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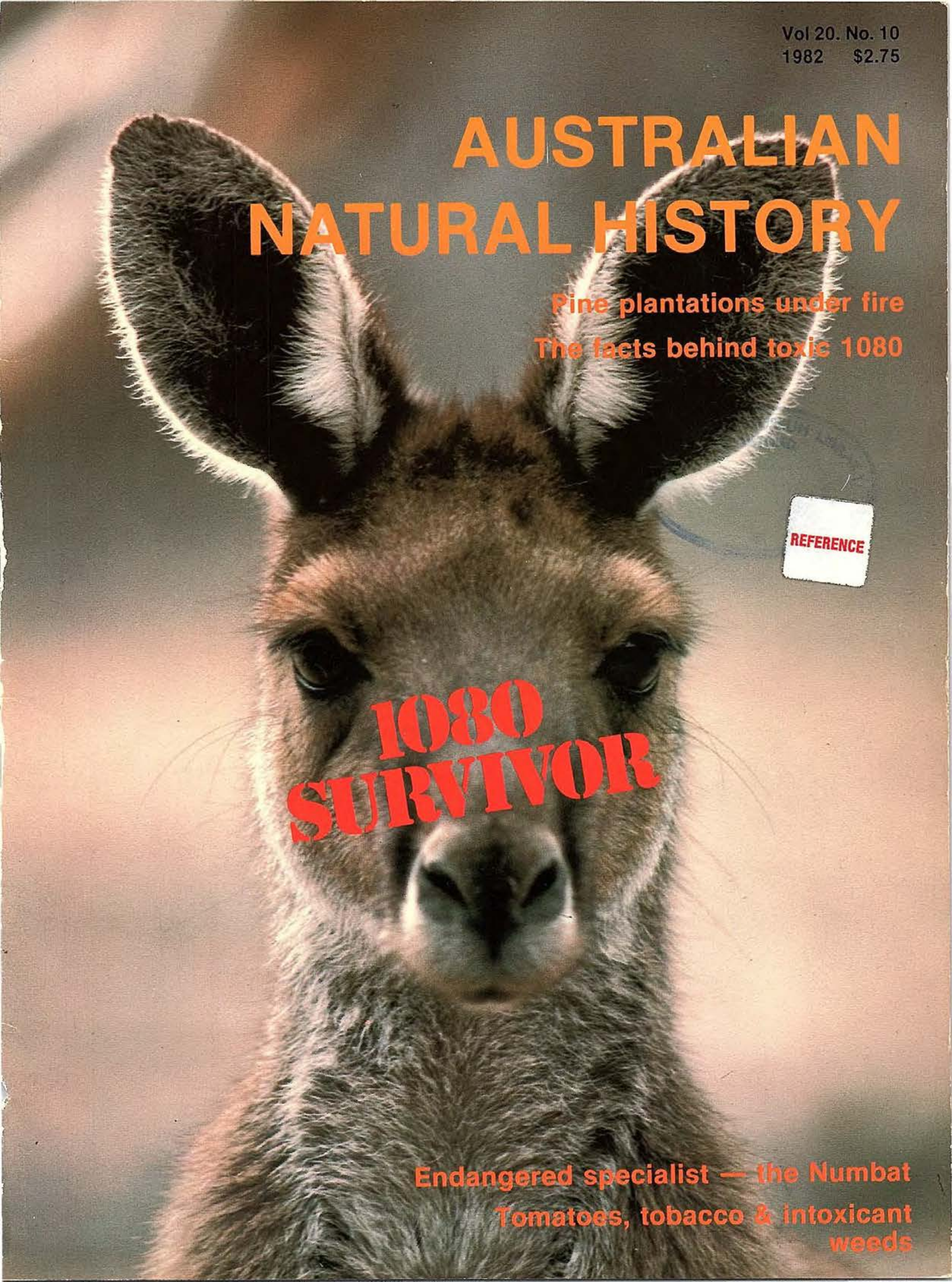
AUSTRALIAN NATURAL HISTORY

Pine plantations under fire

The facts behind toxic 1080



Endangered specialist — the Numbat

Tomatoes, tobacco & intoxicant weeds

AUSTRALIAN NATURAL HISTORY

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An observer in the control room of the Anglo-Australian Telescope at Siding Springs. Photo David Malin.

A small refuge of eucalypt borders a pine plantation in the distance. Photo Harry Recher.

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The editor welcomes articles or photographs in any field of natural history

FROM THE INSIDE

Numbats feed on termites which occur in logs and around the base of trees. Termite mounds are rarely attacked as for most of the year they are as hard as cement, softening only after the winter rains. Photo L.F. Schick, courtesy of the National Photographic Index of Australian Wildlife (NPIAW).

This issue of Australian Natural History features what is probably the most important article published in the magazine over the past two years.

Museum ecologists, supported by biologists in other government agencies throughout Australia are becoming increasingly disturbed by the escalating national pine planting programme. Their concern is not because of the major species of pine tree being planted — the Monterey Pine, *Pinus radiata* — nor the plan to develop a million hectares of plantations, but that massive pine forest planting threatens large areas of native forest.

Already over half of Australia's original forest has been cleared for agriculture and urban development. What remains is a precious resource which needs to be managed responsibly for future Australians.

Clearing native forest and replacing it with the monotonous ranks of pines means that the vast majority of plants and animals dependent upon native forest are lost.

'*Pinus radiata* — a million hectare miscalculation?' presents a case for the authorities to take another look at the pine planting programme and re-evaluate Australian forestry practices in the 80's.

In preparing this article we approached scientists at both the NSW Forestry Commission and the Department of Forestry, Australian National University. The scientist who replied from the Forestry Commission felt the article to be "offensive and insulting to my profession" and that to provide any guidance was an "impossible" task. Comments from the scientists at the Department of Forestry at the Australian National University were helpful and resulted in a number of changes being made to the article before it was published.

It is now up to readers to judge.

The next issue of Australian Natural History will be a special issue devoted entirely to evolution in Australia. Unfortunately, due to space constraints the article examining treecreepers promised for this issue will be published at a future date.

Roland Hughes
Editor

PINUS RADIATA — A MILLION HECTARE MISCALCULATION?

by Harry F. Recher

Because Monterey Pines only grow in certain conditions, the impact of clearing land for pines in southeastern Australia falls heaviest on a few kinds of moist, montane forest.

Above right, clearing part of a mature pine forest. Photos Harry Recher.

Opposite, the Yellow-bellied Glider is just one of a number of native mammals severely affected by the spread of large expanses of pine plantations. Photo Dick Whitford, (NPIAW).

By the year 2000 Australia will bristle with over one million hectres of pine plantations mostly containing Monterey Pine, *Pinus radiata*. Already there are over 500,000 hectares of land under pine and with an annual growth of 30,000 hectares, extensive areas of native forest are threatened with extinction.

Over half Australia's original forest has been cleared for agriculture and urban development making the remaining areas of our native forest a precious resource. They not only provide us with recreation, water and wood, but it is imperative that we manage our public lands in ways which ensure that all parts of the forest survive.

Clearing a native forest and planting pines means that the vast majority of plants and animals living in that forest are lost. Despite this the pressure for more pine plantations at the expense of native forest is increasing from both Governments and timber companies.

Harry Recher is the Curator of Vertebrate Ecology at the Australian Museum and has been working on the affects of the woodchip industry and pine plantations on native flora and fauna.

'Super-trees' are the new green revolution. Trees which grow so fast, so straight, and so easily that overnight the world will reverse the loss of its forests, solve the fuelwood crisis and provide timber in ever-expanding amounts. It does sound a bit wishful, but consider that Australia has had its version of the 'super-tree' for more than a century.

Australia's super tree is the Monterey Pine, *Pinus radiata*. According to a number of people, pine trees can make Australia self-sufficient in wood and wood products. To achieve this goal, foresters throughout Australia have embarked on a programme to plant more than one million hectares of pine by the year 2000. Most of these plantations will be *Pinus radiata*, but in coastal areas where it is warm and humid, Loblolby Pine, *P. taeda*, Slash Pine, *P. elliotti* and Cuban Pine, *P. caribaea* are planted. All are 'New Australians'—immigrants from North America.

The scale of the plantations envisaged for Australia means that large areas of native forest have been and will be cleared to plant pines. The proponents of pine plantations argue that this is justified because Australia

One Australian bird that can survive in pines is the Brown Thornbill. This small insectivore forages on a wide range of native trees and shrubs, including many plants which have foliage not unlike pine needles. Its ability to forage successfully on such a wide range of plants including those with long, thin leaves such as She-Oak, *Casuarina*, may enable the Brown Thornbill to use insects found among pine needles which other native birds cannot. Photo I. R. McCann (NPIAW).

*Chaparral is a coastal shrub community distinct to the coast of California and in many respects not unlike the coastal heathlands we see in eastern and south western Australia.

MONTEREY PINE IN CALIFORNIA

As trees go, the Monterey Pine has rather unpretentious credentials. It is not particularly tall (25—40m), nor given to a long life (100 years or so). The wood it produces is only average, but it is easy to work with, takes preservatives well and has good nail holding qualities. *Pinus radiata* is a native of California but in that golden land of tinsel and stardom, it is scarcely noticed. Monterey Pine is a relict species. That is, it is a species which had a wide distribution, but which for natural reasons is now confined to a small area or series of small areas.

Monterey Pine occurs naturally at only three places on the North American mainland—the Monterey Peninsula 150km south of San Francisco, at Ano Nuevo 65km north of Monterey, and at Cambria 100km south of Monterey. At none of these places does Monterey Pine grow more than 7km from the coast or much above 300m in elevation. In all, it occupies an area of about 6,000 hectares with 4,400 hectares at Monterey, 1,200 hectares at Cambria and 400 hectares at Ano Nuevo. Contrast this to the plantations of Monterey Pine in the Tumut district of New South Wales which alone exceed 60,000 hectares.

Two other species, Bishop Pine, *P. muricata* and Knobcone Pine, *P. attenuata*, are related to Monterey Pine. Together they are the principal species of a group known as the coastal, closed-cone pines. During the Pleistocene, forests dominated by closed-cone pines were widespread along the Pacific coast from northern California to northern Mexico and on off-shore islands.

The dry conditions which developed in California since the last ice age (20,000 B.P.) have brought about the contraction of the closed-cone pine forest and greatly reduced the range of Monterey Pine. The central coast of California is characterized by wet winters and dry summers with an annual rainfall at Monterey and Cambria of 500 mm and 750 mm at Ano Nuevo. Although the summers are dry, they are also foggy and water condensing on the pines is critical for their survival.

Monterey Pines do best on deep, well-drained soils, and it is soil and water which explain their distribution. Too little summer moisture restricts their distribution in the south and wetter conditions north of Ano Nuevo favour trees like Redwood and Douglas Fir. These form closed moist forests from which the closed-cone pines are excluded.

At 100 years a Monterey Pine is old. It is easily killed by fire, but aggressively colonizes disturbed ground and seeds heavily after fire. The closed cones, which give this group of pines their name, open after the tree dies or after they are heated in a fire. This is the same adaptation to fire and environmental stress shown by many Australian plants such as *Hakea* and *Banksia*, and assists these plants to survive in a fire prone environment.

In California the balance between Monterey Pine forests, oak woodlands and chaparral* is maintained by the subtle interactions of fire and fog. Fires allow the pines to seed new forests, but whether those forests survive or give way to oaks depends on how much additional moisture the pines can capture from the summer mists. This in turn is strongly influenced by topography. A solitary pine in an expanse of chaparral* attests to the play of fire, topography and the chance movement of a seed. Because of this mingling of communities, the vegetation of the pine forests seems especially rich. Live Oaks, Native Lilac, *Ceanothus* spp., Poison Oak, *Rhus diversiloba*, Manzanita, *Arctostaphylos*

(Continued next page).

does not produce enough softwood to meet demands and relies heavily on imports. They claim imported wood is not only expensive but puts Australia at a disadvantage during a crisis when wood or wood products might not be available from overseas sources. Each of these arguments has been disputed, as has the extent of plantings needed to meet Australia's requirements for wood or to significantly reduce the nation's bill for imports.

Pines in Australia

The early history of Monterey Pine in Australia is poorly documented. One tale has it that the tree was introduced by gold miners returning from California in the 1850's. Another that it was brought in accidentally with ballast in colliers backloading from California. We do know that *Pinus radiata* was used first as an ornamental tree. The Royal Botanic Gardens in Sydney received one in 1857 and the Adelaide Botanic Gardens had an avenue of Monterey Pines more than 15 metres in height in 1878. These 50 foot trees were less than 12 years old. The tree was also popular on homesteads of the high country throughout southeastern Australia and avenues of giant Radiata Pines, the common term to describe the pines, are a feature of that landscape. So conspicuous are some of these ornamental plantings that they are entered on topographic maps as landmarks.

It is obvious that the fine growth of Monterey Pine on country properties would sooner or later have attracted the attention of the nation's foresters. Australia has few species of conifers suitable for softwood production and the search for species to establish in plantations was well underway by the 1870's.

A thin strip of reserve bordering a large pine plantation after being sprayed with 2,4,5-T. Aerial spraying operations are carried out on pine plantations in order to prevent the growth of weeds which suppress pine growth. Photo Harry Recher.

The first experimental plantings were made in South Australia in 1876. The tree showed superb growth and out-performed the many other exotic and native trees which the South Australian foresters tested. Regular plantings began in 1907 and by 1910 more than a million trees had been planted on 800 hectares. Plantations in the other states followed—1917 in New South Wales and Victoria, 1921 in Tasmania, 1922 in Western Australia, 1925 in the Australian Capital Territory and 1927 in Queensland. The first mill to

tomentosa, Sage, *Artemisia* spp., Baccharis, *Baccharis pilularis*, and Coffeeberry, *Rhamnus californica,* are among the more conspicuous shrubs and small trees. Grasses dominate the ground vegetation, but in winter and spring there is a profusion of native flowers rivalling the floral display of Australia's heaths.

The animal life in the Monterey Pine forests of California is equally diverse. Typically American mammals such as Brush Rabbit, *Sylvilaqus bachmani,* Raccoon, *Procyon lotor,* Coyote, *Canis latrans,* Gray Fox, *Urocyon cinereoarqenteus,* Deer Mouse *Peromyscus maniculatus* and Mule Deer, *Oedocoileus hemionus* are abundant. There are lizards, snakes, frogs, and salamanders, but as always, it is the birds which are most obvious, filling the pine forest with sound and movement.

About 50 species of birds breed in the pine forests and numerous others occur during the winter or on migration. None are restricted to the pines as they occur equally in the associated woodland. Indeed, it is the mix of plant communities and the complex layering of vegetation provided by pines, oaks, shrubs and grasses which encourage the diversity of birds and other animals. Nonetheless, many birds forage on the pines. Golden-crowned Kinglets, *Regulus satrapa,* Chestnut-backed Chickadees, *Parus rufescens,* and Black-throated Gray Warblers, *Dendroica nigrescens* take insects from the foliage. Brown Creepers, *Certia familiaris* and the Pygmy Nuthatch, *Sitta pygmaea* glean insects from the bark of the trunk and along the branches. Nuttall's Woodpecker, *Dendrocopos nuttallii* hunts insects on the trunk and large branches by flaking off bark and probing deeply into crevices. Others hawk insects from the air or hunt seeds on the forest floor. Red-tail Hawks, *Buteo jamaicensis* soar overhead and Cooper's Hawks, *Accipiter cooperli* hunt the forest edges for small birds.

The California forests have a long history of disturbance, but fortunately, Monterey Pine is a resilient species. Logging was commenced by the Spanish in the 15th and 16th centuries and during the 19th century large amounts of pine were exported. There have been forest fires, land cleared for grazing, and pine used as fuel for industry, but the greatest threat is occurring now.

As towns on the Monterey Peninsula have grown there has been extensive subdivision of the forest. Most of the Monterey Pine forests in California are privately owned. When houses are built the pines and oaks may be retained, but the ground and shrub vegetation is removed. In older sections, the pines are dying of old age and there is little indication that home-owners are replacing them. In time there will be a substantial reduction in the number of Monterey Pines in California. The 200 hectares at Jacks Peak and a small area at Pt Lobos near Carmel are the only secure reserves. Outside of these parks there is an accelerating loss of the forest with its complex vegetation and rich fauna.

Although little of the Monterey Pine forest in California is protected, *Pinus radiata* is not an endangered species. Besides the million hectares of plantation planned for Australia, Monterey Pine is an important commercial species in New Zealand, Chile and South Africa. For a tree which is struggling in its own land, it has done well for itself.

process Radiata Pine was established in 1903 at Wirrabara S.A., and the first tree sawn yielded enough wood for 28 apple crates. The tree was called the 'remarkable pine'.

Despite the obvious potential of Monterey Pine, the rate at which plantations were established was at first quite moderate. In New South Wales, for example, up to 1945 barely 7,000 hectares had been planted and much of this was accomplished in the late 1920's and during the Great Depression, first using prison labour and then as a conservation 'make-work' programme. There are probably many reasons for the slow establishment of Radiata plantations in Australia up to the 1940's. The first plantations were not without their problems. Perhaps in a burst of early enthusiasm over the tree's potential, many plantations were established in the wrong places and failed.

Very successful in Australia

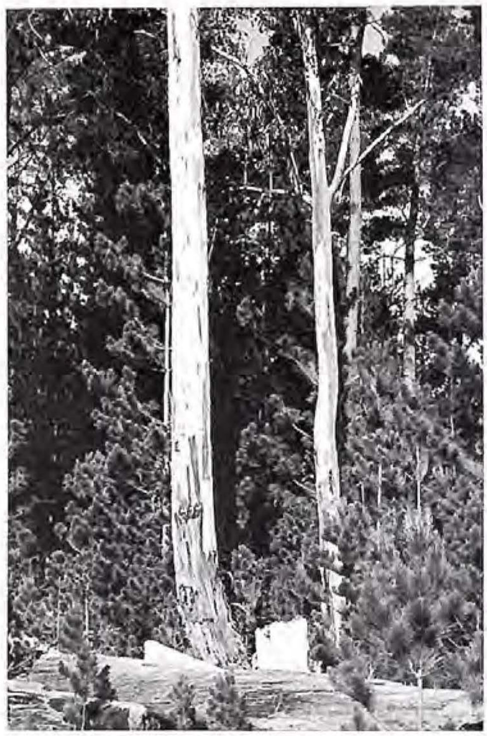
Monterey Pine does grow extremely well in the southern hemisphere. Established in plantations and free of the insects and diseases which plague it in California, *Pinus radiata* is an ideal farm crop. In general, Monterey Pine grows best on fertile, well-drained soils with a minimum annual rainfall of 750mm. Provided that other conditions are met, it will grow well enough in areas receiving as little as 600mm of rain. It does poorly where it is hot and humid. Monterey Pine is tolerant of cold, but can not survive freezing nor can it live through prolonged droughts.

In eastern Australia, these limits restrict Radiata plantations to elevations of between 600 and 1,200 metres, depending on latitude. For example, in New South Wales major plantations are located at Tumut, Bombala and Bathurst. In Tasmania and South Australia, the tree grows well at lower elevations down to sea level.

Massive pine expansion

The expansion of Radiata plantations began in earnest in the 1960's and today there are more than 500,000 hectares planted to Monterey Pine throughout Australia. Most of this is in South Australia, Victoria and New South Wales, but significant plantations have been established in Tasmania and Western Australia. Each year nearly 30,000 hectares of new plantations are established. Mostly these are State Forests, but industry and private individuals are also involved.

The Radiata Pine Association of Australia expects that by 1990 Australia's softwood plantations will produce half of the nation's sawlog volume and 40 per cent of its pulpwood needs. Compared with the 35 million hectares of native forest of which 26 million hectares are considered commercially useful, the million hectares of pine will contribute disproportionately to the nation's wood and pulp requirements. Yields are high and from seed to sawlog takes as little as 30



Mature pine forest intermingled with natives. In this situation more fauna will be attracted to the pine area because of the native vegetation. Photo Harry Recher.

years. Most plantations will be harvested on a 40 to 50 year cycle. However, there is a price. The price is the loss of a large area of native forest.

Compared with other countries Australia has little forest. Twenty-two per cent of New Zealand, 32 per cent of the continental United States, 44 per cent of Canada, but only five per cent of Australia is forested. It could be argued that because of its small population, Australia is relatively rich in forest. With 35 million hectares of forest this is more than two hectares for every man, woman and child or twice the acreage available to Americans. However, **per capita** comparisons are misleading. Ecologically is it the absolute area of forest and the extent to which forests are fragmented into smaller areas that is critical.

Area determines how many plants and animals occur in the forest and whether or not they can withstand the disturbance of logging, fire or storm. Not only does Australia have a small area of forest, but its forests have been fragmented by clearing. We may have more forest per head of person, but we do not have the security of tenure that Americans enjoy. The conversion of hundreds of thousands of hectares of forest to *Pinus radiata* plantations is therefore a matter of concern.

Not all Radiata plantations are established on forested lands. For example, in South Australia most plantations have gone on cleared, agricultural land and in Western Australia pines are being planted in place of forest severely affected by disease.

The most significant environmental problems with the establishment of Radiata Pine plantations occur in New South Wales, Victoria, and the Australian Capital Territory. In these states, governments have preferred to use existing State Forests for pine plantations. In this way they avoid the cost of purchasing land. When it has been necessary to purchase land, it is often forest or land on which a native forest has regenerated. Such land is not only the least expensive, but it avoids the political problems associated with the removal of productive farm land from the tax rolls.

Even if all plantations were established on forest land this would leave nearly 34 million hectares of native forest. Many people might find this reasonable, but events are not that simple.

Important forest threatened

Recall that Monterey Pine only grows where soils are rich in nutrients and well-drained, and the annual rainfall exceeds 600mm. In southeastern Australia this means that the impact of clearing land for pines falls heaviest on a few kinds of moist, montane forest. These montane forests are among the most spectacular in Australia with fine, tall trees and abundant wildlife. Much of this montane forest is highly productive of wood and for this reason little has been protected in national parks or nature reserves. Therefore in districts where there are extensive pine plantings whole forest communities are reduced to the point of extinction.

A typical example of a threatened community are the peppermint forests, *Eucalyptus radiata* and *E. dives* near Bombala on the southern tablelands of New South Wales. Neither New South Wales nor Victoria have reserved adequate samples of this type of forest and because of clearing for agriculture and pine plantations the peppermint forest community has been seriously depleted. The impact may only be regional, but these peppermint associations are exceptionally rich in wildlife.

We should look closely at what we gain and what we lose from the replacement of native forest with pines. Many costs, such as the loss of wildlife, are not properly accounted for.

Environmentalists refer to pine plantations as biological deserts. Foresters contend that this is incorrect and produce lists of animals which have been seen among the pines. Unfortunately these lists do not distinguish between animals passing through the pines and those able to live and reproduce in a plantation. Many animals can be seen in a pine plantation, but only those which are able to find the resources they need for successful reproduction can be considered residents. In the purely hypothetical situation where all native forest was replaced by pines, these are the only native animals which would survive, but they are also the only animals we should list when discussing the native fauna of a plantation.

Actually, neither the foresters in their contention of a rich wildlife nor the environmentalists in their description of a sterile landscape are correct. There is wildlife in a pine plantation, but much less than in a native forest.

Without setting foot in a plantation we could predict that pine plantations in Australia would support few native animals. It is not solely because the pines are aliens in a new land, but because of the nature of plantation forestry. Growing Monterey Pine is farming. Just as we do not expect to find an abundance of native animals in a cabbage patch, we should not expect many in a pine plantation. Although birds may not be as seriously affected by pine plantations as some mammals, they illustrate how native animals are disadvantaged by plantations.

There are several reasons why native birds will be scarce in plantations of Monterey Pine. Plantations are simple plant communities—only one species is planted and all the trees over quite large areas are the same size. As a result, there is only a single layer of vegetation. Ecologists have shown that plant communities with few kinds of plants or little structural diversity support fewer kinds of birds than communities which are rich in plants or have many layers of vegetation. Therefore, a grassland has fewer birds than a woodland, and the woodland has fewer birds than a forest.

Pine forests lack resources

In addition to being simple communities, pine plantations lack many of the resources needed by birds. There are no hollows in which to nest, nectar-rich flowers and fruits are absent, and, compared to native forests, insects are scarce. Neither hole nesting birds such as parrots or treecreepers nor nectar-feeding or fruit-eating birds can be expected to breed in plantations. Even when food is available, native birds may not be able to use it. In the northern hemisphere where extensive pine forests occur naturally, birds have evolved habits and morphological features suited to extracting insects from clusters of pine needles. Such insects may be unavailable to birds which are adapted to forage for insects on the broad leaves of eucalypts.

One Australian bird that survives in pines is the Brown Thornbill, *Acanthiza pusilla*. This small insectivore is a 'generalist' which can be found foraging on a wide range of native trees and shrubs. This includes many plants, such as She-Oak, *Casuarina*, which have foliage not unlike pine needles. Its ability to forage successfully on such a wide range of plants including those with long, thin leaves may enable the Brown Thornbill to use insects among pine needles which other native birds cannot. Other birds in pine plantations feed on flying insects produced outside the plantation or take insects produced in the litter of the plantation floor. Where birds do occur in pine plantations, they are commonly associated with native shrubs and eucalypts which have survived within the plantation or which are retained along watercourses. In the absence of native plants and away from the edges of the plantation, birds are scarce. The lack of a diverse vegetation, an absence of nest-hollows and restricted food sources are the reasons few birds can be expected to colonize plantations.

These predictions have been verified in South Australia, Victoria and New South Wales. Studies in each state have shown that less than half the original forest avifauna manages to persist in a pine plantation. Exclude the birds associated with the edges of the plantation where pine meets eucalypt and less than a third of the native birds nest in the pines.

Pine plantations are simple environments. As such, they cannot support an abundance of wildlife. As crops they must be protected against pests, disease and fire. The cumulative total of these costs is great — Australia's natural environment is made poorer, not richer. Drawing Angela Wright.

The pine plantations at Bombala are typical. Personal counts of breeding birds in montane forests near Bombala have shown that up to 40 species of birds can nest on each 10 hectares of forest. If the entire region is considered, about 75 species breed in the native forest. Counts in the pine plantation recorded a maximum of 12 nesting species for each 10 hectares. The greater number occurred in the oldest stands of pine which had been heavily thinned and in the younger plantations which were still open. In both places native plants were abundant. Only four to six species occurred in the middle-aged pines (12 to 18 years old) where the canopy had closed and shade excluded native plants.

Grouping the birds from all the different aged stands, only 19 species of forest birds nested in the pines. With the exception of a pair of Rose Robins, *Petroica rosea,* all were species which were widely distributed in dry sclerophyll forest. Except for the Rose Robin none of the 16 bird species that are restricted to moist, montane forest were found nesting in the pines.

Just as there are few kinds of birds in the pines, there are few native mammals. Kangaroos, wallabies and wombats are abundant along the plantation roads and in the new plantings where there is grass for grazing, but the small mammals of the forest floor are absent or much less abundant than in the native forest. As with birds, native mammals are affected by the simple structure of the plantation vegetation and a lack of food. Where native mammals occur it is in association with edges or weedy growth of native plants.

Illusion of abundance

Indeed, the association of wallabies and wombats with road edges creates an illusion of abundance. Move back into the pines and it is still. Unfortunately, the concentration of animals along roads fools many people into believing that wildlife can survive in a plantation environment. What they do not see are the animals which are not there. At Bombala seven species of possums and gliders occur in the native forest, but except where native forest has been retained, none survive among the pines.

With the exception of the Brush-tailed Possum, *Trichosurus vulpecula*, and the Sugar Glider, *Petaurus breviceps,* it is doubtful that the average Australian ever sees these animals. Yet the seven are wide spread in native forests. However, they are nocturnal and can only be appreciated with the use of a good spotlight and a walk through the forest after dark.

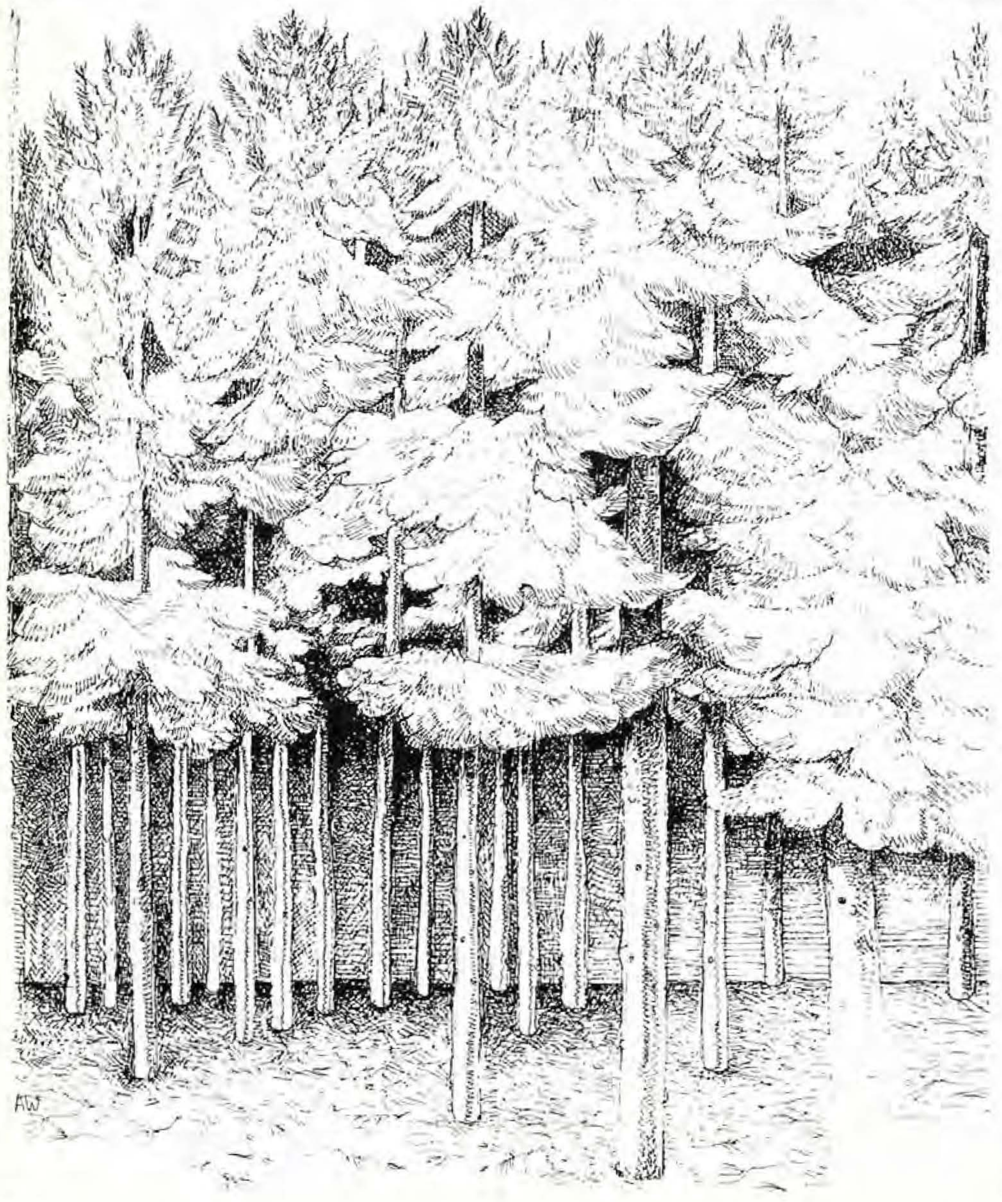
Two species, the Great Glider, *Schinobates volans,* and the Ringtail Possum *Pseudocheirus peregrinus,* feed on gum leaves. Three others, the Sugar Glider, the Yellow-bellied Glider, *P. australis,* and the Feather-tailed Glider, *Acrobates pygmaeus,* feed on nectar and insects. The Brush-Possum and the Bobuck, *T. caninus* are omnivorous and have even been known to eat pine bark. Except for the Ringtail Possum each species needs a hollow as a den. The Ringtail builds a nest or drey of leaves and twigs in tall shrubs or low trees. The other possums will use tree hollows, hollow logs or caves, but the gliders must have a tree hollow. As in the case of birds, the kinds of food and den sites needed by these seven mammals are absent in pines.

Severe impact on mammals

The impact of the pine programme on native mammals is much more severe than on birds. Of the 28 species of native mammals, excluding bats, recorded in montane forest in southeastern New South Wales and East Gippsland, only nine have been seen among the pines.

The loss of wildlife is not restricted to vertebrates. Forest invertebrates are also less abundant in pines than in native forest. Although 400 or so species of insects have been recorded in Australian pine plantations and some have become serious pests, entomologists would expect to find tens of thousands of species in a comparable area of native forest.

The amount of wildlife in a pine plantation can be enhanced by leaving strips or patches of native vegetation. If these are wide enough, they can support a large part of the original forest wildlife and provide resources which allow some species to use the pines. For example, Grey Fantails, *Rhipidura fuliginosa,* will nest among the pines, but go into the adjacent eucalypt forest to gather spider webs to build their nests. Similarly, the Yellow-tailed Black Cockatoo, *Calyptorhynchus funereus,* feeds avidly on pine cones, but must have a large tree hollow in which to nest and insects for



While pine plantations support few kinds of animals, eucalypt forests contain many plant species and have multiple layers of foliage which support both a large number and variety of animals. Drawing Angela Wright.

protein. Presumably nest boxes and other forms of artificial shelter could be used to increase the number of native animals among the pines, but pine plantations will never support the variety or abundance of wildlife found in native forests.

Nonetheless scientists have reservations about the long-term survival of native plants and animals in remnants of native forest retained within and extensive pine plantation. Few of these remnants are more than twenty years old—most are small or narrow. Although some areas have a full complement of wildlife, as occurs in some stream reserves at Bombala, scientists do not know if these are viable populations. Birds may continuously colonize from forest outside the plantation and some of the larger mammals may survive for years, but not reproduce.

2,4,5-T spraying

The environmental impact of a pine plantation does not stop with the clearing of the forest. After the pines are planted they must be protected. Weeds are sprayed with herbicides including 2,4,5-T, a chemical suspected of causing birth defects. The use of 2,4,5-T has been severely restricted in North America because of fears that it may affect people. One problem with 2,4,5-T is that it is invariably contaminated with dioxin, a powerful cancer causing agent and mutagen. Dioxin is degraded very slowly in the environment. The effects, if any, on native animals are not known.

Mature eucalypts are especially sensitive to 2,4,5-T and some areas of native forest retained in plantations have been seriously affected during the spraying of adjacent pines. In addition to weeds, there are animal pests which must be controlled. Carrots baited with the poison 1080 maybe used to control rabbits which damage young pines, but the baits are also taken by possums, wallabies, kangaroos, wombats and native rats which are also killed. The environmental effects do not stop with the poisoning of wildlife.

Clearing causes erosion

The clearing of forest, the construction of roads and site preparation inevitably cause erosion and can lead to the siltation of streams. To protect the pines from fire, it may be necessary to clear fire breaks and burn nearby native forests on a regular cycle. Frequent burning reduces the capacity of a forest to support wildlife. The impact will be particularly great on wildlife in strips or small patches of native forest retained in an extensive area of pines.

What do we gain? We gain wood and this may ease the pressure on the remaining native forests for wood production. At least we gain wood in the short-term, but few plantations in Australia have been planted or harvested more than once.

Just as there are few kinds of birds in the pines, there are also few native mammals. While kangaroos, wallabies and wombats are abundant along the plantation roads and in the new plantings where there is grass for grazing, all is still inside the pine forest. Photo John Fields, the Australian Museum.

It might not be bad if pine plantations proved incapable of sustained yields and we could re-establish the native forest. Unfortunately not only are there inadequate samples of the original forest within plantations as a source of genetic material, but there has been little effort to study and describe the forest before it is cleared. If in 200 years foresters decide to re-establish natives, what will they grow?

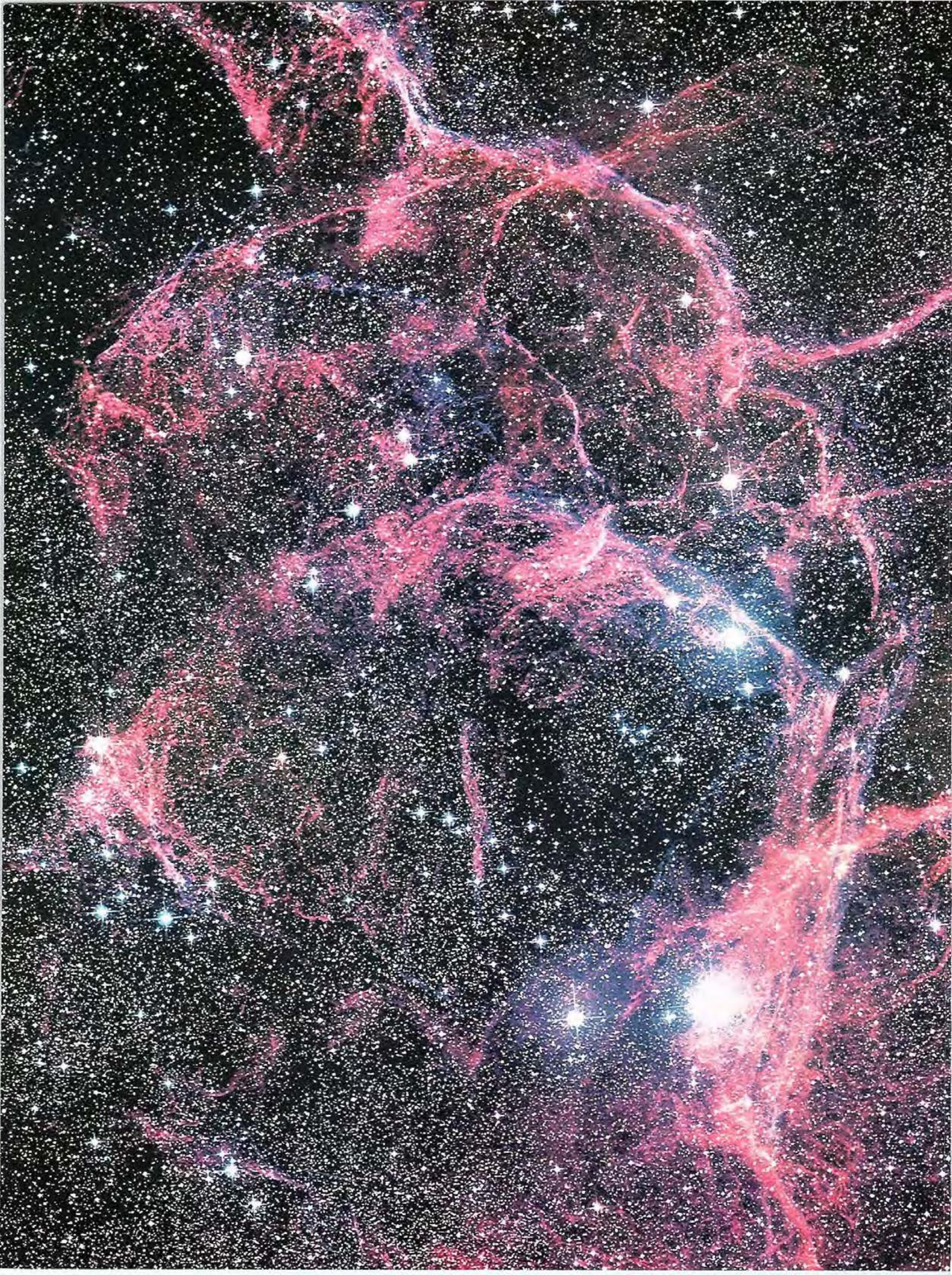
The need to replant the native forest may arise sooner than 200 years. Like all crops pines may need to be fertilized and protected from insect attack and disease. Temporarily the natural soil fertility is adequate, but with rotations of 40 or 50 years the soil may be depleted. Whether the cost of applying fertilizer to plantations can be justified or whether it will be needed remains to be seen.

Of equal concern is the potential for disease and insect attack. The vast areas planted to a single species of tree are an open invitation to the rapid spread of disease and insect pests. Already there are problems with the Sirex wood wasp in Tasmania and southern Victoria and *Dothistroma* needle blight is a serious disease in New Zealand. *Dothistroma* has appeared in Australia, but so far has been controlled with fungicides. Other insects and diseases affect Monterey Pine in California and attention has been drawn to the problems that could be created by such diseases as the Western Gall Rust *Peridermium harknessi*, should they be introduced to Australia.

Despite the potential for such problems, Monterey Pine is a good farm tree. Indeed, it is Australia's 'super-tree', the 'remarkable pine'. Were it not for the destruction of native forest there would be little objection to the establishment of plantations.

The destruction of native forest held in trust for all Australians raises more than questions of environmental impact and the loss of wildlife. The softwood programme appears to value the nation's forests for their land alone. Trees, wildlife, scenery, and recreation are seemingly given no value nor assigned any importance. This is wrong. A forest is the sum of its plants and animals. It is fine to harvest the forest, but we should not measure its value solely in quantities of wood.

As a nation we have lost sight of the future and by accepting the destruction of forests set aside by earlier generations we relegate our heritage to the cash register. Aldo Leopold, who was the founder of modern wildlife management in America, commented that 'We grieve only for what we know'. The tragedy is, not enough Australians know what they are losing.

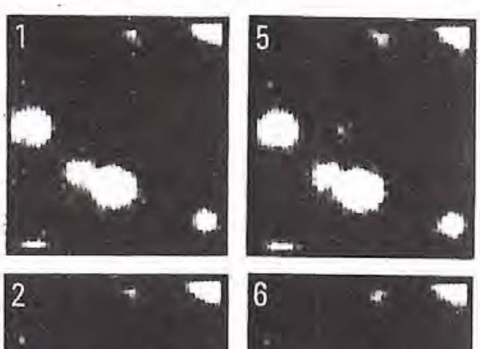


A GLIMPSE THROUGH THE EYE OF THE AAT

The Anglo-Australian Telescope (AAT) nestling among the stark peaks of the Warrumbungle Ranges in northern NSW is generally regarded as being the finest large telescope in the world. Since observations began in 1975, the Telescope has been responsible for a number of important discoveries.

In this second article on the work carried out at the Observatory, David Allen, a senior research scientist, writes on a few of the discoveries made by the scientific team on the AAT.

by David Allen



Eight phases in the cycle of the Vela pulsar. The star (arrowed) is brightest in frames 2 and 4.

Opposite, these wispy veils of gas are the remains of a massive star that blew itself to pieces as a supernova. All the photos in the article are by David Malin.

"But you don't look like an astronomer!"

All too often this is the reaction of the layman when I reveal my profession to him. The reaction typifies the popular view that astronomers are stooped, grey-bearded elders who spend their days in seclusion and their nights in the dark of a dome, and whose life work is to make copious notes on what they see through the cobwebby eyepiece of an antique brass telescope.

Except on the rare occasions that photography is being undertaken, the AAT observer works in the air-conditioned comfort of a clean control room. He shares the room with four computers and a plethora of computer terminals. The telescope lies beyond two doors, and up and down some small flights of stairs, and can be entered only when it's pointing straight up.

The most important tools of today's astronomer are the reels of magnetic tape containing many millions of numbers recorded by computer. In the control room the observer occupies an armchair — not too comfortable, for the night will be long — and sits before a keyboard terminal. Typing skills have replaced night vision as the astronomer's practical assets. In observing teams of two or three, modern-day astronomers witness the discoveries they are making on the green phosphors of an array of terminals.

The early stages of a night may be phrenetic, as the instrumentation is put to the test. Sometimes the threat of bad weather hastens the pace — cloud is the Damocles' sword to the optical astronomer. Later in the night observation becomes routine and the all-night vigil starts to take its toll. Towards dawn, with second wind, the observer once more hurries. All good nights end before one has finished all he would hope to observe.

The simplest of instruments used by astronomers is the photometer. This measures the amount of light received from the star or galaxy being observed. With the help of a computer it was a photometer that first detected the Vela pulsar, a discovery that received much publicity five years ago. Pulsars have been known for more than a decade — they are rhythmic, pulsing radio sources. Over 200 have been catalogued in our galaxy. But until the AAT discovery, only one was known to emit visible light, and that was a fairly bright specimen in the Crab Nebula. We know the Crab pulsar to be the remnant core of a star that exploded nine centuries ago to produce a supernova, and we believe it to be very dense and tiny. It spins 33 times a second and radiates two jets consisting of light and radio waves. As these beams sweep across the Earth, pulses are recorded.

Pinnacle of achievement

The Vela pulsar is the only other known to emit visible light. But it is the faintest ever studied, comparable to the light from a torch on the moon, and its detection by the AAT in 1976 proved to be the pinnacle of achievement in this field. The very fact of its faintness is of interest, for it is thought to be some 12,000 years old. Most other pulsars are older still — their light output seems to fall very fast with time, whereas the radio output is long-lived.

Pictures of the Vela pulsar were ultimately produced, using a sophisticated electronic detector called IPCS. By securing 88 pictures per second for 5½ hours, and then appropriately adding these, eight frames were generated representing eight distinct portions off its period of one eleventh of a second. From these images it was established that the Vela pulsar never totally switches off.

The origin of the light at its faintest is still not clear. Nor is the reason why its optical flashes do not coincide with the radio pulses.

Another discovery, made through the use of photometry but this time extending into the near-infrared, at a wavelength of 1200nm, was more recently achieved. On photographs of elliptical galaxies, David Malin (author of the previous article) had discovered several examples which were surrounded by luminous rings. Although these rings were extremely faint, it was thought that they represented thin shells of material, visible as is a soap bubble, most clearly at their peripheries. The astronomers wondered why the material shined so dimly and it was only after using the photometer that the reason was discovered.

Elliptical galaxies are themselves gigantic agglomerates of old stars, roughly distributed into the shape of a fuzzy rugby ball. Their origin has long been a puzzle, for one cannot generate an elliptical galaxy simply by allowing a cloud of gas to fall in on itself and break up into stars. Instead, this process manufactures spiral galaxies, like our own. The shells, however, give a clue. Since they contain stars as old as their parent galaxy, they are fossils of its formation.

Recent computations by Peter Quinn at the Mount Stromlo Observatory in Canberra show that it is possible to make elliptical galaxies by allowing spiral galaxies to coalesce. Moreover, in such mergers shells of stars are thrown off. This AAT discovery relates to the very formation of elliptical galaxies, and serves to demonstrate that there is still a role for conventional photography in this increasingly electronic world.

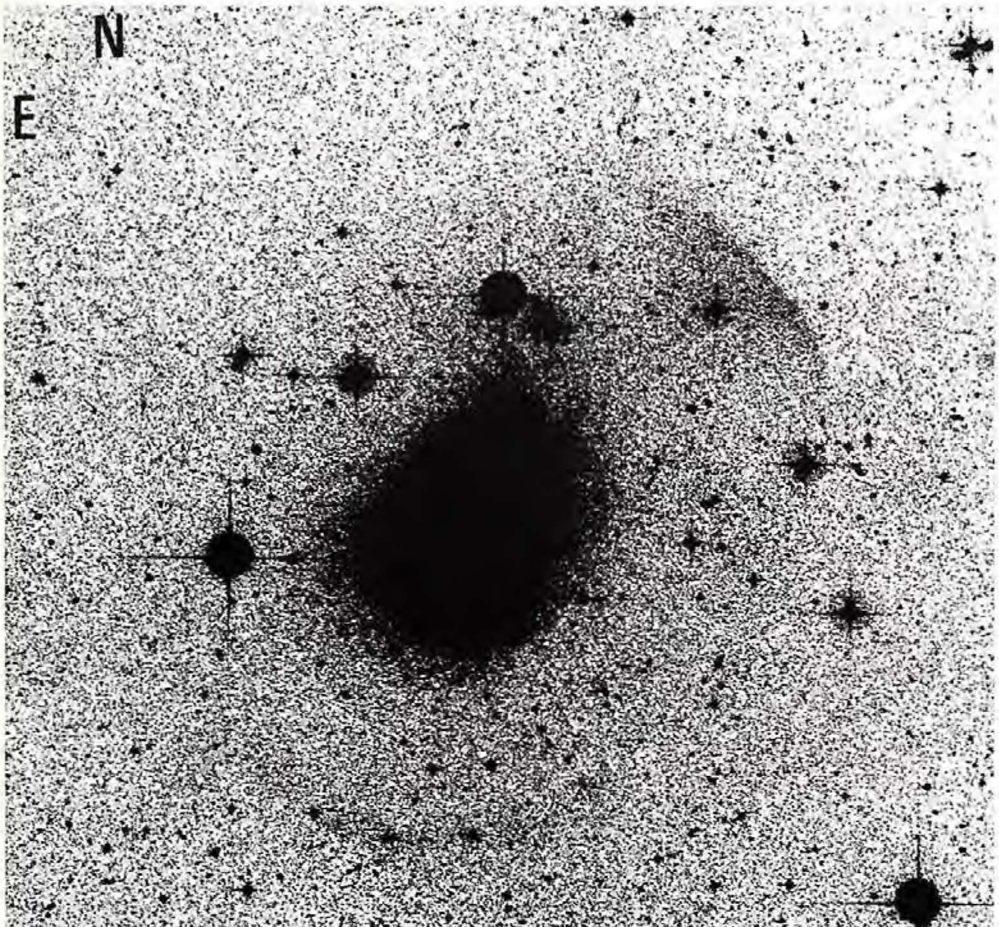
The third discovery, made by astronomers at AAT, was using a spectrograph. The spectra of celestial objects, coupled with the intricate details of their light, can tell astronomers a lot about their physics and chemistry. Astronomers are basically chemists and physicists who work on objects too distant to handle and too big to put in a laboratory — therefore they rely heavily on spectrographs. On the AAT, the spectrograph feeds its light to the electronic detector mentioned earlier, the IPCS, and then to a computer. The computer subtracts all the unwanted radiation from the night sky and presents the result to the user who can assess what he is measuring at the time.

The control console of the AAT is a bewildering array on the first encounter.

However, some discoveries are made only during subsequent analysis of the computer tapes, and so it was with the star SS 433. The strange, spinning pulsars that may be left over from the destructive explosion of a star have already been described. Even stranger objects can be generated.

David Clark and Paul Murdin, two British astronomers, were exploring another remnant from a supernova, following a lead given by X-ray and radio astronomers, when they encountered SS 433. The star was already known, but thought to be of little importance. Clark and Murdin's spectroscopy revealed features they did not immediately recognise. Indeed, it required some weeks of observations by other astronomers before their results made sense. What they recorded was hydrogen gas being ejected from SS 433 in two opposing jets. No such occurrence has been recorded for any other star and the exact mechanism remains a subject of debate. However, the most remarkable aspect is the ejection speed — one quarter that of light. Within our galaxy no other object generates gas motions more than about one tenth as great as that of SS 433.

Discoveries such as these do not happen every clear night. Much of the work of a large telescope adds only fragments of knowledge to a complex picture of our universe.



The partial rings around this elliptical galaxy, seen dark in this negative reproduction, are fossils from its prehistory.

HOW TOXIC 1080 SELECTS ITS TARGETS

by Dennis King

The high level of tolerance to 1080 occurs in a number of animals in southwestern Australia, including the Tammar Wallaby (above) and the Common Brushtail Possum (above right). Tammar Wallaby photo L. F. Schick (NPIAW), other photo E. Beaton (NPIAW).

The mere mention of 1080 poisoning and people sit up and take notice. The perfect example occurred late November, last year, when the Queensland Cabinet decided to abandon maintenance of the 6000 kilometre dingo fence and replace it with a massive programme of 1080 poisoning.

The decision caused such a furore that it was reversed in a matter of days. Had it gone ahead over one million dollars would have been spent baiting an area of approximately 80 million hectares both inside and outside the fence line.

1080 or sodium monofluoroacetate generates this controversy because it happens to be one of the most toxic substances known. Already used across Australia as a method for controlling dingoes, rabbits and foxes, recent studies on its effects on animals have shown that a number of native animals in southwestern Australia have evolved high levels of tolerance to the poison.

Dennis King, a research officer at the Agriculture Protection Board of Western Australia, began studying the tolerance levels of native fauna to 1080 in 1976 and incorporating this work with his studies on myxomatosis and rabbit control.

Sodium monofluoroacetate, commonly known as 1080, is a poison which is highly toxic to most mammals. It is used extensively for the control of vertebrate pests, particularly introduced mammals in Australia and New Zealand. Fluoroacetic acid was first synthesized in 1896, and its toxic properties were discovered in the 1930's. Its sodium salt has been used as a rodenticide since 1945, and its use in Australia during the past 25-30 years has mainly been against rabbits, dingoes and feral pigs.

Fluoroacetate is not toxic until it is converted into fluorocitrate in the body of an animal. This compound blocks the citric acid cycle, a fundamental biochemical pathway of energy exchange in plants and animals. Either the central nervous system or the heart is affected in mammals and the damage to either or both systems can lead to the death of the animal.

In 1943, fluoroacetate was found to occur naturally in the plant genus *Dichapetalum*, native to southern Africa. Between 1961 and 1964 it was also found in other genera of Australian and South American plants. By that time it had already been used as a vertebrate pesticide in Australia for 10-15 years.

In Australia, fluoroacetate occurs naturally in a wattle *(Acacia georginae)* which grows in a restricted area of the Northern Territory and Queensland and in over 30 species of the genera *Gastrolobium* and *Oxylobium*. Toxic species of these plants are mainly restricted to the southwest of Western Australia although one species also occurs in parts of the Northern Territory and Queensland. These plants can contain very high levels of fluoroacetate, and since the first settlement of Western Australia by Europeans, have caused high losses of domestic stock.

High poison levels

One species, known as Heartleaf Poison, *Gastrolobium bilobum*, has been shown to contain up to 2,650ppm of 1080 equivalent in its young leaves. This level of poison content is so high that less than 50 grams of the leaves will kill an adult sheep.

The levels of fluoroacetate differ considerably in different parts of the plants and are highest in the new foliage, flowers and seeds. It is assumed that these high levels of poison in the plants limit the amount of browsing on them by herbivores.

A study on the diet of Western Grey Kangaroos in the southwest of Western Australia has shown that although they do feed, to some extent, on species of *Gastrolobium* and *Oxylobium*, they eat less of the highly toxic species than of the less toxic ones.

Studies on a wide range of native species of mammals in southwestern Australia have shown that many of them have much higher levels of tolerance to fluoroacetate than do members of the same species or closely related species from southeastern Australia.

The toxicity of a substance is usually stated as an LD.50. This is a statistical estimate of the dose of the substance which would be lethal to 50% of a sample of the species tested, and as the effect is dependent on the size of the animal, it is given as a dose per unit of body weight. The toxicity of fluoroacetate to most mammals is in the range 0.1-2.0mg/kg, and for man it is estimated to be in the range of 2-5mg/kg. For many years it was believed that some native fauna in the southwestern corner of Western Australia fed on toxic species of *Gastrolobium* and *Oxylobium* without harmful effect, but this was not studied until recently (see box).

The research confirmed what scientists had expected. The southwestern mammals were significantly more tolerant of fluoroacetate than the eastern Australian mammals due to their exposure to poison plants.

1080 levels in native fauna

Studies on native fauna from the southwestern corner of West Australia showed that the Common Brushtail Possum, *Trichosurus vulpecula*, was approximately 100 times more tolerant of fluoroacetate than the same species in southeastern Australia. The LD.50 for the eastern species was found to be 0.68mg/kg by McIlroy but individuals from the southwest have survived doses as high as 125mg/kg.

Other highly tolerant species of mammals in the southwest include the Brush-tailed Bettong or Woylie, *Bettongia penicillata*, which has an LD.50 of more than 100mg/kg, the Western Grey Kangaroo, *Macropus fuliginosus*, with an LD.50 of approximately 35-40mg/kg and the Bush Rat, *Rattus fuscipes*.

McIlroy has found that in southeastern Australia the Bush Rat has an LD.50 of 1.13mg/kg. A population of this species near Manjimup, WA, has an LD.50 of 36mg/kg. Other populations from the mainland of southwestern Australia have LD.50's ranging from approximately 24-27mg/kg, whereas rats from Mondrain Island, on which Heartleaf Poison grows, have an LD.50 of 80.1mg/kg.

Bush Rats often occur in very dense populations on islands and the rate on Mondrain Island may have to rely on Heartleaf Poison as a food to a greater extent at some times of the year than do those on the mainland.

A Heartleaf Poison thicket near Manjimup, WA, one of the homes of the Tammar Wallaby. The foliage of these plants contain up to 2,600ppm of fluoroacetate. Photo T. Leftwich.

Differences in the tolerance levels of populations of the Tammar Wallaby, *Macropus eugenii,* proved to be of special interest to the researchers. They found that animals from the Abrolhos Islands and Garden Island, WA, have a high tolerance to fluoroacetate. This is in spite of the fact that these islands have been cut off from the mainland for about 12,000 and 7,000 years respectively and no fluoroacetate-bearing plants occur on the islands. The high level of tolerance to the toxin, which presumably evolved as a result of feeding on toxic plants, has persisted for several thousand generations in the absence of further contact with these plants.

High levels of tolerance have also been found in populations of other species of mammals which are outside the range of the toxic species of *Gastrolobium* and *Oxylobium.* These include Western Grey Kangaroos from Kangaroo Island in South Australia and in New South Wales, the Burrowing Bettong or Boodie, *Bettongia lesueur,* and the Banded Hare Wallaby, *Lagostrophus fasciatus,* from Dorre Island in Shark Bay, WA.

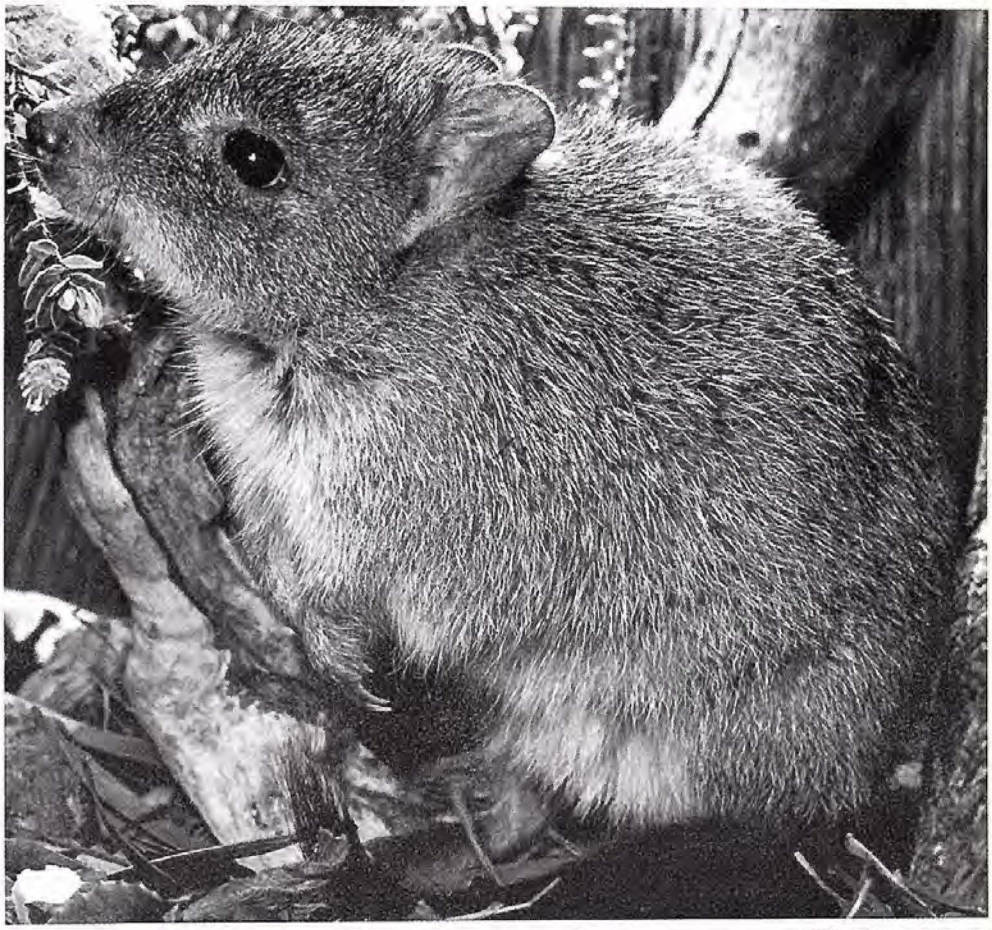
The retention of high levels of tolerance to fluoroacetate in some mammals has been used as a genetic marker to help determine changes which have occurred in the distributions of these species. For example, it has been suggested that the Western Grey Kangaroo evolved in southwestern Australia and radiated eastwards into South Australia, Victoria and New South Wales. However, the Eastern Grey Kangaroo, *Macropus giganteus,* is highly susceptible to fluoroacetate despite having an overlapping range in some areas.

No difference in kangaroos

No difference could be shown in the tolerance to fluoroacetate of Western Grey Kangaroos from the southwest of Western Australia, where they are known to feed on the toxic plants, and those from Kangaroo Island which has been separated from the mainland for 9,000—11,000 years and which has no toxic species of *Gastrolobium* or *Oxylobium* on it.

The Tammar Wallabies on Kangaroo Island are highly susceptible to fluoroacetate, and this, along with the high levels of tolerance in populations of this species in Western Australia, has been interpreted as indicating an eastern development and subsequent western radiation of Tammars.

Knowledge of tolerance levels and their implications regarding the distribution of native



Above right, the Brush-tailed Bettong is another south-western mammal which is highly tolerant to 1080. Photo A. Y. Pepper (NPIAW).

Right, the Eastern Grey Kangaroo is highly susceptible to 1080 despite having an overlapping range with the Western Grey in some areas. Photo H. & J. Beste (NPIAW).

animals is useful when we consider the damage caused by Australia's many introduced mammals. The use of 1080 poison against vertebrate pest species is common in Australia. These pests include recently introduced animals such as rabbits, feral pigs and foxes. The poison is also used against dingoes, which have been in Australia for thousands of years but are still highly sensitive to 1080.

In these poisoning campaigns, attempts are generally made to minimise mortality to the non-target species in the area by making baits relatively unattractive to them or of sufficient size that they cannot ingest a lethal dose of the toxin.

In southwestern Australia target specificity is easier to achieve as the native fauna are tolerant to the poison. The high levels of tolerance to fluoroacetate found in several species of macropods, Common Brushtail Possums and in Bush Rats in southwestern Australia means that these species are at little or no risk from 1080 poisoning of rabbits even if they eat some of the poison bait.

Birds are generally much less susceptible to fluoroacetate than are mammals, and the large reptiles which might be at risk from feeding on baits or on carcasses of poisoned rabbits are highly tolerant of fluoroacetate. The LD.50 for the large herbivorous Bobtailed Skink, *Tiliqua rugosa* from the southwest is almost 500mg/kg and the carnivorous goannas, *Varanus gouldii* and *V. rosenbergi*, from the region can survive doses in excess of 100mg/kg. Therefore through the fortunate coincidence of a potent toxin being found to occur naturally in the southwest after its introduction as a poison for introduced pest species, control programmes can be carried out with a minimum of risk to the native species.

The information obtained from these research programmes is being used to directly benefit native fauna. The introduction of foxes and rabbits to Australia has had an extremely detrimental effect on many species of native animals. Some native species existing in small populations in restricted habitats are under considerable threat from introduced animals, especially foxes.

Fox poisoning programmes using 1080 baits have been carried out by the WA Agriculture Protection Board in order to protect a number of native species. These include marine turtle nests on Northwest Cape, the Western Swamp Tortoise, *Pseudemydura umbrina*, near Perth, the Brushtailed Bettong near Manjimup and several colonies of Rock Wallabies, *Petrogale penicillata*. The bait material, size, and poison content were selected to pose a minimal threat to native fauna. These programmes have all caused substantial reductions in fox numbers.

Studies on the tolerance of a number of rare and endangered species of mammals are planned. These species include the Burrowing Bettong, the Banded Hare Wallaby, the Shark Bay Mouse, *Pseudomys praeconis*, (which now only occur on a few islands off the coast of Western Australia) the Brush-tailed Bettong, the Rufous Hare Wallaby, *Lagorchestes hirsutus*, and the Greater Bilby, *Macrotis lagotis*. The tests use biochemical techniques to determine the extent of intoxication from the poison. Preliminary tests of some of the species (Banded Hare Wallaby, both Bettongs and the Bilby) show that they all have high levels of tolerance to fluoroacetate.

Successful programmes to eradicate rabbits from several islands off the West

The flowers of Heartleaf Poison. Photo Dennis King.

The Bush Rat found in southeastern Australia (above) has a very low tolerance to 1080 which is at variance to the south western animal (opposite). As a result Bush Rats in south western Australia are at little or no risk from 1080 poisoning of rabbits even if they eat some of the poison bait. Above photo H. & J. Beste, photo opposite A. G. Wells (NPIAW).

Australian coast (important nesting sites for seabirds) have been carried out in recent years using 1080 poision. Aerial photographs of Carnac Island taken before and several years after the eradication of rabbits from that island have shown a marked recovery of the vegetation on the island.

It is clear that based on an adequate knowledge of the toxicity of fluoroacetate to both native and introduced fauna, careful use of this highly toxic substance can be of great value in the conservation of native fauna and flora in Western Australia. The long-term retention of tolerance to the toxin also means that some species which occur outside Western Australia, such as the Western Grey Kangaroo and the Greater Bilby, are at little or no risk from well designed control operations using this poison.

By taking advantage of native fauna's tolerance to fluoroacetate the value of this substance can be increased beyond that of an effective poison against agricultural pests and used to directly benefit the unique flora and fauna of Australia.

TIMELY REAPPEARANCE OF A RARE RAT

by Roland Hughes

The site where the Hastings River Rat is found. Photo Linda Gibson.

Lower right, one of the two rats being held in captivity by the Museum. Photo John Fields.

The Hastings River Rat, *Pseudomys oralis,* a native rodent previously presumed extinct in New South Wales since the 1840's has been rediscovered in the Mt Boss State Forest near Wauchope.

Originally only known from two specimens caught in the 1840s this little known rodent was discovered by Linda Gibson, a Museum biologist carrying out a mammal survey in the State Forest in October last year. At that time only one specimen was captured but in January of this year, a Forestry Commission team caught a pair of the mammals.

Linda Gibson, from the Museum's mammal department, is currently studying the two rats with the hope that they will eventually be the first of the species to breed in captivity.

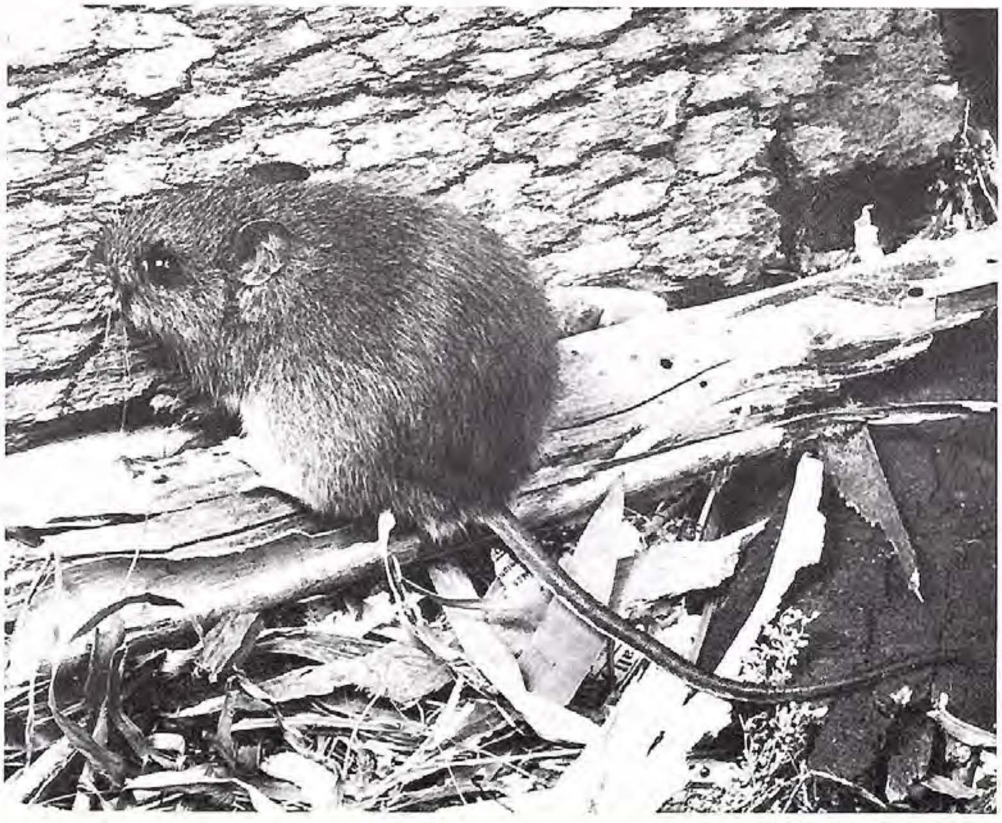
The Hastings River Rat is about 300mm long and has a two-coloured tail, dark grey on the top and white underneath, with a grey body and white feet.

The only other population known to exist in Australia is a very small and scattered community near Warwick in south-east Queensland, which was found in 1969.

The Forestry Commission had planned to build a road through the middle of the site in order to gain access to the rainforest and moist hardwood forests some kilometres away. However, it is now expected that the road will be diverted to protect the habitat of this rare mammal.

Mt Boss State Forest is one of two major areas in New South Wales (Washpool Forest being the other) which has caught the attention of conservationists trying to prevent further rainforest logging.

Already preservation of the rainforest in Washpool Forest has gained ground because of a recent report commissioned by the State Government from scientists in the Forestry Department, Australian National University, which argues that there are sufficient alternative supplies of timber to those available at Washpool.



CENTREFOLD No. 12

Kultarr
Antechinomys laniger

by A. Valente

The Kultarr is adapted to life on open land and inhabits desert plains and *Acacia* shrubland. Photo A. G. Wells, courtesy of the National Photographic Index of Australian Wildlife.

Once considered to be the marsupial equivalent of hopping-mice, the Kultarr was long known as the Jerboa-marsupial. The great length of the hindlegs supported this view but studies of its locomotion now show that it is consistently quadrupedal, bounding rapidly from hindlegs to forelegs. This gait gives it great manoeuvrability, permitting a rapid change of direction by pivoting on its forefeet to evade a predator or perhaps to avoid being bitten by potentially dangerous prey such as spiders or centipedes. Until recently, the Kultarr was placed in a genus of its own, *Antechinomys,* but it is now regarded as a somewhat aberrant dunnart.

Gould provided the first description of a Kultarr in 1856 but incorrectly depicted it on the branch of a tree. A terrestrial animal, predominantly adapted to life on open land, it inhabits desert plains, stony and sandy country where grasses and small bushes constitute the principal vegetation, and *Acacia* scrubland. It has been found sheltering in logs or stumps, beneath saltbush and spinifex tussocks, and in deep cracks in the soil. It has also been found in the burrows of other animals such as trapdoor spiders and hopping-mice but it is not known whether it digs its own burrow in the wild. Captive animals have been observed to dig shallow burrows and to cover the entrance with grass. It is nocturnal and probably spends much of the night foraging for insects.

The breeding season is not known precisely but captive unmated females from south-western Queensland are known to pass through successive oestrous cycles from July until February. Females have either six or eight nipples and young have been recorded in the wild from August to November.

The pouch, a crescentic fold of skin covering the anterior part of a mammary area develops during the breeding season and subsequently regresses. It provides protection for the young during the initial stages of suckling. After about thirty days, when they are about 25mm long, the young leave the pouch and may be left in the nest or ride on the mother's back. Exchange of calls between the mother and young are used in mutual location and are important in stimulating the retrieval of young which have strayed from the nest or become dislodged from her back. Weaning is complete at about three months of age.

The Kultarr is rare over most of its range and populations appear to fluctuate seasonally. It is not directly affected by human activity but its security may be reduced by changed or intensified land use. As a whole, the species appears to be neither endangered nor vulnerable but some populations, such as those at Cedar Bay, Qld, and in southern New South Wales (where no specimens have been recorded since 1900) may have disappeared.

Size (Varies with locality): Head and body length is 80-100mm for males and 70-95mm for females. Tail length is 100-150mm for males and 100-140mm for females. Weight is about 30g for males and about 20g for females.

Identification: Grizzled fawn grey to sandy brown above, white on chest and belly. Midline of face, crown of head, and eye-ring darker. Very large ears; large protruding eyes; long thin tail with prominent pencil of dark-brown to black hairs. The hindfoot is greatly elongated, with only four toes.

Past Scientific Names: *Antechinomys spenceri, Antechinomys laniger.*

Other Common Names: Jerboa-marsupial, Jerboa Pouched-mouse, Jerboa Marsupial-mouse, Kultarr, Wuhl-wuhl, Pitchi-pitchi (last two names referring to *Sminthopsis spenceri.*

Survival Status: Rare, scattered. Presumed extinct at Cedar Bay, Qld and southern NSW.

Subspecies: *Sminthopsis laniger laniger,* Eastern Australia; *Sminthopsis laniger spenceri,* Central and Western Australia.

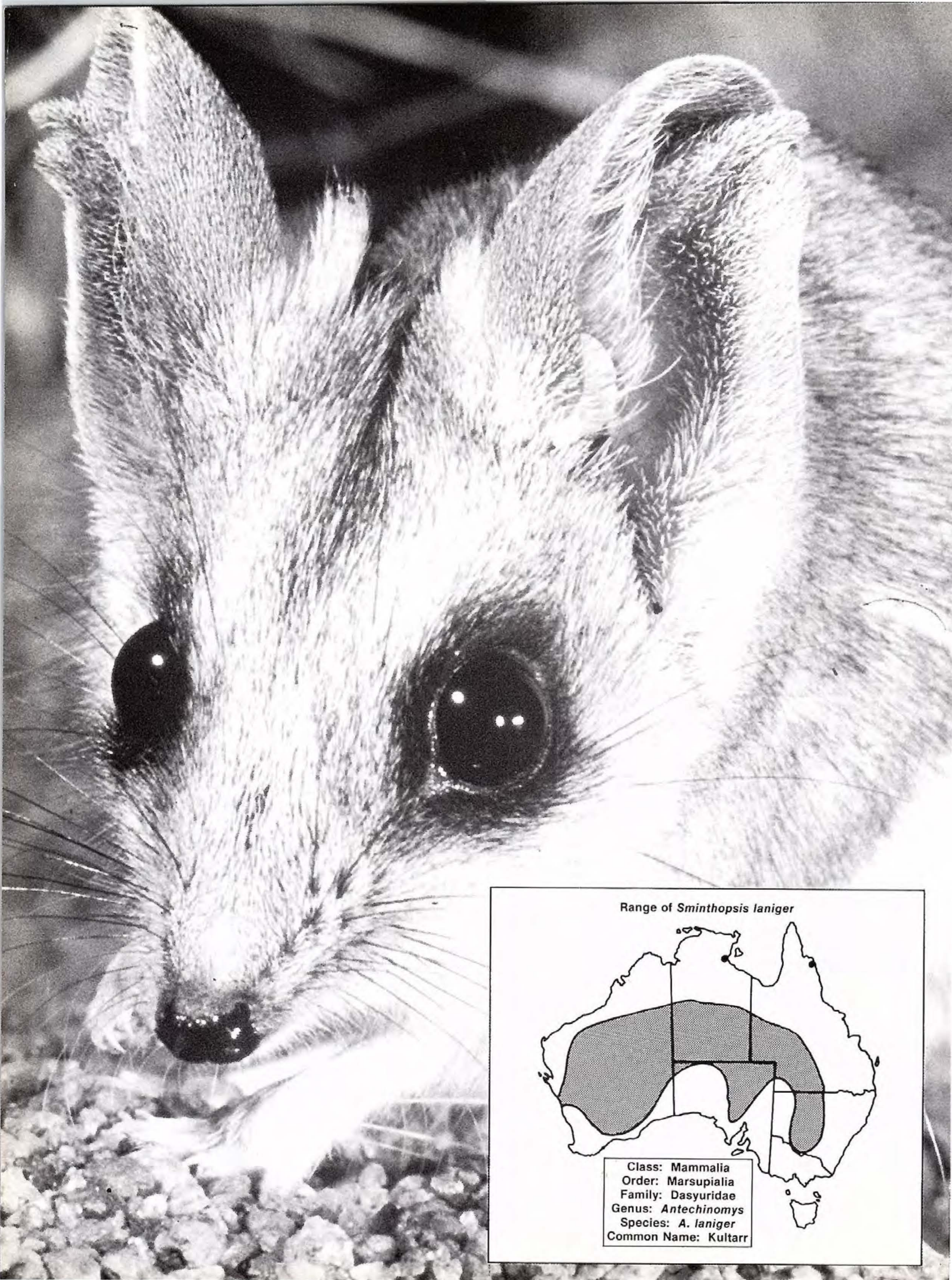
FURTHER READING

Archer, M. (1977). Revision of the dasyurid marsupial genus *Antechinomys* Krefft. *Mem. Qld. Mus. 18,* 17-29.

Happold, M. (1972). Maternal and juvenile behaviour in the marsupial jerboa *Antechinomys spenceri* (Dasyuridae). *Aust. Mamm. 1,* 27-37.

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. Anthony Valente is an Australian authority on the Kultarr and is currently a postgraduate student of La Trobe University, Melbourne.

The Kultarr is rare over most of its range but does not appear to be endangered or vulnerable. Photo A. G. Wells.


Range of *Sminthopsis laniger*
Class: Mammalia
Order: Marsupialia
Family: Dasyuridae
Genus: *Antechinomys*
Species: *A. laniger*
Common Name: Kultarr

THE NUMBAT — AN ENDANGERED SPECIALIST

by Tony Friend

The disappearance of the Numbat from most of its former range has been matched by similar declines in many small to medium-sized mammals on the Australian mainland. The proven existence of Numbats in a small area of Wandoo forest in Western Australia provides the greatest hope for the conservation of the species. Photo H. & J. Beste (NPIAW).

A captive breeding colony — recolonisation of formerly inhabitated forest areas — manipulation of forest fire regimes — predator control. These are some of the urgent points of a programme to conserve and perpetuate one of Australia's most rare and endangered mammal species, the Numbat.

Establishment of a captive breeding colony in Perth proposed by the Western Australian Department of Fisheries and Wildlife is strongly supported by the World Wildlife Fund Australia, which is appealing for sponsorship funds to get the project started.

The Numbat, *Myrmecobius fasciatus,* is a small, unique marsupial seriously threatened with extinction. Its diet consists entirely of termites extracted from ground nests on the wandoo forest floor.

The range of the Numbat has shrunk dramatically since European settlement. Once abundant from the western border of New South Wales to the western edge of the continent the animal is now restricted to a small area of southern Western Australia and north-western parts of South Australia — and the chief cause of this decline is man's destruction of the Numbat's habitat.

Author of this article, Tony Friend, is an officer of the WA Department of Fisheries and Wildlife and is presently carrying out an intensive programme of field research on this rare and precious mammal.

The sight of a Numbat, scratching at the soil in search of termites, or bounding over fallen branches on its way to a hollow log, is one which few people have experienced in recent years. Restricted to the southwest of Western Australia for the last forty years, the Numbat was, until recently, common in certain areas. A decline in the frequency of sightings during the 1970s has caused concern regarding its survival.

The Numbat, *Myrmecobius fasciatus,* is a small marsupial (head and body 25cm, tail 17cm) which is most closely related to the dasyurids (native-cats and other carnivorous marsupials) although it is included in a family of its own, the Myrmecobiidae. There are many anatomical features by which Numbats differ from other marsupials. The white bars across the back and the long tail, with its hairs often erect giving a bottle-brush effect, distinguish the Numbat immediately. However the most radical differences between the Numbat and other marsupials are related to its almost exclusive diet of termites, which are plentiful in the soil and dead wood of eucalypt forest and woodland where it lives.

During a feeding session, a Numbat exposes termites with its forepaws. Small dead branches on the forest floor are turned over, excavations are made in open spaces and around the bases of trees, and termite-infested logs are pulled apart with the sharp claws of the forefeet. Termite mounds are rarely attacked, however, as for much of the year the outer layers of most of these are hard as cement, softening slightly only after the winter rains.

When the termites are exposed, the Numbat picks them up on its very long pink worm-like tongue, which shoots in and out rapidly. Its salivary glands are unusually large, as a considerable amount of saliva is needed to keep the tongue moist during feeding. The long, narrow skull houses about 50 teeth, some of which are grossly abnormal. Numbats only rarely chew their food—the bulk of termites eaten are swallowed whole and are broken up during their passage through the gut.

The Numbat is the only marsupial that is fully diurnal, a pattern of behaviour which may be a consequence of its dependence on termites, most of which are more active in their feeding galleries by day than at night. In the bush, the coloration of the Numbat provides a most effective camouflage, helping to protect it from its natural predators—goannas and birds of prey.

Hollow-logs are common in both Wandoo, *Eucalyptus wandoo,* woodland and Jarrah, *E. marginata,* forest, where Numbats are found. These logs are used extensively for shelter at night and sometimes during the day, especially on hot summer afternoons. Although many Australian mammals use logs, few are as strongly adapted to this form of shelter. The Numbat enters the hollow head-first and emerges the same way, having performed a 'flip-turn' inside (most logs have only one entrance).

As some hollows are barely wider than the animal, this contortion requires anatomical specialisation—due to the flattened nature of the rump, this part of the body is still quite thin, even when the animal is doubled over during a turn. A further adaptation of the Numbat to the log refuge is its ability to expand the chest and mid-body, so it can wedge itself inside the close-fitting hollow, making it difficult to extricate.

Early settlers called the Numbat an 'anteater' because of its diet and anatomy, and although it only appears to eat ants incidentally it has many features in common with placental and monotreme anteaters.

Being colonial insects, ants and termites live in large aggregations, providing a concentrated source of energy for predators which can gain access to them. In his book *Echidnas,* Mervyn Griffiths has listed the anatomical specializations shared by mammals which eat mainly ants and termites, enabling them to dig out and capture large numbers of these insects. These features of anatomy are:

- Extensile vermiform tongue,
- Large salivary glands secreting sticky mucus,
- Long snouts and palates,
- Teeth grossly modified or absent,
- Forelimbs adapted for digging in hard strata to expose insect prey,
- Anomalous stomachs.

Comparison to anteaters

Several unrelated groups of mammals show these modifications. Among the placental mammals, there are the Pangolins from China, southeast Asia, India and parts of Africa, the Aardvark, of eastern and southern Africa, and some edentates, including the Giant Anteater, Tamandua, Silky Anteater and eight species among the Armadillos, all from Central and South America. Two monotremes, the Short-beaked Echidnas, *Tachyglossus,* from Australia and New Guinea, and the Long-beaked Echidna, *Zaglossus,* from New Guinea, also display these features, although *Zaglossus* mainly eats earthworms.

Anatomical and ecological comparisons between the Numbat and these anteaters, indicate how far evolution has taken this marsupial along a parallel path.

The Numbat possesses, to some degree, all the specializations listed above, with the exception of an anomalous stomach. There are no muscular or glandular features in which the Numbat's stomach differs from those of other carnivorous mammals. The other major difference between the Numbat and the anteaters is that, while the Numbat's forelimbs are adapted for digging, this modification is minor when comparison is made with the enormously strong digging and tearing claws of most anteaters.

These differences separating the Numbat from the true anteaters are very significant and point to a different dietary emphasis, that is, on termites alone rather than on both termites and ants. Also in contrast with the anteaters, the Numbat does not attack the mound nests of these insects.

Numbats have an almost exclusive diet of termites which occur in the soil and dead wood of eucalypt forests. Photo L. F. Schick (NPIAW).

The bodies of ants have a much stronger exoskeleton than termites, and large-scale predators require some means of crushing the insects. The true anteaters usually have a muscular gizzard or stomach, sometimes with horny plates or even ingested stones to aid mastication. The soft bodies of termites are ruptured easily and sandgrains taken in by the Numbat with its food perform this task adequately. Ants also differ from termites in that some species possess a powerful sting which discourages vertebrate predators, and distasteful compounds are often present in their bodies. The defences of soldier termites—grasping or flicking mandibles and sticky secretions—are primarily for use against ants and other insect predators. It seems, then, that termite predators need to overcome fewer problems than do ant predators, simply to be able to get a meal. Whether or not a termite predator needs metabolic specializations to utilise this fat-rich diet is as yet unknown.

It was pointed out earlier that termites, being colonial, live in large aggregations. These are of two kinds, a primary aggregation at the nest and a secondary aggregation at and approaching the feeding site. The Numbat differs from the true anteaters in feeding almost exclusively at secondary aggregations. In this aspect, the Numbat resembles the Aardwolf, *Proteles cristatus,* of southern and eastern Africa. The greater proportion of the Aardwolf's food comprises harvester termites, which it collects during foraging raids in the evening and night. At these times, huge bands of termites leave their nests to cut and collect lengths of grass, restocking their fungus gardens and food stores. The Aardwolf locates these bands by sound and smell, then laps up large numbers of the termites with its broad, sticky tongue. Like the Numbat, it eats only small numbers of ants, and does not attack termite mounds as its feet are not strongly adapted for digging.

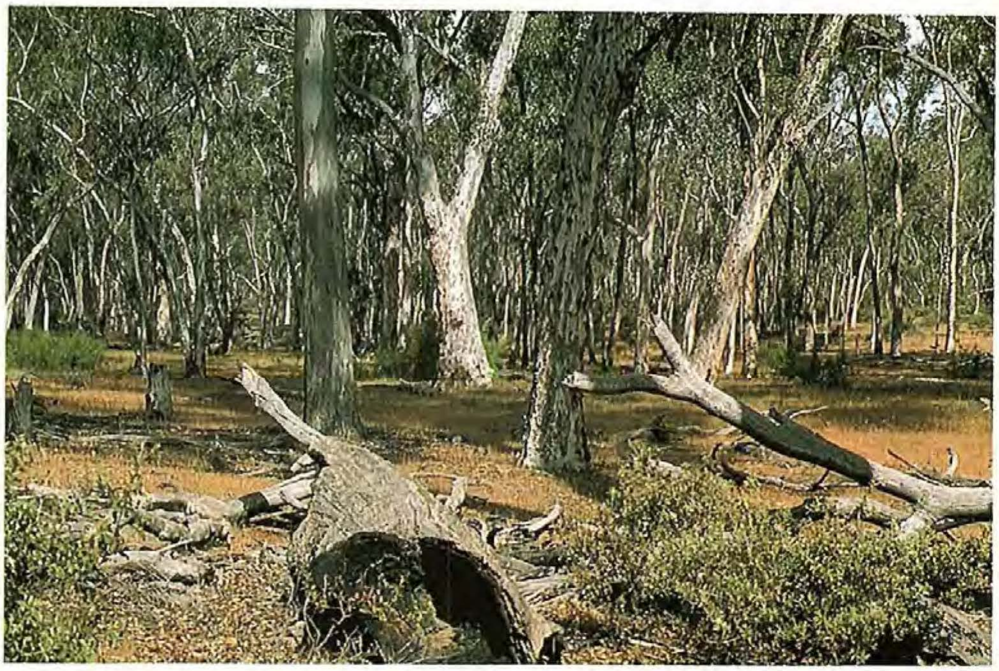
Gathers loose termites

The Numbat and Aardwolf both feed on secondary aggregations of termites and do not possess the large, digging claws necessary to attack nests. Most of the true anteaters in which digging feet have developed, are not able to run quickly on the ground to avoid predators. In response to this strong selective pressure, most of these anteaters either live in trees, or possess body armour or spines and an ability to roll up. The Pangolins are covered with horny plates and can roll up, as do the armadillos with their thick armour-plate. The Echidnas have spines on their bodies, and can dig themselves into the ground with amazing speed. In contrast, the Silky Anteaters, like several pangolins, have developed arboreal agility using prehensile tails. Only the Giant Anteater has no passive means of self-defence besides its size but can move at a slow trot, swim and when cornered, slashes ferociously with its digging claws. Aardvarks have an extremely tough hide which protects them as they rapidly dig themselves underground. The Numbat and the Aardwolf employ camouflage (both have lateral stripes) and fleetness of foot to elude predators.

The Numbat's adaptations to hollow-log refuges have been outlined—the Aardwolf hides in burrows, most of which, incidentally, have been taken over from Aardvarks.

Evolutionary step

It seems that a large evolutionary step is made when a species obtains the ability to dig up mounds, which also necessitates the development of protection from predators. To compensate for the loss of speed, alternative means of defence must appear simultaneously. It is likely that coevolution occurred—as some mammals started digging into termite nests, harder mounds developed and so mammals with stronger digging feet were at a disadvantage. At the same time, loss of mobility caused selection of those types of animals with other means of defence. It is possible that the true anteaters are representatives of groups which coexisted with the early mound-building termites. If this is so, then groups which subsequently developed termite-eating, like the Numbat and Aardwolf, 'missed the bus' in an evolutionary sense. These two species, however, have obviously become successful predators of termites in secondary aggregations. There is evidence that both Numbats and Aardwolves 'clean up' termites around mounds broken open by Echidnas and Aardvarks, respectively. Living within the ranges of these mound-attacking anteaters, the Numbat and the Aardwolf are less disadvantaged by their inability to break open termitaria.



Wandoo woodland was once widespread in the area now occupied by the wheatbelt, but now most has been cleared for agriculture. This type of woodland was apparently the best habitat for the Numbat. Photo Tony Friend.

At the time of its discovery, the Numbat occurred from southwestern Australia, where it was common, thinly through South Australia to western New South Wales. By the 1930s, the species was restricted to the southwest, and northwest South Australia and adjacent Western Australia. When John Calaby's definitive work on the Numbat was done in the mid-1950s, there was evidence of its occurrence only in areas of the southwest.

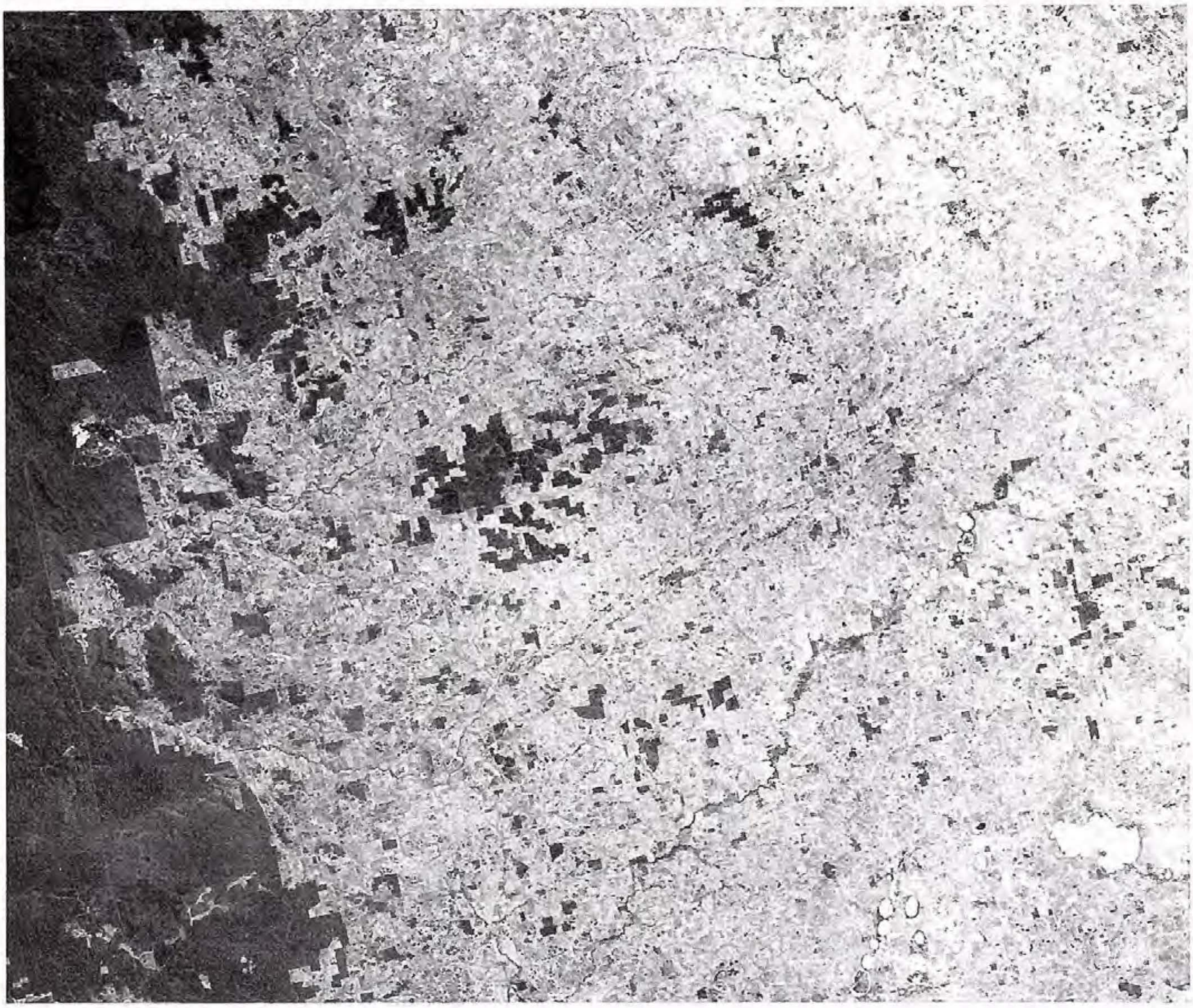
Several authors have commented on the much redder pelage of Numbats which formerly inhabited South Australia and western New South Wales. This form was known as *Myrmecobius fasciatus rufus*, a separate subspecies, being one extreme of the colour variation found among southwestern Numbats. It is easy to see how the red colour of the eastern Numbats would aid the survival of a diurnal animal living in semi-arid areas where red soils are widespread.

Lack of hollow logs

While termites are common throughout the Numbat's former range, hollow logs are not. The fragmentary evidence indicates that the eastern form lived largely in areas dominated by mulga, *Acacia aneura*, a small tree species which does not form hollow logs. As Numbats are known to use burrows sometimes in the southwest, it is probable that they took refuge underground in the eastern part of their range. This habit would have made them vulnerable to predators which could dig, and it may be no coincidence that their numbers declined in mulga country after populations of the introduced Red Fox built up in these semi-arid southern regions. Populations in the southwest survived the establishment of exotic predators like the fox and feral cat.

The clearing of land for agriculture has continued apace, however, and very little uncleared land now remains in the large area, east of the Jarrah forest, which John Calaby designated as containing the most important Numbat habitat (areas of suitable Wandoo woodland) in the 1950s.

Unlike the true anteaters, Numbats are easily able to crush the soft bodies of termites using the sandgrains taken in during feeding. Photo L. F. Schick.



This 1981 Landsat image shows forest as dark areas and cleared land as grey/white areas. Note the lack of substantial uncleared areas east of the large forest belt. (on the left). This was the main area of Numbat distribution in the 1950s. Dryandra (the small dark patch of forest in the centre of the photo) still has a population, but there have been no reported sightings from the two areas to the north and north-east for several years.

The adjacent Jarrah forest which contains some Wandoo is more or less continuous and is large in extent. The proven existence of Numbats, probably at low densities, in this forest indicates that the main forest belt provides the greatest hope for the conservation of the species. Virtually all of it is under the control of the Western Australian Forests Department and is managed principally for its timber value. It is imperative that the management policy which optimizes Numbat habitat be determined.

Manipulation of fire regimes and predator control in particular are being investigated in an effort to build up remaining Numbat populations and reintroduce animals into formerly inhabited areas. It is hoped that suitable sections of the main forest belt can be managed according to these policies, following the adoption of multiple-use strategies for State Forest management.

Captive breeding plays an increasingly important role in conservation strategy today but although Numbats lived for nine years in Taronga Zoo, Sydney and produced young on two occasions, there are no Numbats at present in captivity anywhere in the world. World Wildlife Fund Australia has approved a project submitted by the W.A. Department of Fisheries and Wildlife to establish a breeding colony of Numbats in captivity in Perth. The World Wildlife Fund is now trying to attract sponsorship for this project.

The disappearance of the Numbat from most of its former range has been matched by similar declines in many small to medium sized mammals on the Australian mainland. Today the only hope for the long-term survival of these species is that strategic research on their biology and habitat can be carried out and sufficient suitable land reserved or managed appropriately. The Numbat is a species of great scientific interest as it represents a very different branch of marsupial evolution. The popular appeal of this attractive animal, shown by its selection as the mammal emblem of Western Australia, gives further support to the high priority which is being given to its conservation.

TOMATOES, TOBACCO & INTOXICANT WEEDS

by Rosemary Purdie

Although we come in contact with and depend on the plant family, Solanaceae, everyday of our lives, most Australians probably don't realise the link between such a wide diversity of plant material. In this article, Rosemary Purdie, a botanist with the Bureau of Flora and Fauna in Canberra, gives a brief survey of native and naturalised Solanaceae in Australia.

The thornapples *Datura spp*, have large trumpet-shaped flowers and spiny fruits. The Downy Thornapple, *D. inoxia*, is an introduced species which occurs in all mainland states, usually in disturbed habitats.

Each time you eat a potato or tomato, or reach for a glass of water to drown the effects of too much chili sauce; each time you puff a cigarette or pipe filled with tobacco; and each time you weed the petunias in your garden, you are dealing with members of the plant family Solanaceae.

On a world-wide basis, the family contains approximately 90 genera and 2600 species, many of which are native to Central and South America. About 24 genera and 200 species occur in Australia, and of these six genera and some 130 species are endemic, and 11 species native in both Australia and adjacent countries such as Papua New Guinea, New Zealand and New Caledonia. The remaining species have been introduced into the country, either deliberately or accidentally, and subsequently become naturalised.

The genera occurring in Australia belong to nine tribes. The tribes differ in a number of characters, including the more obvious ones like the corolla shape, the type of anthers, and the type of fruit (see box).

Nine tribes of Solanaceae

The nine tribes are —

Anthocercideae — includes pituri which was used by the Aboriginals as a narcotic and animal poison.

Cestreae — shrubs or small trees which have been cultivated for their attractive and fragrant flowers.

Nicotianeae — tobacco.

Lycieae — Australian Boxthorn and the introduced pest African Boxthorn.

Jaboroseae — Pampas Lily of the Valley, introduced as a garden ornamental.

Solaneae — Tomatoes, Tamarillo, Cape Gooseberry, Kangaroo Apple etc.

Nicandreae — represented by the Apple of Peru, a noxious weed.

Datureae — is represented in Australia by 10 annual or short-lived perennial species and is used in some countries as an hallucinogen.

Hyoscyameae — includes Black Henbane which is used in some countries as painkillers and sedatives.

Most of the genera and species in the tribe Anthocercideae are endemic to Australia, occurring predominantly in southern parts of the continent, with the greatest number of species (19) in Western Australia. Most are shrubs or small trees, and grow in temperate, semi-arid and arid regions.

**The African Boxthorn, *Lycium ferocissimum*, growing along an old fence on the outskirts of Melbourne, was commonly used as a hedge plant when first introduced to Australia.
Photos R. Purdie.**

Of the seven genera in the tribe, only *Duboisia* has been widely used by humans. *D. myoporoides* and *D. leichhardtii*, (*Corkwoods*), which occur in eastern Australia, contain the tropane alkaloids hyoscine and hyoscyamine, the proportions and concentration of which vary with the season and geographic locality of the plants. During the early 1940's both species were cultivated for the commercial production of hyoscine and atropine (respectively) for use in medicinal drugs.

When, during the Second World War, it was discovered that hyoscine could be used to treat bomb shock, and sea and air sickness, its production increased. The quantity obtained from *D. myoporoides* in the war years exceeded the total previous world production from other sources.

Pituri, *D. hopwoodii*, is widespread in arid Australia, and contains the alkaloids nicotine and nor-nicotine. The type and quantity of alkaloid present varies with the geographic

locality, the growth stage of plants, and with different parts of the plant. Early explorers in Australia found that Aboriginals in various areas used pituri as a narcotic and animal poison. In western Queensland, it was prepared as a narcotic by chewing and mixing it with ash to form a quid which was placed behind an ear for safe storage. Early reports noted its ceremonial use, where a quid was passed from person to person, each having a chew. In the Cooper Creek area it was also used in greeting — quids being exchanged, chewed, and returned to their owner.

Early culture shock

Considerable culture shock was experienced by white explorers to whom Aboriginals extended this custom. One Dr Murray, physician to a group sent in 1862 to rescue the survivors of the Burke and Wills party, commented that "the fullest appreciation of their hospitality in offering their highly prized and indeed only stimulant could never overcome our repugnance to the nauseous morsels hot and steaming from their mouths". However Dr Murray also noted that the sole survivor, King, "obtained a chew of pituri when his food became scarce and bad", causing him "to forget his hunger and the miseries of his position" during the seven months he spent living with the Aboriginals on the Cooper until rescued.

Aboriginals, especially in central Australia, would place crushed pituri leaves into water holes to stupify emus and other birds and marsupials, making them easier to kill. After the arrival of European settlers, pituri plants sometimes caused the poisoning of camels and stock animals which ate the leaves.

The plant tribe Cestreae is represented in Australia only by the introduced genus *Cestrum*. The genus contains about 250 species which are usually shrubs or small trees, and sometimes cultivated for their attractive and fragrant flowers. The four species naturalised in Australia were thought to be introduced as garden ornamentals. The most widespread species, Green Poisonberry, *C. parqui*, is toxic to stock animals and poultry, and is now a declared noxious weed in some states.

Members of the tribe Nicotianeae are mostly annual or short-lived perennial herbs — a few are shrubs. In Australia, the tribe is represented by three genera, two of which, *Petunia* and *Nierembergia*, contain introduced ornamental garden species which are sparsely naturalised, mostly in eastern New South Wales. The third genus, *Nicotiana*, contains only one widely naturalised species, Tree Tobacco *N. glauca*, the remaining 16 being native to the mainland and occurring in semi-tropical, temperate and arid areas.

Opposite, chilis, *Capsicum spp*, are an important food item in many countries. Two species are sparsely naturalised in tropical and semi-tropical areas of eastern Australia. Top photo R. Purdie, bottom M. Fagg.

The Downy Thornapple contains compounds which allow the plant to be used as an hallucinogen. Photo R. Purdie.

The genus *Nicotiana* is best known for its narcotic properties, due to the alkaloid nicotine contained in the plants. Several species have long been used as tobacco for smoking, chewing or snuff-taking. The plants first became known in Europe in the late 1490's as a result of Columbus' trip to the Americas, where he found local inhabitants smoking smouldering rolls of leaves by inserting them into a nostril and inhaling several times. Narcotic species were soon introduced to Europe and other countries. However, as noted by one author, the most commonly used species, *N. tabacum*, "spread throughout the world with such rapidity not only because of its pleasant stupifying qualities, but because like other plants before it, tobacco was said to be a potent aphrodisiac". In Australia, *N. tabacum* is cultivated as a commercial crop, and sometimes grows wild in surrounding areas.

Five of the 16 native Australian species of *Nicotiana* were used as chewing tobacco by the Aboriginals. Early white explorers in central Australia described how leaves were almost dried over hot sand, "kneaded into little balls between the teeth in order to give cohesion, then rolled into a mass about the size of the thumb, then dried again and reserved for future use". Often the leaves were mixed with ash from species of *Acacia* or *Eucalyptus*, while wallaby hairs were sometimes added for extra cohesion. These narcotic species of *Nicotiana* and also Pituri were highly prized by Aboriginals for their use in barter, and were often traded to regions well beyond their natural range of distribution. Although in most areas any chewing tobacco was called pituri by the white people, it was usually composed of *Nicotiana* leaves rather than those of *Duboisia hopwoodii*.

Spread of noxious weed

The tribe Lycieae is represented in Australia by *Lycium*, a genus of about 100 often spiny, densely branched shrub species. The Australian Boxthorn, *L. australe*, is endemic to the Australian mainland, occurring in southern arid and semi-arid areas, usually on saline soils at the edges of salt lakes and claypans. Three species are naturalised, having been introduced for use as hedge plants, mostly in rural areas. The African boxthorn, *L. ferocissimum*, which was introduced in the late 19th century, is now widespread particularly in eastern Australia, and is a declared noxious weed in most states.

The tribes Jaboroseae and Nicandreae are represented in Australia by the naturalised species Pampas Lily of the Valley, *Salpichroa origanifolia*, and Apple of Peru, *Nicandra physalodes*, (respectively), both of which were introduced as garden ornamentals. The former species, a scrambling or climbing perennial, is common in waste places, particularly in urban areas, and is a declared noxious weed in several Australian states. *Nicandra* is a monotypic genus widely naturalised in tropical and sub-tropical areas of many countries. In Australia, it is a summer or autumn growing annual herb common in disturbed areas, mostly in eastern parts of the continent.

The tribe Solaneae is represented in Australia by six genera whose species range from annual herbs to small trees. These genera contain a number of important food plants, some of which are grown commercially, and include the Tree Tomato, or Tamarillo *Cyphomandra betacea*, Potato, *Solanum tuberosum;* Eggplant or Aubergine, *S. melongena;* Tomato, *Lycopersicon lycopersicum*, Chili, Paprika, Tabasco or Cayenne-pepper, *Capsicum spp*, and Cape Gooseberry, *Physalis peruviana*. Except for the potato, all the above species are naturalised in Australia, mostly in tropical and sub-tropical areas of the eastern states, having been introduced originally for food or as ornamentals.

Although the tomato is a common food plant now and cultivated in many countries including Australia, it only became widely accepted as edible in the 18th century. Prior to this it was variously considered to be poisonous, was grown as an ornamental, or was used for medical purposes. The name Apple of Love applied to it in Europe during the 17th century, alluded to its supposed (but unproven) properties as an aphrodisiac.

Capsicum has long been used as a condiment or medicine in many countries. The pungent property of the fruit, which gives its well-known bite as a condiment, is due to the volatile phenolic compound capsaicin. Although widely used as a spice in India, Africa and south-east Asia, the genus is native to tropical America, and was introduced to these other regions by Europeans in the 16th century, following which it quickly became absorbed into the local cultures.

The introduced Brazilian Nightshade, *Solanum seaforthianum*, is a climbing shrub sometimes cultivated in gardens and naturalised in higher rainfall areas of Queensland and New South Wales. Photo M. Fagg.

Lesser known uses of *Capsicum* range from healing to torture. In current medicine it is used, among other things, as an ingredient in throat gargles, cough lozenges, and in preparations designed to stop children thumb-sucking and nail-biting. The pungency of the fruit has also been utilised in warfare South American Indians used smoke from burning chilies as a gas to repel Spanish invaders in the 16th century. During the recent Vietnamese War, Buddhist monks in South Vietnam were reported to have armed themselves with sprayguns containing a mixture of curry powder, lemon juice and red chili powder. In the West Indies, chili was used traditionally by the Carib Indians both during manhood rites and in warfare. The latter is said to have involved rubbing chili pepper into cuts and burns inflicted on captive rivals who, after a few days, were killed and eaten. It is not certain whether the prime intent was to torture the victims or season them in readiness for the cook-pot!

Native Australian members of the tribe Solaneae which provided food for the Aboriginals include Wild Gooseberry, *Physalis minima*, a plant with gooseberry-like fruits occurring in northern and eastern Australia, and about 15 species of Solanum which are found in various parts of the country. The *Solanum* berries were sometimes eaten fresh, usually when completely ripe, or were treated in some way, e.g. by washing or heating, or by removing the seeds and placenta. The fruits of *S. centrale* and *S. chippendalei* were staples for Aboriginals in parts of arid Australia because the dried berries, or paste made from them, could be kept for many years. The growth of some of these food species was deliberately encouraged by burning areas in which they grew to promote regeneration of the plants.

Aboriginal medicine

Only one native *Solanum* was recorded to be used in traditional Aboriginal medicine, and was applied as a poultice for leg swellings. Recently, two native species commonly called Kangaroo Apples, have become important sources of steroid drugs used in western medicine, particularly for contraceptives. The species, *S. aviculare* and *S. laciniatum*, (Kangaroo Apples), are now cultivated in the USSR, eastern Europe and New Zealand to provide solasodine, from which cortisone and other corticosteroid compounds are made.

The genus *Solanum* which contains an estimated 1500 species and is therefore one of the largest genera of flowering plants in the world, also contains the largest number of species, both native and introduced, of all solanaceous genera in Australia. The native species occur in all habitats except the saline, alpine and aquatic. They range from annual herbs to small trees, the latter usually being associated with wetter areas in eastern Australia. The shrubby species, which are widespread especially in arid and semi-arid

The shrub *Anthotroche pannosa* is a member of the tribe Anthocercideae. Flowers of species in this group are usually star-shaped and whitish, yellowish or purple-black in colour. Photo M. Fagg.

The shrub *Anthocercis viscosa* is another member of the tribe Anthocercideae. Photo M. Fagg.

areas, are often clonal and hence regenerate readily from roots after disturbances such as fire or mechanical injury. Compared with their populations in undisturbed vegetation, some species are so much more abundant along tracks and roadsides where the soil is regularly disturbed, that Mr David Symon, a botanist who has recently revised the genus in Australia, commented that "one wonders how they fared before roadmaking was common".

The tribe Datureae is represented in Australia by *Datura*, a genus of about 10 annual or short-lived perennial species. Australia has one native and five naturalised species, the latter being common in waste places and agricultural areas, and declared noxious weeds in most states. The native species, Native Thornapple, *D. leichhardtii*, is widespread in arid and semi-arid regions of the mainland.

All parts of *Datura* plants contain the tropane alkaloids atropine, hyoscyamine and scopolamine, a feature responsible for the long history of use of some species as drug plants. One of the most widespread uses was as an hallucinogen. In Mexico and South America, species were employed in initiation rites, and for divination and prophecy, in India and Afghanistan they were used as ceremonial intoxicants, and in Europe they were used in witches brews for initiation rites.

The species were also used traditionally in South America and India as analgesics to deaden pain during medical operations, or for the treatment of various conditions such as pneumonia, heart disease, sexual perversion, hysteria and epilepsy. A list of somewhat

Pituri, *Duboisia hopwoodii*, is restricted to arid regions of Australia, where it commonly grows on sand plains or dunes with spinifex, *Triodia spp.* Photo R. Purdie.

The introduced Apple of Peru, *Nicandra physalodes,* has purplish, bell-shaped flowers and fruit enclosed by the enlarged calyx which has five arrow-shaped lobes at its base. Photo R. Purdie.

In western Queensland, Pituri was prepared as a narcotic by chewing and mixing it with ash to form a quid which was placed behind the ear for safe storage. Photo R. Purdie.

miscellaneous uses through the ages includes their employment for luring virgins into prostitution, for infanticide, to quieten boisterous children, and as hypnotic agents by thieves and criminals. While small doses of the plants cause narcosis, loss of motor coordination and hallucinations, larger doses can cause prolonged comas and eventual death.

The ninth tribe to occur in Australia is the Hyoscyameae, represented by the introduced genus *Hyoscyamus*. The genus contains about 20 annual or herbaceous perennial species which also contain the tropane alkaloids hyoscyamine, scopolamine and atropine. The Black Henbane, *H. niger,* is cultivated in some countries as a commercial source of drugs used as painkillers and sedatives. It also has a long history of traditional usage in magic drinks, as a poison, for prophecy, and in witches brews and ointments. Modern experiments with the latter have led to the hypothesis that Black Henbane was one of the ingredients responsible for the medieval belief that witches could fly. Inhalation of henbane fumes caused one experimenter to report the "sensation that my feet were growing higher, expanding and breaking loose from my body .... at the same time I experienced the intoxicating sensation of flying". In Australia, two species of *Hyoscyamus,* including Black Henbane, have occurred sporadically, but have never become widespread nor persistent.

In summary, some of the naturalised Solanaceae and a relatively small number of native Australian species, are plants which have been important in the traditional rituals of many cultures because of their narcotic or hallucinogenic effects, have found a wide usage in medicine because of the chemical compounds they contain, or are of importance because of their culinary value, often as staple food items. Although a large number of native and naturalised species in Australia have no such special significance, they remain part of a family of world-wide interest.

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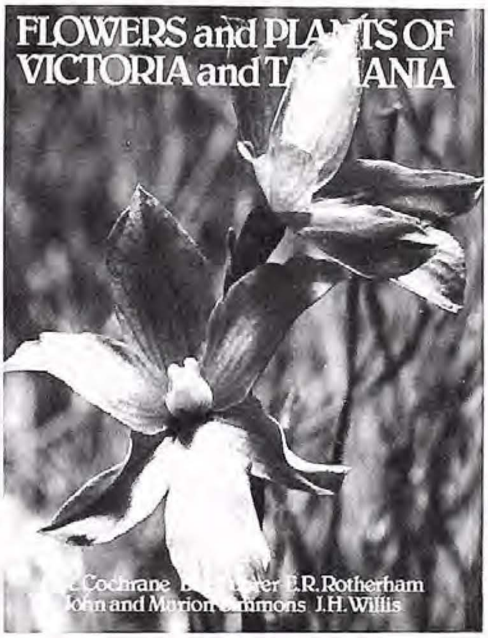
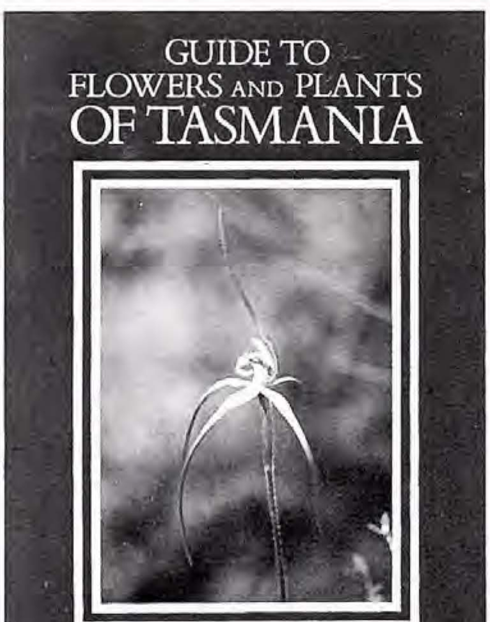
IN REVIEW





Flowers and Plants of Victoria and Tasmania **by G. R. Cochrane, B. A. Fuhrer, E. R. Rotheram, John & Marion Simmons & J. H. Willis, Reed, Sydney 1980, 176 pages, illustrated, $23-95.**

Guide to Flowers and Plants of Tasmania, **edited by Mary Cameron for the Launceston Field Naturalists Club, Reed, Sydney, 1980, 120 pages, illustrated, $23.95.**

At a time when reference books and other authoritative texts are becoming almost prohibitively costly it is somewhat ironical that popular and semi-popular natural history books containing hundreds of colour plates have become relatively inexpensive and well within reach of the enthusiast. When attractive presentation and moderate cost are combined with otherwise all too seldom encountered scientific backing and professional approach as found in Reed publishers' *Flowers and Plants* series covering wildflowers of most of southern Australia, very good value for money results. It is the first published of this series, *Flowers and Plants of Victoria,* now in a third edition revised to include Tasmanian plants, and a new book, devoted to Tasmanian wildflowers alone, that are the subject of this review.

In *Flowers and Plants of Victoria and Tasmania* 653 numbered colour plates depicting almost as many species are presented, arranged in 18 eco-geographical groupings, 16 for Victoria and two for Tasmania. The general text consists of an introduction, including a brief glossary, and short essays on features of each of the habitats or geographic regions, with frequent cross-references to the plates. Each plate is accompanied by a paragraph of text providing vernacular and botanical names, details of habit, habitat, important or striking features, geographical occurrence and any points of interest. Occasionally there is more extensive discussion. There are separate indexes, covering vernacular and botanical names, for the Victorian and Tasmanian sections.

With such a large number of species illustrated and an informative text, this attractive book has already proven itself in earlier editions as a useful reference work and field guide. A comment on the general text on vegetation types is, however, warranted. In the Western Australian and New South Wales books of this series the short essays on different habitat types have been limited to a general introduction and a description of the main features and species of the habitats. I find this more informative and easier to digest than the detailed accounts of large numbers of species often found in this book. Apart from a tendency to repeat information presented elsewhere there is also the inefficiency of having information on one species presented in two places.

So far as the main section of the book, containing the colour plates and accompanying text, is concerned, it is disappointing that scarcely any improvements or revisions have been made. By and large the colour plates are of a high standard technically and in composition and little has been lost in cropping to the smaller format in this edition. Indeed there are some improvements in reproduction as can be seen for example in the sharper images of plates 358 and 359, Narrow and Broad-leaved Peppermints. But one might well have hoped for some of the inferior plates such as 46 Scaly Buttons, 478 Cabbage Fan-palm, 533 Orange Everlasting and 534 Alpine Astelia to have been replaced.

Incorporation of name changes resulting from major taxonomic revisions would not have been too much to expect in a revised edition — but this has not been done and we therefore have, for example, several species still illustrated as *Kochia* when these have been known as *Maireana* for some time in the botanical community and increasingly so among amateurs. The field user is certain to find the change from an arrangement of the plates into sections with headings to simply a continuous catalogue of numbered plates in this edition inconvenient. The page numbers of the sections of plates do not even appear in the list of contents and an index on page 16 first has to be found and then consulted to find the appropriate plates.

With many species common to Tasmania and Victoria, a work treating the floras of these States together might seem worthwhile. I am not entirely convinced of this. In this book the Tasmanian section is appended rather than incorporated—there are even separate indexes, despite the number of common species. Hence, although a species like *Hakea nodosa* occurs in both states it is indexed only under Victoria. However, the general text on the Tasmanian vegetation types, though not indexed, does include references to some plates in the Victorian section where these are relevant.

Although a little disappointing, *Flowers and Plants of Victoria and Tasmania* is without doubt one of the better colour plate books on wildflowers available in Australia today. It has uses well beyond decorating bookshelves and coffeetables. This book will be a worthwhile addition to the library not only of the professional but also of the amateur botanist and of those with a more general interest in natural history. The inclusion of Tasmanian wildflowers and plants will be more useful to some than others and many will prefer to have the separate book dealing with this subject in more detail.

Mary Cameron and the Launceston Field Naturalists Club are to be congratulated on their excellent *Guide to Flowers and Plants of Tasmania.* This attractively presented book containing 300 colour plates of Tasmanian plants, accompanied by brief descriptions, is of good size for use in the field, even in a rucksack on extended walks. It contains a useful glossary with some illustrations and a brief though informative account of the climate and vegetation of the island. The arrangement of the main part of the book is very similar to others in the series as described above. In this case the plates are divided into sections with headings and a section on widespread plants has been included. The latter should prove very useful, since it simultaneously allows the more commonly encountered plants to be featured while not restricting treatment to one region as in the other books.

Unqualified recommendations by a reviewer of any book is a rare occurence and in this case there are some minor deficiences. The plates are for the most part of a high standard, useful, and pleasing to view. However, out-of-focus plates such as 61 *Eucryphia lucida,* 96 *Drosera arcturi,* 119 *Grevillea australis* and 193 *Exocarpos cupressiformis* not only detract from the rest of the work but also convey little information for identification. The map depicting the different vegetation areas in various hues of green is not particularly clear—some of the areas are very difficult to distinguish—and the addition of landmarks such as towns, mountain peaks and possibly even main roads would have made it much more useful. In the glossary a concerted attempt has clearly been made to explain terms in simple English—but some errors have crept in. To describe the calyx as "the outermost ring of floral bracts" is misleading, since the calyx is part of the flower, while the term "bract" is generally reserved for structures subtending the whole flower or inflorescence. Cross-references to the diagrams, where these illustrate terms explained in the glossary, would have been helpful, as would have been the inclusion of a drawing of generalised flower. The figure labelled "dentate" in fact illustrates a crenate margin.

To achieve its aim as a general guide, a book such as this, providing illustrations for identification of only a portion of the whole flora of the region covered, must be compiled with careful thought about the selection of species to be included. In this sense the book is without doubt a success, as it deals with a wide range of families, genera and species, and the representation of conspicuous and important species is good. Nevertheless there is room for improvement in the coverage of the more commonly encountered plants. For example, in the vegetation text there are no fewer than 27 species referred to as important in various vegetation types but not illustrated at all. A plant as interesting and important as the cushion plant, *Abrotanella forsterioides,* should have been illustrated, but is only given a passing mention on page 30. To record examples of other minor errors such as the description of the fruit of *Cyathodes straminea* as a "flattened red berry" yet on the same page that of *C. petiolaris* correctly as a "small red drupe", or the incomplete statement of range of some species, such as *Olearia phlogopappa* and *Cotula filicula,* in both of which the NSW occurrence is omitted, would be almost carping. This is especially so in view of the essential absence of printing errors and of errors in botanical names, all too often encountered in publications of this kind.

The several criticisms made above are all quite minor and scarcely diminish the excellent contribution of this little book. *Guide to Flowers and Plants of Tasmania* is recommended as an invaluable handbook which will fill a need among amateurs, botanists, and field naturalists alike and complement existing highly regarded works on the Tasmanian flora.—*Laurie Haegi, Senior Botanist, National Herbarium of New South Wales.*

A Field guide to Reptiles of the Australian High Country **by Robert Jenkins and Roger Bartell, Inkata Press, Melbourne 1980, 278 pages, illustrated, $17.95.**

This book is a field guide to the reptiles that inhabit the area above 500 metres in southwestern mainland Australia — an area that is probably second only to the beaches of Australia in the number of leisure time visitors it receives.

The book succeeds in its primary purpose of allowing the identification of the reptiles, largely on the strength of the colour plates. These alone, will help most people to identify the majority of species that inhabit the area concerned. The text accompanying the plates is generally helpful, although a few terms escape definition. An example is the various shields on the tortoise shell (p77), the palatine bones (p138) and pterygoid bones (p192).

However, the book falls short in its secondary purpose of providing information on the biology of the reptiles of the area and their relatives. Some of the more egregious examples include the reference to Proteroglyph snakes, the group to which all Australian venomous snakes belong, which are described as having the fang "**preceded** by a number of much smaller teeth" on page 52 rather than 'followed by'. Another error occurs on page 80 where all dragons, agamids, are said to be oviparous when in fact Asian species are ovoviviparous. Physignathus is said to be "distributed throughout continental Australia" (p90) but it is only found along the east coast. Geckos are described as being "nocturnal", having "elliptical pupils", "immovable eyelids" and as being "oviparous" producing "hard, calcified-shelled eggs" (p98). In fact some

geckos are diurnal and have circular pupils, the genera Lygodactylus and Phelsuma, others have moveable eyelids, the subfamily Eublepharinae, some are ovoviviparous, the New Zealand species, and some lay soft-shelled eggs such as the subfamily Diplodactylinae to which most Australian species belong.

Misspellings, tautologies and misusages also occur indicating that the authors were on unfamiliar ground in places. An example being "Jacobson's organ" which is constantly misspelled (pp35, 36, and 273) and "postanal tail" which is a recurring tautology.

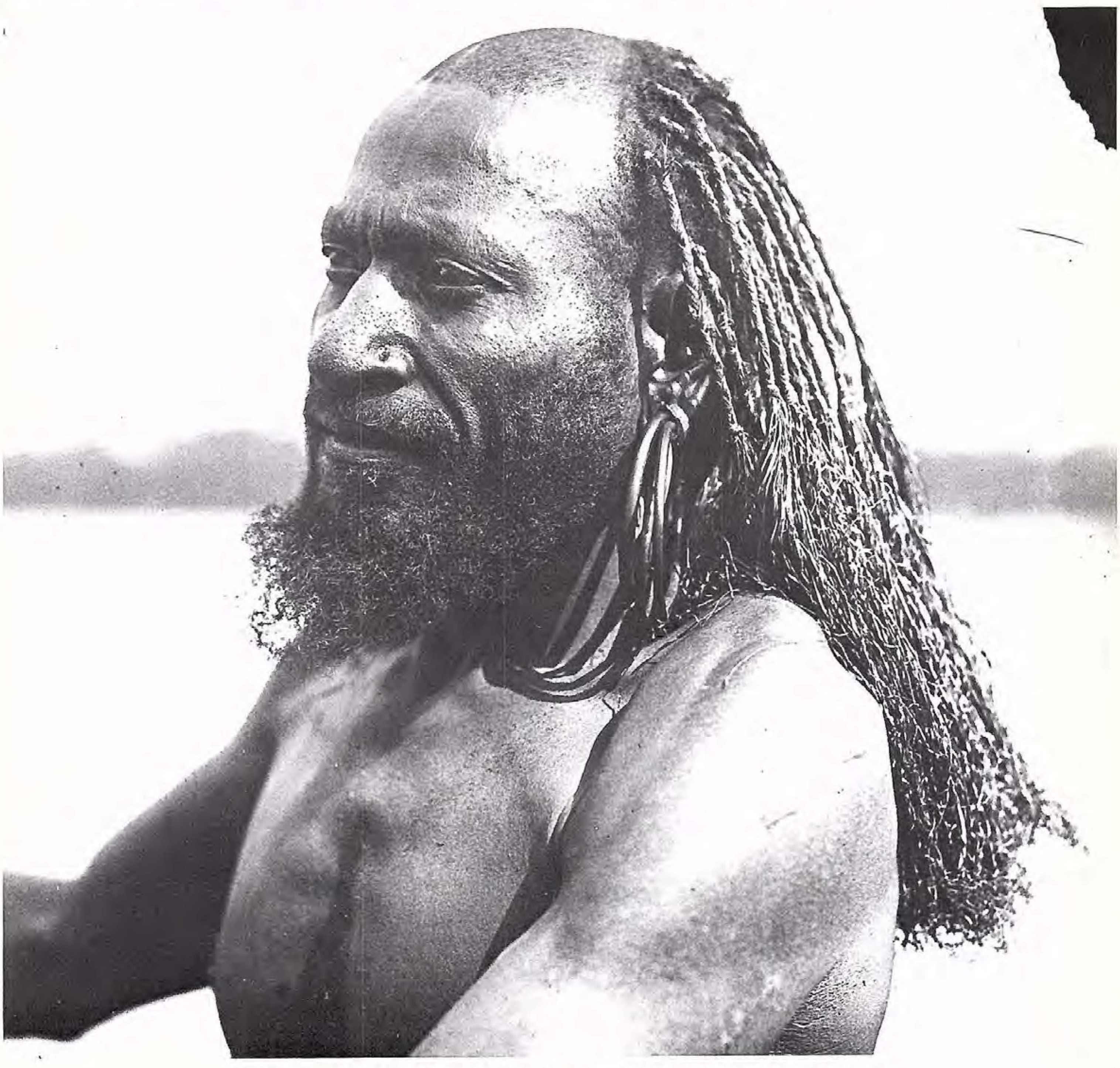
There are also a few observations that are so remarkable that they should be the subjects of scientific papers instead of buried in this popular field guide. The most remarkable of these is the observation that *Leiolopisma mustelina* has "communal oviposition sites which are visited annually by the same individuals" (p167). Communal nesting is well known in this and other lizard species but to my knowledge this is the first observation that the same female returns to the same site in different years.

In general, the book can be recommended to visitors to the high country who want to identify reptiles and who appreciate the 'point to the picture' approach to identification. However, the book cannot be recommended to those readers wishing to find reliable information on the reptiles of the high country and their relatives who might lack the knowledge to evaluate critically the information given in the text. *Allen Greer, Curator of Herpetology, The Australian Museum.*

HURLEY PORTRAITS IN FOCUS

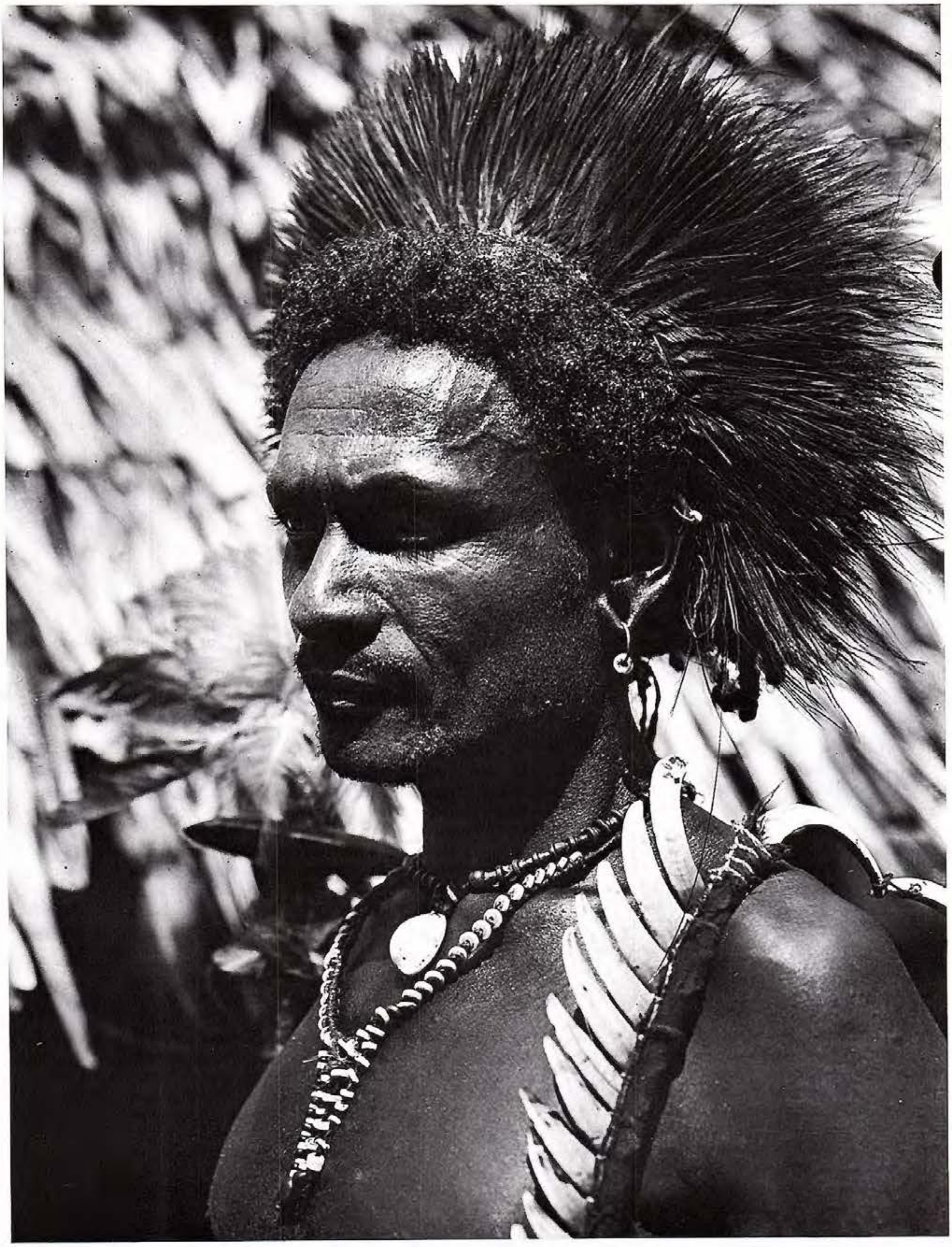
In this series of portraits by James Francis Hurley (1885—1962) we are taken into the world of the people who inhabit what was some of the most inhospitable and unknown regions of western Papua. Taken during Hurley's many expeditions to Papua New Guinea, these photographs form part of an extensive collection of Hurley photographs held on glass negative by the Australian Museum.

James Francis Hurley had an exciting life, being dubbed an 'explorer', 'adventurer', 'pioneer', 'aviator', 'photographer' and 'filmmaker'. Participating in most of the great events of his day Hurley was on the first Australasian Antarctic Expedition of 1911—1913, led by Douglas Mawson, the ill-fated trans-Antarctic expedition with Shackleton in 1914—1916, the Australian Expeditionary Forces in 1917—1918 (where he held the rank of captain), the Ross and Keith Smith England to Australia flight, on the Australian lap, 1920, and, last but not least, his many expeditions in post-World War 1 to Papua New Guinea and the Torres Straits Islands.

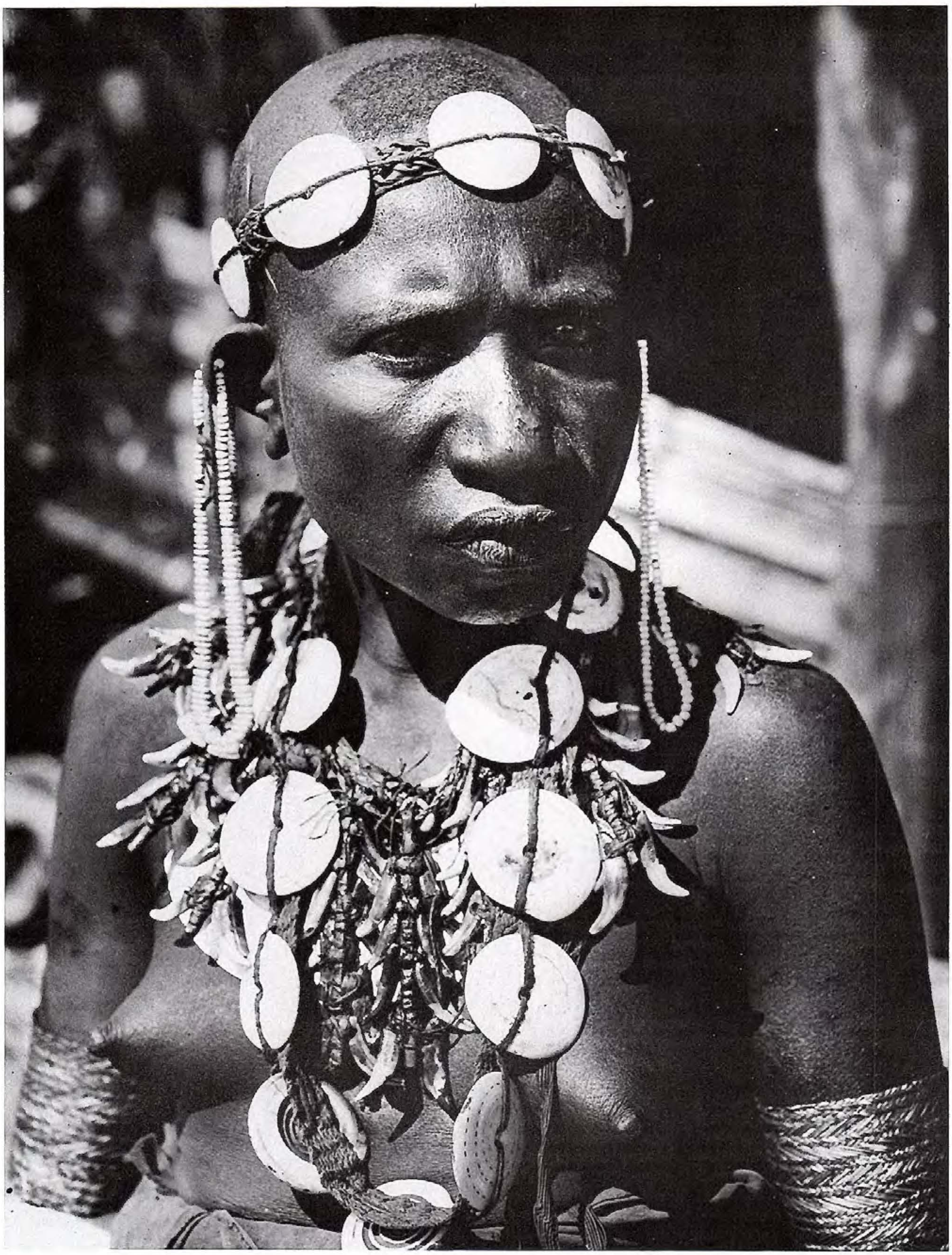


Bust of a man from Lake Murray. (All photos from original negatives made by Kate Lowe.

Native with mourning bands from the Urama Village, Urama, Purari Delta Region, Gulf Division.



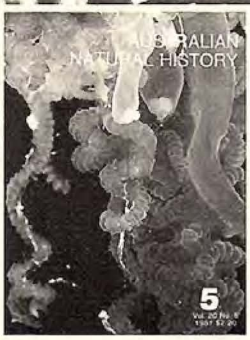
Man of the Ubir Tribe, North East Division, Wanigela, Collingwood Bay.

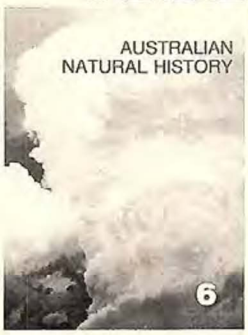


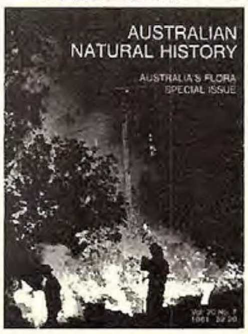
Woman of Goaribari Island, Kerowa, Goaribari Island.

Man of Goaribari Island.

'Coir', chief of civil affairs, Urama, Purari Delta Region, Gulf Division.







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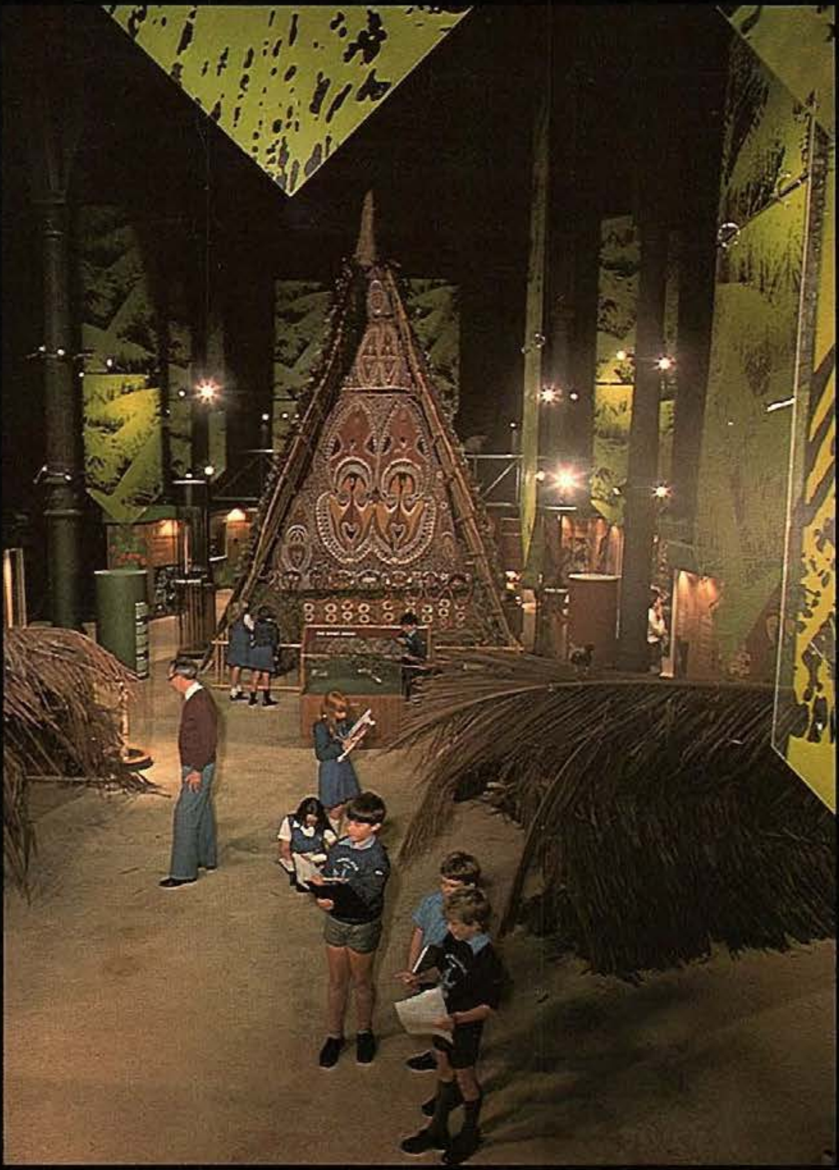

The centrepiece of the Abelam Gallery, which was opened to the public on May 1st, is a haus tambaran or spirit house. Photo Kate Lowe.

FRONT COVER

The Western Grey Kangaroo, unlike its eastern cousin the Eastern Grey Kangaroo, proves to be highly tolerant to 1080 poison, as does a number of the native animals from southwestern Australia. Photo E. Beaton.