in the past has contributed a number of articles to Australian Natural History on this subject.

by David K. McAlpine

***Caladenia alba* is known as the white caladenia though the flower is sometimes pink. The fact that the species shows little structural difference from the related *Caladenia catenata* (*C. carnea* in most literature) has led some mistakenly to regard it as a colour variant of that species. In 1882, long before the general recognition of sibling species and the establishment of the science of population genetics, R. D. Fitzgerald wrote with remarkable perception of the 'innate distinctness' between the two species. Fitzgerald also noted ecological differences between *C. alba* and '*C. carnea*'. Photo David McAlpine.**

Orchids to many people still mean plants of steamy tropical forests, or equally steamy hot-houses, sporting huge vivid flowers. Australia has its share of tropical forest orchids, but here, as in the temperate zone, only the exceptional species have large vivid flowers. Australia's orchids are remarkable not so much for the splendour of their flowers, as for their adaptation to the Australian environment and the intricate mechanisms by which the flowers are pollinated. These mechanisms are often themselves adaptations to the Australian environment in that some depend on certain endemic Australian insects to effect pollination.

The variety of form found in orchid flowers as well as the variety in the vegetative parts is remarkable for one family of flowering plants, and has attracted botanists from almost the beginning of Australian history. The first botanist to investigate our orchids systematically at first hand was Robert Brown (1773-1858) from England. Together with the botanical artist Ferdinand Bauer he sailed Australia's coasts with Matthew Flinders, the man who first proposed the name Australia for the Island Continent. At the very beginning of the nineteenth century Brown collected and soon afterwards described and named a surprisingly large proportion of the familiar Australian orchids. Among the many later workers to study Australian orchids the names of Robert D. Fitzgerald (1830-1892) and William H. Nicholls (1885-1951) stand out because of their magnificent illustrated works.

Orchids are found in all but the very arid parts of Australia. In the tropical and subtropical rain forests most orchid species are epiphytic, which means they grow upon the trunks and branches of trees. In southern Australia most orchids are terrestrial types with potato-like tubers or succulent rhizomes embedded in the soil. Whereas the epiphytes of our northern and eastern coasts represent extensions of a flora widely distributed in tropical lands to the north, the temperate terrestrials are as peculiarly Australian as meat pies and kangaroos. The spider orchids (a section of the genus *Caladenia*), and nearly all the doubletail orchids (*Diuris*, called donkey orchids in Western Australia) are restricted to Australia. While temperate Eurasia and South Africa also have significant floras of terrestrial orchids, the Australian flora has evolved in isolation from these and is quite different.

The temperate ground orchids have mostly acquired the deciduous habit; all parts above ground level die away when the growing season is finished and the fleshy tuber or rhizome survives below the surface during a resting season which coincides with the season least suitable for plant growth. The deciduous condition enables plants to survive extremes of drought, heat or cold, and even fire does not hurt the dormant plants—in fact some orchid species only flower in the season following a bush fire. As much of southern Australia has a mild winter and a dry summer, growth takes place through the winter and dormancy occurs in the summer. Flowering takes place either at the commencement of the growing period (autumn) or at the end (spring). Some kinds flower in summer, particularly at higher altitudes. Above the tree-line in the Snowy Mountains the alpine leek orchids, *Prasophyllum alpinum* and *P. suttonii*, pass the dormant stage below the winter snows and flower in late summer. The elbow orchid, *Spiculaea ciliata*, of south-western Australia often does not reach the flowering stage before the onset of the hot dry summer. Though the base of the flower stem may commence to wither on the hot ground the aerial part of the stem is succulent and provides enough water and nutriment for the flowers to open and the fruits to produce their seed without further support from the roots. Also drought resistant are some of the rufous greenhoods (for example, *Pterostylis boormanii*) which grow in rather arid districts. In an unfavourable season the plant misses the entire season's growth and passes eighteen months or so as a dormant underground tuber. On the theme of living underground, Australia has two orchid species which grow and flower underground. Probably only the mature fruits of the eastern underground orchid, *Cryptanthemis slateri*, break the surface, enabling the seed to be dispersed.

The complexity and variety of orchid flowers are due to the multitude of different ways of pollination, most of which involve the intervention of some insect. Whole volumes have been written on this aspect of orchids alone, and the number of shorter studies is enormous. Only a few examples of the pollination process can be mentioned here.

The tongue orchids of the genus *Cryptostylis* are only pollinated by males of a single species of ichneumon wasp, *Lissopimpla excelsa*. The wasp appears to mistake the flower for a female of its own kind and, in attempting to mate with several flowers in succession, accomplishes the transfer of pollen. The wasp is attracted by the smell of the orchid flower which apparently resembles

(continued on page 184)

Far left, one of the bearded orchids, *Calochilus paludosus*, belongs to a genus widely distributed in Australia and nearby islands. This species occurs in temperate forest areas but is absent from Western Australia.

Top left, the tall greenhood, *Pterostylis longifolia*, resembles the Illawarra greenhood and Boorman's greenhood in its floral mechanism (see text). It is one of many Australian plants discovered by the botanist Robert Brown and named by him in 1810. This plant has suffered some accident during development as the stem is normally vertical.

Lower left, the green-comb spider orchid, *Caladenia dilatata*, has a see-saw type of lip with large green side-sails which rock it in the breeze.

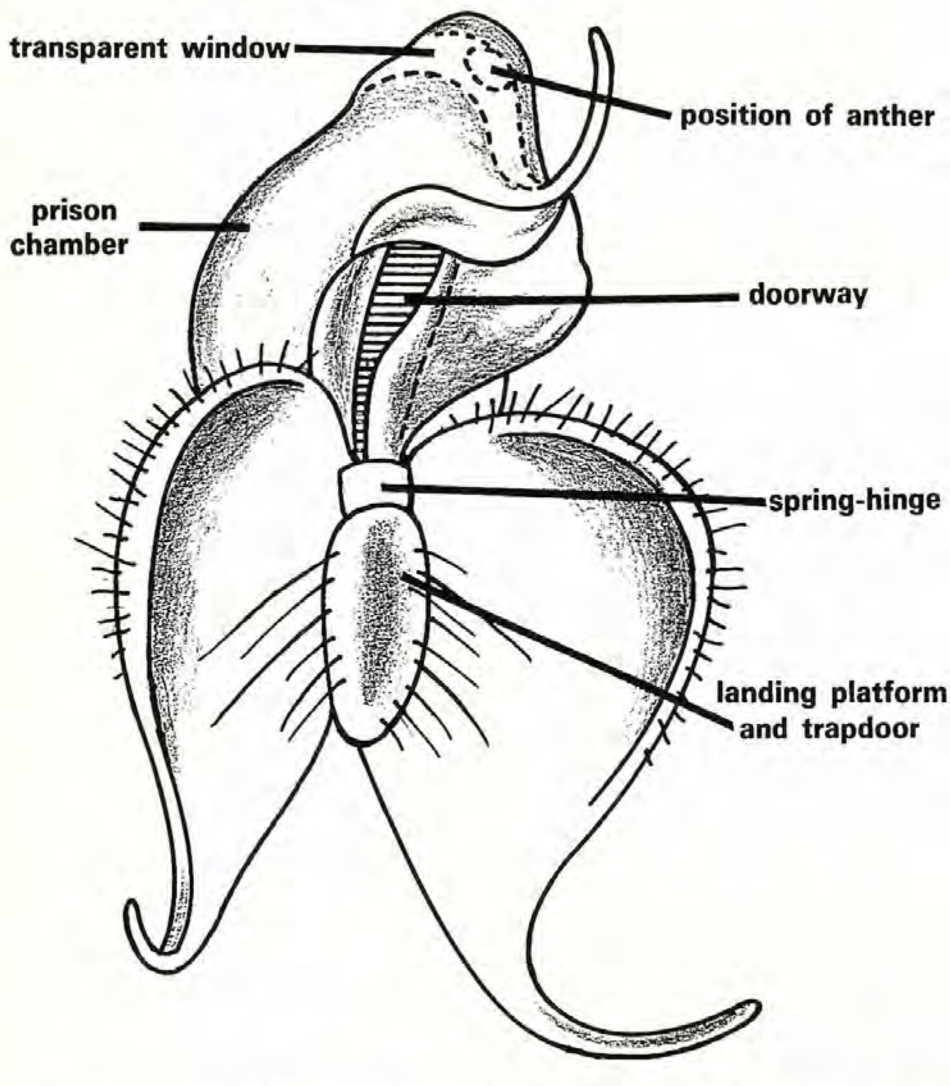
Bottom, the red greenhood, *Pterostylis coccinea*, of the mountains of NSW has flowers of the pitcher type. The slender lip of the centre flower projects in the undisturbed position. That of the flower on the right has sprung inwards, perhaps from contact with an insect. Far left and top left photos by Anthony Healy, other photos by David McAlpine.

Top left, the sun orchids, *Thelymitra*, differ from most orchids in having the median petal (labellum) hardly differentiated from the other petals. This one is the dotted sun orchid, *Thelymitra ixioides*, an abundant plant in many parts of temperate Australia.

Left, the hyacinth orchid, *Dipodium punctatum*, is a leafless terrestrial orchid, but, like the tree orchids, represents a group which long ago reached Australia from the north. Like some other such immigrants it flowers in summer in the southern states.

Top, the tricoloured doubletail orchid, *Diuris sheaffiana*, is a summer-deciduous plant of inland areas of south-eastern Australia.

Above, the green rock orchid, *Rimacola elliptica*, is a very localised plant of wet, sheltered rock faces in NSW. Top left photo by Anthony Healy, other photos by David McAlpine.



Flower of Boorman's greenhood, *Pterostylis boormanii*, an animated fly-trap. Drawing by David McAlpine.

(continued from page 181)

that of the virgin female wasp. I have known several male wasps to enter a room with unfertilised *Cryptostylis* flowers by squeezing under the door—this despite the fact that males form a small minority of the wasp population and are rarely seen at other times.

In a number of Australian orchids we find moving parts contributing to the floral mechanism. The lip (or labellum, the modifed median petal) is often attached by a loose, springy basal hinge. When a bee or wasp alights on the lip of a spider orchid, the lip first sinks under its weight, thus opening up the flower. As the insect proceeds inside it changes the position of its weight on the lip, which then flops over, pushing the insect against the column which bears the reproductive organs. This process, repeated by the same insect on several flowers, gives a fair chance of cross pollination. Rica Erickson, in her fascinating book *Orchids of the West* (Western Australia), likens these flowers to see-saws.

In some orchids the lip quivers in the wind, the long fringes on its margins acting as sails. It is not clear what function this movement serves in pollination, but it occurs in such widely different plants as the greencomb spider orchid, *Caladenia dilatata*, and the fringed leek orchid, *Prasophyllum fimbriatum*, the former pollinated by a male tiphiid wasp, the latter by a minute chloropid fly.

Southern Australia is lucky in having a number of orchids in which the 'irritable' lip moves spontaneously from its own energy source on receiving a suitable stimulus, such as that from an insect. These kinds include the duck orchids (*Caleana*, including *Paracaleana*), one of the bird orchids, *Chiloglottis gunnii*, and nearly all the large group of greenhoods (*Pterostylis*). In orchids of other parts of the world this kind of movement is very rare. I shall here consider the greenhoods further as they include some of the most extraordinary of all flowers.

Flowers of many of the best known greenhoods assume the appearance of the leaves of carnivorous pitcher plants (*Cephalotus*, *Sarracenia*, *Nepenthes*) and like the latter are adapted to catch flies. There are two points of difference, however. The greenhood does not use the trapped insects for food, but only for pollen transfer. And, secondly, a masterly stroke of one-upmanship, it flips the fly into the pitcher with its irritable lip, if it should land upon it.

The most remarkable fly-traps are provided by flowers of several species grouped under the name 'rufous greenhoods'. Of these Boorman's greenhood, *Pterostylis boormanii*, is, literally, a striking example. This flower is not of the pitcher type, but the upper part of the flower or galea, formed by the top sepal combined with the two side petals, forms a chamber with a narrow downward-facing opening. This chamber encloses the slender column, bearing the anther and stigma. When undisturbed the lip is directed downwards from below the opening. Flies are attracted to the lip (probably male fungus midges as in the related *Pterostylis gibbosa*, and probably by scent). On landing the insect is snapped upwards by the movement of the sensitive lip through the opening into a prison-like chamber, the exit now being blocked by the spring-loaded lip. The fly naturally behaves like any fly trying to escape from an enclosed space. It tries to move upwards and towards the light. Firstly, rising against the sticky stigma on the lower surface of the column, any pollen previously attached to its back is likely to remain behind pollinating the flower. Above, light is visible through a transparent window in the galea, but to reach this the insect travels through a tube formed by the side wings of the column. This leads it past the anther. If this is brushed by the back of the insect a sticky disc adheres to it and this has the two pollen masses attached. Thus the insect becomes the involuntary bearer of the whole pollen complex. The insect may at this stage squeeze past the lip and gain its freedom, or it may wait until the lip is lowered (usually in 15 to 20 minutes) when it can simply fall through the opening to repeat the process at another flower. (Insects are not very bright.)

One cannot attempt to give a rounded picture of orchid biology in an article of this length. There is, for instance, the intriguing story of how orchids use certain soil fungi to obtain essential nutrients, even seeming to cultivate them in certain of their cellular tissues. I must mention the need for more research into the lives, distribution, and requirements of our orchids and the urgent need for more reserves to prevent the early extinction of several species. At the time of writing, the crested spider orchid, *Caladenia cristata*, of Western Australia and the Illawarra greenhood, *Pterostylis ceriflora*, of New South Wales are each known to survive on only one privately owned allotment, and for the latter species there is immediate danger of the land being cleared and developed. The lilac doubletail orchid, *Diuris punctata*, is rapidly disappearing from its former habitat between Sydney and the Blue Mountains, a contributing factor being the removal for sale of topsoil in the Penrith district. And over wide areas there is the encroachment of weeds, particularly kikuyu grass, which can totally displace natural plant communities.

MAMMALS FOR ALL SEASONS

by Roland Hughes

Australian mammals survive in a changing continent where land utilisation and man's actions are having a marked effect on habitats and populations. As a result of the changing circumstances regarding Australia's 228 different species of mammals and the age of the previous exhibit devoted to that subject, the Australian Museum is opening a new gallery on representative mammals of Australia, native and introduced.

"Gee, how do you get in there!" seems to be the main thought with each of these schoolboys as they anxiously watch the final preparations taking place for the opening of the new mammal gallery. Photo John Fields, the Australian Museum.

Opening in September, the gallery will be called 'Mammals In Australia' and is being sponsored by the Rural Bank.

Covering all the major areas concerning mammals in Australia, the gallery will feature a number of dioramas as well as systematic guides to the different groups of species. Some of the main areas being covered by exhibits will include the history of mammals in Australia, convergence of similar types of animals, various habitats occurring throughout Australia, mammals of the Sydney region, introduced and endangered mammals, seals and other marine mammals, rodents and bats, monotremes, kangaroos and wallabies, possums, dasyurids or carnivorous marsupials and bandicoots. The comprehensive collection of mammals exhibited will provide public access to Australia's mammals at all seasons.

Australia, today, has a number of endangered species of mammals which reflects badly on European man's colonisation of Australia. Since Captain Phillip's fleet arrived in Sydney Harbour in 1788, 17 species of terrestrial mammals have become extinct, 25 are in very serious danger of becoming extinct and 72 species have suffered a serious decline in distribution and numbers.

Some of the reasons for this decline include the introduction of noxious plant and animal species which have become successfully established at the expense of native species. Pollution of the environment is another cause, with the residues from fertilisers, insecticides and herbicides in some cases directly poisoning animals and in others critically altering their environment.

With the continuous clearing of forests and the replacement of diverse natural ecosystems by farmland many native mammals have been eliminated.

Included in the list of Australian terrestrial mammals whose survival is in some way threatened are Barnard's hairy-nosed wombat, *Lasiorhinus barnardi*, the numbat, *Myrmecobius fasciatus*, and Leadbeater's possum, *Gymnobelideus leadbeateri*.

Barnard's hairy-nosed wombat was only discovered in 1937 and now probably only 70 of these species remain in a gradually shrinking 15.5 square kilometre area of mid-eastern Queensland. Part of this area is incorporated into the recently formed Epping Forest National Park.

During the 1850s the numbat extended across much of southern Australia from New South Wales to Western Australia. Now it is confined to the small area of Wandoo forest in Western Australia. Numbats nest in fallen logs so every severe bush fire deprives it of nest sites. As a result sightings are now rare and there are grave fears for its survival.

Leadbeater's possum through a combination of rarity and misunderstanding of its needs may become the victim of untimely extinction, only just after its discovery in 1961. This restricted Victorian species has suffered from the clearing of forests and removal of the large dead trees necessary for the possum's dens.

While native mammals take the spotlight wherever Australia's mammals are concerned, introduced animals also play an important role as they now form a significant part of the Australian ecosystem.

With no less than 39 species of foreign mammals having been introduced by Australians in the space of 200 years their importance is now becoming fully realised.

Some of these species, such as vicunas, alpacas, and llamas, failed to establish while others like the rabbit, thrived in the new environment with devastating results. Their effects combined with the damage caused directly by humans has had a catastrophic effect on the native mammals. Whether the native mammals would have been able to adapt if the introduction had been more gradual or limited, is anybody's guess. Yet, even now, with the general awareness of these effects by the authorities and the public, efforts to introduce still more foreign species, such as various fish, persist.

While the rabbit is the most widely known of the introduced species, deer, pigs and the cuddly cat probably cause more damage. The Rusa deer, *Cervus timoriensis*, is believed to have been first introduced to Australia by the Victorian Acclimatisation Society in 1868. Others were imported from New Caledonia and released in the Royal National Park, south of Sydney, in 1885. This population, often seen in herds of one to two hundred, is spreading southwards into other areas of New South Wales, while other populations are now spreading across Cape York in Queensland.

The Rusa deer is only one of fourteen species of deer which have been introduced to Australia. These introduced herbivores

The live thylacine, *Thylacinus cynocephalus*, was photographed within an enclosure in Tasmania at the beginning of this century. Although this particular individual had been given a carcass of a domestic fowl for purposes of the photograph, thylacines were branded as killers of poultry, sheep and calves, and a bounty was paid on their heads during the early settlement days of Tasmania.

The carnivorous thylacines evidently evolved in Australia as descendants of dasyurid-like ancestors. In overall form, they are very similar to the placental wolves and dogs of the other continents because they evidently filled a very similar ecological niche.

Until about 3000 years ago when the dingo, *Canis familiaris dingo*, first appeared in Australia, thylacines were common in areas of the Australian mainland as well as Tasmania. With the arrival of the dingo on the mainland, the thylacine began to decline. Within a relatively short time it had become extinct, except in Tasmania, where it continued to survive free of the presence of the dingo, until its final confrontation with Europeans. Photo Harry Burrell, the Australian Museum.

compete with the native herbivores, most commonly kangaroos and possums, and have altered aspects of the natural ecosystems over much of northern and eastern Australia. Many of these introduced species of deer receive protection under the fauna acts of some states, despite the damage they cause the environment.

The pig, *Sus scrofa*, from a population of 74 which were among the passengers of the First Fleet, have spread across much of northern and eastern Australia. Pigs damage the Australian environment by ripping up the topsoil in search of plant tubers and other foods, particularly along watercourses. Like foxes, they are voracious omnivores and are able to consume entire kangaroos, leaving only the smell of the carcass by morning. They kill smaller animals by standing on the struggling prey while eating into its abdomen.

Cats, *Felis catus*, may have been introduced to northern Australia by south-east Asians even before Europeans arrived. If not, cats were certainly introduced in the thousands by Europeans partly in a misguided attempt to control the frightening increase in the number of rabbits. Spread across the whole continent cats compete with native carnivores for prey, transmit disease (such as toxoplasmosis which kills native carnivores and which can infect humans and cripple unborn children) and prey on large numbers of native vertebrates in national parks and reserves in and around Australian cities, driving them to the brink of regional extinction.

Native mammals that can survive in our cities are only those that are most adaptable, such as some possums and fruit bats. On the other hand, pets such as dogs and cats, and pests such as the introduced black and brown rats and the house mouse, thrive in the city environment.

When Joseph Banks and Daniel Solander first collected mammals from the shore of Botany Bay there were at least 25 mammal species living in the surrounding area. Now, that same area is part of the bustling, thriving city of Sydney where very few native species live in the inner urban areas and only about 11, including some rodent and bat species, may be encountered in the other suburbs.

The reasons for this rapid decrease is obvious. The destruction of native habitats and the competition and predation by the many foreign mammal species have taken their toll.

Turn to Mammals in Focus on page 203 for photographs of some of the mammals which will be exhibited in the new gallery.

Top right, the spotted cuscus is the largest Australian possum and its coat generally has a blotched appearance although some (usually the females) have all white coats. Also occurring in New Guinea and adjacent islands, the spotted cuscus only lives in rainforests in Australia. They are predominantly herbivores, but will also take bird eggs, small birds and, in captivity, even chickens. They can emit a penetrating musky odour even when handled gently.

Right, two of the mammals which occur in rainforests, the white-tailed rat, *Uromys caudimaculatus*, an inhabitant of trees and the ground and the red-necked pademelon, *Thylogale thetis*, which lives on the forest floor. Photos John Fields, the Australian Museum.

CENTREFOLD NO. 9

Common bent-wing bat, *Miniopterus schreibersii*

by P. D. Dwyer

The common bent-wing bat roosts in colonies with densities up to 1500 bats per square metre. They can be found in caves, stormwater channels, tunnels and similar structures. Photo Martyn Robinson.

By day, the common bent-wing bat rests in caves, old mines, stormwater channels, and comparable structures including occasional buildings. Typically, it is found in well-timbered valleys where it forages, above the tree canopy, on small insects. Its flight is level and fast, punctuated by swift, shallow dives upon its prey. Where conditions are favourable, colonies are often large: some dominated by males, others by females; some mostly adults, others mostly young.

Large distances are travelled between different roosts according to changing seasonal needs and the dictates of age and reproductive status. The pattern of movement varies, in response to local climatic conditions and the dispersion of suitable roosting sites. In south-eastern Australia cold roosts are sought during the winter to allow hibernation at a time when insect food is scarce.

With the onset of spring, adult females move from numerous widely scattered roosts to specific nursery caves which provide high temperature and humidity throughout the year or—in the southern part of the range—have an internal conformation that retains air which has been warmed by the bats' activities. Scattered colonies located within a single large watershed often use a particular nursery cave year after year.

A nursery cave provides incubator-like conditions in which the young bats, massed upon the ceiling at densities up to 3000 per square metre, are nursed and reared to independence. A single naked young is born to each female, usually in December. While the timing of birth is relatively fixed, mating occurs earlier at higher latitudes. At 28°S in north-eastern NSW, mating and fertilisation occur from late May to early June, prior to hibernation.

Development of the fertilised egg, which is always derived from the left ovary, proceeds slowly and implantation does not take place until shortly before the females come out of hibernation late in August. Thereafter, with warmer weather, an abundance of insect food and the selection of warmer roosts by the females, the embryo develops at a normal rate. No other hibernating bat is known to possess this capacity for delayed implantation. In the tropics (15°S) delayed implantation does not occur and, although mating takes place about September, the young are born in December.

Nursery colonies disband between February and March, adults and juveniles going separate ways. At this time some young individuals disperse many hundreds of kilometres. Sexual maturity is reached in the second year of life and longevity may be in excess of seventeen years.

The common bent-wing bat is preyed upon by owls, pythons, feral cats and, occasionally, foxes. Frequent disturbance of roosts used for hibernation seriously increases winter mortality. Because of its dependence upon relatively few nursery caves, threats to the existence or structural integrity of any of these may place the survival of widespread populations in jeopardy.

Size: Head and body length 52-58mm; tail length 52-58mm; forearm length 45-49mm; weight variable usually 13-17g; pregnant females to 20g. In southern latitudes individuals may enter hibernation weighing 20g.

Identification: Short muzzle, high-crowned head. Last joint of third finger four times length of preceding joint and folded back along line of first joint when at rest. Colour varies with latitude and season from blackish through reddish browns, with paler underside. Mantle of contrasting brown may be present in moulting females. North Queensland populations include rufescent individuals. Larger than *M. australis* which has forearm length less than 43mm.

Synonyms since 1934: *Miniopterus blepotis*.

Other Common Names: Schreiber's long-tailed bat, Schreiber's bat, eastern bent-winged bat, bent-winged bat, largest Miniopterus, long-fingered bat (in Europe).

Survival Status: Abundant.

Subspecies: Infraspecific categories are not well established but two subspecies are currently recognised in Australia:

Miniopterus schreibersii blepotis, eastern Australia

Miniopterus schreibersii orianae, north-western Australia.

Extralimital Distribution: New Guinea, Indo-Malayan archipelago, Africa and Eurasia to 45°N.

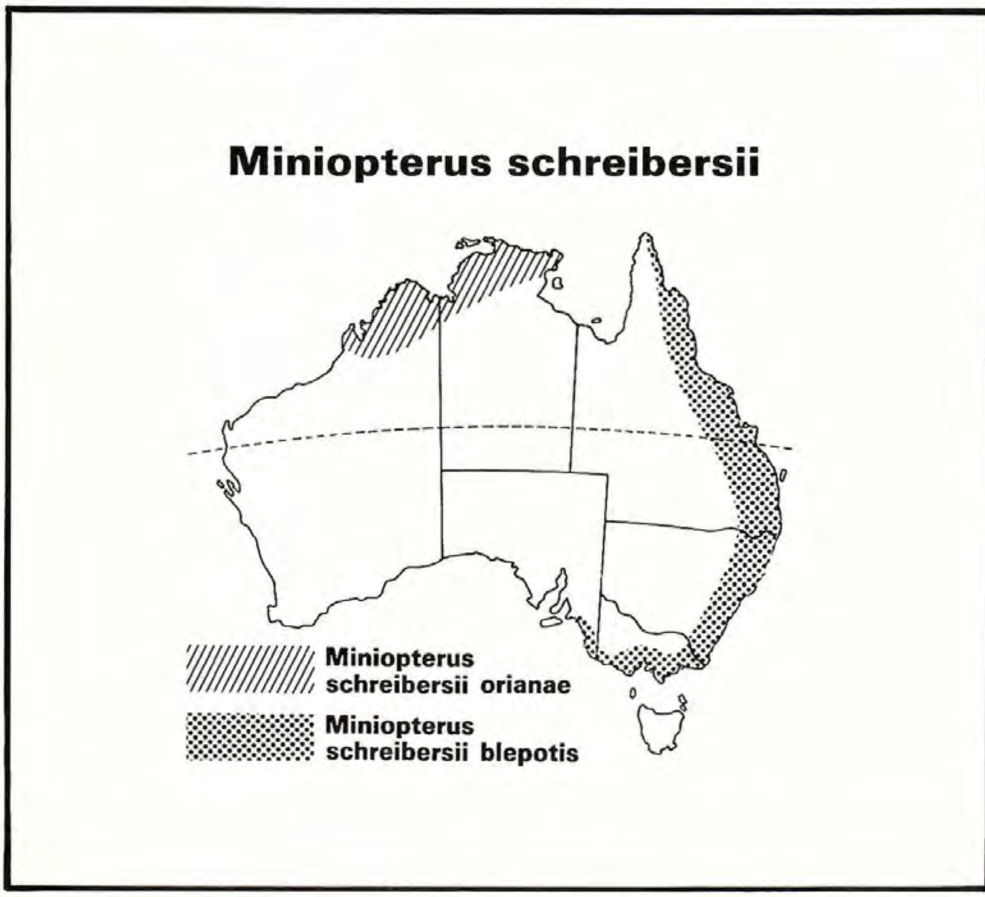
FURTHER READING

Dwyer, P. D. 1966. The population pattern of *Miniopterus schreibersii* (Chiroptera) in north-eastern New South Wales. *Aust. J. Zool.* 14: 1073-1137.

Richardson, E. G. 1977. The biology and evolution of the reproductive cycle of *Miniopterus schreibersii* and *M. australis* (Chiroptera: Vespertilionidae) *J. Zool.* 183: 353-375.

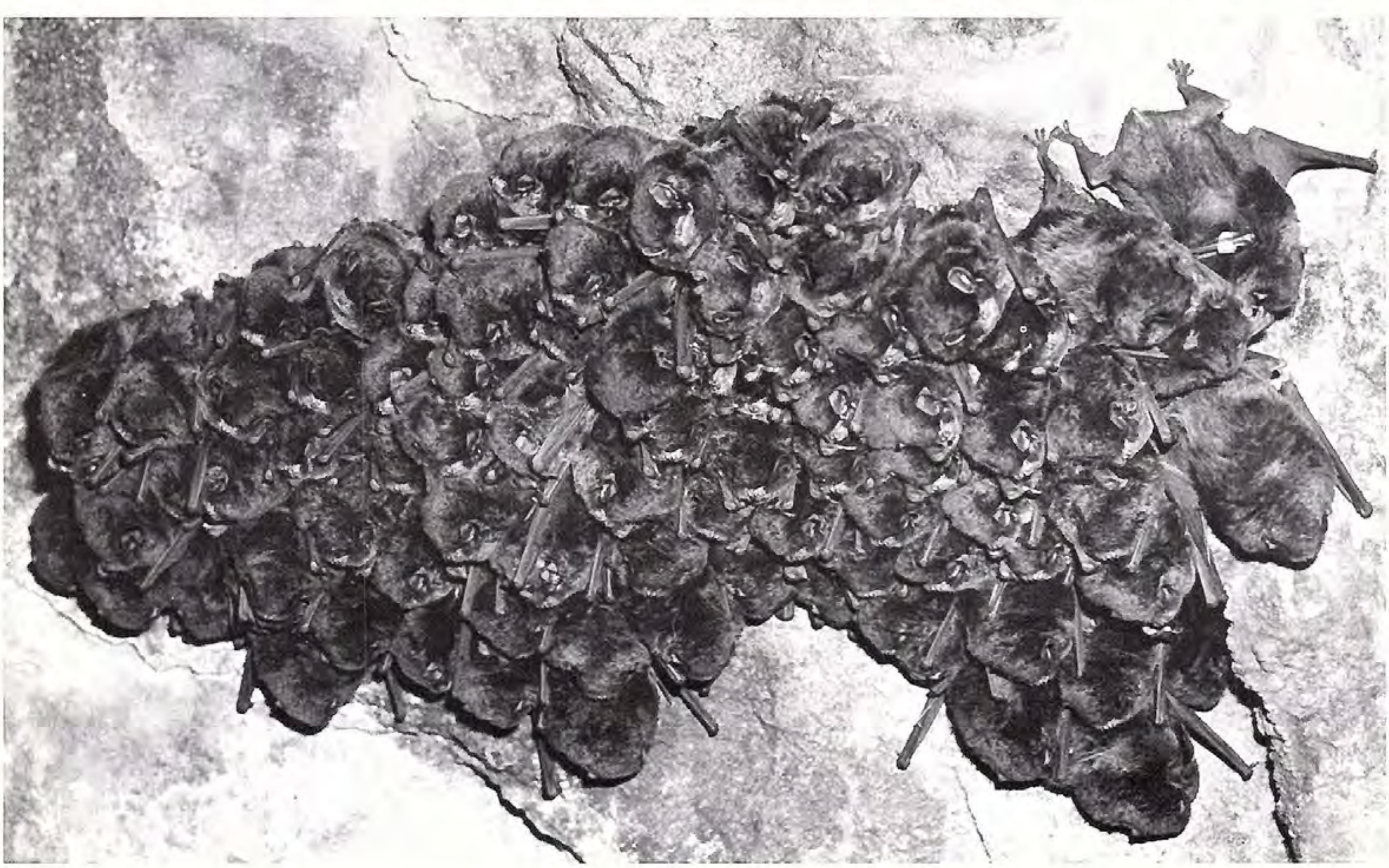
Extract from the forthcoming book, *The Mammals of Australia*, Ronald Strahan (ed.), Angus and Robertson, Sydney. This book includes an account of every species of Australian mammal and will be illustrated with colour photographs from the National Photographic Index of Australian Wildlife. Dwyer is an Australian authority on bats and also works on rodents. Recent work has included 'folk taxonomy' in Australia and Papua New Guinea.

The exhilarating sight of a bat in flight, captured perfectly by the photographer, gives one more sympathy for an animal much maligned and generally regarded with suspicion by most people. Typically found in well-timbered valleys, the common bent-wing bat, *Miniopterus schreibersii*, forages above the tree canopy on small insects. Photo Graeme Anderson.



Class: Mammalia
Order: Chiroptera
Family: Vespertilionidae
Genus: *Miniopterus*
Species: *M. schreibersii*
Common Name: Common Bent-wing Bat

What a crowd! With common bent-wing bats being found in colonies with densities of up to 1500 bats per square metre, this particular colony is only small in comparison. Young bats mass upon the ceilings of nursery caves at densities up to 3000 per square metre where they are nursed and reared to independence. Nursing colonies disband between February and March with the adults and juveniles going separate ways. Photo I. Humphery-Smith.



A LOOK AT THE DINGO

Since the start of European settlement in Australia and the development of a large pastoral industry, dingoes have always been considered a problem by farmers and graziers. As a result of occasional attacks on stock by dingoes a militant campaign was initiated to eradicate them. The campaign has grown since those early days to the extent that authorities are presently spending approximately $2.6 million annually on dingo eradication.

Studies on the biology of the dingo, however, were surprisingly never considered until 1968 when the then newly established NSW National Parks and Wildlife Service embarked on a major study of the ecology of the dingo in northeastern NSW. Undertaken as a result of conflicting views between pastoralists and the Service over management of dingoes in national parks and reserves, the research programme, which is still in progress, has yielded a large amount of information which forms the basis of what we know today about dingoes. Bob Harden, a Research Officer at the NSW National Parks and Wildlife Service heads the programme which is run in association with the University of New England, in Armidale.

by Bob Harden

Dingoes, although very active at sunrise and sunset, are not strictly nocturnal and travel quite large distances during the day. An average distance travelled by a dingo daily would be 17km. Detailed information on dingo movements is usually gathered via radio tracking studies. By this method home ranges can be plotted and an animal's behaviour studied. Photo E. Slater.

Dingoes belong to the genus *Canis* which contains the true wolves, the Old World jackals and the domestic dogs. The skeletal morphology of dingoes is very similar to that of many breeds of domestic dog, and hybridisation occurs in captivity and is suspected in the wild. Hence the precise taxonomic status of the dingo is unresolved, some authorities considering it as a separate species *Canis dingo* (Meyer, 1793) and others as a sub-species of domestic dog *Canus familiaris dingo* (Blumenbach, 1780). Very recently, using a technique involving a comparison of six skull characters, it has been possible to discriminate between domestic dogs and dingoes. This should assist in the clarification of the position in the future.

The origins of the dingo are obscure. It is not part of the ancestral fauna of Australia. The oldest archaeological evidence is that of an almost complete dingo skeleton about 3000 years old excavated from a rock shelter at Fromm's landing in South Australia. This skeleton is very similar to those of present-day dingoes, suggesting that there has been little morphological change in the past 3000 years. All the present evidence suggests that the dingo arrived in Australia at least 3000 but less than 9000 years ago.

The only certainty about the ancestry of the dingo is that it lies outside Australia. A number of possible ancestors have been suggested, among them the Asiatic wolf, but views are divergent and the evidence poor. The only area of general agreement appears to be that the dingo is an old and generalised type of dog with geographically widespread resemblances. In the words of Professor MacIntosh, its ancestry and affinities remain enigmatic.

When Europeans arrived, dingoes occurred throughout all of mainland Australia. They were never in Tasmania, presumably because Bass Strait was flooded before they spread that far south. Today, as a result of control measures and habitat change which accompanied the spreading pastoral industry, their distribution has been reduced. The area in which dingoes no longer occur closely approximates the sheep areas of Australia.

Therefore, in general terms, they are now absent from much of central Queensland, all of New South Wales and Victoria except the eastern highlands, the southeastern quarter of South Australia and a strip up the western coastline of Western Australia. The interface between dingo and dingo free areas is, for many thousands of kilometres, defined by a dingo-proof fence.

Dingo bitches come into oestrus only once each year. The oestrus period, only a few days long, usually occurs in April or May although it may be as early as March and as late as July. Breeding can only occur during the oestrus period.

The litter of pups (usually four to six) is born after a nine-week pregnancy. The pups are born in a den which is most commonly a hollow log or cave. In the densely forested areas of north-eastern NSW, this den is usually located on a sunny northern slope in a small clearing (or under an opening in the forest canopy) surrounded by thick vegetation. It is also usually close to water. Bitches tend to use the same den each year.

While the pups are small, solid food is brought to them from kills made by the parents. The kill may be dragged and carried back, or parts of it may be swallowed by the parents and regurgitated for the pups. Some litters are reared by both parents and some only by the bitch. The cause of this difference is unknown.

When the pups are large enough to travel, they are taken from the den to kills, and eventually other dens are used. The range of the pups is increased as they are moved from one den to the next. We have observed that some bitches move pups from one den to the next in an order which is repeated each year. In this way the pups are gradually moved around much of the range of the bitch. They increasingly accompany the bitch on hunting trips and move around by themselves.

The pups may become independent of the

Dingoes usually operate in small groups where the individual members meet briefly thoughout the day or on subsequent days, but roam separately for a major portion of the time. Within a group, there is considerable overlap of home ranges while boundaries between groups appear to be more rigid and are rarely crossed. Photos E. Slater.

parents as early as six months of age or as late as twelve months. In the former case independence is forced on the pups when the parents abandon them, while in the latter case the pups appear to disperse from the parent-offspring group. There is a relationship between the age at which pups become independent and the number which survive to adulthood. Mortality is high in pups which become independent at an early age. This is largely because they are both too small and inexperienced to hunt adequately for themselves, and many die of starvation. Pups not abandoned by the parents do not face this stress until they are quite large and have much more experience, and mortality is low.

The factors which cause parents to abandon pups at an early age are not understood. The result is that few survive to adulthood and the population remains relatively stable. In years when pups are not abandoned, between two and four pups from each litter may survive to adulthood and the population increases markedly.

The food eaten by dingoes can be identified by the microscopic examination of material either in the stomach or scats (dung) of dingoes. Most of it is mammalian, and hence the actual species can be determined by characteristics of the hair structure which are unique to each mammalian species. By the examination of a large series of stomach contents or scats, the frequency of occurrence of each prey species can be determined.

A number of such studies have been made, each at a different locality in Australia. In each case, dingoes had taken a wide array of prey species, although most of the species occurred only infrequently (less than 5%) and only a few frequently. For example, in northeastern NSW we examined 3,500 scats collected over an 11-year period. We recorded 35 species of mammals, which represents the entire mammalian fauna of the area except for some bats. Only three of these species occurred more frequently than 10%; swamp wallaby (31%), rednecked wallaby (11%) and the bush rat (12%)

In all the studies, the most common species in the scats or stomach contents has been a macropod (the group which contains the kangaroos and wallabies). In study areas where there were wombats, they also occurred frequently. In each study the macropods (or the macropods plus wombats) have collectively amounted to more than half the occurrences. It then appears that the medium and large sized native species are the most important prey for dingoes.

Evidence of predation of domestic stock has also been found, ranging from 7% to less than 1%. The percentage may rise during drought times, although this may be associated with scavenging on dead stock rather than predation of live animals. These figures must be treated with caution when assessing the impact of dingoes on domestic stock as the technique gives no indication of the number of stock mauled but not eaten by dingoes. However, the figures do suggest that domestic stock are not important prey for dingo populations as a whole.

The most detailed information on movements comes from radio tracking studies. Dingoes are trapped, fitted with small radio transmitters on a collar and released again. The location of the animal can subsequently be found using radio receivers with directional antenna. By locating animals at regular intervals over many weeks, the movements of the animal can be observed.

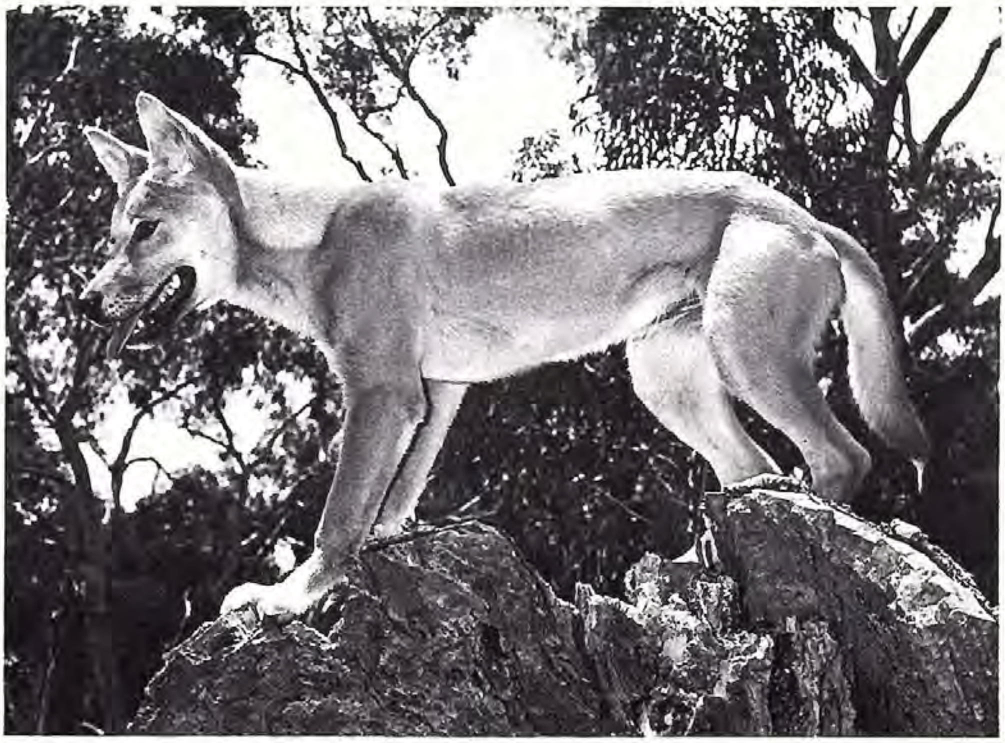
When many hundreds of locations for an animal are plotted together on a map, it can be seen that there is a distinct area throughout which the animal travels and does not leave. The dingo frequently visits the edge of this area, suggesting that it recognises a 'boundary'. Such an area can be termed as home range.

In the dissected and heavily forested areas in northeastern NSW, the home range of adult dingoes is between 2,500 and 5,000 hectares. The edge of the home range is commonly associated with a major topographic feature, such as the edge of the escarpment, a major ridge or a major stream.

Right, dingoes can vary in colour from almost black, like this pup, to a light sandy colour.

Below, a dingo inspects the rotting carcass of a water buffalo. While research has shown that medium and large size native animals are the most important prey for dingoes, carrion also constitutes a significant portion of a dingoes' diet. Photos E. Slater.

The dingo is not part of the ancestral fauna of Australia and present evidence suggests that the dingo arrived in Australia at least 3000 but less than 9000 years ago. The only certainty about the ancestry of the dingo is that it lies outside Australia. Photo E. Slater.



Dingoes do not use their home range uniformly. Parts of it are used intensively and other parts are rarely frequented. National Parks found that there is an association between this patchy usage and the distribution of the most important prey species, the macropods. The areas most intensively used by dingoes are usually the areas of highest macropod density.

The home range is used as a series of sub units, a number of days being spent in each. Therefore dingoes do not travel over the whole range each day, although rapid sorties (out and back) from the current area of intensive use to another part of the range are often made. During such sorties, a part of the edge of the range is usually visited.

By examining the pattern of locations made each fifteen minutes on an hour by hour basis, more detailed information on movements can be gleaned. Two different patterns can be discerned. The first is a slow movement, with many changes of direction, throughout a small part of the range. This results in a criss crossing of the area and this type of movement is associated with hunting. The second type is a rapid movement along major pathways (tracks, ridges and streams) throughout the home range. This type of movement occurs during the sorties described above, and is thought to be associated with sociality and home range maintenance.

Dingoes are active throughout the day, although there is a tendency for activity to be highest at sunrise and sunset and lowest at midday. They are not strictly nocturnal, moving as far in daylight as at night. About two-thirds of each day is spent moving and one-third resting. Typically this takes the form of a short period of activity (average three-quarters hour) with shorter periods of rest (half hour). Periods of activity or rest of longer than two hours are uncommon. The longer periods of activity are usually associated with a sortie to another part of the home range. The average total distance travelled each day is about 17km.

Dingoes are very difficult animals to observe in the wild and as a result dingo society is not well understood. The information at present is formed from a composite of studies of captive animals, inference from movement studies and from some observational studies of wild animals.

Dingoes operate in small groups, the cohesion of which varies in different circumstances. The cohesion of the group increases at higher densities. The group rarely moves as a pack, rather members meet and separate again throughout the day or on subsequent days. Within a group, there is a considerable overlap of home ranges. However, the boundaries between groups appear to be much more rigid and are only infrequently crossed.

This social system based on small groups is very flexible, the flexibility being effected through the degree of cohesion of the group. This affords dingoes a considerable ability to compensate for changed circumstances.

As an example we observed that, as the dingo population increased during our study, group cohesion increased. This resulted in a change in hunting and feeding strategies. Dingoes concentrated more on the larger species (wallabies) and reduced the wastage of these large carcases (one of which can feed a number of dingoes) by feeding as a group and completely consuming the kill. By this change, the impact of their increased numbers on the major food resource, the wallaby population, was reduced.

There is some evidence that group cohesion may also have a role in population regulation. At high densities when group cohesion is high, there appears to be reduction in the number of females which breed, and this may be socially facilitated within the group. Such a mechanism has already been observed in wolf packs.

The maintenance of a social system requires communication between animals. Dingoes communicate when in proximity with each other by a large number of different facial expressions and body postures not unlike those of domestic dogs. They communicate at a distance by howling and, although the repertoire seems to be limited, it appears to be significant and important. Finally, they communicate across time by compounds called pheronomes which are excreted in the dung and urine. The precise nature of the information contained in the pheronomes is unclear, although some of it relates to the physiological state of the animal, for example, oestrus in bitches. Pheronomes are probably detected as odours by dingoes.

In this brief review I have attempted to present a general picture of the present knowledge of the biology of the dingo. While this knowledge has increased significantly in the past fifteen years, many questions remain. Some of the information presented here has been in the form of observations, and the significance of and processes underlying many of these observations are poorly understood. The key to many of these questions may come with a better understanding of dingo behaviour and the operation of dingo society.

The conflict between pastoralists and the dingo continues, joined in recent times by conservationists on the side of the dingo. A wise resolution of this complex problem cannot be achieved from folklore and emotion. It can only be achieved by a sound and objective assessment of the problem, fundamental to which is a clear understanding of the biology of the dingo.

DINOSAUR DIGGING IN VICTORIA

Timothy Flannery is a post-graduate in the School of Zoology, University of NSW, Kensington. Thomas Rich is Curator of Fossil Vertebrates, National Museum of Victoria, Melbourne. Their primary interest is the evolution of the Australian mammalian fauna. In this account of their search for the remains of fauna older than 25 million years they raise some interesting, and, as yet unresolved, questions of Australia's development.

by Timothy F. Flannery and Thomas H. Rich

A fine specimen of a dinosaur's footprint discovered by Dr Tom Rich near Lion Headland, west of Cape Otway.

Recent discoveries of dinosaur fossils in Victoria are leading to a reconsideration of our ideas of Australia during Cretaceous times. Previous knowledge of Australian dinosaurs has come almost exclusively from the dinosaur bearing sediments of Queensland, which contain a very different fauna from that now known in Victoria. Only a single dinosaur bone, a claw, was known from Victoria when the surveys reported here were undertaken. Now well over 100 bones are known.

Victoria's early Cretaceous rocks, between 140 and 105 million years old, are divided into two rock groups: the Strzelecki group in the east and the Otway group in the west, the former possibly up to 6,000 metres thick. The sediments of the two groups are lithologically similar, consisting of alternating bands of siltstone and sandstone with some conglomerate and coal. The sandstone was derived from the weathering of volcanic rocks which contained, among other things, zircon crystals. Using the fission-track dating technique, the age at which these crystals cooled below a critical temperature indicates the time of formation of the volcanic rocks. Rock samples from the fossil plant zone from which most of the dinosaur bones have been recovered have been dated at between 135 and 105 million years before present (Gleadow and Duddy 1980).

The first record of vertebrate fossils from the Victorian Cretaceous is that of Krause (1886) who reported on the remains of a fish and turtle from the Otway group near Casterton. Other fish and turtle remains from the same area were reported by Hall (1900) and Chapman (1919). Although visited recently this area has not proved productive.

The most important early discovery made was that of a government geologist, W. H. Ferguson. While mapping part of the coal-bearing Strzelecki group around the turn of the century he discovered two bones at Eagle's Nest, near Inverloch. A. S. Woodward (1906) described these finds. One was the tooth of a new kind of lungfish *Ceratodus avus*, the other was a claw from the foot of a carnivorous dinosaur which Woodward thought was like *Megalosaurus*. This latter bone, soon to become known as the 'Cape Patterson Claw', was to remain Victoria's only dinosaur fossil for over 70 years. Only one other bone, the limb bone of a lepidosaur, the group that contains lizards and snakes, was found at Eagle's Nest in 1949.

Other published finds of vertebrate fossils from the Victorian Cretaceous are those of Chapman (1912) who described a lungfish scale from a bore near Wonthaggi and the numerous papers summarised in Waldman (1971), dealing with the fossil fish fauna of an ancient lake deposit near Koonwarra. Beautifully preserved insect fossils that include mayflies, stoneflies, dragonflies, cockroaches, scorpion flies, flies, beetles, wasps and possibly caddis flies have been found at Koonwarra. other arthropods present include conchostracans, small bivalved crustaceans, two fleas and one example of a king-crab related to the living *Limulus*.

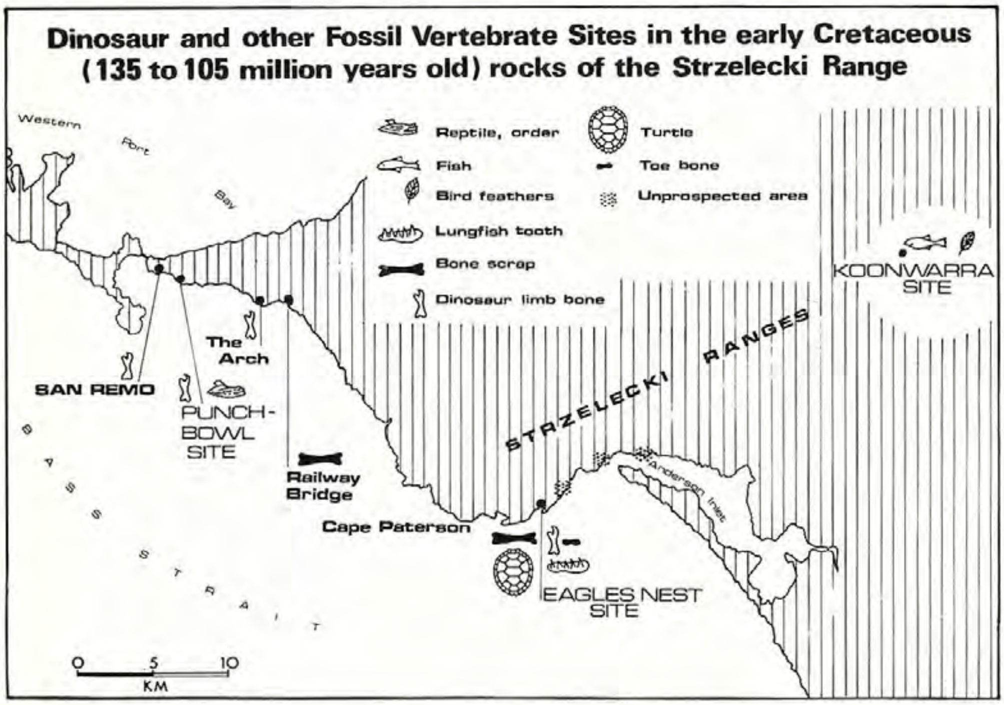
Waldman reported five species of fish from the Koonwarra site and recent excavations have uncovered a sixth form, possibly an early relative of the eels, in the same fauna (A. Ritchie pers. comm.). Five bird feathers from this early Cretaceous locality represent the second oldest bird fossils in the world; the oldest are the remains of *Archaeopteryx* from the late Jurassic of Southern Germany.

The next oldest definite bird fossils in Australia are approximately 100 million years younger. This gap illustrates the incomplete nature of the fossil record of many such groups in Australia.

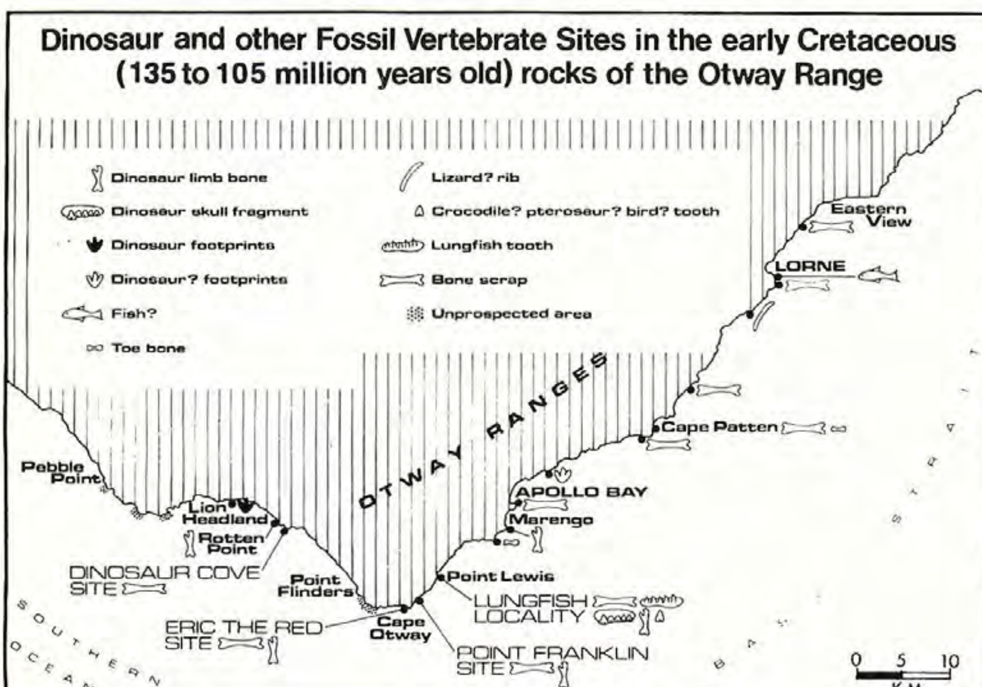
Our search of the Victorian Cretaceous sediments is part of a long range effort to locate the remains of birds and mammals older than 25 million years in Australia. At the present time, for all practical purposes, that is the date when the fossil record of these two groups begins on this continent. Yet by 25 million years both birds and mammals had already been in existence for over 120 million years elsewhere in the world and it is quite likely that the same is true of this continent.

Work in the Strzelecki Group began in 1978 when with the use of Ferguson's map, the site of the original dinosaur find near Eagle's Nest was quickly located and searched. Within minutes of arrival a bone had been found. Upon preparation back in the lab it turned out to be the top end of a dinosaur humerus, upper arm bone. With this incentive the site was regularly revisited, and many bones have subsequently been recovered.

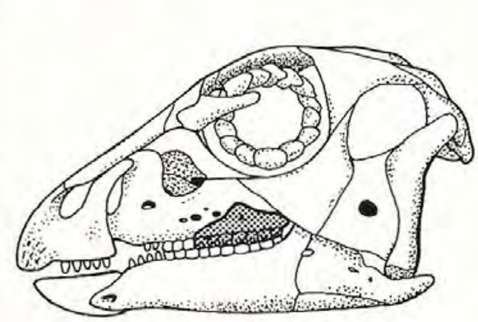
During 1978-79 the search was extended to other areas of the Strzelecki Group outcrop, east of Port Phillip Bay, but it was soon found to be impractical to prospect inland from the coast. Rock surfaces are not usually clean enough to detect fossil bone except in areas where they are being scoured by the sea. So



Dinosaur and other Fossil Vertebrate Sites in the early Cretaceous (135 to 105 million years old) rocks of the Strzelecki Range

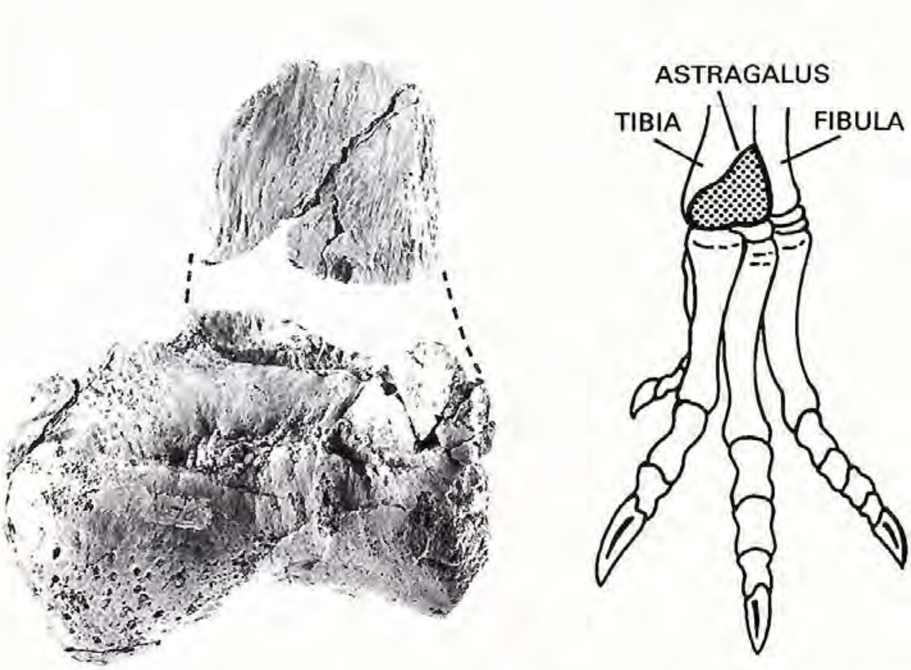


Dinosaur and other Fossil Vertebrate Sites in the early Cretaceous (135 to 105 million years old) rocks of the Otway Range



Map (top left) showing the location of the Cretaceous fossil vertebrate sites east of Port Phillip Bay, Victoria, and (second left) the location of Cretaceous fossil vertebrate sites west of Port Phillip Bay. Maps drawn by Gary Salt.

Outer (far left) and inner (centre) surfaces of a fragment of left maxilla, 45mm long; upper cheek dentition of a *Hypsilophodon*-like dinosaur from the early Cretaceous rocks of Point Lewis east of Cape Otway. Position of the fragment is shown on the reconstruction of the skull of *Hypsilophodon* from early Cretaceous of England.



Anklebone or astragalus of *Allosaurus* from Eagle's Nest, east of Cape Patterson, Victoria, and the foot skeleton of *Allosaurus* from North America indicating original position of the bone.

far, bones have been located in four other coastal areas.

After this early success it was decided to spend the summer of the 1979 field season systematically searching the Otway Group coastal outcrops west of Port Phillip Bay. Even though no bone was known from this area it was felt that such a search would be worthwhile because of the similarities of the Otway and Strzelecki Groups.

Beginning in November 1979 at Eastern View the easternmost outcrop of the Otway Group was examined. Gradually working southwest from there the search continued through the following month and was taken up again in December 1980, by which time all wave cut platforms of the Otway Group had been examined, except for four small areas. The richest concentration of fossils was found in the extreme south at the Point Lewis site which has produced many bones, including two dinosaur maxillae of a small *Hypsilophodon*-like dinosaur, only the second Australian dinosaur from which any part of the skull is known. The Otway Group has also produced two occurrences of dinosaur footprints, the only ones known from Victoria.

At the time of deposition of the early Cretaceous rocks in Victoria, southeastern Australia was closer to the South Pole, perhaps at 60-70 degrees south. Gill suggested (1972) that the high latitude and low temperatures may have been responsible for the scarcity of reptilian bones in the sediments. While the effects of this high latitude remain unknown, some aspects of the fauna may be explained by it although conditions were probably not as severe as envisioned by Gill. The effect of climate upon plant life could not have been too adverse as abundant plant remains, even coal seams, are present. Ginkgos and conifers are the most common elements among the larger plants. Ferns, liverworts, the last of the seed ferns, and some of the earliest angiosperms or flowering plants are also present.

Apart from insects, fish and bird feathers from Koonwarra, the fossil fauna of the Otway and Strzelecki Groups consists of three or more kinds of dinosaurs, two species of lungfish, two lepidosaurs, turtles, and a tooth which may have belonged to a crocodile, pterosaur (flying reptile), or bird. Undoubtedly the number of forms recognised will increase as the many as yet unidentified bones in the collection are analysed.

By far the largest of the dinosaurs in the collection was *Allosaurus*. This carnivorous, bipedal animal from the late Jurassic of North America reached a length of 11 metres. The presence of this animal in Victoria is indicated by a single specimen, an astragalus or anklebone. Two other bones, the 'Cape Patterson Claw' and a toe bone from the Otways, represent carnivorous dinosaurs. These may or may not belong to *Allosaurus*, but the claw at least is different from that of any known *Allosaurus*.

Herbivorous dinosaurs are represented by two kinds of small bipedal ornithopods, one perhaps two metres long and the other twice that size. Both are close to *Hypsilophodon* or *Dryosaurus*. The smaller form is the most common animal in the sediments and the two maxillae mentioned above come from it. The larger form is known only from two femora and a partial hind limb, the only bones found associated so far.

Another possible dinosaur is represented by a large bone which may be a jaw fragment with no teeth preserved. The bone surface bears an unusual ornament, and suggestions for the animal's identity have ranged from a crocodile to an ornithischian dinosaur or even a labyrinthodont amphibian.

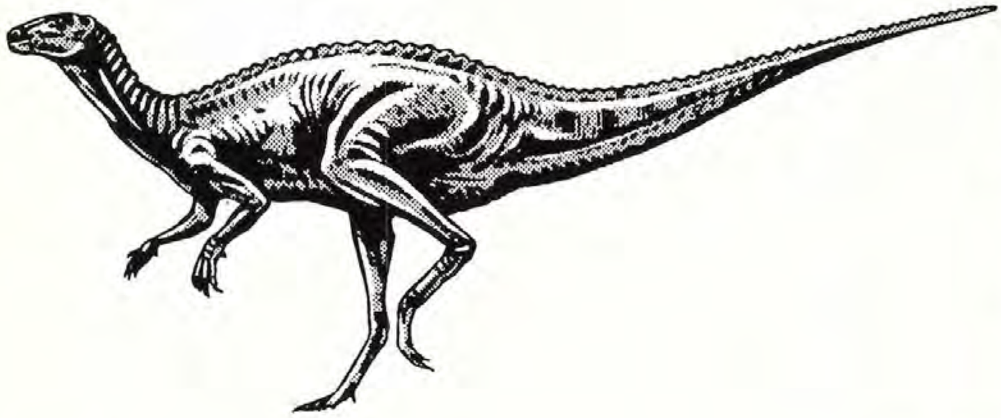
The turtle noted by Chapman (1919) was named *Chelycarapookus arcuatus* by Warren (1969). More turtle remains have since been recovered at Eagle's Nest and are currently being studied. Lepidosaurs are represented by a humerus from an animal about the size of a small varanid or goanna found at Eagle's Nest and from the Otway Group a large rib from an animal the size of a Komodo Dragon. In addition to *Ceratodus avus*, a second (new) kind of lungfish, represented by a tooth, has been found at Cape Otway.

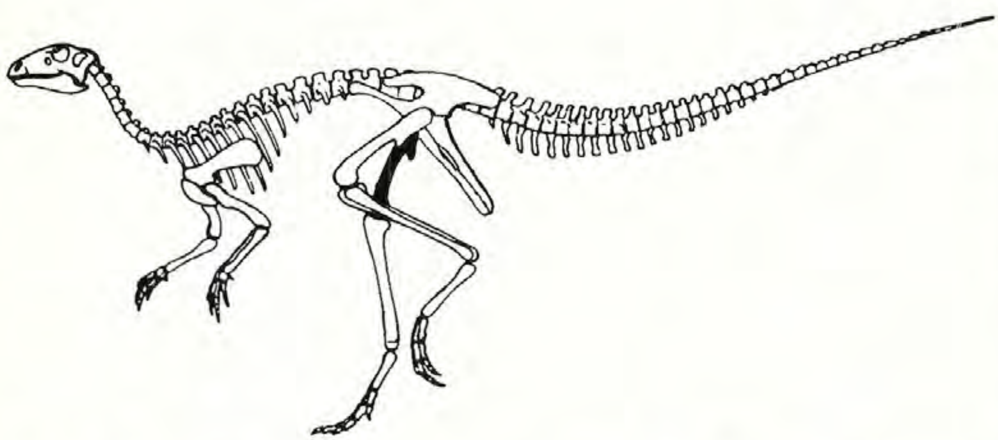
This fauna has some peculiar aspects. While it includes forms found over most of the world in rocks of a similar age, such as the Allosauridae which have been found in all continents except Antarctica, it lacks large herbivorous dinosaurs such as sauropods, ankylosaurs, and iguanodontids. Most of the one hundred or more bones collected are from small animals. Five were not; an example being those from the carnivorous dinosaurs. However, even these five would have to be characterised as small bones from large animals, the largest being 50cm long. The absence of large bones may be due to mechanical factors which did not favour their transport to a site suitable for preservation.

The contemporaneous dinosaur-bearing sediments of Queensland, over 1,000km to the north, are dominated by large ornithischians and sauropods. While the absence of these dinosaurs from Victorian sediments may well be due to preservational bias, it is too early to rule out the possibility that climatic factors excluded them if, even in the Cretaceous, Victoria was at a higher latitude than Queensland.

There are other puzzling aspects of the fauna. The Victorian fossils are well dated by Mesozoic standards at between 135 and 105 million years old. Waldman noted (1971) that the early Cretaceous fish from Koonwarra most closely resembled the late Jurassic fish from Talbragar, NSW. *Allosaurus* and the *Hypsilophodon*-like dinosaurs also look like forms known elsewhere from rocks 20-40 million years older.

Does this suggest that Australia had already become physically isolated from the rest of the world and was then acting as a Noah's Ark for forms which became extinct





An artist's impression of the living ***Hypsilophodon*** **(top left) from the early Cretaceous of Europe and a restoration of the skeleton of the animal (lower left). A fine specimen of the right femur, 145mm long, from the Victorian Cretaceous (above) closely resembles that of** ***Hypsilophodon*****, shown in solid black on skeleton.**

elsewhere as early as the beginning of the Cretaceous? Did these forms find refuge in high latitudes where they could escape competition with more advanced forms? Or is it merely owing to the fact that the record of land animals during the latter part of the early Cretaceous is rather sparse world-wide? These questions remain unresolved at present.

Overall, the emerging picture of southern Victoria 40-95 million years ago indicates the landscape was dominated by a huge rift valley. Active volcanoes were present and large granitic tors, such as Cape Woolomai, rose from the valley floor. Also present were braided river channels, occasional lakes, and patches of forest chiefly comprising gymnosperms such as *Araucaria* and *Ginkgo*. The climate was probably cold, and some lakes may possibly have frozen over in winter. The *Allosaurus* and large lepidosaur stalked the landscape while the much more abundant, smaller dinosaurs, the hypsilophodontids, fed on vegetable matter. The earliest birds may have fluttered in the trees and lungfish lived in the lakes and rivers. A more extensive knowledge of this vanished landscape and its animals and plants will give us a clearer picture of the origins of Australia's flora and fauna.

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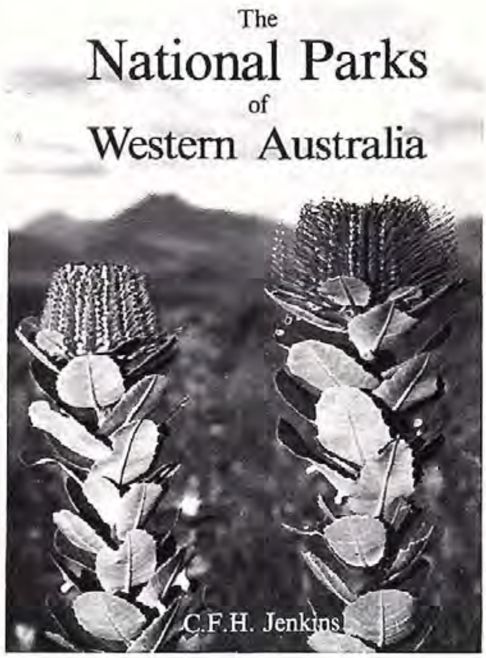
IN REVIEW



Preparing the catch for the feast . . . a scene from the documentary film *Dugong! Dugong!* taken on location. Photo John Fields, the Australian Museum.

The National Parks of Western Australia **by C. F. H. Jenkins, The National Parks Authority of Western Australia, 1980, 78 pages, illustrated.**

A number of books on national parks, particularly those in NSW, have appeared on the market recently. Mostly of the 'how to get there and what to do when you arrive' variety this particular book on Western Australian parks, by the president ot the WA State National Parks Authority, makes a refreshing change.

The first section is concerned with an overview of the role of national parks, their development world-wide and gradual acceptance in present form in Australia. The attitude of early settlers in Australia was one of commercial exploitation, particularly in the removal of forests for the development of grazing and farming lands. As Mr Jenkins points out, it was the develpment of ecology as a science and the rise of conservation groups which led to public awareness in Australian fauna and flora. National parks were seen as more than just recreation areas and instead areas where examples of particular habitat types could be preserved free from the modifying influences of man.

Mr Jenkins also discusses the means by which National Parks in each of the states and territories came into being. In most cases, this involved a consolidation of diverse legislation into one Act, and the creation of a National Parks Service or equivalent under that Act to oversee the declaration and administration of these parks.

Maps are provided to indicate the names and approximate positions of parks and nature reserves in each state, although to be more consistent with the title of the book, the space could perhaps have been better utilised in expanding the information on Western Australian parks. Included in this early section is some information on marine national parks, a sadly neglected area of concern in Australia.

The dedication of national parks in Western Australia is dealt with in detail. In particular, the gradual evolution of various local boards of control into the National Parks Authority of Western Australia and the pressures of multiple land use, mining and park visitors.

The second half of the book deals with the specific national parks of the state, divided into parks in south western Australia, the Pilbara and the Kimberley. Unfortunately the index does not indicate these subsections nor is it made very clear to the reader. The subsections are not numbered and the print showing the title of each subsection is exactly the same size as that of the many subdivisions within each major section.

The "National Parks of the South West" has a short introduction to the natural history of the area followed by detailed discussion of two particular parks in the area (Yanchep and Fitzgerald River), plus short notes on a number of other parks. The information on the two major parks is particularly interesting since the reader is provided with some background history of the early explorers and collectors as well as general material on geology, zoology and botany.

The information regarding other southwestern parks and those in the Pilbara and Kimberley is relatively brief. Although lists of references and selected literature are provided, a greater body of information presented with each park description would have rendered the book of greater practical use to national park visitors. It will still be necessary for people planning a short tour of the parks to find other books or pamphlets with maps, walks, and camping sites as the book alone is inadequate for that purpose.

The final section of the book consists of a one-paragraph summary of all the national parks and reserves vested in the national parks authority. The two dozen pages of photographs provide a few delights, although the colours (particularly the blues) in some were a bit hard on the eyes. It was a pity that many of the photographic acknowledgements were wrong and had to be corrected.

As it stands, the publication provides an excellent introduction to the variety of habitats provided within the National Parks of the west and is certainly worthwhile preliminary reading material before embarking on a tour.—*Kenneth Robinson, University of NSW.*

Dugong! Dugong!, **Produced by the Australian Museum with the help of The Aboriginal Arts Board of The Australia Council, 16mm, colour, 25 minutes.**

There is a warm simplicity about the latest Australian Museum documentary film which makes the subject—hunting the dugong—immediately acceptable to uninitiated viewers like this writer.

The dugong *Dugong dugon*, relative of that other Sirenian species the manatee, is found in coastal seas of the Indian Ocean, South China and the Philippines and on the northern and north eastern coast of Australia.

It is the only herbivorous marine mammal, and the only living representative of its group. Once considered to be endangered as a result of exploitation by the fishing industry for meat and oil, the dugong today is regarded as safe but vulnerable. The cessation of commercial fishing under protective laws has effectively helped the increase in dugong population during the last decade.

Dugong was plentiful and a main food source when Europeans first arrived at Mornington Island to establish a mission in 1917. Nets and spears were the tools used from rafts to capture the animal. Today, the remnants of Wellesley Island aboriginal tribes have been resettled on Mornington Island and have been granted the sole right to hunt, capture and eat native fauna including dugongs.

The film has used this traditional background to introduce the audience to the ritual of the hunt.

One of the old men begins to tell the dreamtime story to a group of children and against this simply told myth two Aboriginal children enact the story of the origin of the dugong, a scene which is handled in excellent taste by the camera and is entirely without sentimental garnish.

From there the film gets on with business-like efficiency to show the community organisation associated with the hunt. Every man, woman and child plays a part in the hunt ritual and despite the modern equipment (outboard motor, dinghy, harpoon with spear head, nylon rope) the spirit of the ceremony comes through quite clearly. Collection of some turtle eggs, followed by the capture of a turtle not only adds an action bonus to the film, but a tasty addition to the feast.

The search for dugong is successful, one is harpooned and taken back to shallow waters where it is slaughtered in ritual style for the feast. There are some realistic gory scenes at the water's edge which some of the more queasy may find distasteful, but the setting of the slaughter softens the impact—far more than a parallel scene in one of our abattoirs would do.

The cooking and distribution of the meat is carried out and although the picnic festive air is well captured by the camera the traditional ceremony of allocation comes through equally clear as does the role of various tribe members.

Henry Peter—the storyteller describes the old days when dugong were caught by nets made by the women from rope made of hibiscus tree bark. This provides strong contrast with previous scenes—watch for the fascinating method of rolling the bark on the thighs, a woman's job which clearly leaves scars. The hunter's job is done once the meat—'beef'—is carved up, and if there are heroes in this tradition it would seem these are the hunters, whose daring and bravery is sung at the corroboree of thanks, which ends the celebration. Don't be alarmed, as I was, to see the warriors painting faces and bodies with what appears to be Berger's paint—only the tins are true to label not the contents.

The film is well put together and the editing has coped excellently with any shortcomings which may have arisen from enforced impromptu segments—and there must have been many such occasions. True, there is a certain jumpiness in the changing scenes and some undesirable gaps in bridging the dreamtime scenes and stories to present-day conditions—but film director Howard Hughes has achieved a documentary which truly reflects conditions on location at Mornington Island, and has underlined that reality by using the Aborigines themselves to tell the story.

The cast of the film comprises the people of Mornington Island, the Director is Howard Hughes, Cinematographer Malcolm Hunt, and the Scientific Advisor is Paul Memmott. *—Barbara Purse, the Australian Museum.*

Australian Orchids

Author's reply

Regarding the review by David K. McAlpine, Curator of Entomology, of my book, *Australian Orchids* ('Australian Natural History' Vol. 20, No.4) I would like to say firstly that I appreciate the very close attention Mr McAlpine has obviously given in his reading. This is a valuable aid in enabling minor errors to be rectified in a work now approaching reprint; the photographs, for example, have been closely checked by experts in the field and those examples agreed to be upside-down will be adjusted. I am pleased that Dr McAlpine found the book 'most attractive' and that 'the photographic quality is generally high' with 'most photographs faithful to the subject'. It was no easy task to assemble these from specialised photographic sources and I was myself delighted with the quality and the geographic and generic coverage I was able to obtain.

I am concerned at the suggestion in the review that there are 'erroneous or misleading' statements in the field of botany (though only one example is quoted). However in this regard I feel I must rely on those for whom the field of botany and the study of Australia's native orchids is a fulltime speciality. I am not a botanist, but have always submitted any text in this field to the appropriate expert at the National Herbarium for comment regarding any academic inaccuracies.

On reading Dr McAlpine's criticism I asked the expert concerned, Don Blaxell, botanist working on orchids at the National Herbarium (who also teaches courses in Australian Wildflowers at the Sydney Technical College's School of Horticulture) if he would again read the published book, which he very kindly did.

For the benefit of readers—yours and mine—I summarise his further comments:

1. He agreed that the 'body' of the flying duck orchid, *Calaena major,* is indeed the broadly winged column and not 'an inflated sepal' as stated on page 4 (the example quoted by Dr McAlpine); however the rest of the duck's anatomy as described appears to be acceptable.

2. He found one further inaccuracy; on page 20 reference is made to the cultivation of *Glossidia* species from 'pseudobulbs'. Mr Blaxell suggests this be altered in the reprint to 'small bulb-like tubers'.

3. There were three statements regarding distribution which Mr Blaxell thought could mislead: *Diuris pendunculata* (page 21) described as 'a native of New South Wales and Victoria' is more accurately described as a native of eastern Australia; *Dipodium punctatum*, described as 'growing profusely in sandstone areas along the east coast of Australia and is found in all States except Western Australia . . .' could imply that it is found only in sandstone areas whereas it is not so restricted. The third example was the reference to *Thelymitra ixioides* as occurring in all Australian States; Mr Blaxell prefers this qualified by the fact that it does not occur in the Northern Territory which in this context should perhaps be regarded as a state.

Otherwise, Mr Blaxell's opinion was that while there were some generalities, these were not, in his view, either erroneous or misleading in a popular publication aimed at the general reader.

The example of an historical 'erroneous or misleading' statement quoted by Mr McAlpine in his review referred to *Bulbophyllum minutissimum*, which grows on figtrees, as being 'first reported in Pitt Street Sydney in the 1840s'. This is popular legend and is certainly not the first time it has appeared in print; however I am happy to qualify it as such if Dr McAlpine's researches have exploded the myth. But I cannot get the point of his comment: 'as by this time that area had been built up for some years' as there most certainly were figtrees in the Pitt Street of the 1840s.

The portion of Dr McAlpine's review which I find especially distressing is when he refers to an 'attempt to counter' my 'irresponsible attitude' and 'message (which) runs something like this: If you find a wild orchid dig it up or remove it from its perch, take it home and try to grow it.

'Nothing in this book, or any other book I have written in my career working for the conservation of Australia's native plants could possibly justify that comment. Dr McAlpine has completely misinterpreted the message of my book, which is basically that our native orchids, in many and varied ways, are worthy of notice and conservation.

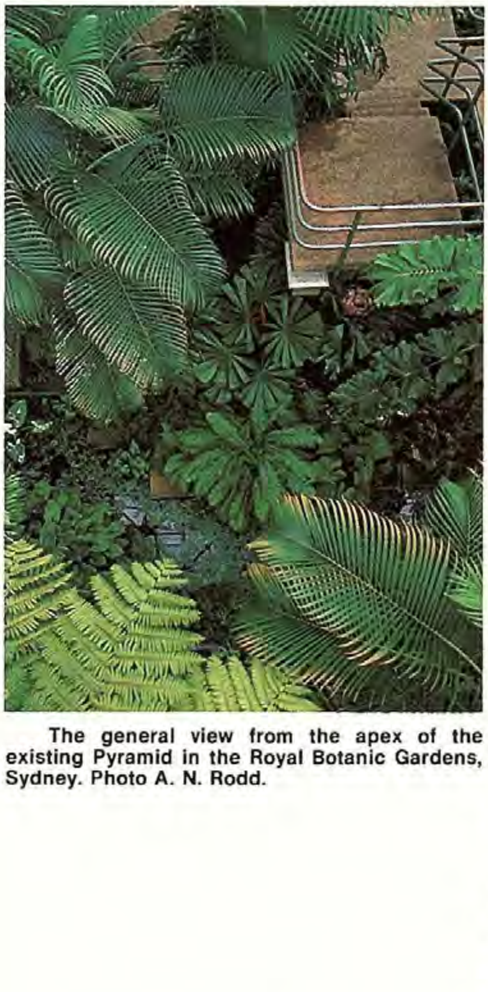
Finally in fairness to my publishers I must point out that Dr McAlpine is sadly astray if he thinks publishers or authors make a 'quick dollar' from a book such as *Australian Orchids.* With full colour throughout and 61 separations, selling for a recommended price of $3.95 and catering to a limited market, it is a proposition very few publishers will even consider.

From the author's viewpoint, the collection of photographs from various sources to ensure a representative coverage of the subject, the gathering and checking of information on the 70 odd species mentioned (description, habitat, distribution, cultivation, etc) involved some months of work, while royalties from the entire first edition are needed to recover the costs of photographs alone.*—Barbara Mullins.*

GOOD THINGS GROW IN GLASS

Perhaps the most conspicuous new development in the Royal Botanic Gardens, Sydney, during the last decade is the pyramidal tropical glasshouse, begun in the early 70's and finally opened in 1976. Built of grey-tinted plate glass on a tetrahedral space-frame of aluminium tubes, and with full control over internal climate, it has provided an ideal environment for plants from the humid tropics. Most visitors find the display of such 'indoor plants' one of the most impressive features of the Gardens. Tony Rodd is a horticultural botanist with the Royal Botanic Gardens.

by Tony Rodd



The general view from the apex of the existing Pyramid in the Royal Botanic Gardens, Sydney. Photo A. N. Rodd.

The Gardens have recently launched a community appeal to raise the money to build two more pyramid glasshouses. With the three glasshouses it will be possible to display separately tropical Australian plants, tropical exotics and ferns and fern-allies. The pyramid glasshouse that will contain tropical Australian plants will be the largest of the three.

The proposed new complex will incorporate many attractive features including wheelchair access. The pyramids will be linked by a subterranean chamber containing educational displays and aquatic plants.

Australian native plant species restricted to wet tropical conditions are relatively few in number compared with species from New Guinea, Indonesia, Central America or the Amazon Basin. Nearly all the commonly grown indoor foliage plants come from these regions, the Americas being by far the richest source. Few Australian species can compete with these for colourful or ornamental foliage, but many of our tropical plants are nonetheless very attractive and of great botanical interest.

From the evolutionary point of view the most interesting ones are those related to plants of other southern hemisphere countries such as South America. These countries were part of the same land-mass as Australia around 120 million years ago, when the flowering plants were in an early but rapid stage of their evolution.

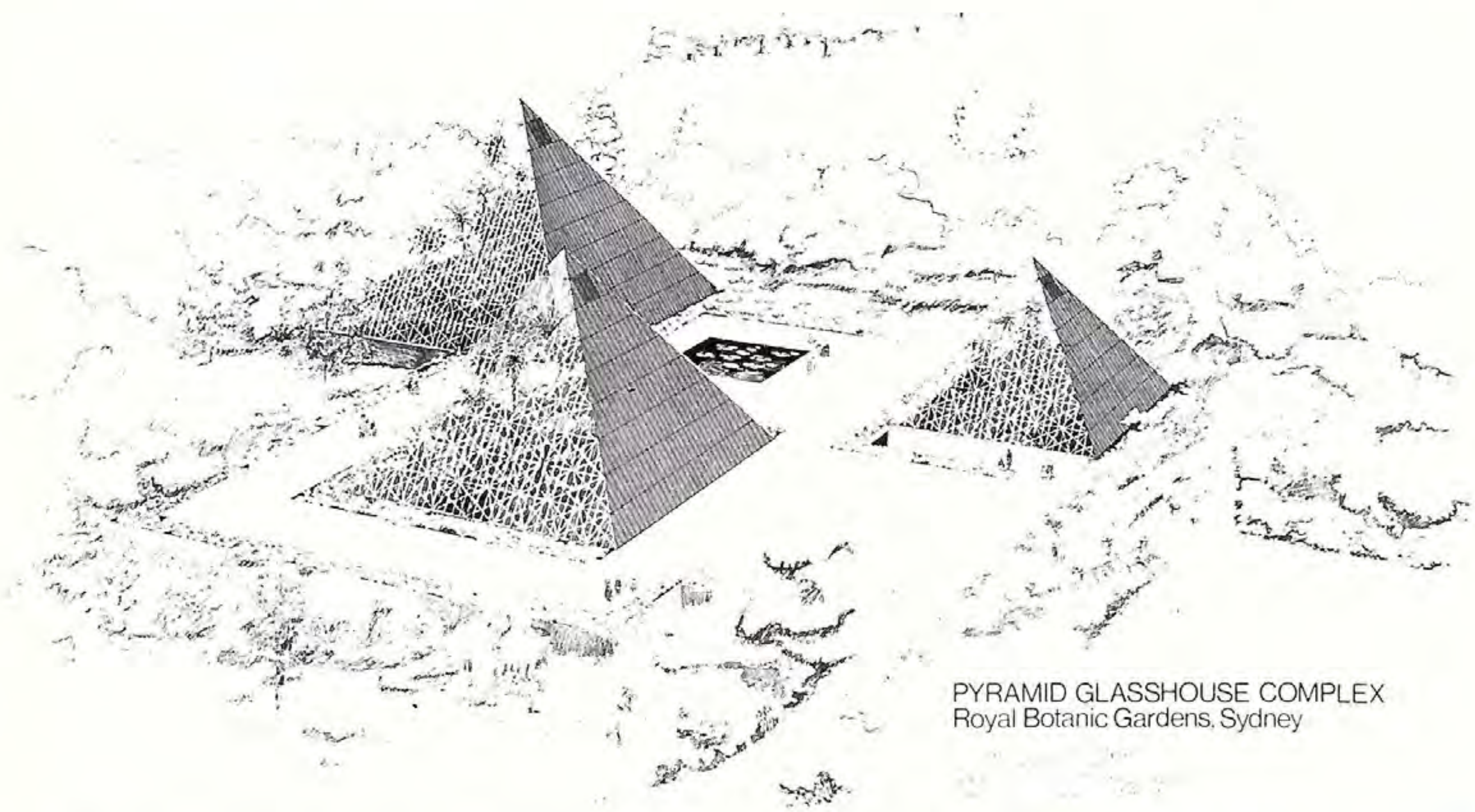
Other Australian species represent the 'tail end' of the rich Indo-Malayan rainforest flora which spread to Australia via a series of dry-land connections or near-connections much more recently. Tropical Australia has a wide representation of species from both these sources; also represented are most of the specialised growth forms of the tropics, such as epiphytes, lianas, insectivorous plants, ant-house plants.

Quite a number of the plants at present on display in the pyramidal glasshouse are Australian natives, though they are greatly outnumbered by the generally more colourful exotics. One group with some interesting representatives is the palm family (Arecaceae). Close to one wall is an eye-catching specimen of the Queensland Black Palm, *Normanbya*, a genus known only from a very restricted region of the North Queensland coast, between Mossman and Cooktown. Its closest relatives are some palms of New Guinea and the western Pacific Islands, but some of its features are quite unique.

A curious climbing plant of wide occurrence in Queensland rainforests, *Freycinetia scandens* is related to *Pandanus*. There is a particularly large and vigorous specimen of it in the Pyramid. Photo A. N. Rodd.

Several other native palms are also in the pyramid. *Licuala ramsayi* is a species with striking circular fan-like leaves, cut into pie-wedge segments at some stages of growth. This is the only one found in Australia out of about 100 species of *Licuala*, the great majority of which are confined to New Guinea and Borneo. Also planted here are three species of *Linospadix*, often called 'walking-stick palms', delightful miniature rainforest palms with distinctive unbranched flower-spikes. This genus has only a dozen or so species but with a remarkably fragmented distribution: one is confined to north-eastern New South Wales and Queensland south of about Brisbane; another group of several species occurs in the coastal ranges of North Queensland but only between Innisfail and Cooktown, and the remaining species are New Guinea endemics. Geographical patterns of this sort are surely very significant in the study of evolution of the Australian vegetation, though the explanation is far from clear at this stage.

The ferns and fern-allies are well represented in tropical Australia. The 'tassel ferns' are an interesting and beautiful group of fern-allies which are in fact epiphytic members of the clubmoss family. These are prized by enthusiast growers, to the point where collecting has almost eliminated them from more accessible rainforest areas. They are not always easy plants to keep alive in cultivation, though, needing humid hothouse conditions in latitudes like Sydney's. One of these tassel-ferns, *Huperzia phlegmarioides*, is well displayed in the pyramid on an artificial log, and



The Art Union is just one of the methods being used to raise the money needed to build the additional pyramids. With the complex of three glasshouses each containing tropical Australian plants, tropical exotics and ferns and fern allies, the public will be well served by the Gardens. The subterranean chamber which houses the educational displays and aquatic plants will be an added feature which should be popular with schools during excursions. Photo courtesy of the Royal Botanic Gardens.

other species are growing in the Gardens' collection but not on display.

One of the weirdest looking plants in the glasshouse is a species of *Myrmecodia*. This belongs to a small group of genera in the coffee family; unlike the trees and shrubs comprising most other members of this family in the tropics, these are epiphytes growing on tree trunks, and the bases of their stems are grotesquely swollen and prickly. When cut open the stems are found to contain a labyrinth of small chambers.

Almost without exception ants are found nesting in these chambers, hence the term 'ant-house plants' for this strange group. The arrangement has obvious benefits for the ants, but botanists have long puzzled over what there is in it for the plant. Some recent studies now suggest that some of the chambers have surface layers capable of absorbing nutrients released by the decay of small pieces of leaf carried in by the ants. Ant-plants reach their greatest diversity in New Guinea and parts of the Malay Archipelago; only two or three species extend into northern Australia. The specimen growing in the pyramid is still very small in comparison with many wild specimens.

These few examples give an indication of the great botanical interest of the tropical Australian flora. The pyramid glasshouse can at present only display a few examples of this flora, its primary function being to show off the world's most ornamental tropical plants. But the Sydney Gardens have in reserve, in behind-the-scenes glasshouses, many additional native species which they have so far been unable to display. In addition, new species are constantly being added as staff do field work in northern Australia.

Art Union

One feature of the appeal is an Art Union with three prizes of a fully paid holiday for two to see the 'Pyramids' in Egypt, Mexico and Thailand with spending money of $1,000, $500 and $250 respectively. Art Union tickets cost $2.00 and may be obtained in the region of the existing pyramid glasshouse at lunchtime, Monday to Friday, and at the weekends, or by writing to:

The Great Pyramid Appeal,
Royal Botanic Gardens,
Mrs Macquarie's Road,
Sydney 2000.

Prizes for the Art Union will be drawn on the 10th October.

Donations to The Great Pyramid Appeal may be made at any branch of the Rural Bank in NSW or sent to the above address.

***Hoya macgillivrayi* is a spectacular climbing plant, only recently rediscovered in Cape York Peninsula. Delicately fragrant towards the evening, this species of Hoya has dark red, waxy flowers up to 6cm in width which hang on long stalks from the flower spurs in loose umbels of six to ten. The bright green, thin-textured leaves which can reach 15cm in length are another feature of the plant which is one of the many Australian natives waiting to find a home in the new pyramid. Photo A. N. Rodd.**

MAMMALS IN FOCUS

With the opening of the 'Mammals in Australia' gallery, at the Australian Museum in September, it is a particularly opportune time to examine more closely some of the interesting mammals which inhabit our land. This excellent series of photographs reveals the characteristic poses of a number of our rare and more common mammals. Each photo clearly shows the physical features of the animal, as well as the occasional glimpse of its habitat.

Above, a brush-tailed rock wallaby, *Petrogale penicillata*, is found in many areas of Australia and can be seen most often in the evenings or early mornings. Brush-tailed rock-wallabies live in caves and rock crevices where the temperature remains relatively constant.

Above right, the greater bilby, *Macrotis lagotis*, or rabbit-eared bandicoot lives in burrows from three to six feet deep so to avoid the oppressive heat of the central deserts, where it makes its home. Bilby's are carnivores, eating both small vertebrates and insects. They breed during March to May having a litter of between one and three young. Once widespread over the southern half of Australia they are now confined to scattered colonies in central Northern Territory with smaller populations in south-western Queensland and West Australia.

Bottom right, the western quoll, *Dasyurus geoffroii*, only occurs in the south-west of western Australia. The western quoll is a carnivore that has a wide range of habitats encompassing deserts and sclerophyll forests. Photo top left by B.G. Thomson, other photos by A.G. Wells.

Above, a male Australian sea lion, ***Neophoca cinerea.*** **Male and female sea lions are easily distinguishable by their large size difference and the male's white or yellowish mane of coarse hair on the nape of the neck. Female sea lions give birth to one pup well above the high-water mark. During the breeding period sea lions congregate on beaches or rocky islands where each bull defends his territory and his harem of one to four cows. Photo H. & J. Beste.**

Above left, an eastern grey kangaroo, ***Macropus giganteus,*** **which commonly inhabits eucalypt woodland and sclerophyll forest. Most of the information gathered concerning grey kangaroos is a result of agitation by the pastoral industry for controls over kangaroo populations because of their competition for food with stock. Research into grey kangaroos' feeding habits has shown that they are selective graziers feeding primarily on grasses which are not preferred by sheep. On a weight for weight basis grey kangaroos do not eat more than sheep and during good years scarcely compete with them. Photo G.B. Baker.**

Left, a feathertail glider, ***Acrobates pygmaeus,*** **glides by means of a membrane that extends from both sides of the body. The tail is highly specialized with each side having a row of hairs which resemble the vanes of a feather. Primarily used for balance and directional control during flight it is also slightly prehensile for movement through trees. Photo Dick Whitford.**

Right, the red-tailed phascogale, ***Phascogale calura,*** **is an agile climber which makes its nest in the hollows of trees and feeds on nectar as well as insects and small vertebrates. Photo A.G. Wells.**

Vigorous cumulus and cumulonimbus building up for a thunderstorm. Almost explosive development of this kind occurs when cold air crosses warm sea along the eastern coasts of Australia and especially during autumn. Spectacular offshore displays of lightning often follow. Photo courtesy of the Bureau of Meteorology, Melbourne.