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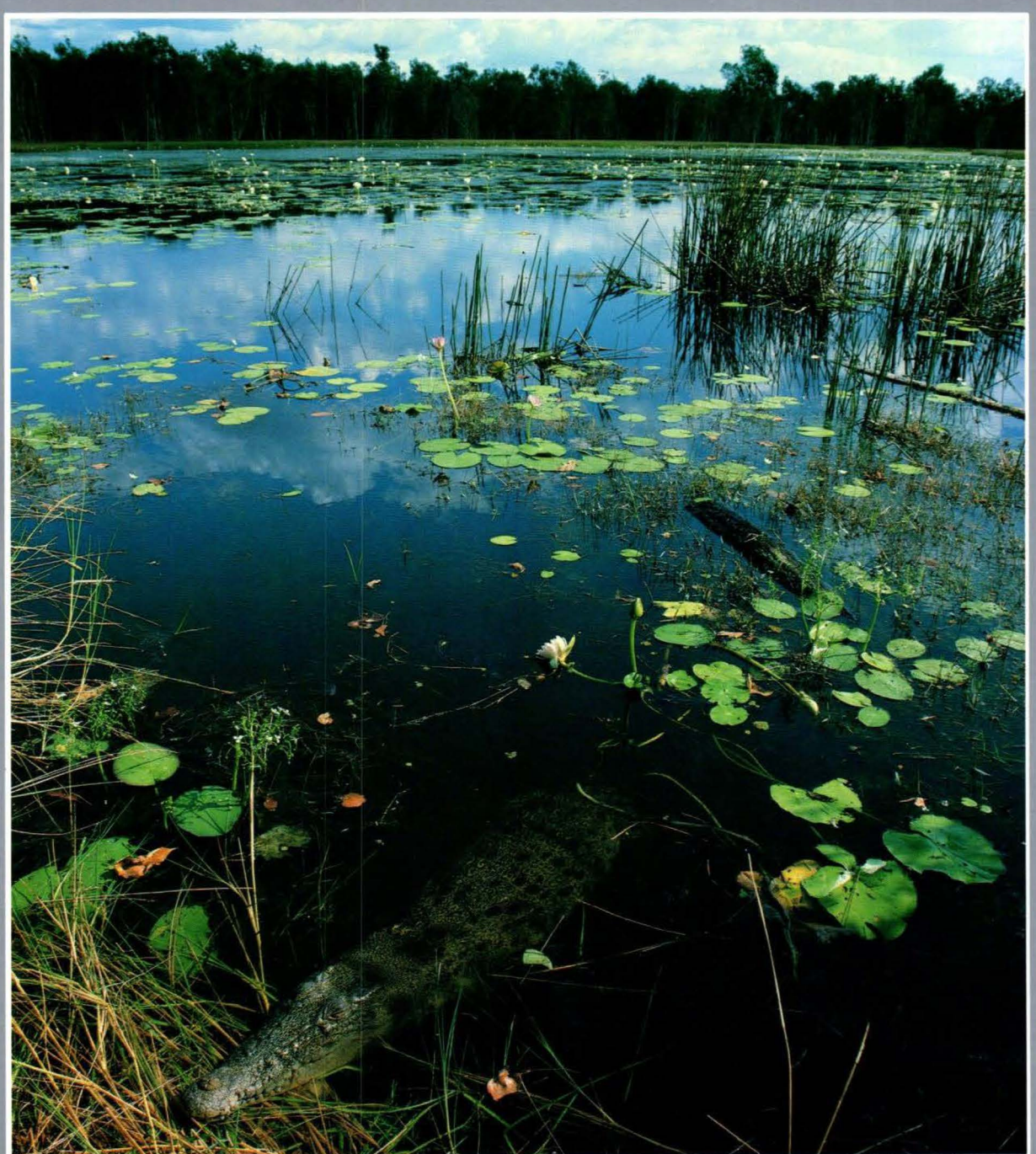

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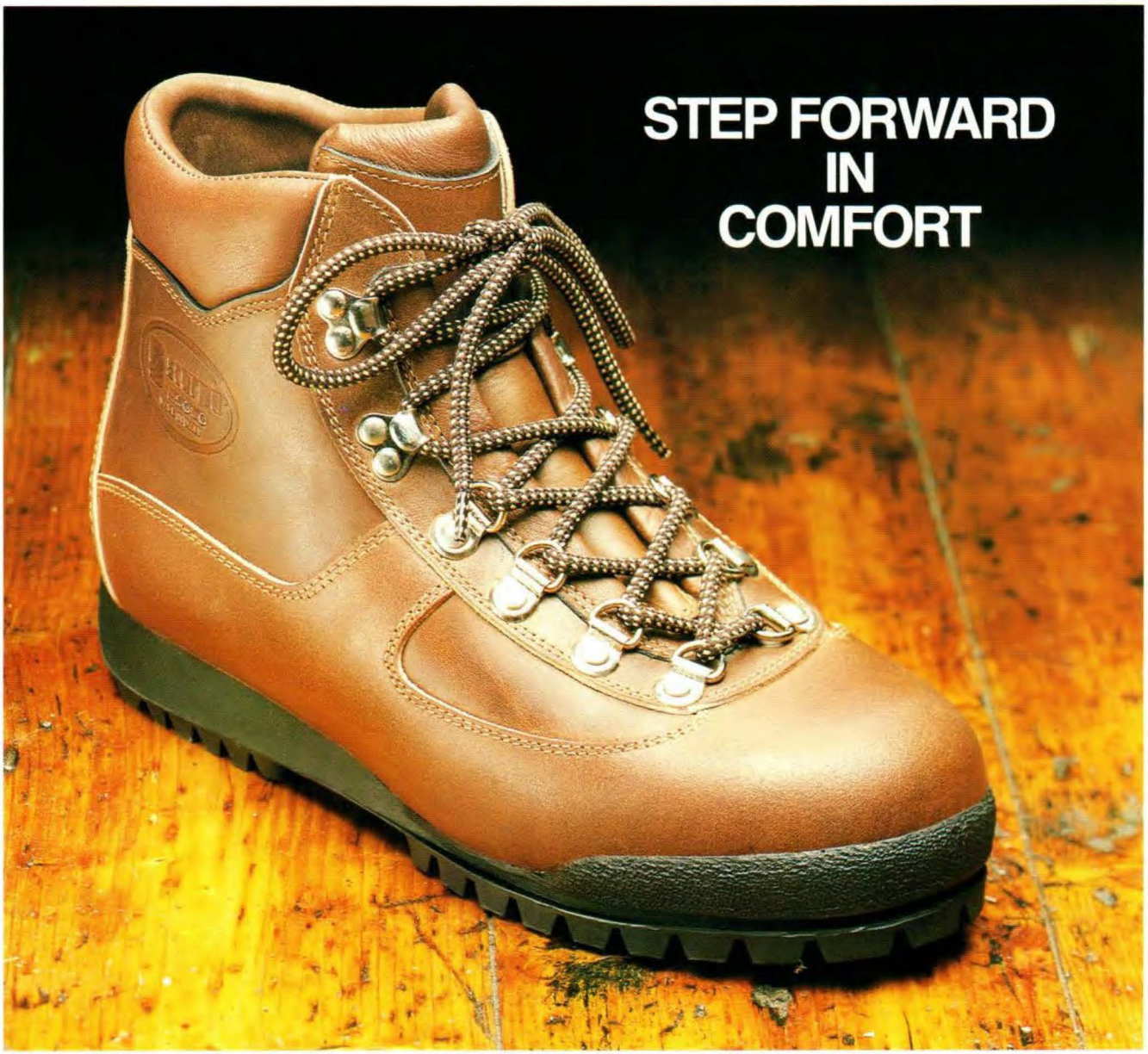

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Front Cover

Saltwater Crocodiles *(Crocodylus porosus)* inhabit rivers and swamps that contain saline or fresh water (as pictured). Their conservation is the subject of an article on page 458. Photo: G. Webb.

EDITORIAL

Since Saltwater Crocodiles became protected in the Northern Territory in 1971, their population has increased, along with the number of crocodile encounters. Grahame Webb explains the changes that have occurred since protection and looks at the benefits of crocodile farms.

To log selectively or not at all is the centre of a conservation dispute over the Downey Creek rainforest in far northern Queensland. Foresters and conservationists both claim they are seeking to conserve the rainforest, yet their views differ radically. *Forum* enlightens both sides of this heated issue.

The implications that plant tissue culture has in conserving species and controlling diseases are explained by Martin Barlass. Also on the subject of plants, have you ever wondered which native species are edible? Tim Low sheds some light in this direction with the first in a series on Australia's unusual edibles.

A.N.H. takes a trip away from home territory to observe the unique ritual of terracotta icon-making, a tradition that stems back into India's remote past.

Regular readers will notice a few changes to A.N.H.—a new typeface, an in-brief section—and this page! As the new editor, I feel fortunate to be part of a team that has upheld editorial excellence since the Magazine's inception in 1921.

Fiona Doig, Editor

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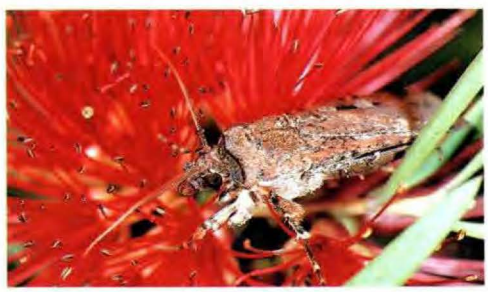
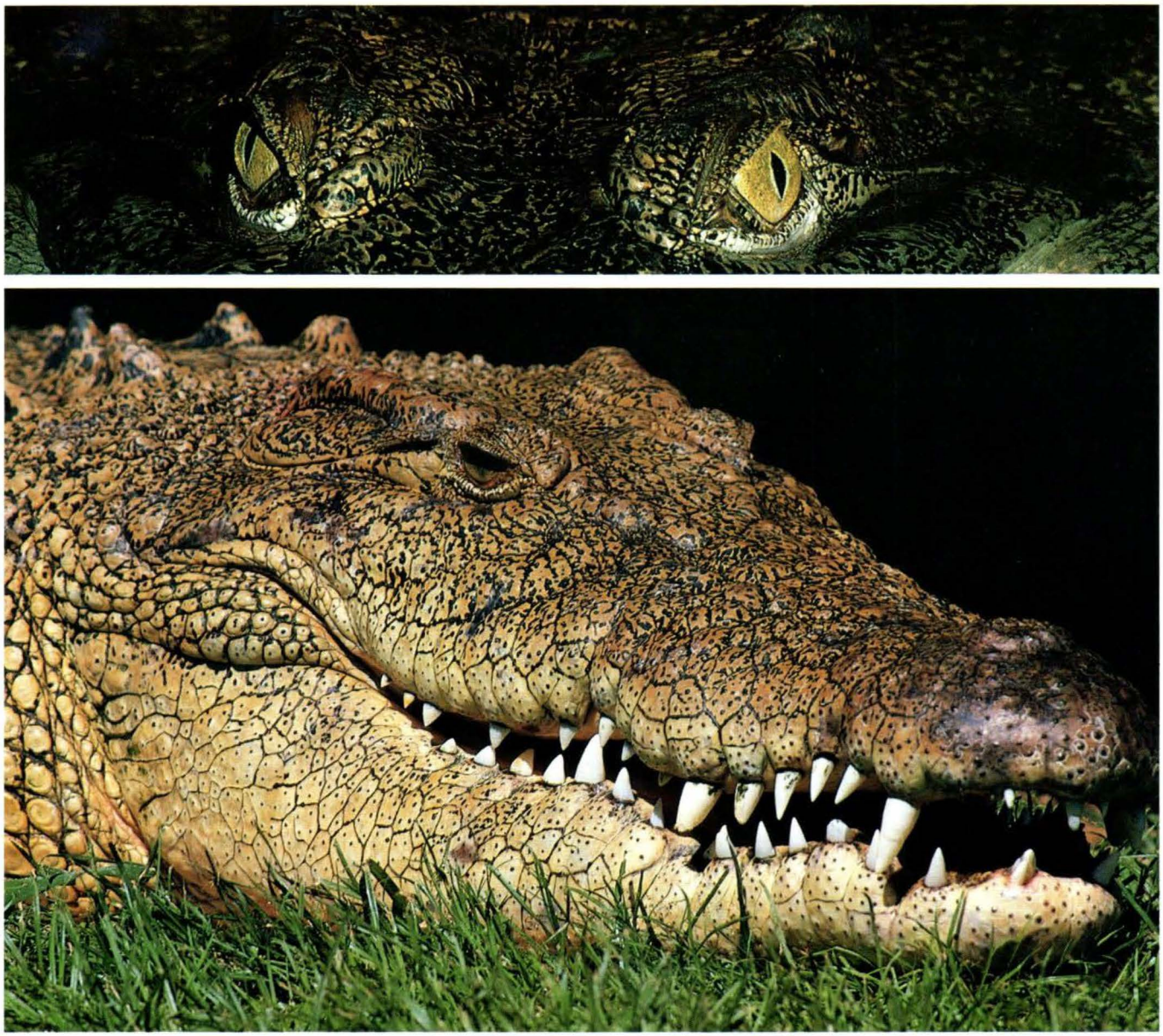


SALTWATER CROCODILE CONSERVATION IN THE NORTHERN TERRITORY

BY GRAHAME WEBB



Below: a male Saltwater Crocodile (*Crocodylus porosus*). Photo: M. Cermack, A.N.T. Above: Crocodile eyes. Photo: R. & D. Keller, A.N.T.

"We've all learnt to value Territory wildlife and live with it—let's keep it that way." So ends a Darwin television commercial promoting the conservation of crocodiles, while giving sound advice about not swimming in areas that may contain Saltwater Crocodiles. The public awareness campaign, supported by brochures, posters, crocodile warning signs, educational slide kits and talks given to school children by wildlife rangers, is aimed at educating the people of the Northern Territory about crocodiles. The more that people know about crocodiles, it is reasoned, the more capable they are of avoiding possibly dangerous situations and the more likely they are to accept crocodiles as an integral and exciting part of Territory life.

A five metre Saltwater Crocodile caught in a trap at Finniss River. Photo: Grahame Webb.

In the Northern Territory in 1971, the Saltwater or Estuarine Crocodile *(Crocodylus porosus)* was protected after 26 years of commercial harvesting. Today, after 14 years of protection, Saltwater Crocodiles occupy most, if not all, coastal rivers, creeks and swamps within the Northern Territory. Their distribution appears identical to that occurring at the time of white contact in the early 1800s. As near as can be determined, the population is 30 to 50 per cent of that existing before commercial harvesting was initiated in 1945–1946 (upper maximum estimate was 100,000 individuals). The average size and age of individuals in the 1985 population is probably less than that in 1945. However, each year it is changing in the direction expected of an established population; that is, larger (older) animals. Under current management plans, the population will remain protected and continue to expand.

Conservation and Management

Management problems posed by Saltwater Crocodiles today encompass neither crocodile 'rarity' nor the threat of a population decline. They involve formulating and implementing realistic, long-term conservation programs that are both biologically feasible and acceptable to the Northern Territory public. Saltwater Crocodiles are large; some males exceed seven metres in length and weigh over a tonne. They are also potentially dangerous animals—such realities cannot be ignored. Their management is currently a compromise between public safety (reducing densities in some areas), public relations (enhancing their value to the public) and conservation (maintaining or increasing densities in some areas).

The future of Saltwater Crocodiles in the Northern Territory appears remarkably secure and their conservation can be approached with confidence and optimism. Such is the consensus view of C.O.N.C.O.M. (Australian Council of Nature Conservation Ministers), the I.U.C.N. (International Union for the Conservation of Nature), the C.S.G. (Crocodile Specialist Group) of the Survival Services Commission and C.I.T.E.S. (Convention on International Trade in Endangered Species of Wild Flora and Fauna). All of these bodies supported the recent shift in May 1985 of the Australian population of Saltwater Crocodiles from Appendix I to the more flexible Appendix II of C.I.T.E.S. Appendix I categorisation is appropriate for species that are endangered to the point where few compromises can be justified. Appendix II permits *limited* commercial use of the species, provided there are stringent monitoring conditions to ensure populations are not adversely affected. There is no evidence currently available to indicate the Australian population of Saltwater Crocodiles is endangered at all.

In contrast to this view, as late as 1984, some people claimed that Saltwater Crocodiles had little 'future' in Australia. Apparently what they meant was 'long-term future'—in terms of hundreds, if not thousands, of years—when the human population of the Northern Territory exceeds a million people. Such projections are difficult to discuss either way, but considering that aquatic fauna survived atomic bombs in Hiroshima and Nagasaki appreciably better than terrestrial fauna*, the long-term prospects for crocodilians may not be all so grim!

So what are Saltwater Crocodiles and why have they become an emotive conservation issue? The literature on Saltwater Crocodile conservation is often contradictory and confusing. All too often it debates irrelevant issues at length, invokes emotive analogies that masquerade as scientific argument and ignores issues on which Saltwater Crocodile conservation may stand or fall. However, there is a considerable amount of useful information available and much of this was assembled for the Australian submission to have Saltwater Crocodiles transferred to Appendix II of C.I.T.E.S.

Biology and Habitat

Saltwater Crocodiles inhabit tidal and non-tidal coastal rivers and swamps that contain both fresh and saline water. All areas they occupy are dominated by distinct wet and dry seasons. Nests are mounds of vegetation selected in areas of tall, dense grasses and/or sedges. These are normally located next to permanent water which, in most cases, does not become highly saline during the dry season. Nesting occurs during the wet season (November to April). About 80 per cent of mature females nest annually with a mean clutch size of 52 eggs. At least 75 per cent of eggs laid do not survive to hatching. Flooding is a major cause of mortality; in some areas it accounts for the destruction of over 90 per cent of nests each year.

Most mangrove communities across northern Australia are in near-pristine condition. Some 60 per cent of known Saltwater Crocodile habitat in the Northern Territory is in Arnhem Land, controlled by local Aboriginal communities. Farming in the Territory is a relatively minor form of land use and does not threaten the wetlands as it has throughout much of Australia and the world.

As elsewhere in Australia, the activities of introduced feral livestock are effecting riparian habitats and some areas used by Saltwater Crocodiles are being degraded. Cattle and the Swamp Buffalo *(Bubalus bubalis)* are the main animals concerned. The habitats most affected are those with dense grasses and sedges that the crocodiles use to nest in. Cattle and buffalo graze the long grasses up to

* Committee for the Compilation of Materials on Damage caused by the Atomic Bombs in Hiroshima and Nagasaki, 1981. *Hiroshima and Nagasaki. The Physical, Medical and Social Effects of the Atomic Bombings*. Hutchinson, London.

Channels created by buffalo drain freshwater swamps. Photo: Grahame Webb.

the waters' edge and buffalo, in particular, promote drainage of freshwater swamps. Where crocodiles nest on the thick rafts of vegetation that float on some freshwater billabongs, the impact of buffalo is most severe. They trample the edges of billabongs, breaking the attachment of the raft to the shore. The complete raft can then float away on wet season floods.

Although buffalo numbers have been significantly reduced over the last three years and will continue to be reduced under the bovine disease control program, it is unrealistic to assume that grazing *per se* will cease in the Northern Territory. Additionally, the buffalo has become a symbol of the Northern Territory and, therefore, it may not be commercially desirous to eliminate it. Neither is it realistic to assume that all areas of wetland will be incorporated into national parks, nor be fenced by landowners at their expense. Yet, if the problem is ignored, nesting habitats in some areas will continue to shrink or disappear over the next hundred years. Wetlands will then continue to lose the suite of native fauna and flora dependent on them, regardless of whether every species involved is totally protected *and* on Appendix I of C.I.T.E.S.!

In any overview, wetlands and crocodile habitats within the Northern Territory are in remarkably good shape. But if we have a conservation obligation, it is to work out a way of maintaining that situation in the long term.

Hunting History and Protection

Crocodile hunting in the Northern Territory started well before the arrival of white man during the early 1800s. Aboriginal people would certainly have eaten crocodile meat and eggs since they first arrived in the coastal regions of the Northern Territory some 30,000 years ago. The first accounts of crocodiles in the Northern Territory were those of early explorers, surveyors, settlers and adventurers of the 1800s. Crocodiles were shot during these early days, either for sport or because they were generally considered vermin. It was not until 1945–1946 that commercial-scale crocodile hunting commenced. This lasted 26 years. In 1971, Saltwater Crocodiles were protected in the Northern Territory. They were not considered in danger of extinction (they have never been considered an endangered species by any Australian statutory wildlife authority). Densities, however, were very obviously low relative to their former abundance and concern about crocodile conservation in general was a growing world issue. Not so for the majority of people living in the Northern Territory at that time: for them, protection was something of a non-issue. Saltwater Crocodiles were rarely sighted in accessible areas where people worked or pursued recreation. Interactions between crocodiles and either people or stock were rare and had been so for the last decade.

The effects of protection were area-specific. In breeding areas, numbers increased rapidly in the first few years after protection because recruits were not being harvested. In remote areas that had not been harvested for several years, this increase occurred before protection. Within two to five years, numbers of crocodiles stabilised in some breeding systems. Apparently, the increase in numbers of sub-adults began to control the smaller size classes. In non-breeding systems, however, numbers of dispersing juveniles increased steadily. Thus the population had risen somewhat dramatically, but it was largely composed of hatchlings and small crocodiles. Although these were rarely seen during the day, they were obvious when surveyed at night. In 1975, crocodiles over two metres in length were still rarely sighted in spotlight counts, even in remote areas.

Within the next five years, the situation changed considerably and a state of 'conservation confusion' developed. On the one hand, some people believed there was utility in promoting the view that crocodiles were not recovering. They went so far as to suggest that crocodiles were at extinction levels in the Gulf of Carpentaria. On the other hand, evidence for a substantial recovery since protection was omnipresent. Fishermen were having their nets robbed by crocodiles in areas where, in previous years, crocodiles had been scarce. The frequency with which crocodiles were being caught and drowned in nets increased greatly beyond that of the previous ten to 15 years. People using recreation areas frequented over the last ten to 20 years were seeing more crocodiles than ever before. Within a 12 month period there were two fatal attacks by crocodiles (both in the Gove Peninsula region on the edge of the Gulf of Carpentaria), two very severe maulings and the infamous 'Sweetheart' began attacking fishing boats in the Finniss River. Pets and domestic stock

were taken by crocodiles, construction divers in Darwin Harbour had crocodiles surfacing beside them, and crocodiles began appearing on Darwin beaches with monotonous regularity.

Protection Priorities

Protection had been introduced to increase crocodile densities and that increase was clearly occurring. Given the longevity of crocodiles (approximately 70 years) and the extended ages to maturity (12 years for females and 16 for males), the majority of crocodiles being sighted were still sub-adults. So how was the path going to be paved for acceptance of populations with more and larger crocodiles in the future? Not, it was reasoned, by 'crying wolf' on the positive effects of protection. The increase in numbers of Saltwater Crocodiles necessitated a more sophisticated approach to their conservation and management. This approach encompassed public safety, public education and the commercial utilisation of crocodiles.

Public safety was given priority, an emphasis which some critics felt was both unnecessary and unduly inflammatory. They argued that the number of people killed and injured by crocodiles was small relative to the road toll and implied that the population in the Top End should simply accept it. Such attitudes were, of course, not popular in the Territory, nor were they realistic. In 1979–1980, the two people killed by crocodiles represented 25 per cent of the number of people killed in Darwin traffic accidents. If 25 per cent of the Sydney road toll was killed by a protected animal, public safety would certainly become an issue. It should also be recognised that the protection of crocodiles *per se* was itself jeopardised by the attacks.

Crocodiles in Darwin Harbour were considered a public threat, so efforts were made to catch, mark and relocate them. This program seemed to be working but, before long, the marked animals were being recaptured at their original sites. Saltwater Crocodiles appear to have a very efficient homing ability, to the extent that one individual walked overland for more than 20 kilometres only to be burnt in a grass-fire when nearing its original capture site.

Crocodile Farms

The first crocodile farm was established at this time on the basis that it would provide a facility into which problem animals could be released. The idea was that in the longer term, when these animals bred, the progeny could be raised for skin production. To date, just over 300 Saltwater Crocodiles have been taken from Darwin Harbour and released into crocodile farms (two additional farms were established later). An additional 35 problem animals came from Aboriginal and non-Aboriginal settlements and cattle stations. Fifty-two animals were collected from the Daly River to establish the breeding stock more rapidly. During the 1984–1985 wet season, 32 clutches of eggs were laid in captivity within the crocodile farms.

The public education program was aimed at teaching people as much as possible about Saltwater Crocodiles. Wildlife rangers from the Conservation Commission of the Northern Territory gave talks to school children and every opportunity was taken to disseminate factual information about crocodiles in newspapers, on radio and on television. Crocodile warning signs were erected at places considered unwise for swimming; crocodile brochures, stickers, posters and educational slide kits were prepared and distributed. A television commercial was produced, portraying crocodiles as old and valuable Territorians, but ones we have to be careful of. The original crocodile farm, which is open to the public, also plays a major role in educating the increasing number of tourists about crocodiles.

Damage to a dinghy caused by the infamous 'Sweetheart', an approximately five metre long Saltwater Crocodile, at Finniss River. Photo: Grahame Webb.

The increasing number of crocodiles in the Northern Territory has resulted in a loss of freedom that most Australians take for granted, with precious little in the way of tangible benefits to compensate. For example: swimming, hunting, fishing, canoeing, sun-baking, camping and all the other activities people enjoy doing on beaches or around billabongs, lagoons and rivers must now be pursued cautiously in the Territory. A more extreme case exists with people, such as fishermen and cattle station owners and staff, whose income depends on working in areas where they are likely to interact with Saltwater Crocodiles. Although crocodiles are only taking a few cattle each year, simple mathematics shows that these 'few' will increase as the number and average size of crocodiles increases. It is clear that in many situations very realistic incentives to conserve crocodiles and crocodile habitats are necessary.

Commercial Utilisation and Conservation

Both the World Conservation Strategy and the Australian Conservation Strategy support the concept that sustained yield harvesting of wildlife is a positive conservation goal in that it supplies tangible benefits from the conservation of a species or habitat. In the case of Saltwater Crocodiles, being large and potentially dangerous, the argument for having a sound management program that values the animals and their habitats in the eyes of the community is even more compelling.

In the Northern Territory, the first steps towards the commercial utilisation of Saltwater Crocodiles are now underway. The approach being taken is termed 'ranching'. The eggs are collected from wild nests, artificially incubated at optimal temperatures and the young are raised in crocodile farms until they reach an optimal size for skinning. Areas from which the eggs are harvested are monitored annually. Additionally, conditions of the permit require the farms to return raised animals to the Conservation Commission for restocking, should the surveys indicate it desirable. Indications to date are that a substantial number of eggs can be removed from wild populations (simulating heavy

A Saltwater Crocodile stalks a Great Egret *(Egretta alba).*
◀Photo: G. Anderson ANT.

natural mortality), with minimal impact on the population.

Farming Difficulties

The raising of crocodiles under farm conditions has not been without problems. Unlike conventional agriculture, there are no reference books to consult. The Edward River Crocodile Farm in northern Queensland has a decade of experience over the newly established Territory farms and they have approximately 80 per cent survivorship of hatchlings through to slaughter. Early tests in the Territory identified a difficulty in getting young crocodiles to start feeding, but this has now been overcome. They are supplied with warm, clean water, heat lamps and are fed on a mixture of fish, beef, chicken plus a vitamin supplement.

It has only recently been recognised that post-hatchling growth and survivorship is intimately associated with the incubation conditions. For example, the large hatchlings that result from low incubation temperatures 'look' good but rarely survive. Research into crocodile raising is now underway in the Northern Territory and crocodile farmers remain confident of establishing a small—but viable—export industry.

University of Sydney researchers have suggested that a direct harvest of sub-adults from the wild may be a more efficient method of obtaining a sustainable yield from the wild populations because the survivorship of these age classes appears to be governed by the numbers of larger crocodiles in any particular system. Such a harvest may be tested in the Northern Territory to assess the impact on the wild population.

The conservation and management of Saltwater Crocodiles in the Northern Territory has been a complex undertaking that has diversified as crocodiles recovered under the blanket protection afforded them. With the exception of the tightly-controlled egg harvests, crocodiles remain totally protected within the Northern Territory. Additional areas of crocodile habitat are continually being encompassed in national parks and reserves. Recently, a small wetland, Melacca Swamp, has been acquired by the Conservation Commission. It was specifically chosen for the good crocodile nesting area it affords, as well as its proximity to Darwin. It will become a national park in the future.

Saltwater Crocodile numbers were able to recover quickly because their habitats were left largely intact. If that situation is maintained then, far from being fragile, their populations must be regarded as being extremely resilient. In a remarkable harvest experiment, the populations were hunted intensively—with all known methods—for 26 years. Yet after only five years of protection, numbers had bounced back and in some cases stabilised, with the population size structure set on a path leading to greater numbers of large crocodiles each year! If one made every miscalculation in the book when designing a sustained yield harvest program for Saltwater Crocodiles, it is difficult to perceive a situation that would simulate the intensity of the 1945–1971 harvest. Yet Saltwater Crocodiles recovered with no assistance other than the removal of hunter-induced mortality.

However, such a situation is dependent on the maintenance of crocodile habitats. If we are concerned with long-term conservation, then this is what should attract our attention. If there is a way of making crocodiles sufficiently valuable that it becomes economically viable to protect their breeding habitats with revenue derived from crocodiles, then, in my opinion, that avenue should be pursued vigorously. The philosophical arguments for and against killing and utilising wildlife become pseudo-academic claptrap if we neglect habitat protection and kill enormous numbers of animals by default.

Many of the standard approaches taken to broad-scale conservation in Australia require serious questioning. We need to reassess fundamentally the 'value' of our wildlife. A technology for wildlife utilisation is available now that was not previously present when many precedents of the preservation dogma were established. If we wish to develop this science as a more precise conservation tool, then we need to use it, quantify the errors involved and rectify them. The time has come to adopt an active, positive and constructive approach to wildlife management, making it a conservation science of which all Australians can feel proud. □

PLANT TISSUE CULTURE
A FAST-GROWING SCIENCE

by Martin Barlass

Plant tissue culture, despite its relatively short history, has placed agriculture in an entirely new perspective. It has great implications for the conservation of endangered species. It has also become an important component of breeding programs aimed at the development of new plant varieties. By being able to grow individual or small groups of cells of living plant tissue, this expanding field of science enables a faster, more efficient multiplication of healthy plant material. Many of the techniques are rapidly being adopted at the commercial level, both overseas and in Australia. Dr Barlass is leader of a C.S.I.R.O. program concerned with the improvement of perennial horticultural species. He is also the Australian National Correspondent of the International Association for Plant Tissue Culture. In this article, he explains the fascinating science of plant tissue culture and how it is being applied to the conservation of threatened species, control of plant diseases and breeding of new varieties.

Plant tissue culture is best described as the growth of small (even microscopic) pieces of plant material called explants on defined nutrient media under artificial, sterile conditions. It is based on the premise that, given the correct environmental, nutritional and hormonal conditions free from microbial contamination, the explant will regenerate shoots, independent of season, on a production-line basis. Within six months, it might be possible to generate tens of thousands of shoots from one selected plant. The shoots, once cut from the cultures, are treated as micro-cuttings so that, after induction of roots, virtual forests can be planted out. It is now possible to achieve this with a wide variety of plant species, from orchids to pine trees and from tomatoes to oranges. Some species still appear to be recalcitrant in terms of a successful response to culture. This may simply be a matter of further experimentation and innovation on the part of the researcher.

Conservation

Tissue culture, because it represents the ability to control plant growth in defined conditions, is currently being applied to several important areas. Many wild plant species, for example, face extinction due to erosion or degradation of their natural habitats. To ensure that they are not lost forever, specimens must be collected and maintained in 'captivity'. Collecting rare or endangered plant species in remote locations, particularly tropical areas, can be fraught with difficulty. Excised budwood or seeds from valuable genetic material in remote regions may rapidly deteriorate due to microbial contamination. The budwood will then not strike or graft and seed viability decreases. With very limited equipment, however, it is possible to reduce the size of the budwood to individual buds and transport them overland out of the area in containers of chlorinated, sterile water. The material is thus maintained in conditions which inhibit microbial growth for some time. Once at a centre with culture facilities, the plant material can then be sterilized and put into culture which will provide nutrients for its continued well-being.

Another problem with collecting native species concerns seed maturity. In some cases, seed does not mature naturally due to lack of nutrients or, as is the case for *Acacia quornensis*, is short-lived and lost before it can be collected. It is possible, however, to collect immature seed and induce the embryo to undergo precocious germination in culture—something it could not do in nature. These techniques are being used by various centres world-wide including the Royal Botanic Gardens at Kew in England and the Black Hill Native Flora Park in Adelaide.

Conservation of type species in 'gene-banks', used either as a source planting of a commonly used plant variety or as a 'museum' of wild species, is basically a problem of space. Plants which grow from seed, such as wheat, are not troublesome for they can be stored for years as seed, except where seeds are short-lived, such as citrus. However, plants that have to be grown from cuttings in order to preserve their individual characteristics, such as woody fruit trees, have to be maintained as growing plants. Therefore collections of these can occupy large acreages. An alternative approach has been proposed which places very small pieces of shoot tips into cryogenic storage (−196°C) possibly for years, to be revived and cultured as required. Although this has only been successful for a handful of examples at present, it is an active research area.

A shorter-term procedure especially useful for the working collection is the storage of tissue cultures at reduced temperatures. The aim is to reduce the number of times cultures have to be transferred to fresh medium, from approximately 20 times to only one or two times per year. This is a great saving of labour and cost. Suppression of culture growth can best be achieved by reducing the temperature from approximately 25°C to 4°C for strawberries, 9°C for grapevines and 18°C for some tropical species. In this fashion, a large collection of clones can be kept in a space the size of a refrigerator, without the need for farm staff and independent of the vagaries of the outside environment.

Micropropagation

The multiplication of plants from tissue culture is reliant upon the regenerated plants retaining exactly the same characteristics as the original plants from which they were derived. This is termed 'cloning'. Cloning, or micropropagation, as a rapid means of multiplying material, has several purposes. It can be used to propagate all required numbers, as is the case with some herbaceous ornamentals such as begonias and syngoniums. It can also be used to create a mother planting of a few hundred plants quickly from one or two imported individuals that are in demand, particularly woody species such as grapevines. The mother planting is then used as a source for conventional propagation. Micropropagation has become the very successful commercial side of tissue culture.

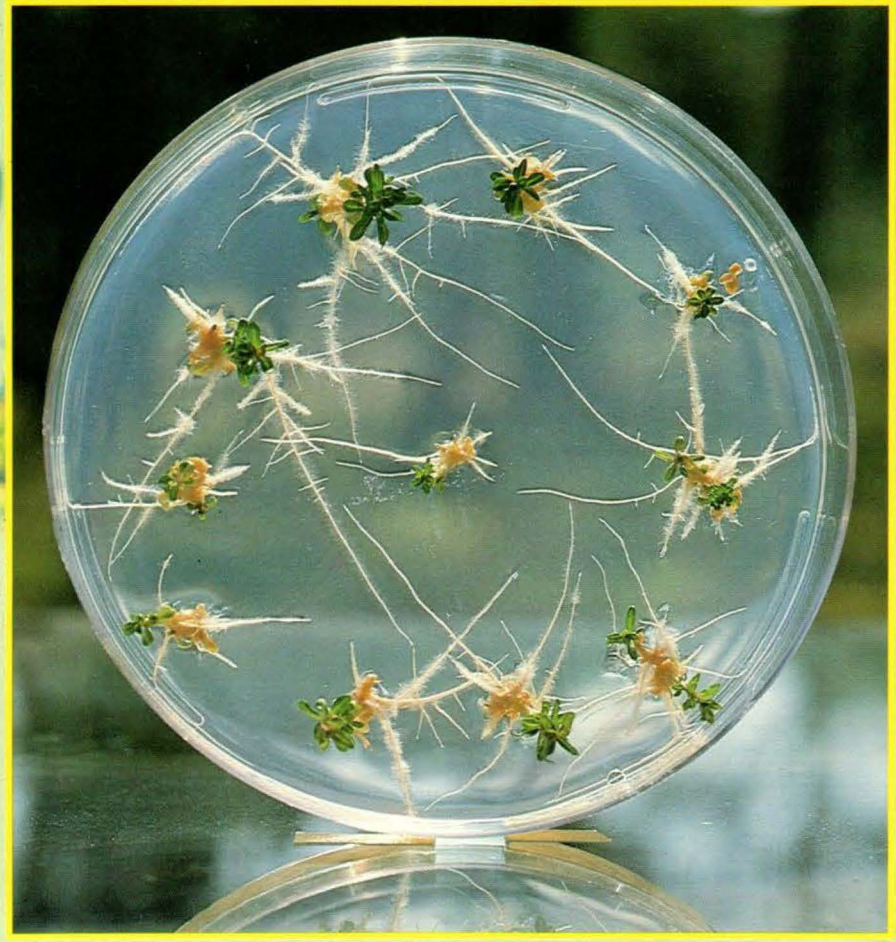
The number of commercial tissue culture companies has expanded rapidly over the last decade. Originally set up for the micropropagation of ornamentals such as orchids, ferns and African violets, many have now diversified into fruit trees and rare exotics. In most of these cases we are talking about thousands of plants per variety. However in some industries, such as forestry, tissue culture concerns millions of plants. Due to the large number of plants needed and the high cost of manual labour, methods of automating tissue culture are now under consideration. At the Centre for Research on Intelligent Systems at Deakin University, Victoria, robotics is being considered as a means of raising a manual subculturing rate of 1,000 tubes per day to around 85,000 tubes per day.

In situations where the unit of propagation is a cloned embryo rather than a cloned shoot, a number of automated methods for planting out have been tested. As these naked embryos would quickly desiccate outside the culture vessel, an early notion for planting out was the insertion of embryos together with a liquid fertilizer into drug capsules to create artificial seeds. It has recently been reported from the United States that two different synthetic seed systems have been developed. In one system, celery embryos are encapsu-

Plantlets regenerating from a sugarcane culture. Photo: Phil Larkin, courtesy C.S.I.R.O., Canberra.

Background photo: Hybridisation of sexually incompatible plants can be achieved by fusing the protoplasts of two different species. The white cells pictured are a suspension culture taken from callus tissue in a liquid medium. The green cells are leaf mesophyll protoplasts. Enzymes are used to strip off the cell walls, enabling the naked cells (protoplasts) from the two species to fuse, thereby forming hybrid cells which may have the potential to be regenerated to form a whole plant. The green and white cells in the centre can be seen fusing. Photo: J.F. Hutchinson and D.V. Beardsell, courtesy Vic. Dept Agriculture and Rural Affairs.

Haploid plants (plants with only half the usual number of chromosomes) being produced from anther culture. Photo: J.F. Hutchinson and D.V. Beardsell, courtesy Vic. Dept Agriculture and Rural Affairs.



A salt-tolerant clone of *Eucalyptus camaldulensis* in a petri dish. Photo: P. Hay, courtesy C.S.I.R.O., Canberra.

lated in a biodegradable, polymer-coated, organic gel; the other uses dry, resinous wafers to enclose carrot embryos. The success of such approaches will, of course, be determined by economics.

Disease Control

Diseases of crops caused by fungi and insects, either in the field or glasshouse, can be controlled by chemical sprays, but not so virus diseases. These sub-microscopic organisms live and multiply within host tissue and, in plants normally propagated by cuttings, are passed on to the new cuttings. Some are heat-labile which means they can be eliminated if the plants are heat-treated to temperatures of 38°C for long periods of time. Others are heat-stable, making this thermotherapy ineffective.

A more efficient method of virus elimination involves the culture of only the extreme tip of the shoot (0.2–0.5 millimetres). Virus particles are either absent from this piece of tissue or the reduced population that is present is inactivated. This results in the regeneration of virus-free shoots. The first successful work of this type was achieved over 30 years ago with dahlias. Since then, virus-free plants have been produced from many more plant species using culture conditions specific to each species.

Mutations

The use of tissue culture for micropropagation and virus elimination is dependent on the regenerated plants being true-to-type and exhibiting clonal stability. But what if they are not clonal? What if the population of regenerated plants exhibits a high frequency of mutations? Obviously, this would prove detrimental to the use of tissue culture for propagation purposes but, conversely, it may prove valuable to breeding programs. Among the population of mutations, one or two may have useful characters, possibly novel to that variety. In reality, and depending on a number of variables, tissue culture can be used deliberately not only to maintain trueness-to-type but also to stimulate variability through particular culture pathways or the use of mutagenic agents. The need then arises to be able to identify, from among the many mutated characters that can emerge, those you are inter-

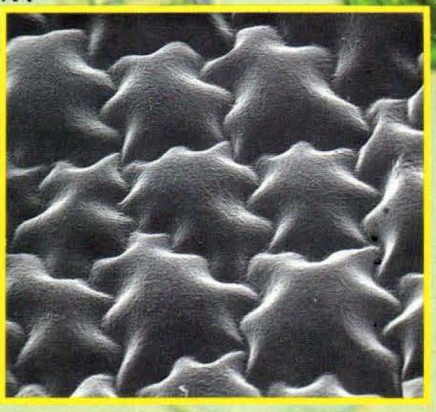
Stacks of tissue cultured plants in a simple commercial laboratory illustrate the problem of space requirements. Photo: V. Hartney, courtesy C.S.I.R.O., Canberra.

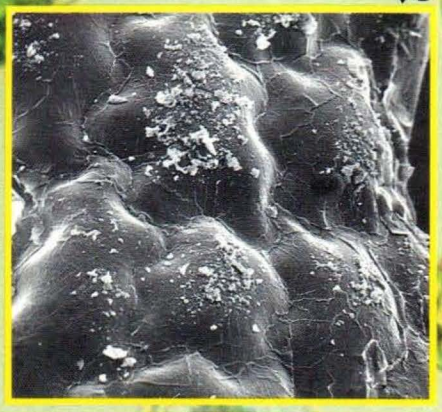
Gerbera plants undergoing acclimatisation, a type of 'test-tube weaning'. Once plants are removed from the culture, they are prone to desiccation because the stomata have not developed their closing mechanism and there is an absence of epicuticular wax. Plants are acclimatised by placing them in a very humid environment (either by spraying with mist or being placed in plastic containers) in a glasshouse. Humidity is gradually reduced as time progresses. Photo: J.F. Hutchinson and D.V. Beardsell, courtesy Vic. Dept Agriculture and Rural Affairs.▼

Regeneration of shoots from a tobacco callus culture. Photo: Richard Brettell, courtesy C.S.I.R.O., Canberra.

A▼ ▼B

Plant growth of *Gerbera jamesonii* in tissue culture. The tube on the right contains a shoot at the start of the procedure; the tube on the left shows growth after six weeks. Photo: J.F. Hutchinson and D.V. Beardsell, courtesy Vic. Dept Agriculture and Rural Affairs.





These SEM photos show the development of epicuticular wax on an elkhorn leaf after it has been removed from the culture. Photo A shows the absence of epicuticular wax while in culture; B indicates wax development of the same plant after two weeks out of the culture. Photo: J.F. Hutchinson and D.V. Beardsell, courtesy Vic. Dept Agriculture and Rural Affairs.

ested in and to do this as early as possible. This need has led to research on methods of detecting or screening in culture for important characters such as herbicide resistance, salt tolerance and resistance to disease. The concept is relatively straight-forward. For example, high levels of weed-killer or salt, or agents of a particular disease, be they fungal spores or toxins, can be added to the culture. Those shoots that survive are classed as worthy of further routine evaluation in breeding programs.

It is possible then to envisage an active role for plant tissue culture in many areas of plant improvement. These are as diverse as plant collecting, germ plasm conservation, propagation, production of healthy material and breeding of new varieties. It is an area of commerce as well as a 'fruitful' area of research for universities, State Departments of Agriculture and C.S.I.R.O. Plant tissue culture is the fast-growing science of making plants grow fast. □

Australian WILD FOODS

This article is the first in a series on the edible wild foods of Australia. Tim Low, author of *Wild Herbs of Australia and New Zealand,* will describe a variety of edible native foods in issues to come. With more than 700 edible species known, there is much to tell and many represent very tasty foods. They can often be found within a stone's throw of Australia's major cities and most are easily identified. While care and moderation are urged, these sometimes tasty morsels can be sampled discreetly without creating environmental havoc.

The study of wild foods provides endless fascination. I was surprised to find that more than 300 common weed species found in Australia can be used as food. Those pesky weeds growing in the cabbage patch can be every bit as nutritious—and often as tasty—as the cabbages themselves.

Weeds are quick-growing plants and few produce the sorts of toxins found in slow-growing shrubs and trees, which face a longer-term threat from plant-eaters. This explains why so many kinds of weeds are edible.

Most weeds found in Australia have been introduced from overseas but much of our native flora is also edible. Long lists of Aboriginal food plants have been compiled but the data, except for northern Australia, is woefully incomplete. Aborigines in south-western and south-eastern Australia were decimated long before their diet could be studied. In any case, the Aborigines did not eat everything that was edible. Except in central Australia, they ate very few kinds of leaves. Leaves are less appealing than many wild foods and, on a diet rich in meat and fruit, are nutritionally unnecessary. Also, they are not easy to prepare without cooking pots, items that tribal Aborigines did not possess.

I enjoy eating leaves. They are an ideal source of vitamins and fibre and their flavours are subtly interesting. I often cook with garden weeds like the wild prickly lettuce and wonder about the possibilities of using leaves from our native plants.

With its ragged leaves and bristly stems, the prickly lettuce looks an unlikely source of food. A common weed of temperate Australia, it is recognised by its harsh, untidy looks and bitter latex. Chromosome studies have led to the conclusion that this tatty-looking weed is our ancestral lettuce.

Some 7,000 years ago, out of the multitude of wild plants, our Mesopotamian forebears chose this weed for cultivation and improvement. At first it was grown for use as a cooked vegetable—a spinach substitute—for its raw leaves taste intensely bitter. Very much later came the development of the familiar salad lettuce, with its crisp, rounded head. Lettuce in this form was not recorded historically until the 16th century.

The natural foods movement today urges us to eat more vegetables, but just how natural is a vegetable like the lettuce? Thousands of years of selective breeding have distorted its original form beyond recognition. The same is true of most of our foods. I know of only one commercially cultivated vegetable that still retains its wild form—the humble watercress, a herb of drains and soaks around Sydney, Melbourne and other large cities. Feral forms of the carrot, radish and turnip are all common weeds in Australia but, like the prickly lettuce, are unrecognisable. Their roots are slender, woody and scarcely palatable.

Among native species there must be many whose edibility awaits discovery. Recently I tasted a few species of native cress (*Rorippa* species). Since they are closely related to watercress, I was not surprised to find they taste the same. I'm now cultivating one of these cresses—an undescribed Queensland species—as a native alternative to watercress. It's a dainty decorative herb, quite drought-resistant which unfortunately runs to seed after bearing only a dozen or so leaves. Like the prickly lettuce, it requires much shaping by cultivation before it becomes serviceable human food.

C.S.I.R.O. scientists in Adelaide face similar problems with the native quandong (*Santalum acuminatum*), a native desert tree with edible fruits and kernels. Quandong has been proposed as a potential crop for arid Australia, as it thrives in desert saline soils. Unfortunately, the quandong kernel is tainted by an aromatic oil, a major obstacle to its commercial exploitation. Like my native cress, it may require intensive selective breeding to produce a marketable strain.

Except for the macadamia nut, all of Australia's wild foods are still at the 'prickly lettuce' stage but, nevertheless, represent tasty and unusual foods.

Wombat berry flowers can be identified by the three fringed petals. Photo: Tim Low.

Wombat berry *(Eustrephus latifolius)*

One of the more common vines of coastal areas, the wombat berry is a familiar sight in eucalypt forests and along rainforest margins throughout eastern Australia as far south as eastern Gippsland.

The leaves may be slender or broad, lined with parallel longitudinal veins. The flowers are white or lavender-pink with six 'petals', three of which are fringed. The characteristic berries are from one to one-and-a-half centimetres in diameter and ripen from bright green to orange, eventually splitting to expose small, black seeds.

Despite their alluring appearance, the berries are tough, inedible capsules. The edible parts of this vine lie underground in the form of crisp, juicy tubers borne on lateral roots. These tubers, which measure between one and three centimetres in length, seem barely worth the bother of excavating. They are easily overlooked because of their earthen colour and often lie concealed beneath stones in hard soil. Nonetheless, the tubers furnished an item of food for east-coast Aborigines who appreciated the sweet, juicy flavour. The 19th century explorer-botanist, Baron von Muller, considered them a potential food crop, "probably capable of enlargement through culture".

Closely resembling the wombat berry is the scrambling lily *(Geitonopleisium cymosum)* which occurs in similar habitats. It has black berries and the petals are not fringed. The roots and berries are inedible but the wiry young shoots can be cooked and eaten like asparagus.

The colourful berries of the wombat berry *(Eustrephus latifolius)* are inedible, unlike the roots which are sweet and juicy. Photo: Tim Low.

Lerp

Lerps are the tiny, protective shields produced by sap-sucking bugs called psyllids (subfamily Spondyliaspinae of the family Psyllidae). Australia is home to many psyllid species and their lerps come in an array of shapes. Some look like inverted baskets or fern leaves, others take the form of shellfish, mimicking tiny oysters, scallops or limpets. They are very small, two to ten millimetres long, and nearly all live on eucalypt foliage.

Red lerps are found on twigs of mulga *(Acacia aneura)* but most species are white, like the illustrated *Spondyliaspis*.

Beneath each lerp hides a tiny larva, sucking sap and manufacturing its shield from anal secretions. Scientists have all but ignored the study of these bugs and fewer than half the Australian species have been named. Distributions are only vaguely known, with most observations coming from the south.

Comprising 75 to 90 per cent starch (the rest water), lerp is a remarkably concentrated and digestible food, a starch of uniquely animal origin. An important food of honeyeaters and pardalotes, it was once widely eaten by Aborigines and occasionally served as a staple food, especially east of Mildura where large concentrations occurred.

According to the observer of Aborigines, Peter Beveridge, writing in 1884: "The deposits are made in such large quantities an aboriginal can easily gather 40 or 50 pounds weight of it in a day. As the Aborigines are extremely fond of this sweet substance, during its season they do very little else but gather and consume it, and they thrive on it most amazingly".

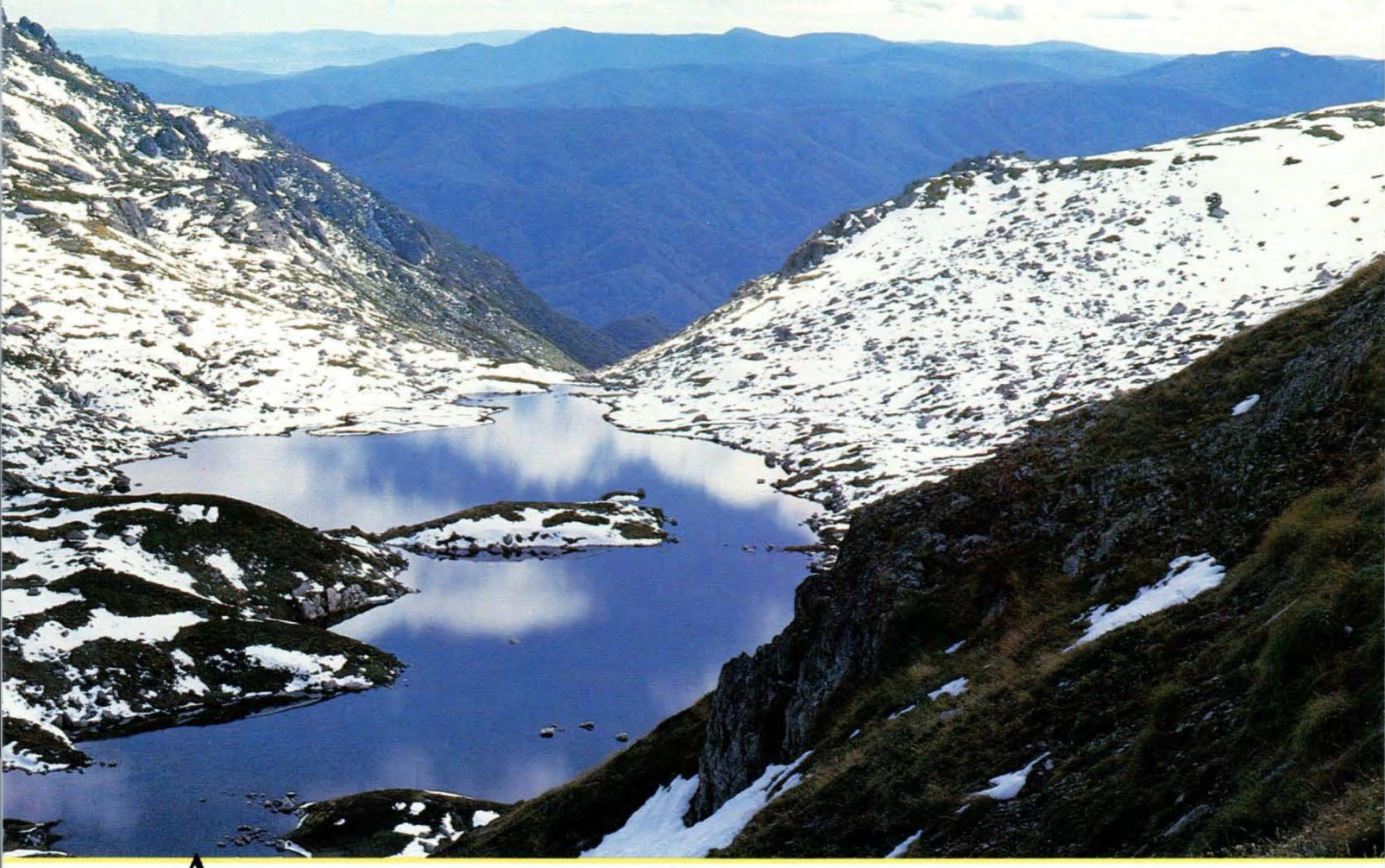
Lerp is usually much less plentiful than this, providing a sugary snack rather than a meal. *Spondyliaspis* lerp is sweet but waxy; many varieties are crumbly and sugary.

Happy Eating . . . □

***Spondyliaspis* lerp is a white lerp shown here on the leaves of *Eucalyptus tereticornis*. Photo: Tim Low.**

MOTH-HUNTING IN THE AUSTRALIAN ALPS

by Josephine Flood



Australia's south-eastern highlands encompass a mountain chain occurring in an arc which stretches from the Brindabella Ranges near Canberra, continuing through the Snowy Mountains and Victorian Alps, terminating at Mt Buller, north-east of Melbourne.

Each year, millions of small, brown moths journey up to 500 kilometres to spend the summer on the summits of these mountains. The annual migration of the Bogong moth *(Agrotis infusa)* played an important role in the life of Aborigines of the south-eastern highlands of Australia.

The moths provided an abundant, easily-collected, seasonal food; extremely rich and high in protein. This insect food source enabled hundreds of Aborigines from these highlands to come together each summer for ceremonial gatherings. Corroborees and initiation rituals were performed, trading markets set up, marriages arranged and, sometimes, intertribal feuds were settled by pitched battles.

Such *long-distance* migration is unique to the Bogong moth and south-eastern highlands of Australia. Outside Australia, the Bogong moth is found only in New Zealand where it does not appear to carry out this two-way migration or aestivation.

Residents of Canberra, and sometimes Sydney and Newcastle, have occasionally become unpleasantly aware of the abundance of Bogong moths that are either resting or swept off-course in their annual flight to the mountains. On 14 September 1867, the Reverend W. B. Clarke could not conduct services in his Sydney church because it was full of Bogong moths: he estimated there were over 80,000 on the windows. On another occasion in Sydney in the 1940s, this time at a garden party at Government House, every iced cake or tart was 'decorated' with a Bogong moth. More recently, moths invaded Canberra in the spring of 1952 and again in 1969, when the resting moths managed to block automatic lifts and air-conditioning shafts on some high-rise office buildings and temporarily black out part of the national capital.

Occasionally these moths were blown off-course and even carried out to sea, as was described in 1869 by A. W. Scott, who saw long lines of their bodies washed up on the beaches near Newcastle. Some might die *en route* or arrive too early and die on the still snow-clad summits. Every year, however, the crevices of at least a few mountain peaks are filled with masses of Bogong moths.

People often panic needlessly when large numbers of migrating moths invade homes and offices. They should be treated like migrating birds and allowed to pass on their way. The simplest method to empty a house full of moths is to merely open the windows and let them out.

Breeding and Migration

The breeding grounds of the Bogong moth are on the inland plains of western New South Wales and southern Queensland where eggs are laid in late April and May. The adult female lays up to 2,000 eggs and dies soon afterwards. The eggs hatch in June. The larvae grow quickly, feeding on the broad leaves of dicotyledonous plants. When fully grown, they crawl from the plant and tunnel underground to pupate. In the final, adult stage, at the end of September or early October, the moths migrate in a south-easterly direction to the mountains to aestivate (the summer equivalent of hibernate).

Each year the moths find their way to the same 'camps' that were occupied by their predecessors. The most favoured moth camps are deep, dark, dry, cool crevices on the windward side of rocky granite peaks, at least 1,300 to 1,270 metres above sea level. The first moths settle side by side, head upwards on the walls. Later arrivals tuck their heads under the wings of the first-comers and layers of moths build up on the rock like tiles on a roof. As many as 17,000 have been found in a single square metre.

In late summer, the moths that survive predators and parasites start the return flight to their breeding grounds. By the end of March most have gone from the mountain crevices. The cycle then continues with

The rugged terrain of the Australian alps in Kosciusko National Park, near ◀Mt Kosciusko. Photo: F. Doig.

Bogong moth (*Agrotis infusa*) on *Calothamnus*. Photo: P. Gobert.

nectar sought, mating occurring and eggs being laid.

This complex pattern of migration and aestivation seems to be an adaptation to the relatively harsh environment of the breeding areas. The moths migrate before the breeding grounds become too hot and dry and are dominated by perennial summer grasses that are unfavourable as larvae food.

Aboriginal Moth-hunters

Each year after the snow melted on the alps, messengers were sent out with message-sticks to summon the different groups of highland Aborigines. They would trek as far as 300 kilometres to reach the meeting place. Such gatherings were held in the Blowering area in the Tumut Valley and around where Jindabyne stands today.

The moth-hunters came from far afield within a region stretching 300 kilometres north to south and 150 kilometres east to west. These people formed part of a great highland confederacy or nation.

When the groups arrived at the meeting place, an advance party would be sent up to the mountain tops to see if the moths had arrived. Certain rites were performed and a smoke signal would be sent up to summon the rest of the moth-hunters.

Each range of granite tors made up the traditional 'pitch' for a particular group. The men would set up camp before the moth-hunting began. The whereabouts of the moth camps was traced by the cawing of currawongs or ravens also preying on the moths. Hunters would enter the crevices carrying wooden dishes or fine-meshed nets made from fibre of kurrajong or pimelea and tied to two poles for easy insertion into recesses. A stick was drawn along the bottom layer of moths, which would then fall into containers held ready below. Some would flutter away sleepily but the majority would be quickly carried to a nearby fire and poured onto hot ashes.

Moths aestivating in rock crevices on Mt Gingera, ACT. Photo: Courtesy Dr I. B. Common.

A fifty-metre-long line of stones is the main feature of this ceremonial site in Namadgi National Park, ACT. Photo: J. Flood.

Preparation

After one or two minutes' cooking, the moths were picked out with a sharpened stick and winnowed to remove dust and ash. The moths were then eaten whole. They taste like roast chestnuts. The texture of the abdomen is oily and nutritional analysis has shown that a whole, cooked moth averages 20 per cent fat and 27 per cent protein, the rest being mainly water.

Large quantities of moths were eaten. If a hunter ate a kilogram per day, he would consume 12,600 kilojoules (3,000 calories)—an extremely high-energy diet. Early settlers in the highlands remarked that Aborigines set off for the summits each spring quite emaciated after the hardships of a lean winter but returned several weeks later looking much fatter, with skins glossy as ebony.

Moth-hunting appears to have been basically a male activity. However, roasted moths were ground up with a stone pestle into a paste and carried in bark dishes to the women, children and old people camping in the valleys below. The women collected much of the staple plant food, which included fruits such as the native cherry and currant and the roasted tubers of orchids, lilies and the daisy 'yam', *Microseris scapigera*. Animal food was equally important, with kangaroos and possums providing a year-round supply.

An Age-old Tradition

Archaeological evidence from Bogong Cave in the Tidbinbilla Nature Reserve south of Canberra shows that moth-hunting has been going on for at least 1,000 years. Moths aestivate in the cave and Aborigines used to camp in some of the nearby rock shelters. Excavation of the shelter floors has revealed stone tools and old fireplaces, the oldest charcoal giving a radiocarbon date of 1,000 years.

A pestle-shaped stone artefact was probably used to grind moths into paste. Similar round river stones have been found high in the Snowy Mountains and on natural routes across the ranges such as Bogong Gap in the Gudgenby area. Examination under ultra-violet light has shown fluorescence on the edges of some of these stones which indicates the presence of protein. The most likely explanation, of course, is that they were moth pestles.

Isolated finds of stone axes, pebble choppers and moth pestles have occurred widely in mountain ranges and a few high-level campsites have been identified. Scatters of stone artefacts have been found on the natural route from Jindabyne up to the Mt Kosciusko area, the highest so far being found on Little Twynam at about 2,100 metres. Other high-level camps have been found at Pound's Creek above Guthega and at Perisher Gap in the Kosciusko area, scattered along the tops of the Bogong Mountains and Brindabellas, and on Mt Buffalo and Mt Buller in the Victorian Alps.

Ceremonial sites are also associated with moth localities where both bora rings and stone arrangements are sometimes found. The latter are found at varying altitudes and take many forms: single lines of stones, stone 'corridors', circles and cairns or piles of stones ranging in number from one to 80. These are found in a wide variety of configurations.

Ceremonial grounds usually consisted of two cleared circles surrounded by earth banks, a few hundred metres apart from each other. The memory of one such ground was preserved in the name 'Rings Creek' on the southern end of the Bogong Mountains. The rings can still be seen there.

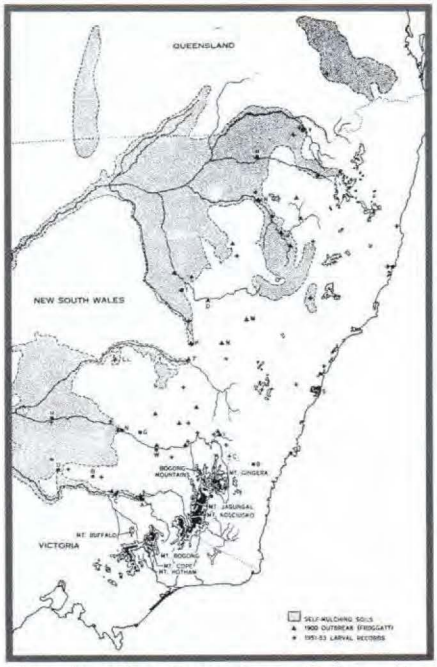
Initiation Ceremonies

According to local tradition, a settler, Thomas Wilkinson, wrote in *The Albury Banner and Wodonga Express*, July 22, 1904:

"On a hill in front of Yallowin (now under Blowering Reservoir) there still remains the mark of a ring made by a blackfellows' corroboree. The corroboree made men of the youths after they had attained a certain age. The corroboree was kept up for six days, but the young blacks were kept out of the way. Afterwards they were taken on to the Bogong Mountains and put in a stooping position whilst their elders raced past them digging their thumbnails into the gum of each young man over a certain tooth so as to loosen it, and the removal of the tooth completed the ceremony. Until this ceremony had been completed the young fellows were forbidden to marry, and if one refused to participate it is certain he would have been killed"

The first stage of initiation, the Kuringal, raised the novices from boyhood to youth and removed them from the care of the women. Then between 18 and 20 years old, when the hunter's beard had started to develop, he was made into a 'warrior' by the Wahu ceremony. In this ceremony all the hair of the head is singed off and the tribal territory pointed out.

The rituals and beliefs of the highlanders are reflected in the types of sites found in the mountains. In the lower valleys, many scatters of stone tools remain from the frequent, large camps established there. Higher up, there are fewer, smaller camps but more ceremonial sites. There is a bora ground or, more accurately, Kuringal ground on the Bogong Mountains, as previously described. Other ceremonial sites are found even higher, on the mountain summits themselves. These are stone arrangements. The largest, most complex site found so far is on an unnamed peak in the Australian Capital Territory between the Cotter and Gudgenby valleys, in the ranges known by Aborigines as Namadgi. This area has now become the Namadgi National Park. From this peak there is a panoramic view of the region; it would have been an ideal place for pointing out the tribal territory in the Wahu ceremony. Further south, a similar stone arrangement lies near Sentry Box Hill. From here, Mt Jagungal, Mt Kosciusko and most of the Snowy Mountains can be seen.



Map showing Bogong moth breeding grounds and migration.

These ceremonial sites are in such remote valleys or so high up the mountains that they have survived the impact of European settlement. However, by the 1870s, disease had taken its toll and the moth-hunters did not survive.

The rugged mountain country was generally an unfavourable environment for the Aborigines. Consequently, the cold, bleak winters were spent away from the bitter climate of the high mountain peaks and tablelands in the lower, warmer valleys. However, each summer, the sustenance afforded by the Bogong moths enabled them to hold great social gatherings in the mountains. Stone arrangements still silently testify to the rich ceremonial life of the highland tribes made possible by the migration of these fascinating moths. □

Dr Josephine Flood works at the Australian Heritage Commission in Canberra. She has spent many years researching aboriginal moth-hunting and has written a book on the subject, *The Moth Hunters*, published by the Australian Institute of Aboriginal Studies.

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A History of Forestry in Australia

By L. T. Carron. Pergamon Press Australia, Sydney. 1985. 355 pp. $39.00.

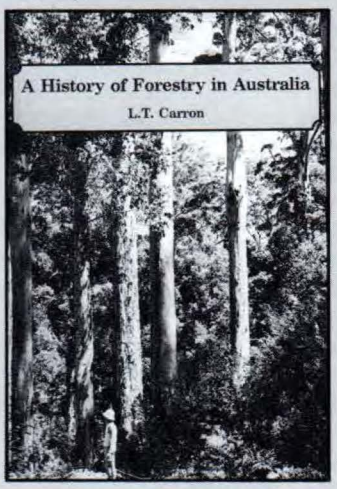
Forestry in Australia has been at the centre of environmental conflict and confrontation for nearly two decades. This conflict casts foresters in the mould of exploiters—forest rapists in league with the timber industry, intent only on ravaging Australia's forests at the expense of the environment and the taxpayer. Yet foresters do not see themselves as spoilers of the environment. Instead, they consider themselves to be conservationists, dedicated to the wise use of the nation's resources. They feel timber harvesting is compatible with the use of forests for recreation, wildlife, water conservation and aesthetics.

These different perceptions of the profession are not contradictory. Forests and forestry operate on time scales longer than most human lives. This makes it difficult for foresters to respond rapidly to changing community values and for others to understand forestry's role in forest conservation.

To understand these conflicts, it is necessary to understand the history of forestry in Australia.

In his book, *A History of Forestry in Australia,* Carron reviews the development of forestry as a profession in Australia. He begins the history in New South Wales with the establishment of the colony in 1786 and carries it through the era of environmental confrontation in the 1970s. Each State is treated separately, and their relationships with the Commonwealth are considered. He concludes with a brief chapter on the private sector.

I enjoyed reading this book. It helped me further understand the attitudes and aspirations of Australian foresters and to appreciate the extent to which political meddling in forest management has interfered with the development of sound forestry policies throughout Australia's history.



Carron's account is not without its deficiencies. In places he shows too strongly the defensiveness of foresters to criticism, reflecting this professions' difficulties in adjusting to the wider community's changing expectations for forests and forestry. He glosses over current and past environmental conflicts where a detailed and careful assessment is necessary for a complete coverage of the last two decades. This part of forestry history, the late 1960s through the early '80s, is the weakest part of Carron's account. Perhaps like Australia's conservation movement it is too early for a considered history of events during these decades. I would also have liked more discussion of people and personalities—something that Carron has chosen to avoid.

Despite these shortcomings, Carron's account is essential reading for anyone concerned about Australia's forests or interested in the challenge to foresters of changing community values and expectations. I personally want to thank Carron, both for his efforts and for a most timely book. I hope another person will show similar initiative and understanding to produce a companion volume on the history of the Australian conservation movement. Conservation and forestry are inseparably entwined and it is regrettable that people who have the same basic objectives of protecting Australia's forests for the benefit of all persist in needless conflict. Carron's history is an opening to constructive dialogue.

— H. F. Recher

Biological Museum Methods (Volumes 1 & 2).

By George Hangay and Michael Dingley. Academic Press Australia, 1985. 323 pp. & 379 pp., Vol. 1: $89; Vol. 2: $78; Set: $130.

As the authors say in the preface, "The primary aims of this book are to highlight the main aspects of the preparator's work, describe as many techniques as practical, and guide the reader to the relevant literature, from which more information can be gained."

A tall order indeed for such a diverse subject, embracing as it does the art of taxidermy and its allied 'arts and crafts'—sculpting, modelling, moulding, casting, embedding, preserving, etc. The authors have done more than highlight aspects. They have, in reality, written the all-time definitive work on the subject. The works of Manesse and Koch and Abels are today of historical interest only; modern technology and techniques have superceded many of the older methods and materials.

While Joe Kish's *Taxidermy Review* has helped the modern taxidermist–preparator keep abreast of the times, books have always tended towards specialisation—mounting game heads, practical taxidermy, etc. The detailed information on various aspects of biological museum methods could be found in various commercial and scientific journals, but never in an easily accessible format. Until now.

The word that most amply describes this superbly-produced two volume work is 'encyclopaedic'. Hangay and Dingley, the senior preparator and his colleague at the Australian Museum in Sydney, might be embarrassed by such a description. But the books are certainly voluminous, detailed, well-indexed and otherwise cross-referenced.

How do you stuff an elephant (or even catch one!)? Sex a flea? Preserve moths (and destroy them, too)? How do you capture bats easily and humanely, or use a car to catch airborne insects alive? How would you restore Phar Lap's heart? Or replace lifelike 'hair' on a long dehaired Thylacine mount? These and literally thousands of other problems faced by preparators (and often, commercial taxidermists) are answered in *Biological Museum Methods.*

Divided into vertebrate techniques (Vol. 1) and plants, invertebrates and

general techniques (Vol. 2), *Methods* has a world-wide sales application. No museum or taxidermy studio anywhere from Anchorage to Ankara should be without these books. In pictorial and sketch form, these books, which are crammed with illustrations, ably reveal many of the difficult methods used in museum preparation.

Biological Museum Methods is a modern classic of its kind. It does for taxidermy and preparation what Jay Mellon's book, *African Hunter,* does for Africana literature. As Joe Kish says in the foreword: "This work is one of those stout timbers that bridges the gap between those who know how and those who want to learn; between one generation of classics and another." He's right.

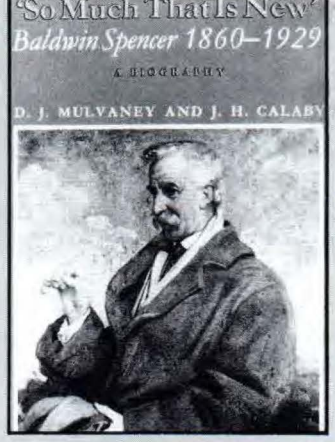
– Col Allison
Author, hunter, taxidermist

So Much That Is New; Baldwin Spencer, 1860–1929. A Biography.

By D.J. Mulvaney and J.H. Calaby. Melbourne University Press, Victoria. 1985, 492 pp. $33.50.

Just as a major biography of Baldwin Spencer is published, it is ironic that one of the few portraits of Spencer, that hanging in the Museum of Victoria and featured on the dust jacket of *So Much That Is New,* is in need of rest from direct light. If there is any symbolism in this coincidence it may be that perhaps Spencer does not really warrant the spotlight of heroism that Mulvaney and Calaby focus upon him.

Nominally, Spencer was all things to all men: artist, biologist, teacher, university administrator, anthropologist, photographer, Commonwealth Government commissioner, museum director, art collector,



V.F.L. President, the list goes on. Mulvaney and Calaby's book highlights all these facets of Spencer's life and more as it traces Spencer's life in great detail. We are taken through his education and early scientific work but the major portion of the book is devoted to post 1887, the year Spencer was appointed Foundation Professor of Biology at the University of Melbourne. In the mid 1890s Spencer met Frank Gillen, Postmaster at Alice Springs, and his friendship and collaboration subsequently secured Spencer's research interests for anthropology. Their joint expeditions and publications were to be of major significance to the evolution of Australian anthropology.

Yet despite the authors' suggestion that an Australian chair of anthropology be named for Spencer, his research was flawed. Spencer was locked into the intellectual strait-jacket of positivism just as surely as his predecessor at the National Museum, Frederick McCoy, had been locked into special creationism. Although both the authors and Spencer deride McCoy, the similarities between the two men are considerable and include both men's abandonment of the National Museum after their initial constructive interest.

The collaboration of Mulvaney and Calaby is not as well integrated as it could have been. Chapter Eight particularly seems to repeat or contradict much of what is found in other chapters.

– C.M. Finney

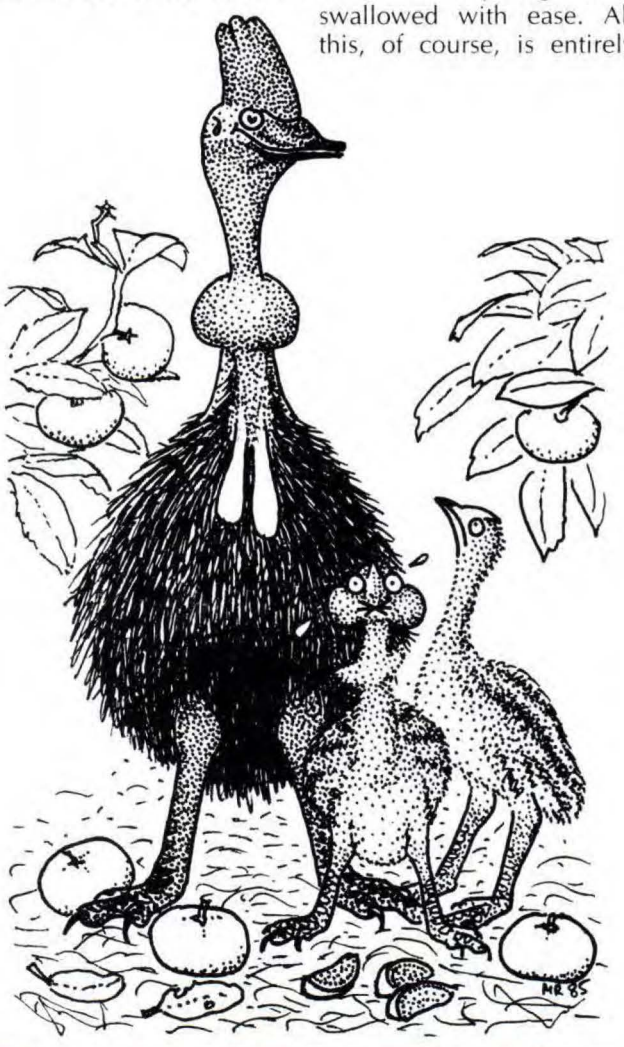
letters

Cassowary Sour

I read with great interest Clifford and Dawn Frith's excellent article and photographs of the Australian Cassowary in A.N.H. (Winter, Vol. 21, No. 9). In 1968 I produced a film on the ratites of Australia and New Zealand and obtained some extraordinary cassowary footage near Tully, north Queensland.

A railway employee had told me that every morning a cassowary with two half-grown chicks came in to feed on grapefruit that had fallen from an old, deserted grapefruit tree. The grapefruit from this tree all appeared to be 'king-size'. Every morning at approximately 8 a.m., a magnificent full-grown cassowary and his two chicks came in to feed on the fallen fruit. The father cassowary would pick up the grapefruit in his mandibles, hold it high in the air and, to my amazement, swallow it whole. Wide-eyed, I would see the bulky grapefruit descend down the cassowary's colourful neck and watch the bulge disappear. The bird would give a final gulp and a grunt or two of satisfaction.

My daily ritual with the cassowaries went on for about four weeks. The two siblings would attempt to emulate their father and pick up the grapefruit but they never quite managed this. I came to their assistance by cutting some of the grapefruit into quarters, which the young birds swallowed with ease. All this, of course, is entirely



contrary to what Georgina Hickey writes in her piece on the cassowary poster.

I formed the opinion, right or wrong, that all cassowaries, given the opportunity, would eat grapefruit which is, of course, a citrus fruit.

My mentor, the late Alec Chisholm, also told me that cassowaries sometimes go fishing, thus adding another tasty item to their menu.

Georgina Hickey writes that the cassowary is second in size only to the Emu, but is it? How is size estimated, by bulk or by height? It would take a large Emu to weigh 43 kilograms while an average cassowary would probably weigh 57 kilograms.

— Harold J. Pollock
Healesville, Vic.

Cassowaries are indeed opportunists! Thankyou for bringing your interesting and enlightening observations to our attention. However, in response to your size query, allow me to reproduce the complete sentence referred to: "Approaching two metres in height, it runs second in size among Australian birds only to the Emu, but outweighs it with an average adult female weight of 60 kilograms." This implies that size, here, is measured by height and Emus are generally taller but less bulky than Australian Cassowaries. —Ed.

Wasp Stings

Your article on the European Wasp (A.N.H. Vol. 21, No. 9) was very timely as I am sure the majority of Australians are unaware of the dangers inherent in this invasion.

Although there has been no reported death from the sting of this insect, it is only a matter of time. Even if death is not the result of a sting, the consequences can be very great as my own experience proved.

I have been stung three times and each time the results appeared more rapidly and with worse effects. The final sting resulted in my having to have two adrenalin injections followed by three courses of injections over three years to immunise the poisons. I now have to carry with me at all times Prednisolone tablets to be taken immediately after a sting and consequently over 16 days.

For those not affected to the extent that I was, in addition to the usual dabbing of vinegar on the sting, Piriton tablets will help minimise the swellings. In fact, one year during the '70s in the U.K. the incidence of stings was so high that every chemist had Piriton tablets on their counters, freely available on demand.

This insect can cause severe distress, even hospitalisation, and for those mere mortals who are allergic to their poison (and you don't know until you are stung!) even death can result. If allowed to reach pest proportions—and the conditions in this country are right for this—each fruiting season will be a time of dread for myself and many others. Every effort should be made now to eradicate any nests and stop this pest invading those parts still unaffected. I wouldn't travel to Victoria or Tasmania during autumn ever again.

— Frances E. Rolls
Helensvale, Qld

ANTipathy

I am in a nursing home and have good eyesight and mind at 86 years of age. I find reading and natural history both good pastimes. About the bullant. Living in the bush, I have seen many bullants and have been bitten often. I remember a chap telling me that, whilst swimming in a creek, he came out in his natural state and sat on a black ants' nest. When he dived into the water they hung on all the more! The most savage bullant I came across was in the Sunrasia area. We called them meat ants. They were very aggressive and found their way up inside your trouser leg and bit a very tender part! I put arsenic bait bones on their nests, but that had no effect. I tried sump oil, kerosene and other means to no avail. The final way was to use gammexane powder (not available now, I think) and that fixed them.

Also, congratulations on the purchase of the opal fossils. That was a great piece of work. Why *should* we let these things go out of the land? All I say is keep up the good work—learning what nature does to survive in the spider basket.

— Arthur Robinson
Ascot Park, S.A.

Human Nature?

I was quite dismayed, after months of turning over pages of frogs, insects, birds, animals and the environment which so affects them, to suddenly come across an article on real, live human beings. I realise that 'anthropology' has traditionally come under the umbrella term of the natural sciences, but I don't think that it's any longer appropriate (if it ever was) that the study of living human cultures should fall into the same category as frogs' eggs or Koala diseases.

If one takes an holistic overview of the natural world, obviously people and their cultures are an integral part of it. But, because one *never* finds studies or documentary evidence in museums or in magazines such as yours of white, Anglo-Saxon, 20th century, human culture, how do we justify similar articles on black people? Is it because their culture is habitually regarded as 'primitive' and in roughly the same category as frogs' eggs or Acts of God? I really don't think so and feel that more thought must be given (by everyone, but in this specific instance, by the editors of A.N.H.) to this issue.

I know that *I'd* be offended if *my* own culture were treated this way and so, it's reasonable to suppose, might the Aboriginal people who are trying to shake off all the false categories imposed by whites ('primitive' being one of these) and to take their place alongside us in the late 20th century world. We do them a real disservice to treat them and their culture as if they belonged, somehow, to the world of insects and astronomy.

Otherwise, thankyou for your great magazine and for the opportunity to express what we'd like to see in future issues.

— Sharan Kellett
Ashfield, N.S.W.

Did you know that in January 1984 Taronga Zoo, Sydney, had Man on display? As part of the Festival of Sydney celebrations, artist Mike Mullins sat in a cage labelled 'Homo sapiens' for 20 days. Similarly in October 1984, but this time in the Metro Zoo, Miami, and for only three days, 'Urban Man' was on display. Actor Albert Vidal was paid $10,000 to do the things urban Man does, including eat, sleep, work in an office, drive a car, etc. Now there are two good examples of white, Anglo-Saxon, 20th century human culture on display! —Ed.

photoart
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A regular gallery of portfolios by talented Australian photographers whose work relates to the natural sciences.

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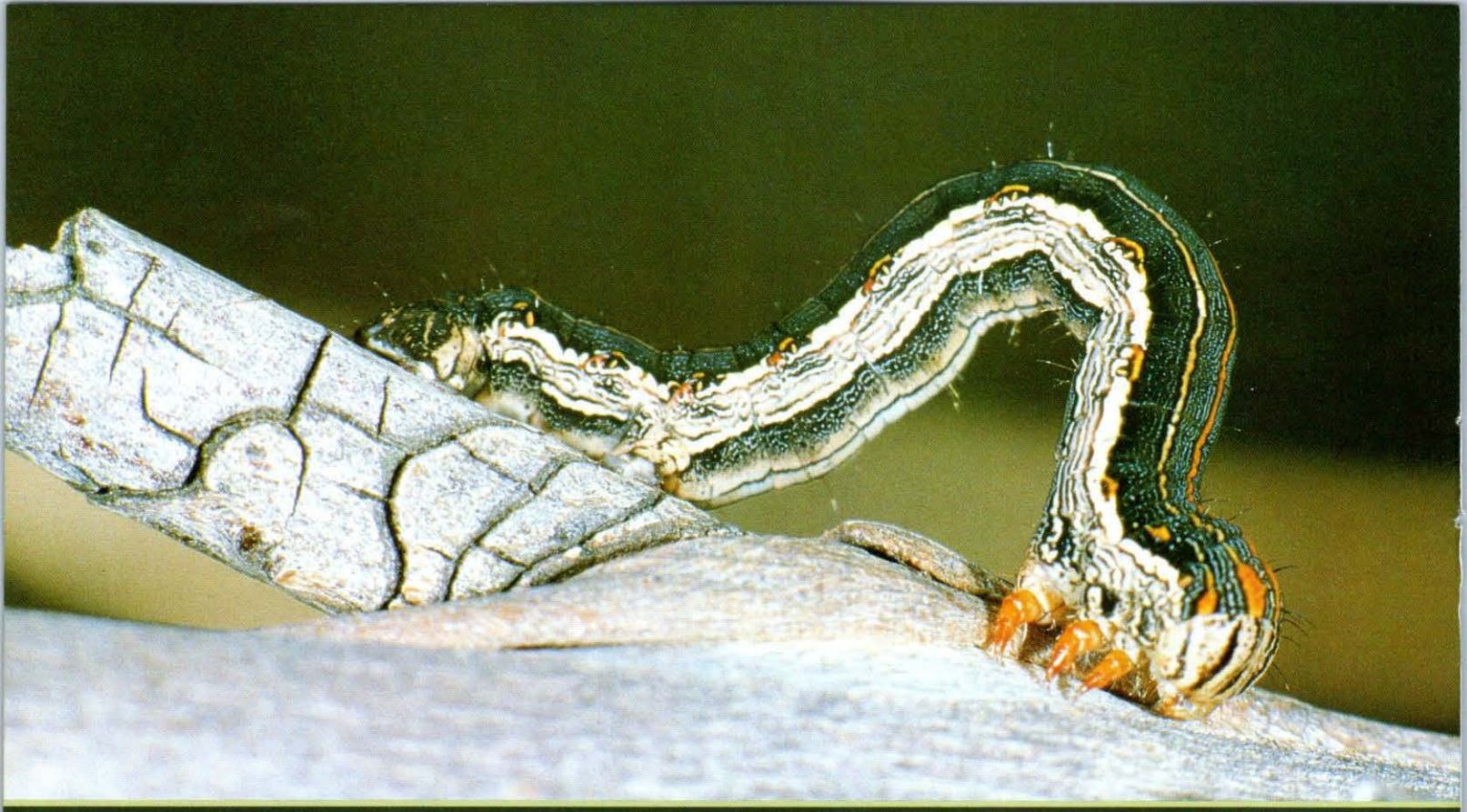
The 'clown spider', *Mopsus mormon*; Cardwell, Qld.

A dwarf tree frog, *Litoria fallax*; Cardwell, Qld.



Paul Gobert

The driving force behind Paul Gobert's photography is a keen interest in Australia and its native species. He finds photography both challenging and stimulating because it satisfies his creative urge.

"My main interest is close-up and macro photography of native flora and fauna in its natural environment. I neither capture nor confine the subject as I enjoy the challenge of getting close to it and feeling that my presence is accepted by the subject," Paul explains.

Paul enjoys being able to use the precision machinery that such detailed work requires. He finds photography provides him with a great deal of mental stimulation because of the many physical and mathematical problems arising that require solutions.

Extensive travel within Australia has enabled Paul to find a variety of subject matter. He has pursued his photographic interest in places as diverse as the Blue Mountains, central Australia including Kakadu National Park, and the Kimberleys in Western Australia.

Paul presently lives with his wife and daughter in the Atherton Tablelands in far north Queensland where most of his photographic pursuits are now concentrated. He generally uses Kodachrome film. □

◀Looper caterpillar; Mt Kaputar, N.S.W.

Botany Bay diamond weevil, *Chrysolopus spectabilis;* Springwood, N.S.W.

Short-horned grasshopper; Emily Hills, Tanami Desert, N.T.

Plant hoppers of the family Derbidae on the underside of a pandanus leaf; Baroalba Springs, Kakadu National Park, N.T.

◀Leaf-eating scarab beetles of the genus *Diphucephala;* Mountain Lagoon, N.S.W.

poster

The Red-eyed Green Tree Frog
Litoria chloris

One of the most spectacular of the green tree frogs found in eastern Australia, the Red-eyed Green Tree Frog, is noted for its brilliantly coloured eyes. The iris can range from a deep orange to scarlet red, with a paler gold border surrounding the pupil. The frog sports a bright leaf-green back and a vivid yellow belly.

A Red-eyed Green Tree Frog can be differentiated from the closely related Dainty Green Tree Frog by its rounded nose and smooth, conspicuous tympanum. It is also larger in size (about 65 millimetres long), has more extensive green pigmentation on its arms and legs, and emits a rather different mating call.

Litoria chloris is found where suitable habitat occurs in coastal and adjacent areas of eastern Australia: from Gosford to as far north as the Cooktown region on the Cape York Peninsula. It inhabits coastal rainforest, wet sclerophyll forests and the grassy floodplains of coastal rivers.

Like other tree frogs, this species features well-developed webbing and large terminal discs on its hands and feet. These discs facilitate climbing and grasping, allowing the frog remarkable dexterity as it manoeuvres through the trees.

An intriguing aspect of the Red-eyed Green Tree Frog is that it rarely descends to ground level except to mate, which occurs after heavy rain. Breeding is generally between September and March, peaking between November and February. Its tendency to remain high in the trees explains why this frog is infrequently sighted.

The males congregate around pools of slow-moving or still water that are often ephemeral in nature. Their calls are generated by inflating the submandibular vocal sacs and consist of a series of long growls or moans, each lasting around a second which terminate in two or three soft trills.

Eggs are deposited either singly or in small, jelly-like clumps, attached to submerged vegetation. The free-swimming tadpoles emerge within a few days.

Metamorphosis is quite rapid in comparison with related species. The juvenile frogs may even emerge from the water as early as six weeks after the eggs are laid.□

– Elizabeth Cameron

Photo: Leo Meier, Weldon Trannies.

The Orange-bellied Parrot

The Orange-bellied Parrot, *Neophema chrysogaster,* has always been something of a mystery even though it was first described from a specimen taken at Bruny Island, south-eastern Tasmania on one of Captain Cook's expeditions in the 1770s. Since then, there have been periodic reports of flocks of 'thousands', interspersed with long periods without any records at all. It has, nevertheless, always been considered a rare bird.

Just a little larger than a Budgerigar and approximately 20 centimetres long, the Orange-bellied Parrot is one of seven similarly sized and shaped species in the genus *Neophema,* all found in central and southern Australia. Its bright green back and distinctive buzzing alarm-call help distinguish it from other similar species within its range.

The Orange-bellied Parrot is a migratory species that breeds in south-western Tasmania. After breeding it moves northwards across Bass Strait to spend the winter on the mainland. Here it is distributed along the coast of Victoria and South Australia, from Gippsland in the east to Lake Alexandrina, south of Adelaide. Between 1880 and 1907 many birds were recorded from the Sydney area but since then there have been no further substantiated records from New South Wales.

Like most other parrots, Orange-bellied Parrots nest in hollow trees. Up to six eggs are laid and studies have shown that adult pairs remain together as long as both birds survive. Incubation is undertaken by the female alone with the male feeding her at the nest every three hours.

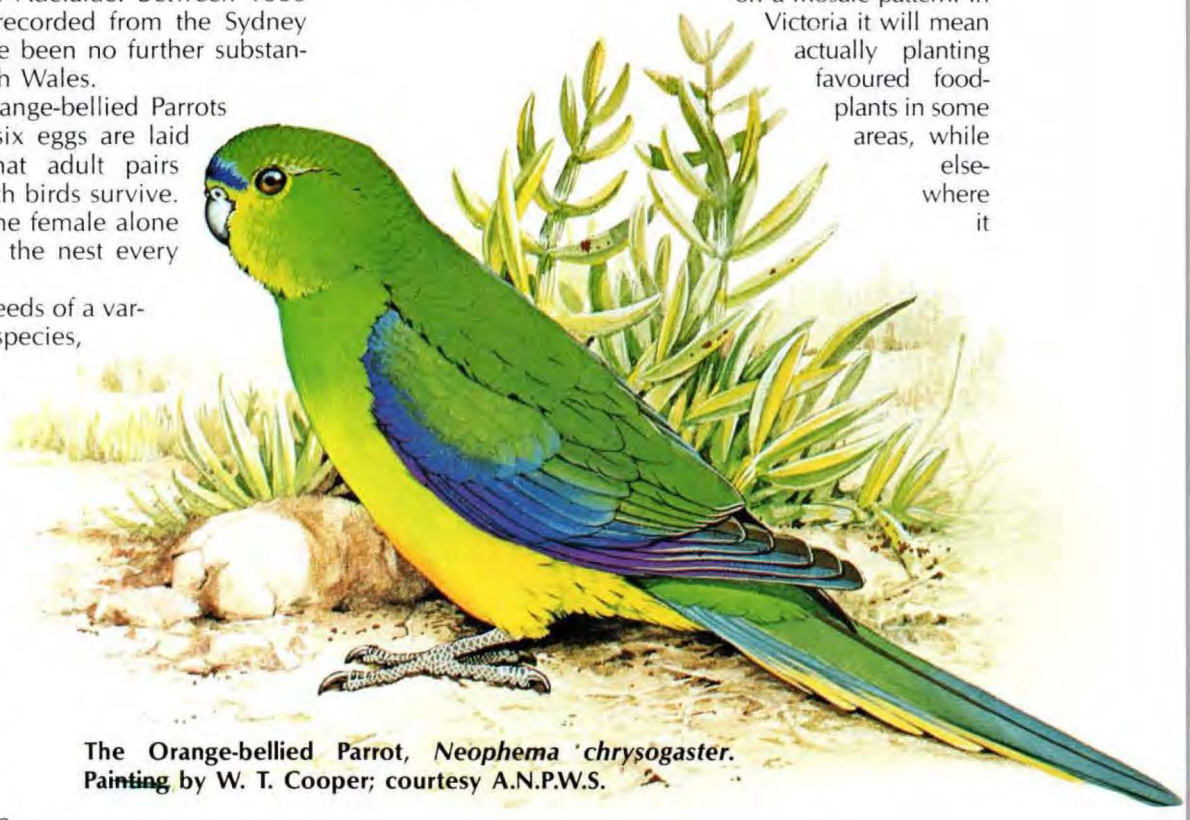
In Tasmania, birds feed on seeds of a variety of sedgeland plant species, favouring different species at different times during the summer. During migration in north-western Tasmania, they feed on beachfront vegetation, notably 'sea rocket' and native grasses, whereas on the Bass Strait islands seeds of saltmarsh species are taken. In Victoria, most birds have been recorded living in and feeding on saltmarshes. In South Australia they favour the beaches and dunes where 'sea rocket' and 'buzzies' are the major food source.

Concern over the fate of the parrot, coupled with an extreme lack of knowledge of its ecology, in 1979 led to the study of this species by World Wildlife Fund (Australia) in an effort to determine management priorities for safeguarding it. This study has since been supported by the three States in which it occurs and the Commonwealth Government. So far, investigations justify fears for the species' future. With a maximum population of less than 200 individuals, it probably rates as the rarest and most endangered bird species in Australia at present.

The main cause of the Orange-bellied Parrot's decline is loss of habitat, particularly in the wintering range where the preferred 'dry' saltmarshes are now something of a rarity with large tracts of former habitat, especially in Port Phillip Bay, having been lost to development over the years. Other important factors include introduced predators—chiefly cats, but also foxes—and seed-eating birds (such as goldfinches and sparrows) that vie for the same food resource during critical periods of the winter.

One of the findings of the study has been that the Orange-bellied Parrot is by nature a traditionalist. It returns to the same locations each winter. As many of these preferred habitats have now been identified, the main objectives are to safeguard these important areas against further habitat loss. This can be achieved by minimising disturbance and threats of predation and competition and, most importantly, by enhancing food supplies through careful management.

This will involve different objectives in different areas. In south-western Tasmania, for example, it means creating feeding areas of different ages through controlled burning on a mosaic pattern. In Victoria it will mean actually planting favoured food-plants in some areas, while elsewhere it will mean the exclusion of four-wheel-drive activity.



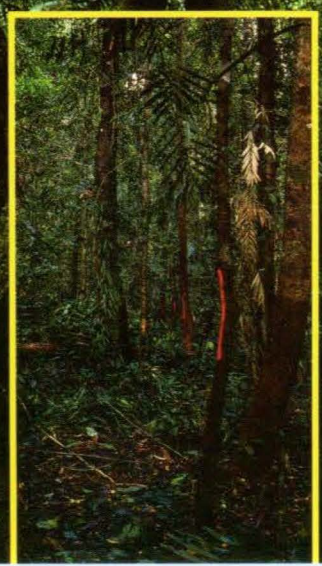
The Orange-bellied Parrot, *Neophema chrysogaster.* Painting by W. T. Cooper; courtesy A.N.P.W.S.

An encouraging find from the counts undertaken over the last seven years is that there is no clear indication of any continuing decline in the overall population but there are also no signs of an increase. With so small a total population, we are aware that one major problem could spell disaster for the species. It has generated a lot of good will Australia-wide in recent years. Let's hope all the efforts to assist the Orange-bellied Parrot will have the desired effect and this beautiful bird will be safeguarded for future generations. □

Peter Brown
National Parks and Wildlife Service, Tasmania

Rainforest vegetation must continually fight for available light like these vines taking advantage of a break in the canopy. Photo: Leo Meier, Weldon ◀Trannies.

The rapid decay of vegetation in the rainforest environment necessitates the shallow root system typical of rainforest trees. The roots are buttressed for stability as can be seen by this flaring trunk. Photo: Leo Meier, Weldon Trannies.



Various markings are used to indicate a tree's future. A blue ring around the trunk means the tree cannot be cut down or damaged in any way. A blue cross followed by a number indicates the tree is to be felled. Although blue paint is generally used, the red vertical lines on the small trees in this photo signify they are to be cleared for a road or other access. Photo: Leo ◀Meier, Weldon Trannies.

Architect's impression of the proposed canopy walkway through the Downey Creek rainforest. Illustration: courtesy M. Ferris, W.P.S.Q.▶

by Heather Grant

FORUM

DOWNEY CREEK: THE GREAT LOGGING DISPUTE

Conservation is the key issue at the heart of the Downey Creek logging debate. The conservationists want to stop the logging and have the area placed on the World Heritage List. The foresters and the Queensland State Forestry Department insist that selective logging is essential for the preservation of the forest. It is ironic that both sides claim they are seeking what is essentially the same goal—to conserve the natural beauty and harmony of this rainforest. Heather Grant, one of the journalists flown up to the area to observe the logging operations, uncovers here the underlying disputes and elucidates the arguments behind both sides of the issue.

A 200 year old rose mahogany stands majestically awaiting its death, a blue cross on its trunk. Nearby another tree has gained a reprieve, for now, with the horizontal swish of blue paint.

These markings represent selective logging as used at Downey Creek, 30 kilometres south-west of the northern Queensland sugar town of Innisfail. A rugged, lowland tropical rainforest covering 8,040 hectares, conservationists have described Downey Creek as 'a living museum', home to 1,000 plant species. They want logging to cease and the area to be placed on the United Nations' World Heritage List.

A lot of claims have been made about the logging operations. Interestingly, the logging operators, Foxwood Limited, and the conservationists both want to achieve the same goal—to conserve the forest—albeit for different reasons and through different means.

On a recent tour of the catchment area, Foxwood's general manager Fred Clark told me: "We're more interested in conservation than the greenies. We're not ripping the guts out of the forest. We want to come back in 40 years."

The Queensland Forestry Department allows Foxwood to harvest only 2,995 hectares of the Downey Creek catchment. Almost 4,000 hectares is deemed inaccessible or non-productive while a further 960 hectares has been set aside as a scientific area. The latter consists of a lowland complex mesophyll vineforest on basalt soil. This will never be logged.

The Queensland Forestry Department supervises all logging. Atherton-based chief forester, Tom Just, said that strict environmental constraints have been imposed. Only trees marked by foresters can be felled. He pointed out that the direction of the fall is predetermined to ensure optimum protection of the canopy and surrounding growth.

Foxwood uses the wood for structural timber and expensive veneers. Although Downey Creek is home to about 1,000 plant species, there are only 140 commercial species in the forest. Among the most preferred are the Queensland maple *(Flindersia brayleyana)*, Queensland silky ash *(Flindersia bourjottiana)*, Queensland walnut *(Endiandra palmerstonii)* and the northern silky oak *(Cardwellia sublimis)*.

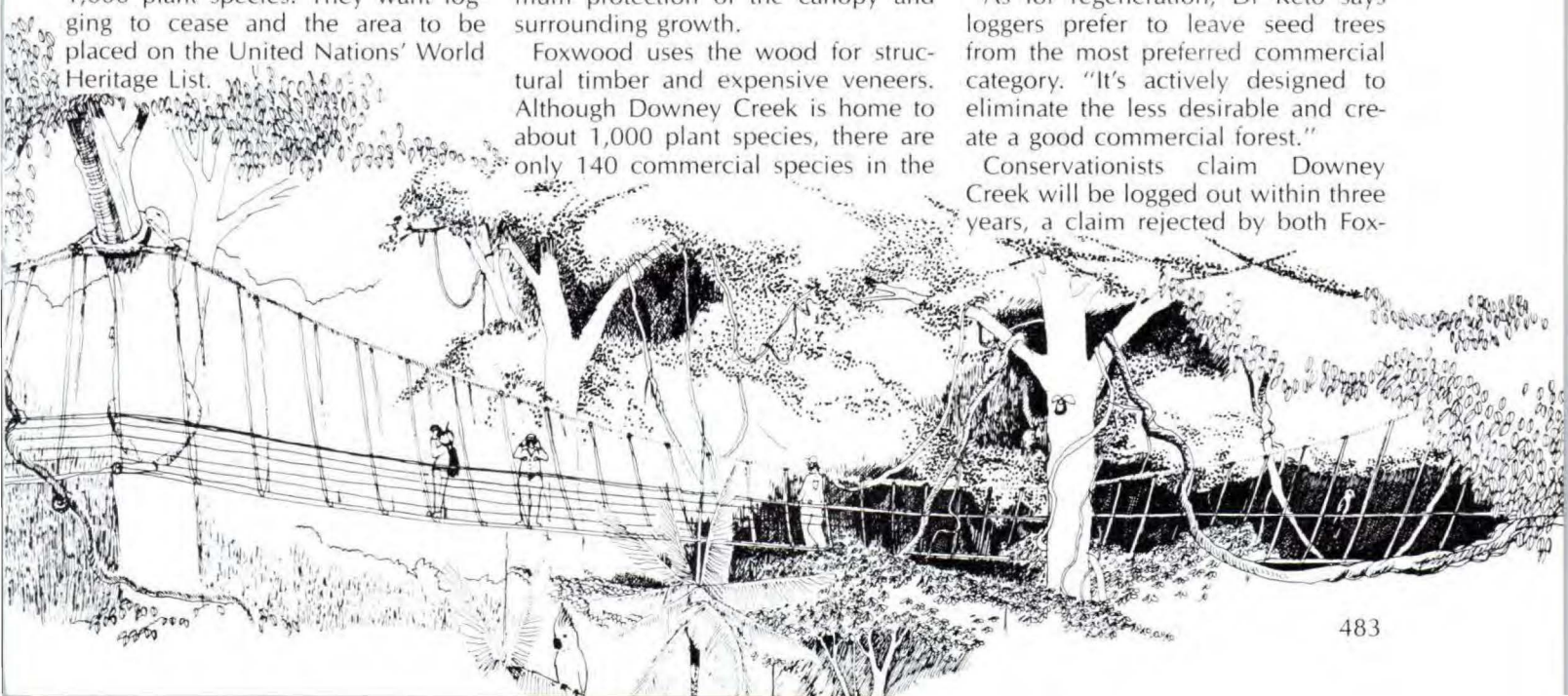
According to Dr Aila Keto, from the Rainforest Conservation Council of Queensland, there are also ten endemic species in Downey Creek that are restricted to the wet tropics. These include the *Buckhamia* species and *Macadamia whelani*. The silver silkwood *(Flindersia acuminata)* is the only endemic in the highly-preferred category for logging.

Before any tree can be logged, it must be marked. A blue cross indicates the tree can be felled. Mr Just says tree marking is designed to minimise damage while fully utilising tree resources. It ensures a well-stocked stand is retained and that there is an adequate number of seed trees for regeneration.

However, Dr Keto feels the guideline could still allow change of the forest's ecological structure. "A more open structure favours trees that like those conditions, so the long-term danger is loss of species", she maintains.

As for regeneration, Dr Keto says loggers prefer to leave seed trees from the most preferred commercial category. "It's actively designed to eliminate the less desirable and create a good commercial forest."

Conservationists claim Downey Creek will be logged out within three years, a claim rejected by both Fox-



The ethereal beauty of the Downey Creek rainforest.
Photo: Leo Meier, Weldon Trannies.

wood and the State Forestry Department.

According to Mr Clark, only about eight to ten trees per hectare are logged in any one year. Up to 20 small areas are harvested in that period. Logging operates on a three year cutting cycle for an area, which is then abandoned for about 40 years to enable regeneration.

Foxwood acknowledges that logging can cause some damage. Nevertheless, foresters say the overall percentage of trees felled in one year is equal to the natural mortality rate in a forest. In any one year, states Mr Clark, up to five per cent of the accessible rainforest is harvested under the cutting cycle system. He also believes the impact has been limited because of the multiple small units logged, rather than one large area.

Certainly from my own visit, I could not detect any signs of the areas being logged from the air. There were no tell-tale gaps in the canopy. It seems almost as difficult to tell on the ground which areas have been logged. In one area logged 12 months ago, the canopy was almost restored. A rotting stump is the only reminder of logging in another area abandoned in 1968.

Despite the foresters' argument of minimal impact, conservationists still maintain that even limited damage cannot be justified.

A number of conservation groups, including the Wilderness Society, Australian Conservation Council, Rainforest Conservation Council and American Society of Mammalogists, are putting their weight behind the campaign to stop logging at Downey Creek. "It's one of the most important pieces in the area for World Heritage listing with its unique species of plants and animals, and particularly its massive trees", Ralph Lindsay from the Wilderness Society asserts.

Tasmanian Senator Norm Sanders is also a vocal opponent to the logging.

Senator Sanders emphasises that Australians need to reappraise their values. "In New Guinea, local people are being offered a very enticing financial carrot to have their rainforests cut down. However, they have more sense than we have down here and are beginning to refuse these offers.

"This is a very big sacrifice for them because they have practically no other economy to speak of.

"But it wouldn't affect us if the logging stopped", Senator Sanders maintains. "Just how selfish are we?"

Conservationists are prepared for a trade-off. They suggest building a one-kilometre canopy walkway in Lower Downey. They believe that tourism—not logging—is the industry of the future for northern Queensland.

"It would damage a small part of the forest but we're willing to give that up to save the rest", states Senator Sanders.

"Unfortunately it doesn't make sense to say it should be protected for itself, its own intrinsic values. So we're saying 'save it for tourism'."

The Queensland Government may also be viewed as going part way toward a compromise. At present, a joint National Parks–Forestry Department feasibility study into the concept of a national park rainforest tourist complex is underway. The proposed 14,500 hectare national park would be centred on Palmerston Highway, providing Innisfail with a predominantly virgin rainforest at its doorstep.

"It will lend itself to all types of rainforest and national park activities, scenic walkways, waterfall lookouts, forest drives, camping and research", State Forestry Minister Bill Glasson said.

"It would also provide an ideal setting for the $5 million canopy walkway tourist complex and research centre, planned by the Innisfail branch of the Wildlife Preservation Society."

The proposed park would provide a missing link between the western and eastern sections of Palmerston National Park. It would adjoin the scientific area but would not actually include Downey Creek. The Government maintains that tourism and logging are not mutually exclusive.

However, the conservationists' tourist proposal is only a stop-gap. What they really want is the registration of rainforests from Cooktown to Townsville on the World Heritage List. This tract would include Downey Creek and the Daintree, the Windsor Tableland and Cardwell Range. "It's clearly realistic", says Mr Lindsay. "It's a tiny part of Queensland, very small compared with the Great Barrier Reef."

Conservationists agree that the Queensland Government has proved to be a stumbling block. Premier Sir Joh Bjelke-Petersen is on record as saying that not one more inch of Queensland would be nominated for World Heritage listing. Traditionally, nomination has been the State's responsibility. But pressure, through rallies and lobbying, has now been placed on the Federal Government to lodge the nomination with U.N.E.S.C.O. by the end of 1985, the deadline for the 1986 agenda.

At the time of writing, the Federal Government has not indicated whether or not it will nominate. However, Senator Sanders warns that inaction would not only mean loss of a valuable part of Australia's natural heritage, but also could sound the fall of the Government.

"If it misses that date, then it cannot be nominated until late 1987 and by then, all accessible virgin rainforest will have been logged", says Mr Lindsay.

"The tourist potential of Downey Creek will have been obliterated and the world will have lost a magical forest", he adds. □

QUIPS, QUOTES & CURIOS

This issue, we introduce a new section to A.N.H. featuring short items, new discoveries, the unique, the unusual and the extraordinary.

Naturalists—A Definition

So you think you're a naturalist, do you? If alive today, Charles Kingsley, a noted 19th century naturalist and theologian, and author of *The Water Babies* (1863), may have disagreed. In 1855 he listed the "qualifications required for a perfect naturalist": "Our perfect naturalist should be strong in body; able to haul a dredge, climb a rock, turn a boulder, walk all day, uncertain where he shall eat or rest; ready to face sun and rain, wind and frost, and to eat or drink thankfully anything, however coarse or meagre; he should know how to swim for his life, to pull an oar, sail a boat, and ride the first horse which comes to hand; and, finally, he should be a thoroughly good shot, and a skilful fisherman; and if he go far abroad, be able on occasion to fight for his life." *(Glaucus; or the Wonders of the Shore,* Cambridge.) It appears that Kingsley thought a necessary pre-requisite of a naturalist included being male. Apart from this, how you feel you fit the description?

STOP PRESS! 'Burnt'-orange-bellied Parrot

Fears for the future of the Orange-bellied Parrot were expressed when controlled burning-off around Birch's Inlet on the western coast of Tasmania could not be restrained and an estimated 36,700 hectares of buttongrass plains in the area were burnt in November, 1985.

Buttongrass plains form one of the principal food sources for the Orange-bellied Parrot. They favour young grasses, between four and eight years old. However, because the plains around Birch's Inlet had not been burnt-off for some time, the Parrots no longer found them attractive. This contributed to the dwindling numbers of Orange-bellied Parrots in the area. The birds generally nest around Melaleuca, Port Davey and Bathurst Harbour in Tasmania and the burning-off around Birch's Inlet was part of an agreed management plan to encourage the Parrots to return to the area for nesting and thereby increase their numbers.

An unexpected change in weather caused the fire to get out of control. However, the Minister for National Parks, Mr Beswick, confidently predicted that the Orange-bellied Parrots would return to the area within two or three years as a result of new regrowth in the area. A report from the Director of the National Parks and Wildlife Service, Tasmania, Peter Murrell, stated that the area had been thoroughly surveyed prior to starting the fire. No nesting birds were found in the area and only one Parrot was spotted. The Orange-bellied Parrot is featured in our *Rare and Endangered* section on page 481.

Electricity Bill

Recent research has disproved the former theory that a Platypus locates its food by snuffling about, relying on tactile sensations and/or chemoreception. Chris Tideman, from Canberra's A.N.U., has conducted behavioural experiments that indicate the Platypus bill is highly electrosensitive (in the order of millivolts). Its prey emits small electric fields (all living organisms emit some sort of electric field) which the Platypus in turn detects. A small electric battery was used as the voltage source in these experiments. One was placed alongside a shrimp (a favourite food of the Platypus) and, invariably, the Platypus would go for the battery.

A Postage Problem

Post-postal strike: And we thought we had postage problems!

Frank Buckland, a popular natural history writer from England, wrote in 1876 an amusing anecdote of how he had once sent a bear's foot to a friend as a Christmas present. The friend didn't like the look of it, so forwarded it on to another friend, but without a covering letter. The recipient decided that the now putrefying paw must be "the foot of some savage" and sent it to an eminent anthropologist. The anthropologist's wife opened the package and immediately summoned the local policeman who declared that it was indeed a man's foot and that "he knew the man who had lost it". Scandals were only averted by the belated arrival of the covering letter. *(Log-Book of a Fisherman and Zoologist,* London.)

Gould League's 75th Anniversary

The Gould League is celebrating its 75th anniversary.

Nowadays, the League is more than a society of bird enthusiasts as it was when it began in 1910 as the "Gould League of Bird Lovers of New South Wales". The League was named after 19th century English naturalist, John Gould. John and his wife Elizabeth were prolific painters of Australian native animals.

Originally, birds were the motivation for forming the League. Its first pledge was: "I hereby promise to protect all birds except those that are noxious and to refrain from the unnecessary collection of wild birds' eggs".

The Junior Tree Wardens' League was formed in 1936 with a similar conservationist attitude to plants. In

1967 the Gould League of Bird Lovers of New South Wales and the Junior Tree Wardens' League joined to become the Gould League of New South Wales.

The new pledge was to the entire environment: "Earth is our home and I promise to try to keep it beautiful by learning to understand and conserve its soils, air, water, natural beauty and all its living things".

The Gould League distributes many environmental books, posters and other material. Gould League officers will readily give advice or help to schools or anyone in the community. A network of Environmental Regional Committees has been established to help schools with planning.

The Gould League welcomes membership and can be contacted at Beecroft Public School, Mary Street, Beecroft, NSW 2119, (02) 84 6235.

Pre-Linnaean Nomenclature

The two books in which Linnaeus first used the binomial nomenclature for species, familiar to all of us today, were *Species Plantarum* 1753 and *Systema Naturae* 1758. All previous names are dismissed as 'pre-Linnaean' and have no status in modern scientific literature. Previous naturalists, and Linnaeus himself when young, had tried to give specific names which incorporated *all* the distinguishing features of that species. For example: the Queen Conch (from Bermuda, south-east Florida and the West Indies), now universally known as *Strombus gigas* L. (L. for Linnaeus), passed under such earlier aliases as *Murice Orecchiuto per il gran labbro che sporge* (Buonanni), and *Buccinum ampullaceum striatum, clavicula miricata, apertura leviter purpurascente* (Lister), and Marbled Jamaica Murex with Knotty Twirls (Petiver). The former description is Italian and, directly translated, means: 'a long-ear murex for the great lip that protrudes'. The second description is the more formal Latin name, roughly translating to: 'Crooked trumpet, big-bellied, fluted with a small cavity, pointed opening, becoming lightly purple'. Scientists of that era must have had an amazing capacity for retention! (S. Peter Dance, *Shell Collecting: an Illustrated History*, London, 1966, p.70.)

Trees of the Future

In a joint project, Australian Pulp and Paper Mills (A.P.P.M.) and the C.S.I.R.O. will work together to breed better species of trees. A.P.P.M. envisages spending over a quarter of a million dollars on facilities to accommodate the project at Ridgley, Tasmania. But the benefits of such a project will not be realised until the new breeds reach maturity—in the next century!

Huge Fossil Find

Over 15 tonnes of fossil samples have been unearthed in an area near the Gregory River in north-western Queensland. The discovery was made in April, 1985, by a team headed by Professor Michael Archer of the School of Zoology at U.N.S.W. It has attracted volunteers from all over Australia, anxious to take part in this historical work.

This discovery marks the most significant fossil mammal find in Australia to date, with fossils ranging in age from 50,000 to 15 million years.

Over 100 previously undiscovered kinds of mammals have been found. "That more than doubles the previous known record. Up until this discovery, there were only 70 named Australian species over two million years old", states Prof. Archer.

Some fossil remains are evidence of the existence of a previously unknown order of mammals, yet to be named. Fragments of jaw bones and teeth have been recovered which, according to Prof. Archer, are unlike that of any animal ever evolved. So far, the animal has been identified as a rabbit-sized carnivore but the unusual teeth and jaw structure have made its diet and eating habits the subject of much speculation. The mystery will continue to baffle researchers until a more substantial find, such as a complete skull, is made.

"It makes a tantalising curiosity because we have no modern models to use as a comparison", Prof. Archer points out. He has suggested the hypothesis that the animal may have preyed on eggs.

Other significant fossil finds include over 20 new species of bats, some of which relate to European and not Australian species. The first complete skull of a Platypus-like animal heralds the best find of a monotreme from the Tertiary Period. A carnivorous kangaroo estimated to be about 15 million years old is also amongst the unique finds.

Despite the sheer enormity of these discoveries, Prof. Archer notes that they have resulted from exploration of less than one per cent of this new fossiliferous area. "Each time we return, we make new discoveries."

Because the discovery involves such vast amounts of fossil material, there have been tremendous problems in transporting the fossils from the locations to railway stations. The areas are virtually inaccessible to road vehicles, so the R.A.A.F. has been assisting by air-lifting the samples out with helicopters. However, the process is extremely costly and the enormous area of yet to be explored fossiliferous rocks indicates that it will be an ongoing challenge for many years. There is also the problem of preparing the fossils: so far, over half of the limestone recovered has been prepared, but researchers are running out of acid. IBM and the Burketown Shire Council have assisted in transporting the fossils to Sydney and the research is partly supported by an A.R.G.S. Program Grant provided by the Federal Government.

Professor Archer informs us that for any person or any institution interested in genuine scientific immortality, one way of ensuring their name is passed into the future is to help support the Riversleigh Research Project. In exchange for urgently needed financial assistance, benefactors can arrange to have an exciting new species of Australian

animal named after them. Professor Archer may be contacted in the School of Zoology, University of New South Wales.

Battery Rabbits?

It is interesting how some great ideas just never quite take off. The following piece was reported in *The Australian Museum Magazine* (A.N.H.'s former name), Vol. 1, No. 2 (August, 1921):

> A 'BROODY' RABBIT. The best way to neutralise a pest is to utilise it, and a new way to turn our harmful, unnecessary rabbit to good account will be of interest to the man on the land. The strange behaviour of a rabbit, described in *Nature*, of 1st March, 1900, may point the way to a new avenue of usefulness for the rabbit.
>
> "Last year, in an aviary in one of the wards of the Caterham Asylum, a wild rabbit turned a dove off its nest and sat on the two dove's eggs until they were hatched. This year the nurses are trying another hatching operation. They have placed two bantam's eggs in the same nest. The same rabbit has taken to these eggs, and only leaves the eggs to take its food, returning at once to the nest." Now all that is necessary is to carefully select a number of rabbits with the hatching habit well developed and segregate them; after a few rabbit generations have come and gone, a company could be formed to supply poultry farmers with rabbit incubators. The incident is curious, if true, and, as Mark Twain would say, it is curious anyway.

Tried & True?

Old methods are sometimes claimed to be the best but some are rather outdated as this extract from *The Australian Museum Magazine*, Vol. 1, No. 1 (April, 1921) goes to show.

> ". . . the house fly, *Nusca* [sic] *domestica*, is also known as the typhoid fly on account of its being a carrier of the germs of this disease. Formalin has proved to be the best poison, and a few drops of five per cent formalin placed in a saucer of sweetened milk will cause the death of all flies who partake of it. If proper care were taken in the first place to prevent flies breeding, by covering up receptacles for garbage and such places as manure heaps in stables, they would eventually disappear.
>
> Flea larvae feed upon dust . . . To dispose of fleas we must therefore get rid of all dust by thoroughly scrubbing out the room with hot water into which a small quantity of carbolic has been poured, and by beating all carpets.
>
> Cockroaches are best destroyed by placing baits of borax and breadcrumbs, or equal parts of ground-up chocolate and borax, in the places where they lurk. Plaster of Paris sprinkled about will also be greedily consumed by the insects, and on being taken into their digestive system it hardens, and so causes death. Paris green blown into their hiding places has the effect of driving them out."

The editor welcomes contributions for this section. If you know of any weird and wonderful natural occurrences, why not drop us a line?

ROBYN WILLIAMS

Sir Macfarlane Burnet . . . a Giant in Medical Research, Inspired by Natural History

A.B.C. RADIO SCIENCE SHOW

How fascinating it is that many truly great analytical thinkers started their interest in science by collecting things. Charles Darwin, Sir Julian Huxley (biologist and founder of U.N.E.S.C.O.) and our own Sir Macfarlane Burnet had a boyhood passion for beetles. Yes, beetles! J.B.S. Haldane once said he didn't know whether there is a God but, if one exists, He must have an inordinate fondness of beetles.

One can picture the young Burnet in the woods of Victoria, in solitary pursuit of more of these infinitely varied insects for his collection. During these excursions, like Darwin and Huxley before him, Burnet probably developed his extraordinary capacity for concentrated thought and imagination. He was clever at school and knew a profession could be his for the asking. Medicine was the obvious choice and he duly attended the University of Melbourne. But practice as a G.P. or even a medical specialist was put aside. For him the quintessence of medicine lay not in the direct care of the sick but in the intellectual challenge posed by the processes responsible for disease.

Consequently, Burnet became a research scientist and virtually *invented* a whole new field—that of immunology—or, at least, the modern theory of this fundamental aspect of life: self and not-self. We are exposed every moment of our lives to millions of foreign microbes: viruses, spores, fungal blights and bacterial plagues. All are capable of eliminating us within hours or days. Yet normally we do not succumb and this is due to our ability to recognise, and then reject, these lethal particles. But how can we differentiate the tiny invading enemy from the often equally independent cells of our own bodies? This was Burnet's great challenge.

That he managed to crack the code and solve the puzzle is part of modern scientific history. It was recognised in the highest awards open to a research scientist: the Nobel Prize for medicine and physiology in 1960 and later, the Order of Merit, an award in the personal bequest of the Queen.

Burnet was, for over two decades, the Director of the Walter and Eliza Hall Institute in Melbourne. While there, he still worked at the bench and tried to fathom mysteries of plagues like influenza. Having cracked the code of the antibody response, Burnet endeavoured to discover how we might keep ahead of 'flu pandemics. It is easy to forget that influenza can be a terrible killer. The outbreak in 1918 wiped out between 25 and 40 million people worldwide! Our immune system counteracts viruses by producing antibodies with complementary shapes, rather like a key in a lock. Every time nature produces a virus with a different shape—one our immune system cannot defend immediately—an epidemic can occur.

Sir Macfarlane Burnet.
Photo: courtesy W.E.H.I.

But where do new 'flu viruses come from? Geographically speaking, many seem to originate in the region of China. But the mechanism appears to be mediated by animals, especially some birds. The idea is that two strains may invade a bird, then recombine to produce a different genetic code and, in doing so, create a new virus. With Professor Frank Fenner in Canberra, Burnet worked out the details of this disease pattern in wildlife. Since then, researchers at the John Curtin School of Medical Research at A.N.U. have tried to invent new viruses and so keep one step, or one generation, ahead of nature. The aim is to produce vaccines that will protect populations around the world from the next killer pandemic.

Vaccination has been one tangible consequence of Burnet's work; in addition he provided the basic framework for organ transplantation, for our current understanding of autoimmune disorders like rheumatoid arthritis and for new insights into human cancer. Sir Macfarlane is known for his concept of 'immunological surveillance'. This hypothesis suggested that the defence (immune) system could recognise cancer cells as foreign and therefore reject them or prevent their spread. Although now known to be only partially true for many human tumours, the concept, like clonal selection, has led to a great deal of productive research and a better understanding of the cancer process.

But for myself and countless scientists in Australia, the main heritage of Sir Mac's life has been the establishment of medical research excellence in this country. He refused to leave Melbourne for Harvard or other famous overseas establishments. "We can do it here too", he always insisted.

In the field of biology he contributed in many ways. He helped to establish the Australian Institute of Marine Sciences near Townsville, northern Queensland. He wrote about the ageing process and Altzheimer's disease. He also speculated in sociobiology and we used to differ vigorously about the extent to which human beings are dependent behaviourally on genes rather than environment.

When he died last winter, just before his 86th birthday, I marked his passing on radio. The young interviewer asked me what I was going to talk about and I mentioned his name. "Who's he?" she asked. Several other youthful folk also pleaded ignorance . . . which is why I wrote this article. □

Snorkels and Aqualungs

Accessories for Life Under Water

BY NOEL TAIT

When back swimmers dive they take with them a bubble of air. Photo: Kathie Atkinson.

It would seem to be a characteristic of *Homo sapiens* to develop technologies enabling survival in environments for which his body is not adapted. Man's first attempts to remain for extended periods under water are lost in history. Yet over the last few decades, technological advances have brought the wonders of the underwater world within easy reach of the average person. There are, of course, several other groups of land dwellers that have developed flippers, snorkels, aqualungs and wetsuits—all the accessories required by the modern human diver. The difference is that these 'accessories' were developed by natural processes and incorporate changes to the actual body parts.

It is rather paradoxical that the three groups of organisms which made the most extensive invasion on land—the flowering plants, vertebrates and insects—have also made the most extensive adaptations back to water. In their evolution back to water, these various organisms have retained many of their adaptations to life on land, reworked others and added new features of their own.

Plants in a Natural Aquaculture

Aquatic flowering plants have retained their roots, stems, leaves and their supporting and conducting tissues—organs that originally allowed them to colonise their less dense terrestrial environment. Flowers, developed to allow sexual reproduction in the absence of a watery medium, are still retained by aquatic plants. Because the flowers are usually held above water, animals and wind are still responsible for pollination and seed dispersal.

Aquatic plants have taken on a variety of growth forms to suit the aquatic medium. These vary from the emergent plants at the water's edge (for example, bull rushes), to those with elongate petioles (stalks) that allow the leaves to float on the water surface (water lilies) to free-floating forms (water hyacinths) and to completely submerged plants (such as the Canadian pond weed).

Lungs as Accessories to Gills

The principal concern of animals faced with the aquatic environment is *how* to breathe under water. Aquatic animals extract oxygen from the water either directly through the body wall or by means of especially thin extensions of the body called gills. These gills are supplied with blood which picks up the oxygen, usually with the aid of an oxygen-binding pigment such as haemoglobin. The oxygen is then carried to all parts of the body by the circulatory system.

In terrestrial animals, gills would be ineffective. The thin, flimsy structure of gills is necessary for absorption of oxygen. It would not be supported in the less dense air and would therefore collapse, reducing the surface area dramatically. Furthermore, they would dry out and the body would lose excessive amounts of water. In terrestrial vertebrates and insects the respiratory system has become internalised.

Among vertebrates, these internalised respiratory organs, the lungs, arose as a pair of outgrowths from the forepart of the gut. Connection to the exterior is maintained via the mouth and nostrils. The development of lungs is believed to have occurred in several lines of ancient fish as a means of supplementing the dwindling oxygen supplies in warm, stagnant waters. One of these lines gave rise to amphibians—and so began the progressive evolution of vertebrates to life on land.

Along with changes to the respirat-

Even when mating, water striders can support themselves on the surface of the water. Photo: Kathie Atkinson.

ory system, modification of other parts of the body also occurred. The fins developed to form limbs capable of holding the body above the ground. The developing embryo was protected by a shelled, waterproof egg in reptiles, birds and monotremes or by its retention within the female reproductive tract in marsupial and placental mammals. Protection from the greater temperature fluctuations on land was afforded by the development of insulating layers of feathers or fur.

Remaining Under Water

Each of the three groups of terrestrial vertebrates (reptiles, birds and mammals) has made significant contributions to life in water. Some of the most spectacular of these include marine turtles, penguins and whales. Although these animals have independently made the water their home, they share characteristics that have enabled them to adapt to this new environment. These include a general streamlining of the body form and the modification of limbs to form paddles. In the cetaceans (porpoises, dolphins and whales), the tail has become modified as the major source of propulsion, just as it is in fish. The blade of the tail, however, is horizontal rather than vertical and the force is derived from an up-and-down rather than a side-to-side undulation of the body.

All these aquatic animals must, however, periodically come to the surface to breathe. None is capable of remaining indefinitely submerged and deriving oxygen from the water. They have, however, developed means for allowing them to remain submerged for far longer periods than any terrestrial vertebrate. They can also make rapid and repeated dives to great depths—a situation that would result in the bends (the formation of nitrogen bubbles in the blood caused by a too-rapid decrease in pressure) if practised by humans.

Rather than increasing the relative size of their lungs, as would be expected to allow them more air, many of the best divers have relatively small lung volumes and when they dive they expel air—exactly the opposite to what we do. The small air (and thus nitrogen) volume explains the lack of the bends, but how do they manage to stay under water for so long? The answer seems to lie partly in the oxygen-carrying capacity of their blood—by the increase in blood volume and number of red cells containing haemoglobin. There is also another oxygen-carrying pigment called myoglobin, which occurs in muscle tissue and gives the red colour to meat. Seals and whales consequently have darker muscles than their terrestrial counterparts.

An important feature of the circulatory system of all vertebrates is that blood can be diverted preferentially to different parts of the body according to need: to the intestines after a meal or to the muscles during exercise. In a diving animal, the blood is directed to the brain. The heart and other organs, including the muscles required for movement, receive little blood. After using up the oxygen stored in the myoglobin, the muscle tissue then acts anaerobically, that is, without oxygen.

Cetaceans have also lost their dense covering of fur characteristic of most mammals. Instead, their insulation is provided by a layer of fat, called blubber, under the skin. So the wetsuit is not a recent invention.

Insects—Masters of Adaptation

While we may be impressed with the underwater endurance capacity of aquatic vertebrates, the insects have developed even more diverse strategies for life in water. This is not surprising, for the insects are by far the most adaptable group of animals.

Approximately three-quarters of all animal species are insects. Insects have a completely different respiratory system to the vertebrates. Instead of lungs they have a system of air-filled tubes (tracheae) that pass throughout the body and there are numerous openings (spiracles) located down each side of the body. Oxygen is not carried in blood bound to haemoglobin but diffuses through these air-filled tubes.

How then is this system modified to allow insects to breathe under water? The manner by which this is achieved closely parallels man's efforts to artificially prolong his stay under water. Different groups of insects have adapted to a wide range of habitats within the aquatic environment: from surface-dwellers and mid-water swimmers, to bottom-crawling forms. They are found in lakes, rivers, ponds and ephemeral pools; slow-moving water and water falls. Yet insects are largely confined to fresh water and only a few species have been able to invade the sea.

Heavenly bodies

Some insects, such as the water striders, are literally able to walk on water. By means of non-wettable hairs on their feet, they are able to skim over the surface of the water, pouncing on small creatures that are trapped by the surface water tension. These insects do not need to modify their respiratory system as their bodies are held above the water.

Who invented the snorkel?

Many aquatic insects have developed a snorkel enabling them to breathe air while they are beneath the water surface. The respiratory openings have been reduced to a

single opening at the tip of the snorkel. In some groups, such as the so-called water scorpions, the snorkel is very long. This enables the insect to remain on the bottom in shallow water and yet maintain a continuous connection with the atmosphere. In human technology, this is the equivalent of the hookah.

Mosquito larvae are perhaps the best-known aquatic insects. Their snorkels are quite short and the animal swims by a characteristic wriggling motion of the body to the surface. The snorkel pierces the water surface and, if undisturbed, the larvae will remain in this suspended position.

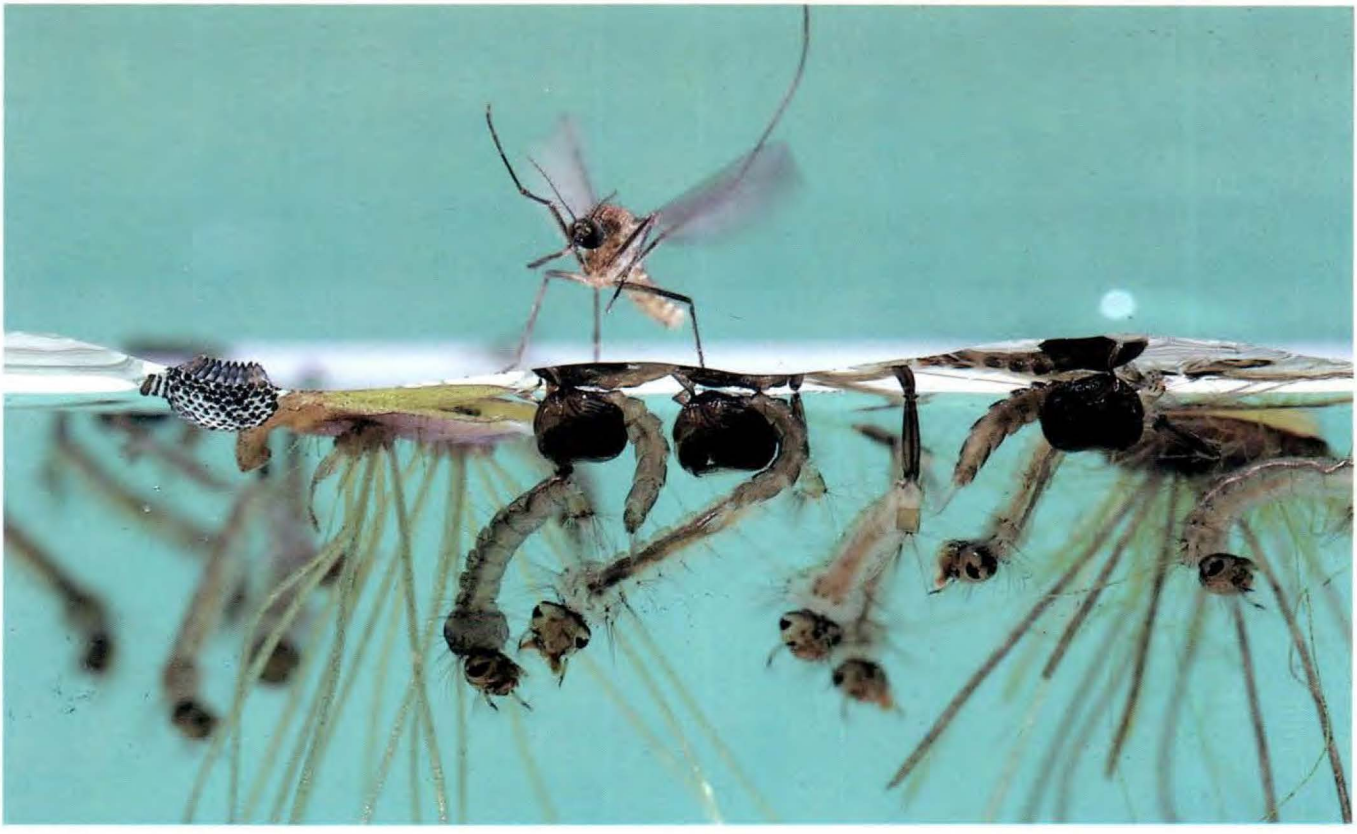
When disturbed, or in order to feed on microscopic organisms in the water, they rapidly descend using the oxygen in their air-filled tubes. Eventually they must return to the surface to breathe. To prevent water from entering the air tubes, a valve closes over the opening of the snorkel. They don't have to actively blow water out of the snorkel as we do when we surface.

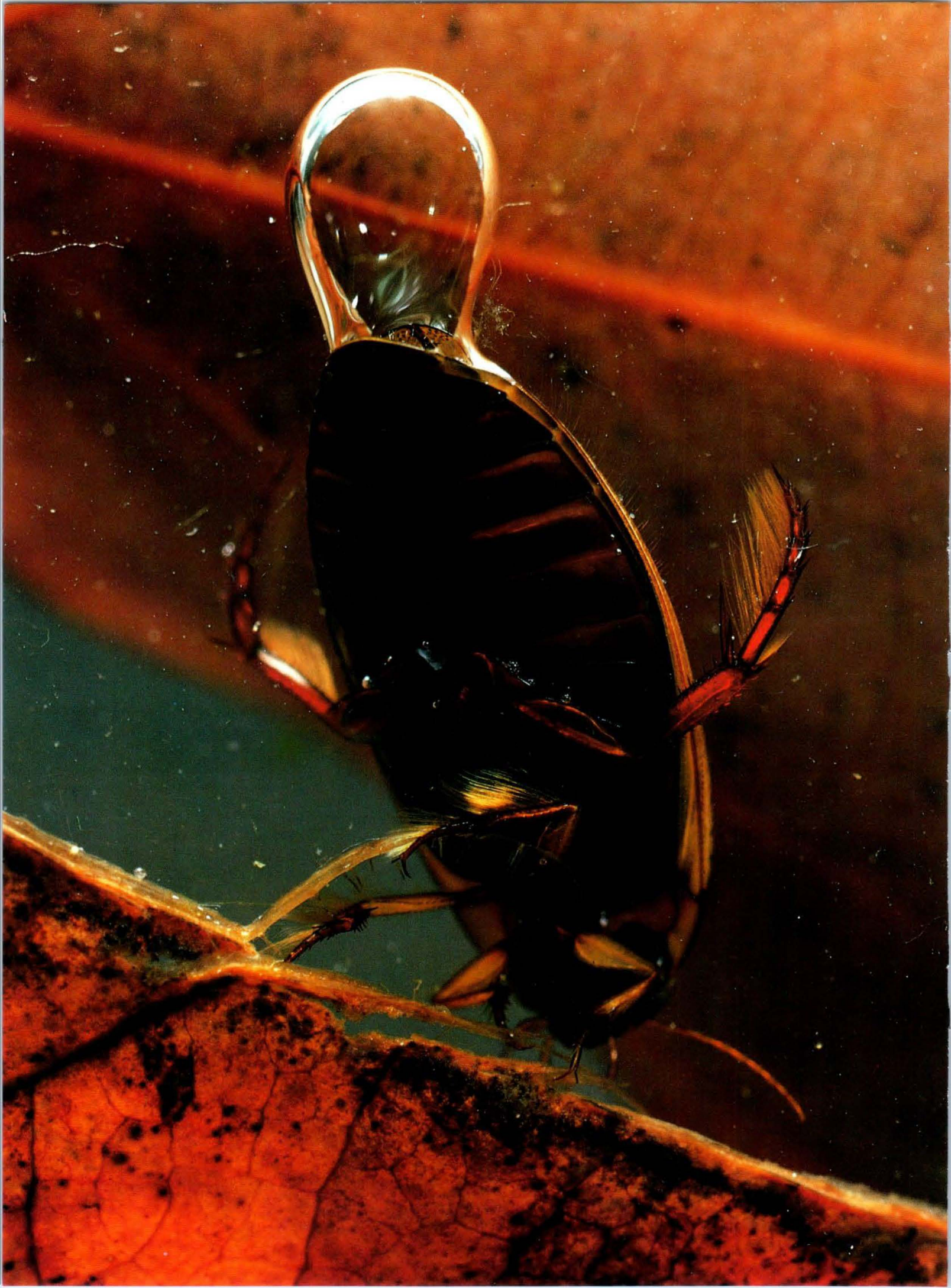
Development of the aqualung

Insects with snorkels, like humans with snorkels, can only stay under water for as long as the supply of oxygen in the air passage lasts. Some insects are able to prolong their stay under water by taking a bubble of air with them—a sort of aqualung. The bubble is held on the underside of the body, under the wings or both. Apart from the extra supply of oxygen, the bubble acts as a site for

Maintenance of a continual supply of air is provided by the very long snorkel of the water scorpion. Ravenous carnivores, they catch their prey by means of their mantis-like fore limbs. The shape of this species provides camouflage among the leaves at the bottom of shallow ponds. Photo: Kathie Atkinson.

Mosquitoes only spend their juvenile stages in water. The larvae wriggle to the surface to breathe through the snorkels at the end of the abdomen. The pupae, however, surface head-first and have relocated their snorkels to the head end. The adult mosquito emerges head-first without getting its body wet. Photo: Kathie Atkinson.





absorption of oxygen directly from the water. There is one big problem, however, and that's buoyancy. To remain submerged, the insect must swim continuously or hold on to some submerged object. The same problem occurs when humans dive but it's a problem that has been overcome with the weight belt.

A variety of insect species has, nevertheless, adopted this method of respiration under water. These include various aquatic beetles and bugs called water boatmen and backswimmers. They have strong paddle-like limbs to propel themselves through the water. Most of their time is spent at the water surface breathing atmospheric air but they rapidly submerge when disturbed, or to feed. One interesting group of beetles, called whirligig beetles, are particularly hard to surprise as they have a divided eye. One half is above the water surface and the other half below.

Both the water beetles and backswimmers spend their entire life cycle in water. Yet many of them have retained the ability to fly. This explains their sudden appearance as fully grown adults in your swimming pool. It is rather difficult for an insect to take off directly from the water surface because of the surface tension. The air bubble held under the wings overcomes this problem. When at the surface, the air bubble elevates the wings above the water. The force of the beating wings, then, is sufficient to drag the rest of the body free from the water.

Return of the Gill

Unlike aquatic vertebrates, some insects have modified their respiratory systems to such an extent that they are able to remain submerged indefinitely. To do this they have surrendered the openings to the respiratory system entirely. Instead, they feature a closed system of air tubes ramifying throughout the body. Oxygen diffuses from the water, across the body wall and into the tubes, to be distributed to all parts of the body. For small insects, enough oxygen can be absorbed through the body surface but for larger ones, specially developed extensions of the body provide an increased surface area for the absorption of oxygen.

Many groups of insects have evolved gills thus enabling them to remain submerged indefinitely. This damsel fly nymph has its gills as three flattened blades at the tip of the abdomen. Photo: Kathie Atkinson.

We have now gone full circle and developed gills again—but gills with a difference. Instead of being supplied with blood capillaries, they are supplied with fine air-filled tubes. So the distribution of oxygen to the tissues is still via the same system that was developed in terrestrial insects. Aquatic insects that have gills include damselflies, mayflies and caddisflies. These insects spend only their juvenile stages in water.

The juvenile dragonfly has gills tucked away in the most unusual place. They hang down into the lumen of the rectum and ventilation is achieved by sucking water in and blowing water out—a sort of constant douche. This activity is also put to another use. Most of the time they are rather sluggish creatures, concealed among the bottom vegetation. However, by violent expulsion of water from the anus, they can shoot forward with considerable speed by jet propulsion.

We can see that the diversity of adaptations displayed by aquatic insects is truly remarkable and makes the aquatic vertebrates appear rather stereotyped by comparison. So next time you go scuba diving and bemoan the fact that so much energy is required to muster and don the paraphernalia required to spend a brief period under water, spare a thought for the humble mosquitoes, dragonflies and beetles that do it with such grace and ease. □

The divided eye of the whirligig beetle allows it to see above and below the surface of the water at the same time. Photo: Kathie Atkinson.

◀The aqualung of this dytiscid beetle can be seen extending out from under the wing covers. Photo: Kathie Atkinson.

Densey

The blackberry sawfly *(Philomastix macleaii)* cuts a hole with her saw before pushing another egg through the leaf. Photo: Densey Clyne.

Next time you walk past a blackberry bush and it makes a sound like a raspberry, don't pretend you didn't hear. Stop and look—track down the sound among the prickles.

Actually it's more a short, sharp buzz than a raspberry but it's certainly directed at you. It's a warning to keep away, coming not from the bush itself but from a rather pretty orange, black and white insect with shiny wings. You'll find it on a leaf, resting at an angle with its head down and legs clasping the leaf stalk. Wait for the next buzz and you'll see how the raised and partly-opened wings vibrate to produce the sound.

This is the female of a sawfly called *Philomastix macleaii*. But perhaps you don't know what sawflies are? To begin with, they're not flies at all. They're closely related to the wasps—but they don't sting. Sawflies are thought to be rather like the ancestral Hymenoptera, the primitive forebears of all the wasps, bees, ants and present-day sawflies. But by contrast with the helpless, legless, cossetted grubs of their near relatives, sawfly larvae are active and self-supporting, like the caterpillars of moths or butterflies.

The blackberry bush could just as well be a native raspberry, the sawfly's natural food. Blackberries, closely related to raspberries, are just a convenient and widespread foreign food substitute for this particular sawfly. But why is the sawfly sitting in that position and why does she refuse to budge even when you bump the leaf?

Well, all sawflies are rather sluggish compared with their volatile relatives but this one has a special reason for staying put. The reason is under the leaf she's sitting on. Have a look without disturbing the sawfly. You'll see what looks like a lot of little purple jellybeans dangling from it. They're the sawfly's eggs and she's there to protect them.

The most remarkable thing about this sawfly is the way she lays her eggs—she actually pushes them *through* the leaf, from above.

Sawflies get their name from the tiny saw-like egg-layer of the female. It's used for cutting through or into leaf tissue to make a place for the eggs.

Some sawflies hide their eggs inside leaf tissue. Some leave them exposed. Whatever the method, the operation is carried out with astonishing precision.

The blackberry sawfly stands on the upper surface of the leaf. She makes a tiny hole in it, cutting through until you can see the tip of the saw protruding underneath. Then she squeezes her long, narrow egg through this hole. The egg is bigger than the hole and it's soft, so you can see it constricting as it passes through. Down it goes, finally popping out free to hang under the leaf.

Before she lets the egg go, the sawfly releases a blob of 'glue' that immediately spreads around the attachment point to fix the egg to the underside of the leaf.

Now the insect withdraws her saw, moves away a bit—and down comes another egg. And so on. When all her purple jellybeans are in place she takes up her guard position. The eggs are not invariably purple. I've seen one female laying green eggs while another, apparently of the same species, was laying purple ones on the same bush.

The female will stay around even after the translucent green larvae have hatched out. Then, before her offspring have finished their first meal off the leaf they were laid on, she'll die.

Less elegant but no less remarkable is the technique of some of the common gumtree sawflies, better known for their conspicuous larvae. These are the ones sometimes called spitfires because when you touch them they spit out a blob of oily, yellow fluid. In fact 'spit' is not a good word since the fluid stays on the mouth and is swallowed again later. It's harmless, by the way, but smells strongly of eucalyptus—pleasant to the human nose but no doubt nauseating to some predators.

One of these gumtree sawflies is a rather ordinary-looking insect called *Pseudoperga lewisii*—Lewis's sawfly. You'll find the female sitting on top

Clyne looks at.....

SAWFLY SKILLS AND STRATEGIES

of a gumleaf, close to a kind of elongated blister with straight edges and a row of tiny serrations along one side.

If you were to remove the top of the blister with a scalpel you'd find the sawfly's slender eggs lying side by side in a symmetrical row. To put them there, the sawfly inserts her saw between upper and lower surfaces of the leaf to make a space and lays her eggs one by one.

After a while, as the eggs develop inside this secure, temperature-controlled incubator, the blistered part of the leaf dies and goes brown. Soon the larvae hatch and chew their way out.

The little grey sawflies huddle together in a star-shaped clump, heads together at the centre, tails pointing out. This is their 'between meals' position while they're digesting bits of their nursery leaf. Their mother stands over them, her legs forming a cage. She, too, buzzes in their defence. By the time the larvae are independent enough to move away, the female's brief life as a winged adult has come to an end.

Sawflies as a group are solitary insects, without social organisation. But as you'll have gathered, the *larvae* are gregarious. In fact, it seems to me that gumtree sawfly larvae take togetherness to extremes. Right from the start they huddle together for safety and even when feeding they don't move far apart. They cast their skins supported by their fellows and they pupate together underground.

Best known of the gumtree sawflies is the big, handsome *Perga dorsalis,* the steel-blue sawfly. Its older larvae, black with distinctive white bristles all over, make an eye-catching clump while at rest, and the stripped stems of young trees usually indicate their presence.

Many people find these insects disgusting to look at but if you can overcome this repugnance you'll find that for simple leaf-munchers, they have some quite sophisticated habits. Their communication system, for instance. They use audible signals, a kind of simple morse code you might call it, tapped out by their tails. It's just a way of keeping together.

If the food supply runs out, the sawflies move in a mass from one tree to another. At times they go two or three deep, riding on each other's backs. At other times they string out, but the laggards quickly put on a burst of speed to catch up.

During these migrations, a larva that's got out of touch will lift up its tail and tap quite audibly on the branch. A distress signal perhaps? Or maybe just a simple "hey, wait for me". And its fellows will respond, tapping vigorously to guide the stray back to the claustrophobic huddle that means safety for sawfly larvae. □

Lewis's sawfly *(Pseudoperga lewisii)* with egg blister in gumleaf. Photo: Densey Clyne.

Young larvae of Lewis's sawfly *(Pseudoperga lewisii)* with attendant female. Photo: Densey Clyne.

Sawfly larvae curled in typical defensive attitude. Photo: Densey Clyne.

THE AUSTRALIAN DESERT CRAB

A side-walk to the conventional crustacean

by Pamela and David Maitland

The last thing one expects to find in the hot, dry Australian outback is a crab. Crabs are largely a marine group of animals. They need water. All crabs have gills for breathing water and most depend on water for the development of their young. How is it, then, that Holthuisana transversa *or, more pronounceably, the Side-walker as the Bourke locals call it, can divorce itself from water for breathing and reproduction, two immensely important life functions? Pamela and David Maitland, from the School of Zoology at the University of New South Wales, explain how and why.*

This is a male crab in a defensive posture near his burrow, having just come out for feeding in the early evening. The largest crabs are five to six centimetres across the shell and weigh between 30 and 40 grams. Photo: David and Pamela Maitland.

The Side-walker is distributed throughout the semi-desert central and northern parts of Australia, where long periods of dryness are interrupted by unpredictable bouts of rainfall. At the end of the drought in early 1983, for example—a drought that effectively lasted six years in Bourke in north-western New South Wales—the Side-walkers were, remarkably, still to be found.

The lifestyle and the physiological adaptations of the Side-walker are very important to its survival. When it is hot and dry the Side-walker literally sits it out. It goes into a state of dormancy, living off stores of fat in its tissues. It does this inside what many desert animals build: a burrow. The burrows of the Side-walker are tortuous constructions sometimes going deeper than a metre in the case of the largest crabs. These burrows are made along the sides of drainage ditches and river banks in dense clay

soil. They must be constructed when the river or flood plain is in flood because the clay soon sets rock-solid once the water evaporates.

The burrow's opening is often (but not always) sealed with a mud cap that the crab works into place. This cap dries hard and it may take rain-water to soften the cap sufficiently so that the resident can push its way out again. The cap helps seal out the heat and conserve moisture trapped in the soil, allowing the humidity inside the burrow to be higher than that outside. In the height of summer, when the ground temperature often exceeds 60°C, the crab inside will be at a comparatively cool temperature somewhere in the 30s! Because the relative humidity of the burrow is high, the crab will not lose as much water through evaporation as it would if the surrounding air were dry. The Side-walker is very tolerant to desiccation and can lose up to a third of its body weight (which is equivalent to almost half of its total body water) and still survive.

Characteristics of the soil in which the Side-walker lives are very important to its survival. The heavy, dense clay does not wash away easily and absorbs water slowly. Once saturated, however, it also takes a long time to lose this water by evaporation. This is because the clay is made up of closely packed, microscopic particles that effectively cling onto the water. Also because of these soil characteristics free water is unavailable to the crab. In order to solve this problem, the Side-walker employs an interesting behavioural mechanism.

At night, as the temperature falls, less water vapour can be held in the air inside the burrow and so it condenses out as dew. Also as night falls, the top of the burrow cools down more than the bottom. The Side-walker, taking advantage of this gradient, goes up to the top and cools itself off. By then moving back down the burrow where the air is warmer, water condenses on it and, in this way, is resorbed.

One of the most remarkable of the Side-walker's adaptations to land is its ability to breathe air using 'lungs', ventilating them in a most extraordinary fashion. To better explain how it ventilates them, a brief description of the internal anatomy of the crab is in order.

A▲

▼B

These two photographs show how *Holthuisana transversa* ventilates its gill chambers (its lungs) when it is breathing air. A strong light is being shone underneath the crab. The large dark mass is the body contents which, in A, have been pulled over to the right side. The left lung is filled with air and the right one is emptied. In B, the body contents have been pushed to the other side, forcing the old air out of the left lung and sucking fresh air into the right one. Photo: David and Pamela Maitland.

The vital organs (guts) are enclosed in the body cavity by a flexible body wall. On either side of the crab's body cavity are the gill chambers. These house the gills used to breathe in water. It is through the lining of these gill chambers that oxygen from the air is absorbed. This lining is thin and richly supplied with blood. The gill chambers are also greatly enlarged, compared to wholly aquatic crabs, to offer an increased surface area over which oxygen can be absorbed. Air enters and leaves these 'lungs' through a small opening on either side of the mouth. Remarkably, in order to ventilate the lungs, the crab shifts its vital organs contained within the body wall to and fro, so that as one lung is emptied of air, the other one is filled.

When the rains come, usually from October onwards, the dormant rivers fill and the flood plains submerge once more. It is at this time that the Side-walker becomes active

The land crab, *Holthuisana transversa,* or Side-walker, is endemic to Australia and is found on flood plains near ditches and water holes or along river banks. This is a flood plain on Rossmore Station near Bourke, New South Wales. Photo: David and Pamela Maitland.▼

A female *Holthuisana transversa* lays comparatively few but large eggs, which she carries around tucked underneath her abdomen. They hatch into miniature crabs and if water is not immediately available, then they can remain with the mother in an arrested state of development for as long as six months. Photo: David and Pamela Maitland.

and does the things that crabs normally do. It feeds, moults and breathes using its gills.

Crabs have a hard outer skeleton, the shell, which does not expand after it has hardened. Therefore, in order to grow, this shell must be shed. When the much softer new shell has formed underneath the old one, the crab absorbs water and the old shell splits at the back at the junction between the thorax (the main body) and the abdomen (tucked underneath the thorax). The crab laboriously squeezes itself out. When free of its old shell, it imbibes water once again to increase its volume as much as possible before the new shell hardens. It is for this reason that water is essential for moulting.

The Bourke locals have often talked about 'those crabs that climb up trees and die'. When we first heard this expression we had no idea what they were talking about. Later we realised that these 'suicidal' crabs were, in fact, the cast-off shells of the Side-walkers, some of which had floated in the flood waters and had become stranded in the lower branches of the trees.

When out and about, the Side-walker eats whatever it can, even other Side-walkers if necessary. It must eat voraciously so it can build up its reserve of fat for when the water dries up again; it may be many months or even years before it will get another chance to feed.

The Side-walker's life is characterised by extreme fluctuations in environmental conditions: from a desert one minute to a flood the next. It is surprising, therefore, that the Side-walker seems to breed at certain fixed times of the year. These are times when it is most likely to rain in the region or when water is available from the drainage of other areas (northern Australia). In Bourke, the Warrego River drains the Great Dividing Range so that when it is the rainy season in Queensland, the river may be full even though Bourke might be as dry as a bone.

Whether or not water is available, the female lays relatively few (100–350) large, yolky eggs around late October until early November. Like all freshwater crabs, they hatch approximately four to six weeks later into miniature crabs. Skipping the tiny swimming larval stage is advantageous because they would run the risk of being carried to unfavourable areas or even to the sea where they would not survive. A small crab, on the other hand, that can cling to things, is less likely to be carried away by currents. Because there is no way of predicting exactly when the rains will come, the female Side-walker also keeps her young with her, tucked underneath her abdomen. This is somewhat reminiscent of a possum or kangaroo's pouch and, for this reason, the Side-walker has been referred to as the 'marsupial crab'! The young are in an arrested state of development. They do not moult or grow and experiments have shown that they can survive in this state for up to six months in the film of water the mother carries them in. When free-standing water is present, the mother releases them in it. Only then can they continue their development.

Here we have a veritable Dr Jekyll and Mr Hyde of crabs, one that can switch from an aquatic to a terrestrial being and back again. It is an animal that can cope with the extremes of its environment, from flooding to desert conditions. When there is abundant water it regularly comes out of its burrow to feed, release its young, moult and mate. When the relentless sun has dried up its aquatic home, the Side-walker adopts its terrestrial ways. It breathes air with its lungs and protects itself from the heat and desiccation within the humidity and relative cool of its burrow. It lives off its reserves of fat and stores of water in its tissues and its metabolism slows down. It is clearly a most remarkable animal.□

Terracotta Icons
of the Mewar Region – Its People and their Beliefs

Barely known to other parts of India and the Western World, the tradition of making terracotta icons in India's Mewar Region stems back many centuries. The belief in the power of deities manifested as terracotta icons is deeply rooted and almost the entire Mewar Region is governed by icons that have been installed in shrines. Each shrine has a mythical or legendary tale attached to it as Pramod Kumar explains.

A painted terracotta icon of two versions of the Mother Goddess—Naganeshawari-mata and Chamunda-mata. Photo: P. Kumar.

The icons are baked by wood firing for three to four hours in the open ground. This is known as *awada*. Photo: P. Kumar.

Icon of Mahenduji-Bhunaji on horseback, the folk legend heroes of the ◀Gujar caste. Photo: P. Kumar.

The people of the Mewar Region live in a world of supernatural beliefs. For centuries they have practised ritualistic image-worship unaffected by modern civilisation. They believe in ghosts and spirits, and in the powers of exorcism held by their priests. It is through the priests that the gods and goddesses are regularly worshipped.

The Mewar Region covers the hilly southern part of the State of Rajasthan comprising the Udaipur, Chittor and Bhilwara districts. Two main tribal groups, the Mina and Garasia, dwell in rural settlements. Their position is relatively low on the Hindu social scale. Other pastoral and animal-rearing caste groups include the Gujar, Dhangi, Rebari, Parmar and Jat.

Icons of these peoples' deities are made of terracotta in a village called Molela. At Nagari near Chittor, Gupta Period (320–600 AD) clay icons sacred to the god Shiva have been found, indicating the long-standing tradition of terracotta icon-making in the Mewar Region. Approximately 20 families of the potter caste group called Kumhar are, by heredity, engaged in making terracotta icons.

Gods and Goddesses

Gods and goddesses of tribal and village folk are the central themes for artistic creation for the potters of Molela. They are represented in either anthropomorphic or serpent form. Worship of a particular deity of a tribal or caste group is not restricted to that group's community. Dharmraj, the tutelary god or guardian spirit of the Gujar community, for example, is not only worshipped by the Gujar people but by other tribals as well; and the Mother Goddess, in her different incarnations, and the protective deity Bheroji are worshipped by almost all the tribals and caste groups.

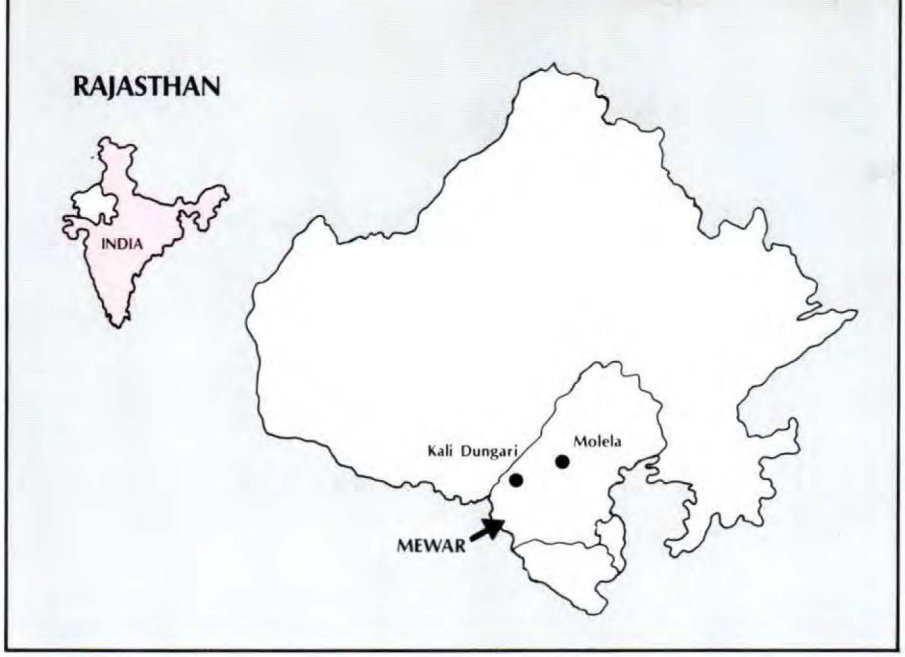
Worship of the Mother Goddess pervades India's remote past. Art historian Anand K. Coomaraswamy wrote in *History of Indian and Indonesian Art* (1963): "The chalcolithic culture was everywhere characterised by matriarchy and a cult of the productive powers of nature, and of a mother goddess; and by a great development of the arts of design. We must now realise that an early culture of this kind once extended from the Mediterranean to the Ganges Valley, and that the whole of the Ancient East has behind it this common inheritance."

The Mother Goddess, called in local dialect *mataji* (mother) or *devi* (goddess), is highly revered and adorned by the tribals and village folk of the Mewar Region. She is worshipped in her various manifestations and different names but generally she is portrayed carrying a sword, drum, trident and bowl of blood in her four hands. Animal sacrifice, as a way of pleasing the Mother Goddess, is a common practice and wine is also offered.

The god Dharmraj is depicted in terracotta on horseback, carrying a spear and lotus in his two hands. In the background a serpent, herd of cows, shepherd, peacock, sun and moon are painted. His divinity is shown by a halo. Oral tradition still preserves the folk epic of Dharmraj among the Gujar people.

Almost all communities in the Mewar Region worship Bheroji as their village's protective deity. There are 52 types of Bhero in folklore. In terracotta icons two Bheros are portrayed together, known collectively as Kala-gora Bhero (*kala* meaning black and *gora*, fair). They are shown standing, carrying a trident, thunderbolt, skull and noose, and with them is a dog. Kala-gora Bhero are the only gods that are installed in almost every shrine.

Takhaji and Vasaki are the snake gods of Mewar tribals. The names are local versions of classical Sanskrit words *Takshak* and *Vasuki*—snake gods associated with higher Hindu religion. Like the worship of the Mother Goddess, the snake-god cult has a very long history in India. Mewar folk believe that the benevolent soul of an ancestor is reborn in snake form and must be worshipped. Ancestors in snake form guard their family's hidden treasures in the earth and only an appointed family member can take the treasure. Molela potters make snake god icons with much dexterity. They may have one, three, five, seven or nine hoods. Snake wives are also shown on both sides of the main figure.



Molela potters also make icons of heroes and heroines of folk legends famous for their cure of paralysis, tracking down thieves of livestock or for their powers of exorcism. Such icons include Ratno-Rebari, portrayed seated on camel back; Bhunaji and Mahenduji, two brothers on horseback carrying spears in hand; Lala-bai and Phula-bai, two sisters associated with esoteric rituals.

The Mina, Garasia and other folk of lower strata in Hindu society buy and worship icons of various deities made at Molela. The largest sale takes place in the month of *Magh* (January) because the god Dharmraj was born on the sixth day of this month—a day regarded as sacred and auspicious for the installation of icons. April, July and November are also considered good months to buy and install icons since agricultural buyers are usually free from harvest work during this time. They are also in a better position financially to spend money on religious activities. However, in cases of emergency, icons may be bought at any time of the year.

Buying Ritual

Tribesmen undergo the lengthy, ritualistic process of buying and installing icons for various reasons. For example, a tribal may vow at a shrine to offer a new icon if his wish is fulfilled. This wish could be anything from having a male child, to the safe delivery for a pregnant wife, retrieving stolen animals or even winning a court case. Sometimes, if a tribal is going through repetitive disasters, the priest will ask him to offer an icon to the shrine as a remedy to stop misfortunes.

Potters sell icons in an outer room of their home. The complete icon-purchasing ritual takes at least two days, thus making it necessary for the potter to provide boarding and lodging facilities for the tribal group. The tribal priest meticulously selects the uncoloured icons, the entire group displaying enormous patience while the transaction takes place. Often the priest will go into a trance while selecting the icon and, while in the trance, will bargain with the potter. After selecting and paying for the icon, it is left with the potter to be coloured.

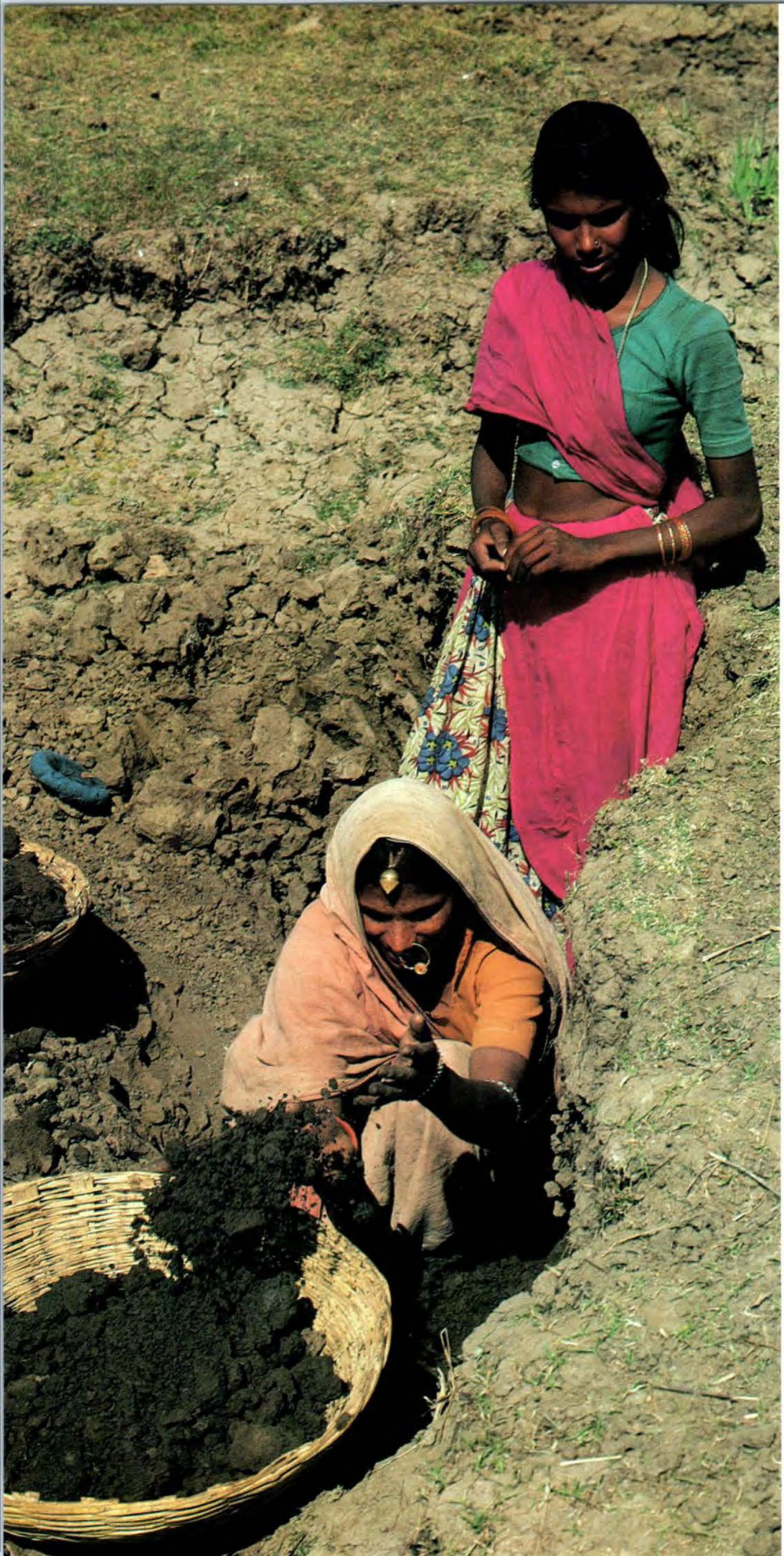
The colouring of icons is a relatively new practice. It takes a considerable amount of time, during which the buyers may take a trip to Nathdwara, 11 kilometres from Molela, a pilgrimage centre for people from all over the States of Rajasthan and Gujarat. Here they buy red and white cloth, called *osad,* to wrap the icons before returning to Molela in the evening.

After spending the night at the potter's house, the group prepares for its journey home. Red cloth is used to wrap icons of the Mother Goddess, while icons of male gods are wrapped in white. The tribesmen put the icons on their heads and the priest, who carries his peacock-feather fan, icon chain, conch shell and thunderbolt, goes into a trance and declares the beginning of the return journey.

At the same time, one of the tribesmen plays his conch which is followed by *thali* (bronzeplate), *madal* (drum) and *ghungharu* (cymbals). With the priest leading, they commence in single file towards the Banas River, about one-and-a-half kilometres from Molela.

At the bank of the Banas, the river worship ritual is performed. They put the icons vertically on the ground, unwrap them, collect wood and light a fire and an incense stick. The priest puts coconut pieces into the fire while chanting *mantras* (hymns). Once again the priest goes into a trance. Touching the icons with his peacock-feather fan, he blesses his

Tribals leaving Molela with the priest leading and others walking in single file, carrying icons on their heads. Photo: P. Kumar.



devotees and then announces that they may proceed with the journey home.

Each tribal and caste group has its own shrine, which may be an open platform or a thatched hut. In front of every shrine is a guard deity in the form of a stone icon, known as Poliyaji. It is an unspoken rule that Poliyaji is worshipped before any other deity in the shrine.

Installation Ritual

I once witnessed the installation ritual of two icons of Dharmraj in a shrine at a small Garasia tribe settlement, Kali Dungari, about 100 kilometres from Molela. The two icons to be installed in the shrine were bought at Molela five weeks previously and carried to Kali Dungari on foot. It is customary for the priest and icon-carriers to stop for any tribal who wants to worship the icons by viewing them reverently. At such times, the images are unwrapped so that they may be exhibited. At each stop, the priest goes into a trance and blesses the gathering of devotees.

Upon reaching Kali Dungari, the icons were not brought straight to the shrine but were first taken to every hut of the Garasia tribesmen, where the images of the deities were displayed for ritual viewing and food offerings were made to them. Finally, just after dusk, the icon-carriers came to the hut of the head priest leading the procession.

They stood in a line and a woman, with her face covered by a veil, came forward carrying a metal tray on which lighted clay lamps had been placed. After she had rotated the tray before the deities in order to honour them and had scattered grain over them, she applied an auspicious mark to everyone's forehead. After the welcome ritual, the whole procession entered the hut and the icons were unwrapped and placed on a cushion where they remained for the rest of the night. The priest lit a sacred fire and went into a trance several times during the night. The tribesmen played drums, sang devotional songs and kept night vigil.

The next morning the icons were again wrapped in cloths and, with the

Two Kumhar women dig clay for icons from Dhornia-ro-nado, one-and-a-half kilometres from Molela. Photo: P. Kumar.

beating of drums, banging on metal trays and the blowing of conches, the procession started for the shrine, which was located one kilometre from the settlement on top of a hillock. The music continued all the way. After entering the shrine, the tribal priest fell into a trance and ordered the removal of the old icons and the installation of the new. After the icons were installed, the priest, still in a trance and vigorously shaking his head and hands, started blessing the devotees with his peacock-feather fan. When everybody had bowed in front of the deities and received blessings, the priest came out of the trance, thus bringing to a close the installation ritual. In the evening a fair was held and tribal people gathered from places near and far.

The technique for making icons is in itself quite interesting. The main responsibility for obtaining the clay lies with Kumhar women who dig the clay from one of two places—Solarka-chapar or Dhornia-ro-nado. The actual icons are made by the Kumhar craftsmen who prepare a mixture of clay and donkey dung and make a flat surface as a background on which to place the figure. Another flat slab, prepared from the same material, is roughly chipped into shape with an iron tool. At this stage, only half a vertical bisection of the animal is made. This is rested on two small clay supports which are attached to the flat background, enabling the icon to remain hollow. Other parts of the figure are made separately and then fixed to the main base. The potter does not use moulds to make the icon, only the dexterity of his fingers. Once this stage is completed, the icon is left to dry in a shady place for seven days and then for a further two in the sun. The baking of icons by wood firing for three to four hours in the open ground is called *awada*. Between 30 and 50 icons can be baked at a time.

Folk art, such as represented by the making of terracotta icons, is significant from two points of view. Firstly, it has its own characteristic aesthetic value, which is less restrained in expression than classical art. Secondly, it has a functionary role and, therefore, is more closely related to the people of the region whence it stems. Terracotta image-making has been carried on for centuries at Molela and is a unique form of art with great significance for the study of folk culture. □

Moray Eels: Dangerous or Docile?

The two-metre moray eel, impaled on the spear for over 15 minutes, showed no signs of movement. Cautiously the diver took the spear with the moray attached and began to surface, when suddenly the moray wrenched itself free and started to swim up the spear. Despite dropping the spear, the moray quickly overtook the fleeing diver, savagely biting his arm. It was three months before use of that arm was regained. Another diver, trying to induce a moray out of its crevice, soon had it gently taking food from his hand.

Somewhat contradictory? Not really. Moray eels have a reputation of being aggressive attackers with venomous teeth. Like most animals, they will attack when threatened or provoked; and when these attacks do occur, they can be vicious and persistant. Generally moray eels will only venture completely out at night. However, they may be seen protruding from their holes during the day, their large mouths slightly open and their heads swelling and contracting as they respire. Ancient Roman stories relate how morays were kept as pets in aquaria and were even trained by one Roman to respond to his voice and take food from his hands.

But is their bite venomous? Some species may have venom glands, but to date none have been confirmed. The danger lies in the sharp teeth which grasp and hold prey. As these teeth are not designed for chewing or tearing, and as only prey that is small enough to be swallowed whole is taken, stories of divers' arms being ripped off are probably fallacious. Most divers bitten by morays claim the bite is sharp and painful but short in duration.

Three green moray eels *(Gymnothorax prasinus)* protruding from one hole is a relatively uncommon sight. More frequently only one is found per hole. Photo: Kathie Atkin◀son.

Moray eels (family Muraenidae) are inhabitants of coral or rocky reefs where crevices and holes provide suitable hiding places. Found in up to 60 metres of water, morays are generally under a metre in length but may grow to over two metres. Most of the 48 species found in the tropical and temperate waters of Australia possess long, sharp fangs which are used to catch fish, cephalopods (squid and octopus) and crustaceans. The fangs are backward-depressible. This means that prey is prevented from escaping out of the mouth and must slide—in one direction only—down to the stomach.

The body of morays is without scales or paired fins. It may be brilliantly coloured or patterned and is slimy to touch due to a mucous coating that is secreted from the epidermal cells of the body. The green moray, *Gymnothorax prasinus* (pictured), owes its colour partly to an algae that is mixed with the slime, and rocks that this moray brushes up against are left with a green coating. When dead, the green moray turns to a dull brown.

The mucous of many species is toxic and, when tested in mice, causes paralysis, loss of equilibrium, and dypsnea resulting in death within two hours. If touched with the hands that have cuts or open wounds, it can cause a tingling sensation. As cleaning fishes are not active at night when most morays leave their holes to feed, one role of this toxic secretion could be the prevention of external parasites.

As with many ferocious-looking creatures, spurious stories abound about the morays' cunningness, savage behaviour and poisonous bite. Although this fish appears to be much maligned, divers should always respect it as a potential danger. After all, it is the moray that decides when it has been provoked.□

— Denise Rennis

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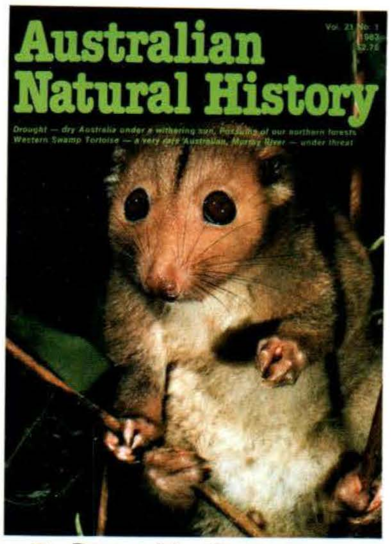

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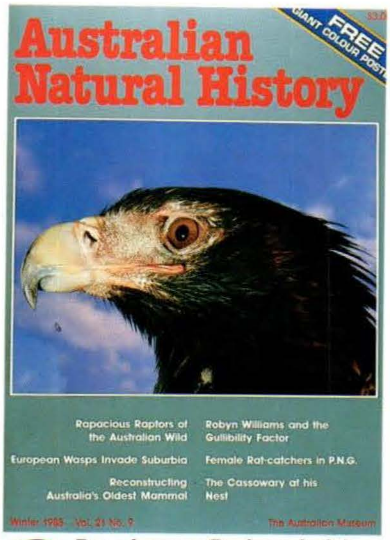

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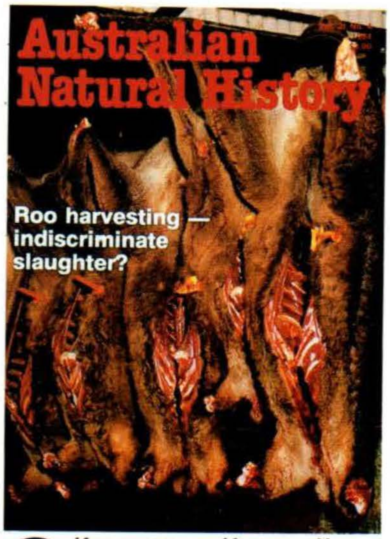

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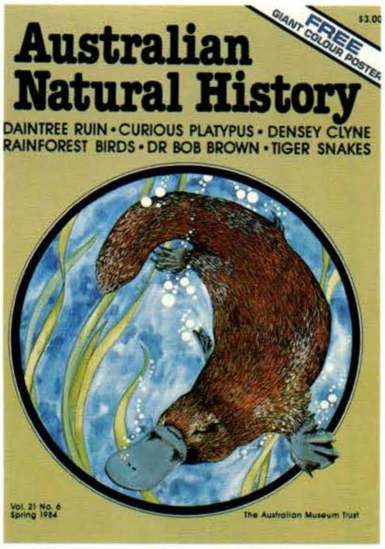

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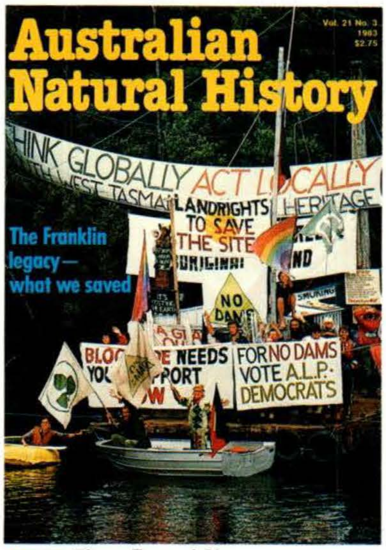

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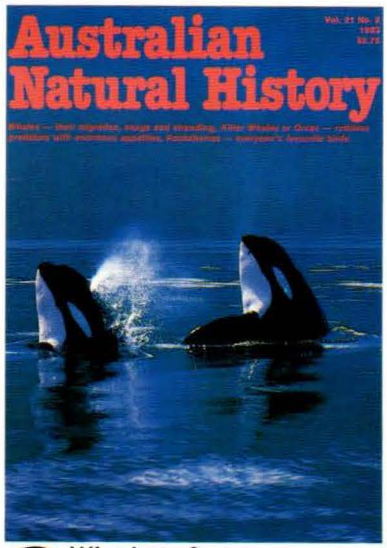

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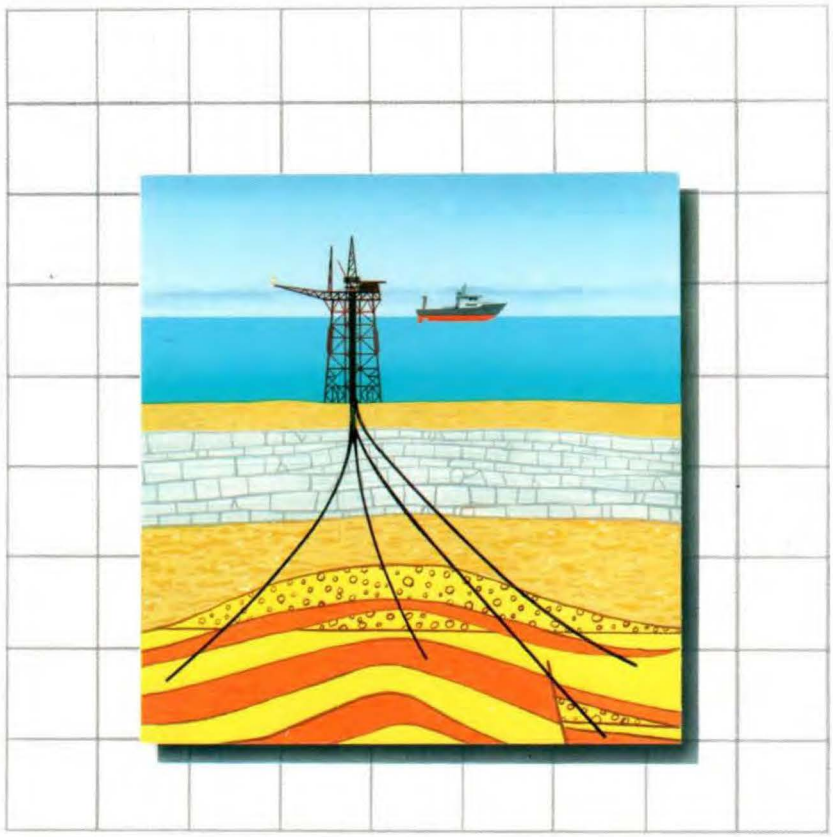
Another world record set Down Under...



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