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## Front Cover

These fantastic crystals of antibodies complexed with influenza neuraminidase from a pilot whale may well lead the way to a vaccine for the 'flu. See Photoart, p. 276.

# EDITORIAL Revelations

It's hard to believe that there are still parts of the world where the fauna is virtually unknown. The Star Mountain peaks in Papua New Guinea were such a place until recently, when a joint expedition from the Australian Museum and the Papua New Guinea Division of Wildlife explored this remote area to study its vertebrate fauna (see p. 244). Expeditions like this cover rugged terrain: they demand not only amazing stamina but considerable financial support. The Ok Tedi Mining Co. Ltd generously provided that support. Such assistance is to be acknowledged—it benefits the environment in the long term.

Support also arrived swiftly when a Pygmy Right Whale sojourned last

summer in Portland Harbour, Victoria (see p. 266). News spread and ardent volunteers and scientists enabled the first-ever study at close range of this little-known species.

As a species, humans appear virtually unconquerable. We can scale mountains, study whales, and alter genetic pathways (see QQC p. 271). Yet something as small as the influenza virus is the scourge of western industrial society; a bout of 'flu can weaken the strongest individual. However, new breakthroughs in the fight against this virus are being made now. Some spectacular photos of influenza crystals and the search for a cure to this virus are presented in Photoart (p. 276).

—Fiona Doig, Editor



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### Rubber Doubt

I read your very interesting journal each quarter and must compliment you on its preparation. The texts and photographs are of unusually high standard and I learn more from ANH than I do from any other journal, including international ones in my own profession!

I found the article *A Teatillating Titbit* in the QQC section of ANH (vol. 22 no.4, 1987) professionally interesting and I wondered if Geoff Smith uses a natural rubber compound (as opposed to a synthetic rubber) which comes in either dry or latex form. If he does, it could well be that we have a mutual interest and perhaps the inclusion of the article in our international journal *Rubber Developments* may result in stimulating interest in the use of specialty teats. If he does not, it could be that the use of natural rubber, with its better tear resistance, could be a means of improving his product with regards to durability.

—R.A. Billett  
**Malaysian Rubber Bureau  
 (Australia)  
 Melbourne, Vic.**

*Geoff Smith does, in fact, use natural rubber (not synthetic) for his specialty teats and a copy of Mr Billett's letter has been forwarded to him. Due to the patent conditions, the exact composition of the rubber used cannot be publicly disclosed.*

—G.H.

### Trial by Media

Robyn Williams (ANH vol. 22 no. 4, 1987) says, approvingly, that a recent decision about the level of kangaroo culling was apparently made on the basis

of Australia's image abroad. Surely we should avoid such a cultural cringe, and make decisions on the basis of data (Grigg's article on kangaroo culling, ANH vol. 21 no. 4, 1984 and, more recently, vol. 22 no. 5, 1987), and our beliefs about the ways animals should be used, rather than by the desire for a good media image in foreign eyes. We should make our own moral judgments.

—Rod Power  
**Macquarie University**

### Another Man's Poison

When I was a boy, my father pointed out to me that, in terms of protein intake, no food could be more appropriate than the flesh of one's own species, since it provides the appropriate amino acids in just the right proportions. As a professional soldier whose job was to kill other humans when ordered to do so, he asked, like James F. Weiner (ANH vol. 22 no.4, 1987), what is our objection to cannibalism. As a zoologist, I look at the question slightly differently and ask why cannibalism is so rare in the animal kingdom.

First of all, exclusive cannibalism is impossible. Because of the necessary inefficiencies of metabolism, a population of carnivores requires a self-perpetuating population of food animals (a 'standing crop'), the combined mass of which is at least ten times the combined mass of the predators. Thus, a species that suddenly became completely cannibalistic would be able to have no more than one great binge before disappearing from the face of the Earth. On the other hand, there is no bar to a limited number of



GEORGE ALEXANDER

**Many placental mammals (particularly wild ungulates and domestic cows) consume the efforts of their reproduction, stopping just short of their tasty offspring. Ewes, however, rarely need to bite the umbilical cord.**

the older members of a species feeding to a considerable extent upon the more numerous smaller members (which have fed on other species). This is effectively the situation among Saltwater Crocodiles in the rivers of northern Australia, where a minority of large animals eat a high proportion of the young adults.

Cannibalism can also occur early in a life history: there are some larval insects that eat each other (so that only one member of a brood survives) or that hatch inside the mother's body and consume her flesh. Cannibalism is also not uncommon among tadpoles or hatchling reptiles. The significant limitation is that, on simple thermodynamic grounds, cannibalism cannot extend beyond some individuals at some stage of the life history.

It is instructive to consider the multitudinous instances where the opportunity for cannibalism is not taken up. This includes all instances of adults that care for their eggs or young, including such tempting situations as mouth-brooding in carnivorous cichlid fishes. It would, of course,

be self-defeating for an animal to engage in the effort involved in reproduction and then to consume the products thereof, but we may nevertheless marvel at the delicate inhibitory mechanisms that permit a female mammal to eat her afterbirth and to nibble along the umbilical cord until just short of her equally tasty offspring. We should not be surprised that the inhibition sometimes fails in domesticated mammals or that, in nature, eating a litter may be an appropriate response to a lack of food for the mother. Eating of 'excess' juveniles can be a population control measure, as in the African Lion, but there has never been much support for Jonathon Swift's (1729) proposal to reduce poverty in England and Ireland by fattening the children of the poor for consumption at the tables of the rich.

On the whole it makes good sense (in evolutionary terms) for members of a species not to eat each other. The benefit of cannibalism is slight except in very special circumstances and, to avoid the danger of self-extermination, it must be so hedged with inhi-



bitions that it is probably more cost-effective to let the nutritious carcass of a dead relative decay than to permit it to be eaten. This is particularly the case in social species, where the status of an individual is usually the outcome of physical contests, which stop well short of serious injury to the contestants: if the loser were considered edible, the tendency to kill would be greater.

Humans evolved from a long ancestry of social primates and it is reasonable to assume that the earliest *Homo sapiens* had instinctive inhibitions against cannibalism. By the same token, however, they were probably also inhibited against killing each other—a barrier we have notably overcome. It is thus possible that we are now permitted by our instincts to engage in meritorious mass killings but that an antique instinct still prevents us from taking advantage of the food thus provided. Another possibility, to which I incline, is that our general tendency not to eat each other is cultural rather than innate and essentially an in-group phenomenon, related to the fact that we tend not to kill our fellow humans to get at the food in their bodies, but rather to take over the food resources that they control.

If this were the case, one might expect human cannibalism to be restricted to areas where animal protein is hard to come by and (as on small islands) there are severe restrictions on population size. I do not wish to engage in controversy over whether or not people have systematically eaten each other in recent times but, if they have, I wouldn't be surprised to learn that it occurred in

Melanesia and Oceania. That it may have occurred elsewhere as a matter of magical ritual should not be difficult to comprehend by those who, each Sunday, consume what they believe to be the transubstantiated flesh and blood of their Saviour.

—Ronald Strahan  
Australian Museum

### Spawn Stinks

In Gordon Claridge's article *In the Red* (ANH vol. 22 no. 4, 1987) the confusion between *Oscillatoria* and coral spawn is discussed. As a guide to differentiating the two it is stated that whilst decomposing *Oscillatoria* gives off an offensive odour, the same is not true of coral spawn. I must disagree strongly with this assertion. I was present on Heron Island late last year at the time of mass coral spawning, and the stench of the decomposing coral spawn washed up on the beaches easily rivalled (and was not dissimilar to) that of decomposing *Oscillatoria*, which also washes up onto Heron Island's beaches from time to time. However, *Oscillatoria* is distinguishable even with the naked eye by its granular, 'sawdust' appearance, whereas coral spawn seems comparatively smooth in texture; and, as pointed out in the article, only occurs in quantity on a few days in early November and December.

I would just like to add that I admire your magazine greatly, in particular the level to which your articles are pitched (interesting to both scientist and layperson) and the quality of photography and layout.

—Claudia Catterall  
University of Queensland

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HAL COGGER

Mist wreaths the campsite at Dokfuma.





# Journey To The STARS

by **Tim Flannery**  
**Australian Museum**

In April 1987 a joint expedition from the Australian Museum and the Papua New Guinea Division of Wildlife filled in one of the few remaining 'blank spots' in our knowledge of the fauna of New Guinea. The expedition, consisting of myself, Hal Cogger and Lester Seri, travelled to the Star Mountains in far western Papua New Guinea with the purpose of surveying the mammals, reptiles and birds of this region, which until then had remained largely unknown.

Since they were first named in 1910, the Star Mountains have fascinated explorers and naturalists alike. But until 1965 they remained as inaccessible as the celestial bodies that are their namesakes, and it is ironic that humanity had well and truly entered the space age before the jagged peaks of the 'Stars' (Scorpion, Capella and Antares) had been visited. And it was not for lack of trying that they remained unexplored. The renowned 1936–1937 Archbold Expedition from the American Museum of Natural History made a determined attempt to ascend the Stars and nearby ranges, but the loss of their aircraft meant that they could push no further than the foothills. The 1965 British Climbing Expedition that finally conquered Capella and Scorpion took six months and many aerial re-supply drops before they were successful. Twenty-two years would elapse between the first ascent and our visit, and yet during this time the Stars' vertebrate fauna would remain un-





The author, Tim Flannery, at Bultem village, near Tabubil. The animal is *Rattus rattus*, an immigrant into the area that arrived with the mine. It was caught by one of the children.

seen and unknown.

Our opportunity to visit the Star Mountains came about through the commitment of the Ok Tedi Mining Company Ltd (OTML) to ensure that environmental damage is kept to a minimum in the area affected by their mining operations. The company has created one of the world's largest gold and copper mines at Mt Fubilan in the southern foothills of the Star Mountains. The terrain is unbelievably difficult, with 339 rainy days per year and frequent landslides. Because of the size of their project, and the unique environment within which it is situated, OTML has gone to great lengths to ensure that no long-term environmental damage will ensue. The OTML Environment Section is responsible for this aspect of the operation and our request for financial help was directed there. Our expedition would clearly be an expensive one, and was in a region in which the mine would have only a minor impact. However, OTML could see the advantage of having baseline data from the area, and thus fully supported our proposal.

Even with the help of OTML, it is not easy to reach the Stars. To walk from the mine site would take over a week. A round trip by helicopter takes 45 minutes, but it has its difficulties and dangers. We chose to use the helicopter, but this left us with many problems to resolve. We had never seen our proposed landing site on Mt Capella, and didn't know if it was suitable for landing or had drinking water nearby. We didn't

know about local weather conditions (which we later found to be treacherous) and the helicopter would be operating near its altitudinal limit. It was clearly essential to carry out an extensive reconnaissance of the area, both to test the helicopter at high altitudes and to inspect the terrain and weather. We discovered that the maximum load the chopper could safely carry was 160 kilograms, and that the weather was so changeable that flying could be called off at any moment. Thus equipment for each load had to be carefully chosen. It was decided that I should travel up first. More than half the load would be taken up by my bodyweight alone. With the remaining 75 kilograms, I had to include clothes, personal equipment, a tent and enough food to last for a week or more in case the weather closed in and left me stranded.

Stepping out of the helicopter onto the herbfield that was our chosen campsite was like entering another world. Twenty-five minutes before, I had been standing in the noisy, crowded mining town of Tabubil. The herbfield, called Dokfuma, where I now found myself was silent and freezing. Mist was still hanging over much of the tiny valley, but through it I could glimpse the mossy, gnarled southern pines that ringed the herbfield. A tiny frog called from a moss mound and nearby I could hear distinctive wingbeats. They belonged to the majestic McGregor's Bird of Paradise (*Macgregoria pulchra*), which re-

mained hidden in the mist. For a short time I felt like the loneliest person on Earth, standing in a dank and almost silent valley, in a spot where perhaps no human had stood before. As the faint sound of the returning helicopter grew louder, I was reminded that there was work to be done. Our time was limited; and before long a camp had to be set up, equipment sorted and made serviceable, and traps laid. I quickly remembered that Dokfuma is at 3,200 metres, as the smallest exertion left me gasping for breath and feeling altitude sick.

Over the week we spent at Dokfuma, we slowly became familiar with its topography and plant and animal life. The mixed vegetation of the small valley is a testament to the intermediate position of New Guinea. Many of the trees were southern pines, with *Dacrycarpus* (similar to the Huon Pines of Tasmania), *Phyllocladus* (Celery Top Pine) and *Papuacedrus* (Native Cedar) species being the most common. The nearest relatives of these trees are today found in Tasmania, New Zealand and South America,

**The undescribed skink (genus *Lobulia*) is found only on isolated peaks along the cordillera that forms the mountainous spine of New Guinea. About ten centimetres long, it was the only reptile found at Dokfuma.**

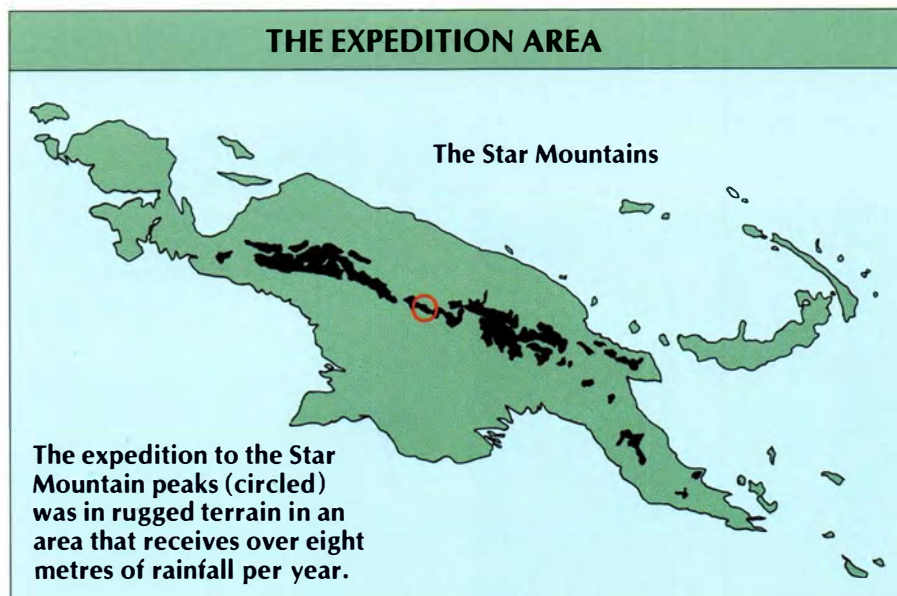




and they are evidence of Gondwanan connections. Yet among these relics grew some surprising newcomers: a beautiful red-flowered *Rhododendron* of Asian origin, epiphytic orchids of the genus *Dendrodium*, and a small umbrella tree (*Schefflera* sp.) that attracted flocks of small green parrots.

Daily the camp was enlivened by visits from McGregor's Bird of Paradise, which is the least-known and rarest member of its family. This striking crow-sized bird fearlessly approached our camp and, after observing us, would fly—or more often glide—off with the characteristically

loud 'whoosh' made by its wing feathers. As it hopped about among the branches of its favourite food tree (*Dacrycarpus*), its extraordinary orange eye-wattles would wobble comically. McGregor's Bird of Paradise is only found on the highest peaks of the Snow, Star and Owen Stanley Mountains, and its fearlessness, large size and restricted distribution make it vulnerable to any kind of habitat disturbance or exploitation. Other birds were constant camp visitors, including the Snow Mountains Mannikin (*Lonchura montana*), Alpine Pipit (*Anthus gutturalis*) and Grey-headed Thrush



'Capella', the young tree-kangaroo, soon adapted to camp life. Is he an undescribed race of Doria's Tree-kangaroo, *Dendrolagus dorianus*?

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HAL COGGER



**A mating pair of an undescribed small tree frog in which only the males appear to have an extraordinary fleshy proboscis, the function of which, if any, is unknown. These frogs were found in the region of the upper Ok Tedi River.**

(*Turdus poliocephalus*). Droppings of the Dwarf Cassowary (*Casuaris bennetti*) were also seen in a small glade.

The tiny frog that I had heard on my first morning turned out to be one of the most interesting finds of the expedition. On some of the other high peaks of New Guinea, only one species of frog (family Microhylidae) is present. At Dokfuma, two microhylid species occur. Each has its distinct call and habits, one preferring clear ground among the ferns and herbs, the other preferring the forest edge or moss mounds. Both species appear to be undescribed, while the only reptile, a small black skink, that we found in the area is

HAL COGGER



**One of the two small microhylid frogs found in the alpine herbfields and moss forests around the Dokfuma campsite. These frogs, less than two centimetres long, call loudly and frequently, even at air temperatures below 5°C.**

related to a form that occurs on a number of high peaks in the New Guinean cordillera.

The mammal fauna of Dokfuma was harder to find, but also had its share of surprises. On our first afternoon after setting up camp, the three local men that accompanied us had gone hunting with a dog. In the distance we could hear the uncanny howling so typical of New Guinean dogs when they've located an animal, and so we awaited their return with interest. Griem, our most active and diminutive hunter, arrived first with a large billum (string bag) slung

HAL COGGER



**A baby mosaic-tailed rat (*Melomys* sp.), one of the nocturnal foragers of the subalpine herbfields.**

across his chest. "D'bol!", he ejaculated, as he opened the billum to reveal a large brown tree-kangaroo. I became increasingly excited as I examined the animal, for it looked unlike any tree-kangaroo I had seen before. While clearly related to Doria's Tree-kangaroo (*Dendrolagus dorianus*), which is common in eastern New Guinea, it differed in a number of ways. Had we discovered a race of tree-kangaroos unique to the Star Mountains? Only time and a thorough study, now underway, will resolve that question. In my excitement at examining the large tree-kangaroo, I had quite overlooked a second man, Serapiap, who was carrying a small brown ball of fur. It turned out to be a nearly independent young tree-kangaroo. 'Capella', as he was soon named, became our constant companion and camp mascot.

On some still mornings the eerie chorused howling of New Guinean wild dogs drifted in across the misty valley. Signs of their presence in the

HAL COGGER



**One of the beautiful rhododendrons that were so common at Dokfuma.**

HAL COGGER



**One of New Guinea's most beautiful tree frogs, *Litoria iris*, shows its spectacular 'flash' colours when viewed from below through a glass sheet. This specimen, which is cryptic green on top, was found on the road between Tabubil and the Ok Tedi mine.**



form of well-worn trails and droppings were abundant, yet we never sighted one of these shy animals.

Shortly after dark, Dokfuma's most abundant mammal inhabitants became active. The rats of the alpine herbfields come in many shapes and sizes. We found three different kinds. The most common is a species of *Rattus*, and not very different to look at from the bush rats found in Australia. However it is only half the size of these and is clothed in long luxuriant fur. It may well be unique to the Star Mountains and is possibly an unnamed species. Only slightly less common than this animal is a mosaic-tailed rat. This handsome beast may also be an undescribed species, as it doesn't resemble closely any mosaic-tailed rat that I have seen from elsewhere in New Guinea. A baby mosaic-tailed rat was found in a moss nest in a small tree around the herbfield margin. Towards the end of our stay we found the third rodent species. It was a tree-mouse (*Pogonomelomys ruemmleri*) that is known from other high mountain peaks in New Guinea. It is a curious little animal with a short face and large eyes, and a prehensile tail with a grasping tip for climbing about in low bushes and trees.

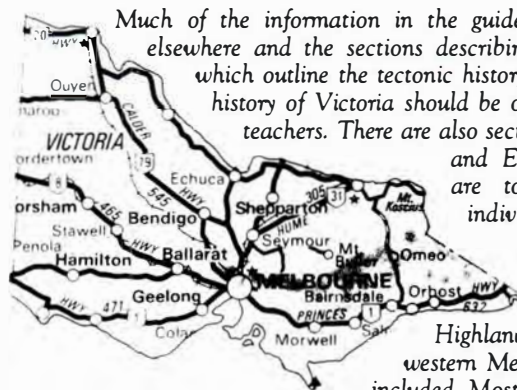
Only two additional mammal species were obtained during our stay. One was a tiny marsupial, the Long-tailed Pigmy Possum (*Cercartetus caudatus*), which is common in New Guinea's high mountains. The other was a tiny bent-winged bat (*Miniopterus macrocneme*), which was attracted to our camp at night by the innumerable moths that flocked to our kerosene lamp. Very few bats occur high in New Guinea's mountains, so it was surprising to be visited nightly by these tiny insectivores.

As the time drew near to leave Dokfuma, we again began to wonder if our departure would be delayed by bad weather. However, the morning of the appointed day broke clear and sunny, and our evacuation was effected without incident. By the time the last of us had arrived back in the hot and humid mining town of Tabubil, it was easy to believe that Dokfuma had been a dream. Dokfuma is such a different place, an 'island' of alpine plants and freezing peaks in a sea of tropical verdure. For the zoologists of the expedition, our journey to this unique environment had been as exciting as travelling to the heavenly stars themselves. □

# Victorian Geology Excursion Guide

The Victorian Geology Excursion Guide is the culmination of a joint project between the Victorian Division of the Geological Society of Australia and the Australian Academy of Science. It has been written by local authorities who have been chosen because of their particular knowledge and ability to present the most up-to-date geological information about the area. The editing and publication has been done by the group which was responsible for "Perspective of the Earth."

The guide has been written to cater for a wide audience ranging from school teachers and tertiary students to interested amateur geologists, field naturalists and tourists.



Much of the information in the guide has not been published elsewhere and the sections describing the geology of Victoria which outline the tectonic history, stratigraphy and igneous history of Victoria should be of special interest to school teachers. There are also sections on Economic Geology and Engineering Geology which are topics emphasised in the individual excursions.

Twenty-five excursions covering the Western District, the Victorian Highlands and the eastern and western Melbourne Trough have been included. Most of the excursions are 1 day excursions departing from Melbourne, but there are some which could be of 2 days duration in which cases the option is described in detail in the introduction to the excursions. Each excursion is presented as a separate chapter within which each of the sites is described in terms of the geological features present.

**The location of each site is described in detail by means of directions from the previous site. The directions for the locality of the first site for each excursion are given from Melbourne. Details of special conditions, dangers or the necessity to seek permission to enter a site are also given.**

The geological features exhibited at a site are described separately and illustrations have been used extensively to aid descriptions. Where appropriate the location of nearby sites which show similar features is given.

As well as the many well known sites of geological interest there are descriptions of new sites which have been chosen because they exhibit excellent examples of geological features.

The guide also contains an extensive index which includes both localities and geological features.

Available Sept./Oct. '87 — Order enquiries: (062) 47 5335



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Some spider orchids of the genus *Caladenia* have a different visual mechanism but they also produce a pheromone. Shown here is the Arrowsmith Spider Orchid (*C. crebra*) being pollinated by a male *Campylothylnus assimilis*. The male wasp carries pollen sacs gathered from its visits to other orchids of the same species.





1. The flightless female thynnine wasp *Megalothynnus klugii* lives underground for much of her life. When she is ready to be fertilised and fed by the male she emerges from the soil and climbs to the top of a low plant. 2. From this vantage point the female emits a pheromone that attracts a flying male.



3. In a pick-up action, which may take only a fraction of a second, the male grasps the female with his legs. 4. With the female secured underneath, the male will carry her to a source of nectar.

# Dinkum or Decoy?

## The dilemma of a Flower Wasp

text and photos by Babs and Bert Wells

Male flower wasps of the subfamily Thynninae (order Hymenoptera, family Tiphidae) have difficulty discerning the difference between the females of their own species and the labella of hammer orchids. They are attracted to both by either a pheromone or pheromone-mimicking chemical respectively. The latter ensures that pollination of these orchids occurs.

Little is known of the biology of

thynnines, even though 38 Australian genera have been identified, with some 500 species. Of the various species and genera collected by us, the males ranged in body length (head to tail) from nine to 40 millimetres; however only a few of these are implicated in orchid pollination.

Hammer orchids belong to the genus *Drakaea*, a group of terrestrial orchids endemic to Western Australia. Four species have been named and another four are undescribed.





Male and female thynnine wasps (*Hemithynnus annulatus*) feeding and copulating on the blossom of *Eucalyptus ficifolia*.

The tiny inconspicuous flower of hammer orchids sits at the top of a long slender stem, which, in one species, may be up to 40 centimetres tall. The stem rises from one small, flat leaf at ground level. Hammer orchids can be difficult to find and, for the newcomer, are easily overlooked.

The labellum of the flower is its most conspicuous part. Close examination shows that this part resembles a wingless insect, complete with glistening eyes, hairy thorax and fat body. It is held outward from the stem by a hinged arm, which allows movement in only one direction—toward the column and pollinia. This unusual structure intrigued early botanists until it was observed that the plants were being visited and pollinated by male flower wasps. The association between the insect and the orchid took on new meaning when it was realised that the

labellum and the female wasp had a distinct likeness.

Hammer orchids, like many other terrestrial orchids with only a single or a few flowers, do not offer nectar as an attractant. They also lack the bright colours that are associated with more conventional pollination systems. Their pseudo-insect decoy may therefore be an alternative attractant.

Female thynnine wasps are wingless and somewhat ant-like in appearance. They spend much of their time underground but emerge from the soil to mate and feed. After emerging they climb to the top of a small shrub or grass stem, pose in a characteristic manner with antennae erect, and release a pheromone to attract males. It is this posture that the hammer orchids mimic.

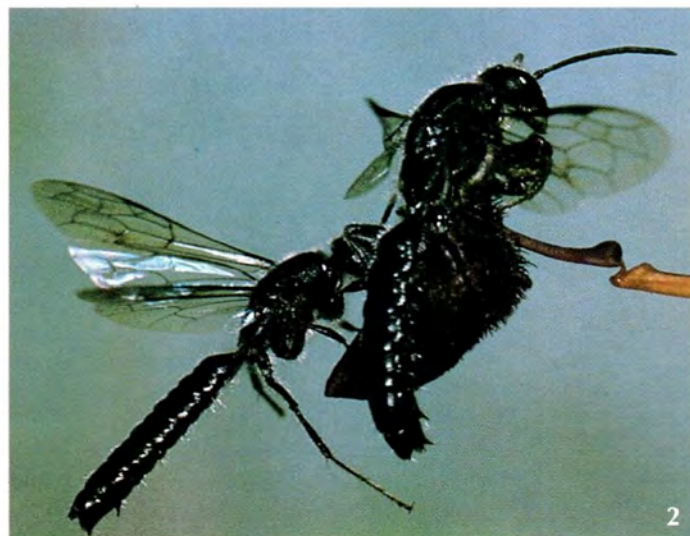
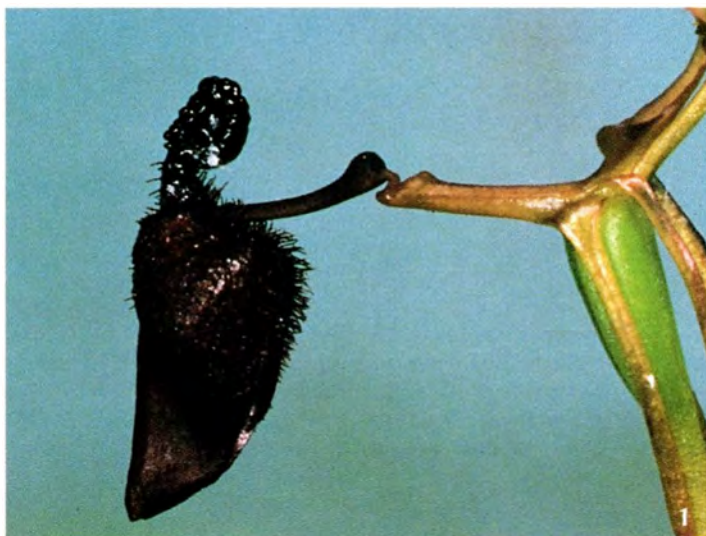
Male thynnine wasps appear to spend most of their time either flying in search of females or feeding on the

blossom of shrubs or trees. When the scent of a female is detected, the male flies low in a zig-zag course upwind to the source. He has to be quick, because other males may compete aggressively for her favour.

In a pick-up manoeuvre, which may take only a fraction of a second in some species, the male grasps the female and carries her to some nearby higher vegetation where they couple. In other species, coupling occurs immediately and the pair then takes off toward a source of nectar. In some cases this may be close by, but on several occasions we have tried to follow larger, more visible thynnines, only to have the coupled pair vanish into the distance.

While feeding, the pair remains coupled. In due course the male drops the female to the ground. James Ridsdill Smith, entomologist from the CSIRO in Perth, believes the female is most likely returned to near her original pick-up location, which is almost certainly the location of a population of scarab beetle larvae which are hosts to flower wasps. Here she burrows into the soil to seek out and oviposit on the host larva. After hatching, the grub feeds externally on the beetle larva, finally consuming it, pupates and eventually emerges as an adult wasp. It is not known how specific the thynnine-scarab relationship is, but relative size does appear to be a factor—that is, larger species of wasp parasitise larger scarabs.

Recent studies by botanists and entomologists concerned with orchid pollination have established that the orchid-insect relationship is species-specific, that is each species of orchid attracts only one species of wasp. Evidence of this constancy has





been reinforced over a number of years of collection and identification, and seems to remain true even when populations of the same orchid have been separated by a great distance.

Consider the way in which hammer orchids have exploited the sexual behaviour of thynnine wasps. Not only do the flowers present a visual decoy by mimicking the female, but they also emit a chemical attractant similar to the pheromone produced by female wasps. The male wasp approaches on the wing and, grasping the labellum, attempts to carry it off. However, the hinged arm prevents this and the wasp, with the decoy firmly clasped, is catapulted into the column. Pollen transfer then occurs. Our observations showed that this sometimes happens with quite a struggle, as if the inverted wasp resists release of the labellum. On other occasions the contact was only momentary, as if, perhaps, the wasp had perceived the deception.

Some speculation exists as to whether the orchids reach full pollination potential at a time when female thynnines have not yet emerged, or at least when females have not reached numbers great

enough to satisfy all searching males. If indeed this is the case, then male wasps would be most vulnerable to deception in that period. The orchid therefore may have evolved to flower when male wasps are high and females are low in numbers.

Our field observations, and those of other workers, have shown that the weather pattern has an influence on male thynnine activity, which increases dramatically when the ambient temperature rises to 30°C and above, particularly with pre-storm or low pressure conditions prevailing. Most activity seems to occur between the hours of 10 am and 2 pm. This information was useful when organising our travel to field locations, enabling us to avoid the unproductive periods of inclement or indifferent weather, which were surprisingly frequent during the active season between August and December.

Even in a confined population of a specific orchid, known to be pollinated by a thynnine wasp, the action often eluded us—many hours of watching being fruitless. However, by isolating one orchid some distance from the colony, even by only 50 metres, there was sometimes an immediate response, with one or more males flying onto the labellum. Some observers suggest this indicates that the wasps had become aware of the deception, and had lost interest, their interest being renewed when an orchid suddenly appeared in a new location.

On other much less frequent occasions, by sheer luck it would seem, we found ourselves in a large population of thynnines that were vigorously active. So aggressive were they that one of us would have to physi-

cally ward off the insects from the subject, while the other set up the camera equipment.

A few species of other genera of ground orchids are also pollinated by specific wasps, namely the Elbow Orchid (*Spiculalea ciliata*), the Beard Orchid (*Calochilus robertsonii*) and some species of spider orchids (genus *Caladenia*). The insectiform labellum of the Dragon Orchid (*Caladenia barbarossa*) has appendages that resemble legs, thus adding even more realism to the decoy.

Not all thynnine wasp species are implicated in orchid pollination, and many terrestrial orchids are pollinated by insects other than thynnines, such as native bees, beetles, flies, gnats etc. These orchids also have evolved unusual and individual strategies to attract their specialised pollinators. However, photographically, we found the reaction of male thynnines to the trickery of hammer orchids, and of their related species, to be by far the most spectacular, and indeed the most rewarding. □

*In Western Australia all wildflowers, including the terrestrial orchids, are protected by strong legislation. In 1985, the Western Australian Department of Conservation and Land Management granted a special licence and a contract to the authors for six months to photograph orchid pollinators in action. The equipment and techniques developed for this project subsequently produced the work illustrated here. From this, a submission of four colour prints won the scientific category of the AIPP Professional Photographer of the Year Awards in 1986.*

**1. A hammer orchid (*Drakaea glyptodon*) offers its decoy labellum—resembling the female thynnine wasp's glistening eyes, hairy thorax and fat body.**

**2. Two male thynnine wasps (*Zaspilothynnus* sp.) compete for the decoy.**

**3. One wasp wins and attempts to carry off the pseudo-female.**

**4. The hinged arm of the labellum catapults the wasp into the pollen structure where pollen grains are transferred.**







C.A. DEACON

Scene from an Antwerp (Belgium) bird market. The sign, translated, reads "Young Amazon parrot guaranteed to speak". A Sulphur-crested Cockatoo also awaits sale.

## COCKATOOS PESTS NOR PETS

by Ken de la Motte and Graeme Phipps  
Taronga Park Zoo

If we were playing an anagram word game we would score credit points by converting *pest* to *pets*. A well-orchestrated campaign exists that purports to do just that. We are told that trapping cockatoos helps solve the farmers' crop predation problems, provides a humane alternative to control measures such as shooting and poisoning, and, if exported, will satisfy a market demand of these birds as pets, thereby raising funds that can be applied to conservation programs.

Attractive and plausible though these thoughts may seem, the reality is otherwise. There is a considerable body of articles and reports rebutting the above contentions, but they never seem to get as much airplay as the pro-export lobby. Our aim within

the limits of this Forum presentation is to consider just two aspects of the debate: firstly, does trapping provide long-term benefits to farmers, and secondly, do wild-caught cockatoos make good pets? If the answers to these two questions are negative, then pro-trade arguments will be fatally flawed.

### Cockatoos as Pests

Despite the contention that the only solution to the conflict between farmers and cockatoos is the removal of the birds by shooting, trapping and poisoning, detailed studies have shown that the only hope for a long-term solution is an integrated and indirect approach based on sound, ecological principles. These indirect methods of control are far more cost-

effective in terms of the time and materials required to keep birds off crops, less frustrating for the landholder, and do not involve the active destruction of wildlife. A necessary consequence of these methods is that farm efficiency, and thus real income, is increased through better yields and less labour wasted in futile shotgun patrols of crops.

Attempts at removal of bird pests, in particular the Sulphur-crested Cockatoo (*Cacatua galerita*) and the Galah (*Eolophus roseicapillus*), have generally been shown to be ineffective in damage mitigation because the population dynamics of abundant species are geared towards the loss of up to 90 per cent of juveniles in their first year. Without habitat alteration, numbers



quickly recover as the survivors take advantage of ample nest sites and food. In Australia the cockatoo problem is further exacerbated by the emergence of fledglings coinciding with the maturation of summer grain crops (primarily sunflower and sorghum). It is this 'doomed surplus' of young birds that is the target of the direct control methods of shooting, poisoning and trapping.

Traditionally parrots form large flocks to search for what was once a sparsely distributed food source. The conflict between cockatoos and grain growers has arisen primarily because farmers have simultaneously reduced natural food sources and, in its place, provided a highly nutritious and localised food source.

An ecological approach to the problem is clearly needed. Management techniques that exploit the birds' natural behaviour, and aim at altering the crop environment in terms of its attractiveness to birds, have shown most promise. These include early sowing and harvest so as not to coincide with a population increase after the breeding season, and planting where the crop will be less susceptible to bird attack, such as away from treed watercourses, forests and flight paths. The planting of tall 'screen' plants around the crop perimeter, together with the use of 'scare-shooting' with high-powered rifles, reinforces the birds' fear of feeding in those areas in which they cannot survey the approach of predators. Screening trials have been shown to reduce the time and cost of patrolling a crop and the amount of seed loss by up to 85 per cent. Complementary strategies such as decoy crops, and the provision of feeding stations of trash grain or stubble area, will enhance the effectiveness of deterrent methods by giving the birds feeding alternatives.

The acceptance of these management techniques has been slow for two reasons. Firstly, the majority of grain growers incur little damage and the costs of control are not justified. Indeed, out of a survey of 71 district agronomists throughout Queensland, New South Wales and Victoria, only four received frequent requests for advice on controlling birds. Secondly, this advice still relies

heavily on direct methods such as shooting, with only few agronomists advocating crop management as a solution.

It should be stressed that these indirect management options represent an integrated approach as any one technique on its own is unlikely to succeed. Each property, and indeed region, should be assessed for its past history of cropping and bird attack and the possibility of future bird damage, and the crops planned accordingly. Armed with this approach, district agronomists will be well placed to offer grain growers some real alternatives in bird pest control. For instance, after careful appraisal, the decision may be *not* to grow a particular crop, substituting it for a less bird-susceptible one. We

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**“ . . . the petshop  
bird . . . will not make  
an ideal pet in a  
Manhattan  
apartment . . . ”**

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are not only pro-birds but are pro-farmers, and intend putting together a practical manual aimed at assisting farmers to manage crop-predation by birds.

Unfortunately, there will still be those landholders who insist on planting opportunistic crops (for example, long, thin crops along rivers bordered by forest) with no regard for sound agronomic or ecological practices. In the past these growers have received a disproportionate amount of publicity through the media, resulting in a distortion of the true nature of bird damage suffered State-wide. It is interesting to note that severe bird damage has often been correlated with poor farming practices. However these severe losses are restricted to relatively few farms with the vast majority of crops suffering

only minor losses. Finally, it should be emphasised that inefficiency in crop management should not be used as an excuse to destroy local, native bird populations.

### **Cockatoos as Pets**

The Sulphur-crested Cockatoo and the Galah figure prominently in the local pet trade, and these two species are the main ones considered as candidates for exportation. In our view their reputation as good pets is over-exaggerated. People imagine that the talking and performing pets they see on television are the birds they are buying in the petshop. This is not so. The 'talking' birds are almost always taken as partially-feathered nestlings and hand-reared to the point that they 'imprint' on humans. Such birds are able to be taught to mimic words and to perform tricks. By contrast the petshop bird that has been live-trapped as an adult that was a member of a pair or social group will not make an ideal pet in a Manhattan apartment or a suburban backyard.

The current method of housing cockatoos kept as pets is totally unsatisfactory and requires urgent regulation. Adult cockatoos are confined to 'cocky cages', which not only forbid the birds any chance of obtaining adequate exercise, but also make most of the environmental decisions for them. By way of explanation, if a cockatoo was to be housed in an aviary, it would be able to fly from perch to perch and, if the aviary was sensitively designed and sited, seek cooler, shaded parts of the aviary on hot days and warmer, sunnier areas on colder days; it would be able to rain-bathe or bathe in a large water dish; if provided with leafy branches to chew, a lot of time would be spent in this activity; and it would be able to maintain an appropriate distance from perceived or potential enemies be they humans, dogs, cats or whatever. There would also be the opportunity to provide other aviary mates, which are essential to the well-being of birds in which allo-preening is an important social function.

The 'cocky cage' denies all of these opportunities. The doting new owner doesn't recognise that keeping a wild-caught cockatoo in a



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'cocky cage' introduces stresses that may make the bird difficult to train. Attempts to have 'cocky' sit on the hand or arm is often met with a painful bite from the bird. Likewise, if cockatoos are liberated into the living room with the thought of training them to fly onto the arm or giving them exercise, damage to the furniture may result, and the cockatoo is usually not co-operative with its replacement into the cage at the end of the exercise period.

In addition, cockatoos have raucous alarm and contact calls, usually exercised in a dawn or dusk chorus. The amount of contact calling will be greater in a cockatoo kept in solitary confinement. The calls are particularly undesirable in a house pet, and are definitely unappreciated by neighbours. Little wonder that many cockatoos are liberated each year by owners, the evidence of which exists in and around all capital cities.

Society in general should be questioning the whole wild cockatoo pet trade and its local effects before it is foisted onto an unwitting North American or European market.

Not all cockatoos live in Australia. The islands to the north (Indonesia, West Irian, Solomons, New Hebrides and the Philippines) have several species, including two subspecies of the Sulphur-crested Cockatoo. These animals have been legally exported to North America and Europe. It is therefore germane to ask what has happened to the hundreds of thousands of individuals that have been marketed there over the last decade. A few specialist aviculturists breed them and sell hand-raised young birds at a premium price to the pet trade, but no established captive populations exist. In the absence of information to the contrary we would suggest that the majority die within the first 12 months of capture, although a few may survive for many years in captivity. Records of United States (and Australian) zoo bird departments show that cockatoo species are regularly offered to them as gifts by harassed pet owners.

In summary, we are not opposed to people keeping birds as pets, as the psychotherapeutic value, as such, is undeniable. But let them be aviary-bred Cockatiels or Budgerigars—not wild cockatoos! House pets they are not. House pests they become. People should not be taken in by any sleight of hand that turns *pest* into *pets*.



TRACING THE TRADE ROUTES  
**PITURI**  
OF AN INDIGENOUS INTOXICANT



A Pituri shrub growing in Western Australia.

A.G. WELLS

by Tim Low

Burke and Wills endured frightful hardships during their last wretched weeks in central Australia. Local Aborigines helped ease their pain, plying them with fresh fish, nardoo cakes, "nice fat rats", and the "stuff they call bedgery or petchery", described in Wills' diary (published 1863) as having a "highly intoxicating effect when chewed, even in small quantities".

Burke and Wills died only weeks later, the first whites ever to have partaken of the Aboriginal drug now known as Pituri. Whether they en-

joyed the experience we cannot say, although the expedition's sole survivor, Mr King, certainly did; while living with Aborigines he chewed Pituri a number of times to dull his hunger and pain.

Australia's Aborigines used few drugs, and the Pituri of desert tribes has attained a mystique all of its own. Traded over hundreds of kilometres, zealously hoarded and preserved, it figured prominently in the lives of dozens of tribes over much of central Australia.

Pituri is the dried leaves and



stems of an outback shrub, *Duboisia hopwoodii*, named after Mr Hopwood of Echuca, a patron of the fateful Burke and Wills expedition. A species of the alkaloid-rich Solanaceae family, the Pituri plant is closely related to the tobaccos (genus *Nicotiana*), Deadly Nightshade (*Atropa belladonna*) and the hallucinatory thornapples (genus *Datura*).

Early pharmacists were quick to investigate Pituri, hoping its alkaloids might prove useful in medicine. They must have been disappointed to discover the active constituent was nicotine, the alkaloid in cigarettes.

Pituri was often dismissed as mere chewing tobacco, a description that belittled its immense versatility as a drug. Chewed Pituri quids were passed from mouth to mouth to promote mirth during talks and feasts. The drug raised stamina on long desert treks: one Aboriginal boy supposedly walked 260 kilometres in two days with no other sustenance. Pituri was said to inspire courage during warfare, and to enable men to 'fire-walk' on hot stones. It made men voluble: the desert traveller Mr Gilmour (cited in Bancroft 1877) met an old man who "refused to have anything to say or do until he had chewed the pituri, after which he rose and harangued in grand style,

ordering the explorers to leave the place".

Cigarette-smoking hardly produces effects like these, and anthropologists in recent years have been forced to reassess the significance of nicotine as a drug. In the Americas, Indians used very potent tobaccos as significant mind-altering substances, and the Pituri was chewed by Aborigines were also very strong. Their nicotine content, already two to three times that of cigarettes, was further enhanced by adding highly alkaline ash from special acacias, releasing the nicotine from its bondage with acids and enhancing its uptake by the body. Nicotine in such doses has a depressant effect, and the user attains a trance-like state, immune to pain.

Pituri was widely traded by Aborigines, and herein lies a mystery. The main centre for Pituri processing lay in far south-western Queensland, near Bedourie, a small desert town probably named phonetically after the drug. Pituri from this area was traded throughout a region of 550,000 square kilometres, passing along trade routes running south to Lake Eyre, north to Cloncurry, and west into the Northern Territory. Yet Pituri already grew in some of these places. Why was it traded?

A traditional view has been that

Aborigines living outside south-western Queensland simply didn't grasp the connection between the precious stashes of dried Pituri chips, traded in special woven bags, and the slender-leaved shrub that grew on their own tribal land. For, contrary to anthropological wisdom, Aborigines were not consummate botanists, and tribes often remained ignorant of plant foods and medicines used elsewhere.

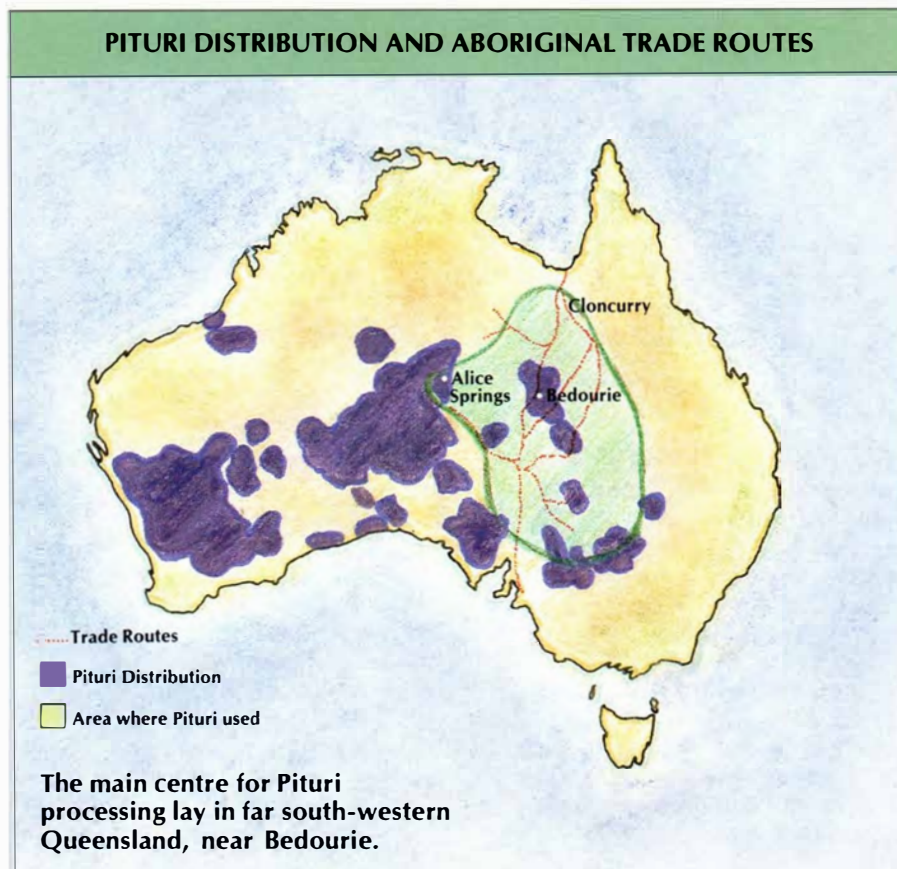
More recently another view has been expressed. Analysis of Pituri plants from different places has revealed considerable chemical variation. While Queensland and some Western Australian plants contain nicotine as their main alkaloid, plants from the Northern Territory are dominated by nor-nicotine, a more potent alkaloid more toxic to people. Bedourie Pituri may have been preferred because it was safer.

In the western half of the Northern Territory, Pituri appears to have been spurned in favour of wild tobaccos (*Nicotiana* spp.). Of these, the most popular species (*N. gossei*) contains only nicotine, but at least one of the species used, *N. benthamii*, also yields nor-nicotine. Aborigines in these parts used Pituri only to capture Emus and wallabies, hurling the leaves into waterholes where the animals would become drugged and easy to club to death.

Pituri from the western deserts of the Northern Territory is the only kind I have tried. I made a quid by pounding the leaves and mixing them with chalk in place of ash. Sucking on the quid produced an immediate dreamy state that was mild in intensity but long in duration. Lunch was taken two hours later and I suddenly became dizzy and weak, and feared I would collapse. This state passed after 20 minutes. I also tried smoking the leaves. This produced a pleasant heightened state, followed by deep relaxation. No ill-effects were noted.

It must be stressed that random tasting, chewing or smoking of plants is not a recommended practice, especially when the plants contain known toxins. The nicotine in two commercial cigarettes can kill when chewed, and Pituri is also dangerous.

Why Aborigines in the western half of the Northern Territory did not use Pituri I cannot say. Perhaps they considered it dangerous, although I suspect they were simply maintaining an old tradition by using wild







TIM LOW

**Pituri shrubs growing on a roadside in the south-western corner of the Northern Territory. Mt Connor can be seen in the background.**

tobaccos, which are widespread in central Australia but rare in most of the regions where Pituri was traded.

The tribes who controlled the Pituri trade have lost their way of life. Pastoralists with their cattle, and the arrival of the overland telegraph, destroyed the local culture. The best record of the trade was kept by "Protector of Aborigines" George Aiston, although his account was not published until 1937, long after the trade had ended. Aiston declared that the curing of Pituri, which involved drying the leaves in sand ovens, was the monopoly of local Pituri tribes. He noted that "any child born to the horde or tribe who belonged to the pitcheri Moora automatically succeeded to all rights and privileges in the distribution".

The drug changed hands at unique markets along the trade routes where as many as 500 eager Aborigines assembled. Bartering would begin at the first camp that was met after leaving the Pituri grounds.

Aiston wrote:

*"after everybody had rested and fed, one of the party would throw down a bag in front of the assembled camp; anyone who wished to buy would throw down, perhaps a couple of boomerangs, perhaps a grinding mill, or whatever he could spare; the pitcheri seller would leave his bag until something that he wanted was offered; this he would accept by picking it up and the buyer would then pick up the bag of pitcheri. Perhaps another member of the pitcheri party would see something in the goods offered and would throw down another bag; if the buyers were not satisfied they would pick up their offerings, and if the seller was not satisfied he would pick up his bag of pitcheri. The camps near the pitcheri grounds never became big markets because the pitcheri was more valuable the farther away it was traded. The near camps were only used to get enough utensils and weapons for use when travelling to the more prof-*

*itable markets."*

A few white people took up the use of pituri. The anthropologist Pamela Watson interviewed an early settler who remembered a hotel in western Queensland serving whisky spiked with the drug as a knockout drop. Bushmen sometimes smoked the leaves when their tobacco ran out and, during the 1890s, the drug was supplied to the Chinese community in Sydney as an opium substitute.

Watson believes that Aborigines became addicted to Pituri. The ethnographer Walter Roth wrote in 1901 that "Blacks will usually give anything they possess for it—from their women downwards". He noted that among Aborigines "there appears to be as great a craving for pituri as amongst Europeans for alcohol, a fact which is put into practical and economic use by drovers, station managers and others". Traditionally the drug was the preserve of older men, but by the turn of the century women





TIM LOW

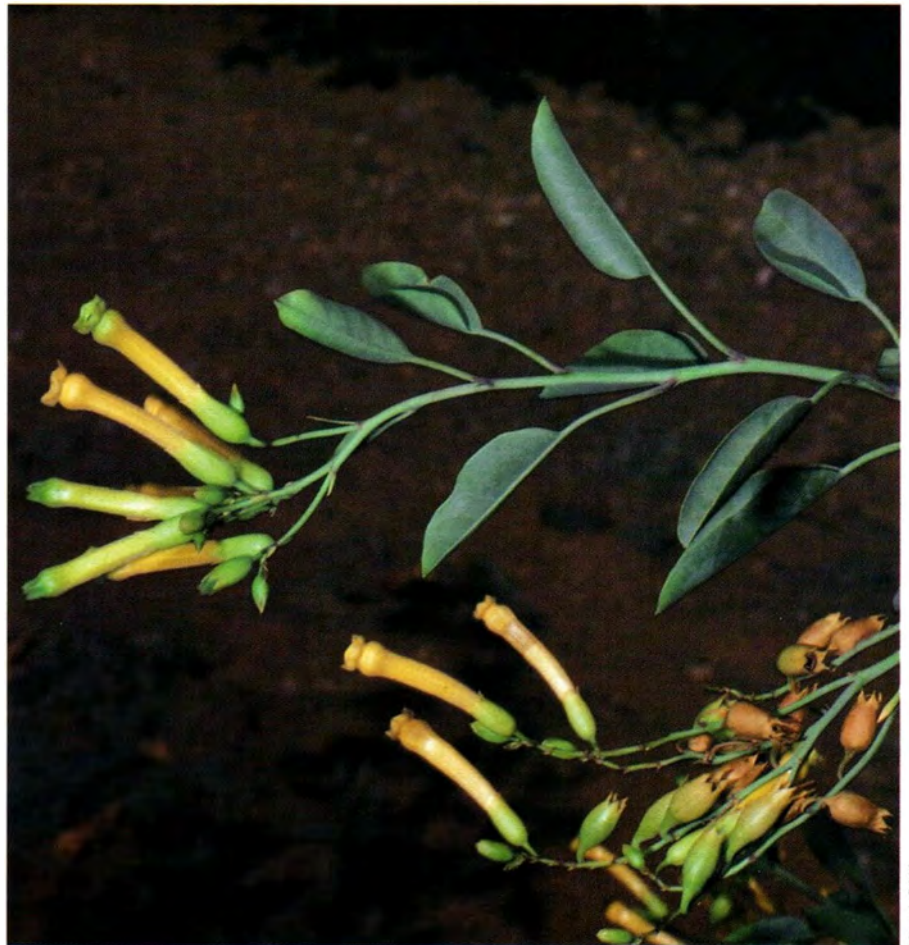
The native tobacco *Nicotiana excelsior* is nowadays called 'Pituri' in the Northern Territory, creating confusion with the true Pituri. This species, growing here within the Olgas, supplies the Pitjantjatjara Aborigines with a very popular chewing tobacco. The slender white flowers are characteristic.

were using it as well. After chewing, the Pituri wad was stowed behind the ear, where it is possible that additional nicotine was absorbed through the sensitive skin.

Pituri was largely supplanted by white-man's tobacco (and perhaps to some extent by opium). By 1900 the two were becoming interchangeable—there are reports of Pituri smoked in pipes and of tobacco quids mixed with acacia ash.

'Pituri' remains popular among Aborigines today, although the plant now in use is more likely to be one of the wild tobaccos. These are closely related to the commercial tobacco (*N. tabacum*) and there are 16 Australian species, although only a few were used as drugs. True Pituri has been confused with wild tobaccos since at least the 1920s, and in the Northern Territory the name now applies to both.

Wild tobaccos are tall herbs with large soft leaves and tubular flowers on long stalks. The exception is Tree Tobacco (*N. glauca*), a South American shrub that is now common in outback Australia. The Pitjantjatjara Aborigines chewed several kinds of wild tobacco and, according to



TIM LOW

**Tree Tobacco is a South American weed with psycho-active properties. It is used as a drug in South America and reputedly by some Pitjantjatjara as well.**

anthropologist Nicolas Peterson, even adopted the introduced Tree Tobacco, which is used as a drug in South America. Its leaves, like those of some native tobaccos, contain the alkaloid anabasine and little if any nicotine.

At Uluru National Park the wild tobacco *N. excelsior* is especially popular. Pitjantjatjara descend in land rovers upon the Olgas where the plant flourishes along damp gully lines. Wild tobaccos are milder than true Pituri, and probably compare in strength with European chewing tobacco. They were, and still are, extremely popular drugs, and today are probably the most sought after Aboriginal plants in the Northern Territory. Like Pituri, they are often chewed in quids mixed with acacia ash.

Now that Aboriginal communities own vehicles, the use of these wild tobaccos may have increased in recent decades, although, like so much about these plants, this remains a matter for speculation. In fact, the more one looks at the whole 'Pituri' phenomenon, the more questions arise. After decades of con-

fusion over the identity of plants called 'Pituri', and faced with a historical record that is incomplete and contradictory, it seems certain the full 'Pituri' story will never be known. □

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## Succulents for Supper

There is something of the animal in succulent plants. Those fleshy leaves and succulent stems invoke the texture and shape of fingers and limbs. So *fleshy* are such plants that they render other plants flat and two-dimensional. No wonder whole clubs and societies are sworn to cacti and their kind.

But to botanists succulent plants are a professional nuisance. They are too bulky to fit into normal plant presses and the turgid leaves are too watery to be easily dried. They are apt to sprout and grow within their folders, weeks or even months after collection. Even when succulents can successfully be dried, they shrivel and shrink into a pitiful mockery of the original plant.

Australia's botanists are luckier than most; our succulent plants have smallish leaves. American botanists fare much worse—imagine devoting

a field trip to drying and pressing agaves and cacti (ouch!).

But even in Australia lazy botanists may skirt the larger fleshy plants, leaving these under-represented in Australian herbaria. Botanists in Adelaide told me how they recently put in a special effort to collect an agave (*Agave americana*), an introduced feral plant now common in South Australia but scarcely recorded in the State herbarium. With fleshy spike-edged leaves a metre or two tall and flower stalks ten metres high, no wonder most botanists look the other way.

Yet succulent plants often bear edible parts, and, in America, Indians harvested the leaves, seeds and fruits of cacti, as well as juicy agave leaf bases. In Australia, explorers and settlers made vegetables of the saltbushes, and Aborigines harvested the fruits of succulent pigfaces

(*Carpobrotus* and *Sarcocolla* species).

Pigfaces are attractive plants. From creeping stems they sprout showy purple flowers, which give way to purple or red fruits. The juicy pulp tastes delightfully like salty strawberries or soft figs, and pigfaces can be considered among the best of all native fruits.

Pigfaces were important foods of Aborigines, as early observers attest. The following account by colonial botanist Carl Wilhelmi, written in South Australia in 1860, suggests the fruit was a staple food:

*"Pressing the fruit between their fingers, they drop the luscious juice into the mouth. During the karkalla season, which lasts from January until the end of summer, the natives lead a comparatively easy life; they are free from any anxiety of hunger, as the plant grows freely in all parts of the country. . . The Port Lincoln blacks eat only the fruit of this plant, but those living between the Grampians*

**Eastern Pigface forms thick mats on beaches and headlands. Plants growing in full sunshine, such as this one photographed on Fraser Island, bear the most fruits.**



PHOTOS: TIM LOW





The fruits of Karkalla are bright red and crowned by succulent horns.

and the Victoria Ranges, as a substitute for salt with their meat, eat also the leaves of this saline plant." (Trans. R. Soc. Vic. 5:172).

The French naturalist Labillardiere, anchored off Tasmania in 1800, noted in his *Voyage in Search of La Perouse* (1800) that "This fruit is a delicacy among the New Hollanders, who seek for it with care, and eat it as soon as they find it". Explorers also witnessed Aborigines eating the fruits, notably Edward John Eyre in South Australia and George Grey in the west.

Australia has six native pigfaces, although some of these are difficult to distinguish and the species definitions are open to dispute. The problem lies partly in their succulence: botanists collect pigfaces rarely and so the pool of specimens for study is small. There are three species of *Carpobrotus* on coastal dunes and one, Inland Pigface (*C.*

*modestus*), on southern plains. *Carpobrotus glaucescens* is the common species of eastern beaches, Karkalla (*C. rossii*) its counterpart in the south, and *C. virescens* the Western Australian form. These are sometimes confused with *Sarcocolla praecox* and *S. bicarinata* of southern deserts and plains, although the latter are more upright plants and their flowers have fewer 'petals' (actually modified stamens). Some botanists believe *S. bicarinata* to be a natural hybrid between *S. praecox* and *C. modestus*, and in old reports of Aboriginal use it is sometimes difficult to know which genus is referred to.

These true pigfaces are easily confused with Round-leaved Pigface (*Disphyma crassifolium*) of southern beaches and inland plains. It has smaller, less angular leaves, and small capsules on tall stalks in place of fleshy fruits. The juicy leaves are, however, edible raw and good to eat, and much tastier than *Carpobrotus* leaves, which may irritate the throat.

Pigfaces must not be confused with garden Pigweed (*Portulaca oleracea*), an edible weed with tiny yellow flowers. Pigweed is so-named because pigs eat its leaves; pigfaces, rather, just look like pigs—they have something of the animal within them.

Good eating! □



Round-leaved Pigface has juicy salty leaves that were probably harvested at times by Aborigines, although no evidence for this has survived.





# ROBYN WILLIAMS

## Snorkel Sense

Friends often call me a technological primitive. It's not that I don't understand modern devices, I simply find them intrusive, more trouble than they're worth. Accordingly, I have never used a computer, had a credit card or bought a microwave oven. But I do appreciate elegant and useful machinery, such as the snorkel.

People have been diving for hundreds of years using various kinds of apparatus. Aristotle mentions breathing apparatus in common use, presumably around 300BC; indeed Alexander the Great is quoted as using such equipment to stay under water for long periods. In the long history of diving we can find sundry ingenious systems from the long tube carried above the submerged person on a pontoon (recorded by Pliny in the first century AD and then Roger Bacon in 1240), to various skin bags in the 16th century, and, inevitably, designs by Leonardo da Vinci. Fins were perfected by a Commander Corlieu of the French Navy in 1935, having invented them in 1920. In 1331, pearl fishermen in the Persian Gulf were reported using goggles of near-perfect transparency (before glass was introduced), made from highly-polished tortoiseshell. And the 'aqualung' was, of course, the brainchild of Captain Jacques Cousteau (1943).

But what could be more straightforward than the snorkel—a tube held between your teeth that projects above the water? Indeed, the ancient Greeks used such a device, made from hollow reeds. My first snorkeling experience was a revelation. After you've managed to suppress the instinct to pant and learn instead to breathe steadily, the views below are from another world. If you ever need to convince sceptics that support should be given for marine science, just hand them a snorkel and point them towards some sheltered coastline.

My latest expedition was to New Caledonia. Through the window of the graceful Caravelle jet, I could see the massive fringing reef—the longest barrier reef in the world after

our own. There are 300 different species of coral in the waters of these tropical islands, including the famous fluorescent ones. I saw plenty of them, even while snorkeling off the beach of my hotel, close to the rather ugly port of Noumea.

Hard coral, white and round, like frozen brains, great mounds of brilliant blue, staghorns with purple tips—they all glide underneath like some exquisite landscape from another planet. You can suddenly be surrounded by hundreds of small fish, just out of reach, with seahorses and parrot fish, and in crevices, the silly red and blue clown fish, hiding in the fronds of their sea-anemone host.

Then, the blue-black blob you take to be a sea-slug rapidly expands and weaves to the surface. Then there's another. Two metre-long sea snakes, just an arms-length away. Are they dangerous?

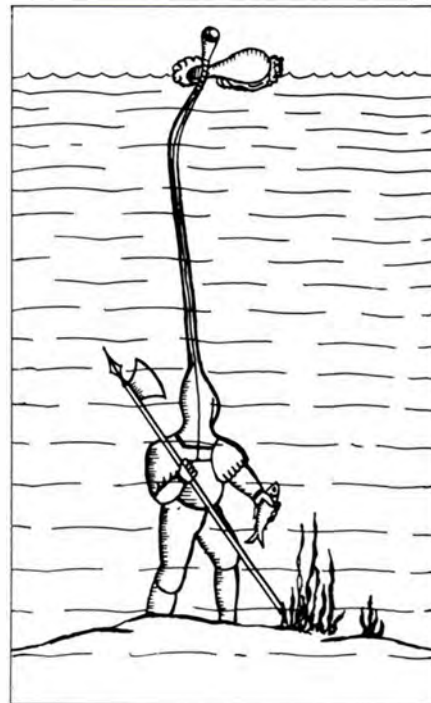
I went to the aquarium in Noumea to find out. The Director is marine scientist Joannot Pascale, who studies coral growth and the *Nautilus* cephalopods. She assured

me that the snakes we saw are no threat, but that the yellow and black kind has venom five times more powerful than that of a cobra. Fortunately, they're not aggressive.

She also showed me the magnificent display of fluorescent coral at the aquarium. It is said to be the only place in the world where such coral can be seen on such a scale and with such sustained glow. They are indeed impressive. But why do they produce light? I conjectured that it's to enable the algae, which live symbiotically in the coral, to photosynthesise, especially in murky waters. Pascale agreed, as some reefs are obscured by silt, but then added that fluorescing coral is also found in fairly shallow water where light is plentiful. Could it be, then, that the extra light from the coral allows photosynthesis to continue after sunset so as to increase coral growth? Who knows? But it's a fascinating speculation.

The work on *Nautilus* proceeds apace. This is one of the really ancient genera and it could be the ancestor to modern cephalopods like squid and octopus. But you won't see *Nautilus* when snorkeling. They live in very deep water and rise to the surface at night when there's no moon. Last year, for the first time, marine scientists in Hawaii managed to get one of the species (there are four) to reproduce in the laboratory. It lived for only three weeks, but researchers like Joannot Pascale are very excited.

Fluorescing coral and the extraordinary *Nautilus* are just two of the mysteries from an ocean where there are thousands. Some of these mysteries come in the form of questions that the scientifically-minded are curious about. Others involve aspects of research vital for the health of marine industries. Now that Australia has achieved the front rank in many aspects of the science of the sea, are we now in danger of allowing such efforts to dwindle? Professor Peter Sale from the University of Sydney thinks we are. He's one of many scientists worried about recent cuts to Australia's marine research budget. I wonder whether Barry Jones or Senator John Button ever go snorkeling? □



**Underwater breathing apparatus designed in the 16th century. A skin bag, from which a tube emerges, is fitted over the diver's head. The tube is held above the water by a float.**



# POSTER Green Python

The Green Python (*Chondropython viridis*) is a member of the Boidae—a family of large, non-venomous snakes that kill their prey by constriction. This family includes the boas and pythons. They have flexible jaws, enabling them to engulf prey with diameters greater than their own, and possess vestiges of a pelvic girdle and hind limbs in the form of horny spurs on either side of the cloacal opening. Being comparatively small boids, Green Pythons average 1.2 metres in total length and occasionally reach 1.8 metres.

Green Pythons forage on the ground at night but spend most of the day resting in elliptical coils on branches or in hollow trees. Their adaptations for nocturnal activity include heat-sensitive pits in some scales of the upper and lower lips, which help them to locate warm-blooded prey, and vertically elliptical pupils, which open and close further than round pupils. Green Pythons have large sharp front teeth and adults feed primarily on birds and small mammals such as *Rattus* species. The young, which usually roost close to the ground, appear to eat mainly lizards and employ 'caudal luring' to attract them. In this specialised feeding behaviour, a snake lying otherwise motionless protrudes the tip of its tail from between the coils of its body and wriggles it sinuously; the tail is thin and a different colour from the rest of the body and looks like an enticing worm to an inquisitive lizard, bird or mouse. As the young pythons mature, the colour differentiation disappears and so does the caudal luring behaviour.

Green Pythons are also highly adapted for their daytime arboreal lifestyle. Their bodies are compressed from side to side and there is a distinct ridge along the backbone. The tail is also compressed and prehensile for grasping branches. Specialised back muscles enable the snakes to extend long portions of their body unsupported while climbing from branch to branch. The colour of adult pythons is also ideally suited for lying inconspicuously draped over a branch among leaves; they vary from dull to bright emerald



CLIFFORD AND DAWN FRITH

green with cream or white scales running along the backbone or scattered over the back. The green colour occurs because cells containing yellow pigment (xanthophores) form a yellow filter over a layer of particles in the skin that, due to the refraction of light, appear blue. Some 'Green' Pythons lack the yellow pigment and are entirely blue (axanthic).

Young Green Pythons are a different colour to the adults. They vary from bright yellow through tan to dark brick red, and have conspicuous splashes of colour along the backbone and sides; these markings are cream on dark individuals and white surrounded by brown on yellow individuals. The tail is a similar contrasting colour, as mentioned above. A conspicuous dark-edged white line runs horizontally through the eye and beyond, camouflaging it. This line is very faint in adults.

The dramatic change to adult colouration occurs around two years of age when the snakes are about 70 centimetres long. The transformation may take only a week or two and occurs without shedding the skin.

Male pythons may possess longer

cloacal spurs than females, and they are used in courtship and mating. The female Green Python lays 12 to 22 eggs in a sheltered spot such as a hollow log or tree, then coils around them and broods almost continuously until they hatch about 10 to 12 weeks later. This behaviour protects the clutch from predators and also maintains a fairly constant humidity and temperature for incubation. When the ambient temperature drops, the female can stabilise temperature around the eggs by 'shivering'—producing muscular contractions of the body which raise falling temperatures.

In Australia, Green Pythons are found in only a few pockets of closed canopy rainforest in north-eastern Cape York Peninsula but they are relatively common in New Guinea and the Aru and Schouten Islands, at altitudes below 1,800 metres. They prefer undisturbed forest habitat but are occasionally found in monsoon forest, cocoa plantations, bamboo thickets and even kunai grassland. □

—Greg Mengden  
and Elizabeth Cameron  
Australian Museum





by Andrew Arnold  
Department of Conservation, Forests & Lands

# PORTLAND'S ■ CHANCE ■ ENCOUNTER

**With a Pygmy Right Whale**





Frank Ziegler approaches the whale.

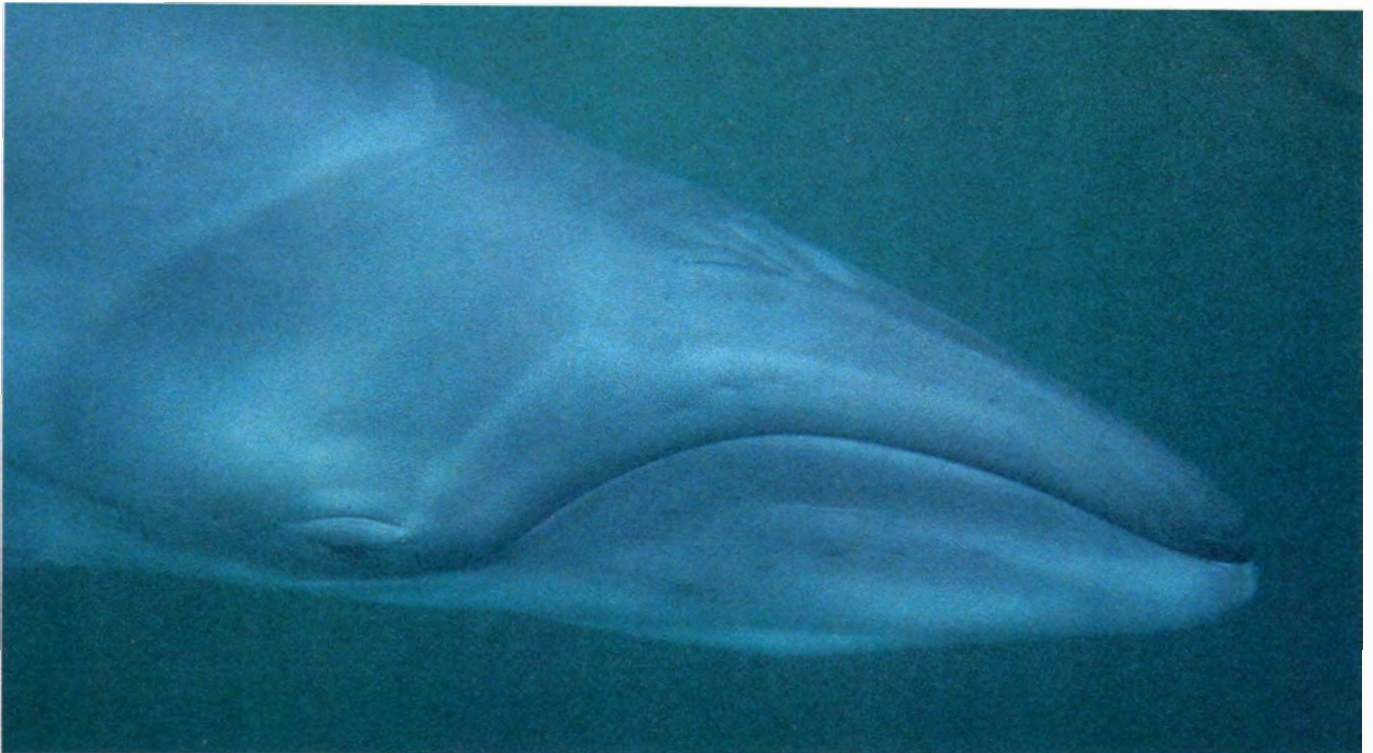
The timing seemed incredible. Barely had we held our first whale rescue training workshop and now we were in the throes of organising the real thing. Early on Monday 1 December 1986, Denis Read, Conservation, Forests and Lands (CFL) Regional Manager, 'phoned to brief me on the activities of Portland's strange cetacean visitor. A three-metre-long whale had found its way into Portland Harbour several days previously, and was circling about in what appeared to be a disorientated state.

Denis immediately suggested that we implement the new Victorian Whale Rescue Plan. Our first job was to identify the whale. However, Bob Warneke, the Department's marine mammal researcher, was away on a research trip and identification without his expertise would be difficult.

The whale spent very little time near the surface during the first few days, so it was nearly impossible to observe the key features required for identification. Many of its features closely resembled those of a young Minke Whale (*Balaenoptera*

*acutorostrata*), but a Minke Whale of this body length would almost certainly still be suckling. On rare occasions Minke Whales are known to 'lose' or abandon their calves before they are weaned. Little is known about rearing young baleen whales, so clearly, if our visitor was a young Minke, its only real chance of survival was to find and re-unite it with its mother. By 10.30 am we had a light plane in the air carrying out a reconnaissance of the waters of Portland Bay and nearby Bridgewater and Discovery Bays. The search,





**Close-up, underwater shot of Rosie, Portland's cetacean visitor, a juvenile female Pygmy Right Whale.**

however, was to prove fruitless.

As part of the implementation of the Whale Rescue Plan, Project Jonah and the Whale Rescue Centre in Melbourne were notified of the situation and within a few days a party of volunteers arrived in Portland.

It was agreed by all concerned that the best course of action was not to intervene while the whale appeared to be healthy. Proposals to drive the whale out of the harbour into open water were rejected, as it was considered that such attempts would be likely to place further stress on the animal and expose it to other risks. By now the contact network was buzzing. Rhys Puddicombe from the Australian National Parks and Wildlife Service in Canberra 'phoned me for a first-hand account of our mystery visitor. When I gave him details of its appearance and behaviour he suggested it might be a Brydes Whale or a Pygmy Right Whale.

Our site controllers Charles Cooper and Kevin Sleep were now almost permanently at the harbour site during daylight hours, monitoring the whale's condition and trying to cope with constant questioning from a steady stream of sightseers. They had been joined by Frank Ziegler, a local professional diver. Frank's intimate knowledge of the harbour, particularly under water, his keen interest in marine biology and his photographic skills were to be

invaluable over the next few weeks.

The whale had by now established a pattern of swimming in the south-western corner of the K.S. Anderson No. 1 Dock adjacent to large concrete grain silos. For the first week the swimming pattern seemed remarkably regular, the whale swimming under water in circles within a radius of 50-100 metres and surfacing to breathe at intervals of approximately one-and-a-half minutes. This was punctuated by a few very long or short dives. When surfacing, the whale would slightly raise the upper part of its head out of the water to expose its paired blowholes. As it submerged, the head first entered the water and the arched back then emerged exposing a small, recurved dorsal fin about two thirds along the length of the body from its head. The tail flukes remained submerged throughout this surfacing activity. As well as the rhythmic pattern of surfacing, the whale regularly thrust its snout out of the water at an angle sufficient to expose its blowholes and breathe, before sinking backwards into the water.

Frank Ziegler tried diving with the whale and the response was encouraging. The whale appeared curious and unafraid, and had even approached closely enough to touch Frank's outstretched hand. Close underwater observations by Frank, Kevin and Charles showed that the whale had a distinctly bowed jaw, a

white chevron extending from the top of the body almost to the pectoral fins, and the complete absence of any throat grooves. The elasticity of the throat grooves in the 'gulping' whales (as opposed to 'skimming' whales) allows the maximum volume of water to pass out through the baleen plates. We were now convinced that the whale was a juvenile female Pygmy Right Whale (*Caperea marginata*).

The Pygmy Right Whale is the smallest species of baleen whale and one about which little is known. There have been very few opportunities to observe free-swimming individuals and most of the information about the species has come from stranded specimens. Here was a unique opportunity to learn more about the natural history of this elusive marine mammal. I 'phoned Dr Bill Dawbin at the Australian Museum in Sydney: "Every piece of information that you can collect will be important. You must take every opportunity to photograph and observe its movements and behaviour." Bill rang me at 9.30 am on Friday morning. He was about to board a Melbourne-bound flight en route to Portland, carrying with him ultra-sensitive sound-recording equipment.

In the meantime, concerned about the present location of the whale next to one of the most frequently used sections of Portland



Harbour, I contacted Captain Don O'Donnell, Harbour Master with the Port of Portland Authority. Captain O'Donnell advised me that the next few weeks in the Port were likely to be one of the busiest on record with the start of the main period for grain and live sheep exports, and the off-loading of a consignment of pencil pitch for the Portland Aluminium Smelter. Fortunately the whale had avoided swimming near the main shipping berths but two difficulties still had to be overcome. Many Portland residents were by now ardent whale watchers and their parked cars were blocking the main access routes used by incoming grain trucks and other port traffic. Captain O'Donnell proposed clearing a berth site currently being used as a pipe storage area to provide a safe parking and viewing area.

The proposed shipment of pencil pitch also gave us some concern. Pencil pitch is transported as a crystalline solid but dust associated with unloading operations is known to sensitise human skin to ultraviolet light causing severe sunburn. We could only speculate about the likely risks to a marine mammal. After discussion between the CFL, Port of Portland Authority, Portland Smelter Services and the Whale Rescue Centre, a strategy for the unloading operation was devised to minimise the risk of spillage. In addition, an inflatable oil boom was laid across the water in No. 1 Dock to reduce the chance of any floating material coming in contact with the whale. The unloading operation went smoothly and without incident to the credit of all concerned.

Bill Dawbin arrived on Friday 5 December on the 5 pm flight from Melbourne. By 6.15 pm we were down at the harbourside and within a few minutes he had verified our identification. Bill set up his sound-recording equipment and commenced the long and tedious waiting often associated with sound-recording cetaceans.

Frank Ziegler had begun to videotape the whale's movements underwater and a deep gash was discovered in front of the right pectoral flipper. Perhaps she had sought the sheltered waters of the harbour in order to recuperate? By now the whale was responding very positively to Frank and Charles Cooper when they entered the water. Her curiosity was insatiable and she would swim rapidly towards them

within a few seconds of them submerging. Frank named her 'Rosie' because of her underwater agility which he likened to playing 'ring a ring o' roses'. At first Rosie seemed unsure of the video camera and would not approach Frank while he held the unit in front of his face. This made taping difficult but fortunately she soon overcame this aversion.

Our main concern relating to her welfare was whether she was feeding. Plankton and tiny fish comprise the main food of baleen whales, and gut analyses carried out on Pygmy Right Whales caught by Russian whalers in 1972 revealed unidentified species of the crustacean copepod *Calanus*. Charles carried out some plankton trawls near the surface in the No. 1 Dock area. Substantial plankton levels were found to be present. A thick layer of marine vegetation on the harbour bottom and its sloping sides also contained abundant plankton life. However we had not observed anything that could be interpreted as feeding behaviour.

The videotapes suggested that she seemed to be losing condition, and the volunteer groups thought some attempt should be made to feed her. Although we had doubts about the value of doing this, it was unlikely that such experiments would be harmful. Six attempts were made over the period of one week to release blended squid and fish in a fine cloud directly in the whale's path. Although she was seen swimming through these 'food clouds', there was no sign of feeding activity.

Throughout Saturday, Bill continued to monitor his sound-recording equipment. Sound-monitoring in the harbour was at times frustrating due to the background noise—in particular, the constant throb of a generator on board a ship anchored just outside the harbour and, later in the day, heavy rain. Bill's patience, however, was rewarded when he succeeded in recording a series of clear, well-spaced sounds over a period of about half an hour. More success with recording followed on Sunday before he had to return to Sydney in the evening.

Bob Warneke arrived back on Sunday. His considerable experience with whale strandings led him to conclude that the harbour had formed a man-made whale trap, "entry through the narrow entrance being relatively easy but exit extremely difficult for a small cetacean unused to navigating close inshore".

Bob also informed us that the Pygmy Right Whale was only the second occurrence of this species in Victorian waters this century. He told me about observations carried out on the species in South Africa. Apparently nearly all specimens seen or caught inshore have been juveniles. These South African researchers postulated that the appearance of *C. marginata* in inshore waters in spring and summer might represent part of a general dispersal of animals after weaning. Their records suggest that Pygmy Right Whales are, when seen, frequently in sheltered, shallow bays and that this has been interpreted as normal behaviour rather than the actions of sick and dying animals prior to stranding.

Despite the concern about the apparent loss in condition, Rosie continued to exhibit similar behaviour patterns over the next fortnight, with her swimming concentrated in the No. 1 Dock area. However, at 4.15 pm on Christmas Eve, Kevin Sleep noticed a marked difference in her behaviour. Her circular swimming pattern had become irregular and had slowed down, and at times she entered shallow water in the far corner of the dock and floated motionless for long periods. Although still swimming quite freely, she showed no interest in Frank when he dived near her, which was in com-

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**Pygmy Right Whale skull, remains of a stranding on Bruny Island, Tasmania.**

plete contrast to her normal response. The average period between breaths had shortened noticeably and averaged about 100 per hour, although there was still considerable variation in the length of periods between breaths. Dr David Fitzpatrick, the District Veterinary Officer, was alerted, and the whale rescue sling and kit placed on standby. This mystifying behaviour continued for about four hours and then suddenly at 8.30 pm she was observed to resume her normal swimming and breathing pattern.

Our regular daily monitoring continued into the New Year. Rosie appeared active and healthy except for a few minor abrasions that seemed to heal quite rapidly. There was no substantial repeat of the erratic behaviour observed on Christmas Eve. On 6 January, while Charles Cooper and David Fitzpatrick were diving with her, Charles noticed what he believed could be feeding behaviour. The whale was seen with her snout in seagrass and weed along the sloping side of the ten-metre-deep basin in the dock. As she raised her snout, sediment was stirred up. Unfortunately it wasn't clear whether her mouth was open, or partly open, during this activity, so these observations were inconclusive.

On the evening of Sunday 11 January, Kevin Sleep observed a new pattern of swimming not previously observed. The whale appeared to glide through the water for a distance of about eight metres, the top of her head just breaking the water surface. The next night at dusk I also observed the same gliding motion but this time the whale's mouth was gaping open

and the baleen plates were exposed. A likely explanation was that the whale was feeding on the plankton that rises to the surface at this time. We were jubilant!

Perhaps the most remarkable aspect of this whole account was the attention that the whale received from the people of Portland and the crowds of summer visitors. Captain O'Donnell's foresight in clearing the harbourside had provided an excellent viewing and carparking area, which from dawn until dusk was scarcely empty. Overnight Rosie had become a local celebrity. So there was great public consternation when the whale was reported missing from her usual place on Thursday 22 January.

On Saturday morning a local fisherman reported seeing a whale swimming in a tight circle off Crumpets Beach in Portland Bay south of the harbour. But just before noon Charles Cooper located Rosie in the outer harbour swimming off the foreshore beach. It appeared she had ventured out into Portland Bay but had now returned.

The whale's presence in the outer harbour raised a new set of problems for us. Many of the activities of the Australia Day weekend at Portland focused on the outer harbour, and the presence of many small motor craft meant that there was the risk of collision. So the local FM radio station 3RPC was contacted to broadcast warnings, while CFL staff advised people of the whale's presence as they launched their boats.

Sunday was good beach weather and many people crowded onto the narrow strip of sand on the foreshore within the outer harbour. During

most of the morning Rosie circled off the beach, remaining in water about three metres deep. However by mid afternoon she began to move inshore amongst the swimmers. I watched her circle back on five consecutive occasions, approaching within two to three metres of one family group that was standing in knee-deep water staring in amazement. A windsurfer leapt off his board and ran toward the whale; I saw her lunge her tail flukes out of the water in two rapid successive beats and speed away from the shallow water. At no time did she appear to be at risk of stranding, despite the shallowness of the water.

After the events of the Australia Day weekend Rosie remained for another ten days in the harbour. During this time she ranged throughout the harbour area, sometimes returning to her original dock location and sometimes cruising over the seagrass bed just off the harbour beach. But as mysteriously as she appeared she departed. Fisheries and Wildlife Officer Bob Jackson made the last confirmed sighting at 1 pm on Thursday 5 February 1987 from the marina within the outer harbour. Several unconfirmed reports added to the enigma of her disappearance. A crewman of a freighter anchored outside the harbour entrance at this time claimed to have seen "a large whale wider than three metres" swim past. When the ship eventually berthed, Kevin Sleep went aboard to try and locate this crewman, but language difficulties and reluctance to come forward frustrated this. There were other claims that two whales had been seen swimming together in the harbour. However we treated them with some scepticism as a large Australian fur seal had been sighted by our staff earlier in the vicinity of the whale.

Our initial apprehension on the whale's arrival had now been replaced by great relief at her successful return to the sea. The whole exercise had been a success in terms of the co-operation of the CFL with volunteer groups, the application of the CFL Victorian Whale Rescue Plan to the situation, and the scientific recording undertaken.

Much had been gained from this unique visit to Portland by the Pygmy Right Whale. The impact of her visit has been a lasting one. Not since Portland Bay was the centre of whaling on the Victorian coastline, 150 years ago, has a whale so influenced and dominated the minds of Portlanders. □



# QUIPS, QUOTES & CURIOS

## A Not So Sticky Problem

Have you ever wondered how dolphins and Killer Whales can maintain their sleek, smooth, low-drag and foul-free surfaces when other synthetic materials (and creatures that, perhaps, don't rely so much on speed and agility to catch their prey) become fouled with slime and encrusting organisms? Similarly, have you ever wondered why we have to routinely brush our teeth to rid them of attached biological debris, yet the insides of our cheeks, which are subject to the same fouling milieu of sticky molecules, bacteria and food, are free from such bioadhesions?

The mucosal surfaces of the inside of the human cheek and the external skin of dolphins and Killer Whales have been the subject of Dr Robert Baier's research, at the State University of New York at Buffalo. Using various biophysical techniques, Baier and four of his associates have demonstrated that the seemingly diverse layers of human intra-oral mucous membranes and the external mucosal skin of dolphins have similar architectural and chemical designs, which significantly differ from the non-mucosal surface of external human skin (*Biophysical Studies of Mucosal Surfaces*, pp. 83–95 in *Oral Interfacial Reactions of Bone, Soft Tissue and Saliva*, IRL Press Ltd, Oxford, 1985).

Oil placed on human skin will quickly adhere and spread, whereas if placed on dolphin skin it will only 'bead'. Measurements of the wetting and spreading



C.A. DEACON

of various liquids of known surface tensions and molecular sizes on different surfaces provide contact angle data that lead to a parameter known as 'critical surface tension'. The mucosal surfaces examined gave critical surface tensions between 20 and 30 dynes per centimetre (one dyne is a unit of force equivalent to one millionth of a newton). Critical surface tensions of this order seem to be typical of minimal biological adhesion; higher critical surface tensions for non-mucosal surfaces (30–40 dynes per centimetre) correlate with stronger biological adhesion.

Microscopic examination of the epidermis of human skin shows it to be

## Have you ever seen a barnacle stuck to a dolphin's back?

made up of a relatively thin layer of fully keratinised and un-nucleated (dead) cells. In contrast, the epidermis of the inner cheek and dolphin skin is much thicker and consists of fully nucleated (living) cells right up to the most superficial zone. More importantly, the outermost epidermal cells are surrounded by a glycoproteinaceous exudate of their own making. When the exudate surface was characterised it was shown to have a low critical surface tension (20–30 dynes per centimetre), indicating that it might be this low-surface-energy film that is responsible for the foul-resistant properties of mucosal surfaces. If indeed micro-organisms do attach and colonise, the lack of

strong adhesion of the glycoproteinaceous veil facilitates passive detachment by weak mechanical forces into the surrounding watery medium, whether it be the mouth or the sea.

These same low-surface-energy properties have recently been successfully imparted to completely synthetic materials, such as artificial heart sacs and substitute blood vessels, and a non-toxic, foul-resistant coating for ships is not far behind.

—G.H.

## Transgenic Animals

Modern biology has recently seen the emergence of a startling new technology that has the potential to change the productivity of our domestic



farm animals. Recombinant DNA techniques, which allow the isolation and test-tube modification of single genes from any organism, have been combined with a novel method of gene transfer. Together they provide a means whereby a gene can be isolated from any species of animal, plant, bacteria or fungus, and transferred to any other species in such a way that the foreign gene becomes an integral functional part of the recipient species' genetic information. When the recipient species is an animal, the new animals are called 'transgenic'.

Recombinant DNA is prepared by fragmenting the DNA of the donor organism with special 'restriction' enzymes, combining the DNA fragments with bacterial or bacteriophage DNA, and cloning the recombinant molecules in bacteria to purify the individual molecular species. Modification of the isolated genes to ensure their proper op-

eration in the new host is achieved in similar fashion. The isolated, purified and modified gene is then transferred to single-cell embryos of the recipient species by the procedure of micro-injection. In this technique, a very fine glass needle is inserted into one of the two pronuclei of the embryo, and 1-2 picolitres (a billionth of a litre) of DNA solution injected into the pronucleus.

The production of transgenic animals was first developed in laboratory mice. Recently, however, the technique has been extended to domestic farm animals. The aim here is to transfer modified genes to these animals in order to enhance their performance in the production of economically-important farm products such as meat, wool or milk.

In our laboratory at CSIRO in Sydney, we are producing transgenic sheep. Our first experiments are designed to dramatically increase the

growth rate and metabolic efficiency of sheep. To do this, we have prepared a special growth hormone gene, in which the portion of the gene that regulates the rate at which growth hormone is produced has been changed to allow much more hormone production than usual in the transgenic animals. Several variations of the recombinant gene have been tested in laboratory mice, where we have shown that transgenic mice can be made to grow nearly twice as fast and twice as large as normal mice when the gene is 'switched on' by the addition of zinc to their diet. These mice transmit the new gene to their progeny quite normally, and do not grow fast unless the gene is 'switched on'.

We have been able to produce four transgenic sheep containing one of our early variations of the recombinant growth hormone gene. We are one of only three laboratories worldwide that have mas-

tered this technique in sheep, and hence are pleased with our success at overcoming the difficulties involved in adapting the technique to this species. However, the gene inserted into these transgenic sheep is not operating as efficiently as we would like, and we have made a new variation of the gene to overcome this. The animals containing the modified gene will be born during the spring of 1987, and we hope they will respond to the gene as we have predicted.

While this new technology is still very experimental, its power and potential for improved animal productivity is awesome. Animals with enhanced growth rates, increased wool or milk production, and improved physiology in areas such as reproduction, are certain to be part of the farm within the next several decades.

—Kevin Ward  
CSIRO

## Shark and Sole

It is a well-known fact that some species of sharks are dangerous to humans. During World War 2, many military personnel had to, in one way or another, spend long hours in the open sea; shark attack, and the fear of shark attack, thus became tactical war-time problems that required immediate attention. Consequently, scientists associated with the United States Navy developed the first chemical shark repellent—'Shark Chaser'. It was a copper acetate-nigrosine dye mixture, compressed into a 150-gram cake. When required, the cake would be unwrapped and swirled about the user to create an



P. POTTER

Australia's first transgenic sheep, produced at CSIRO, Prospect, Sydney, in 1986.



## Compiled by Georgina Hickey

enveloping black cloud. However, post-war retrospection, together with carefully controlled tests, cast severe doubt on Shark Chaser's efficacy. What effectiveness it may have had was due merely to the visual screening effect of the black dye. But Shark Chaser wasn't all bad—it *did* act as a psychological aid, suppressing fears of those people stranded in shark-infested waters (be the sharks real or imaginary).

The disappointing experience with Shark Chaser cast doubt in some peoples' minds about the practicality of a chemical approach, in general, to shark repellents. However, chemical deterrents do have many potential advantages over other deterrent methods (electrical, acoustic or visual stimuli). They are simple to use, not bulky, cost little and are easy to manufacture and distribute.

So the search for an effective chemical shark repellent continued, but mostly with negative results. Recently, however, the discovery by Eugenie Clark of the natural shark-repellent properties of a Red Sea flatfish—the Moses Sole, *Pardachirus marmoratus*—has provided some hope for the development of an effective chemical repellent (*Natl Geogr.* 145: 718–27, 1974).

The sole emits a milky secretion from glands along its dorsal and anal fins, which is retained in part in the fish's mucous coating. Dissolved in seawater, a protective halo of about ten centimetres in radius surrounds the fish, acting as a powerful repellent to and causing abnormal behaviour (such as thrashing

about and rapid opening and closing of the gills) in some sharks.

The active component of the secretion is an acidic protein called pardaxin. It acts on the sharks' gills, causing deleterious effects on their ability to regulate passage of salt (in the forms of ions) across gill membranes. In particular, it is a potent inhibitor of an ATPase—an enzyme that acts as an ion pump and is critical for effective ion regulation and salt balance. In a marine environment, in which the salt content of the water is many times higher than that of the animals' cells, maintenance of a proper salt balance is essential for survival. It is no wonder, then, that sharks shun this chemically-aversive fish.

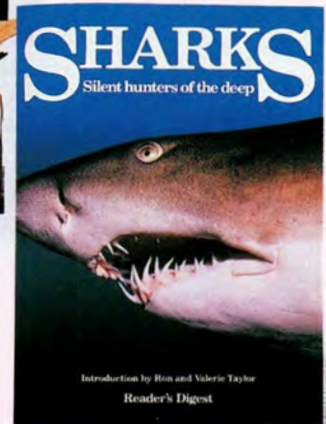
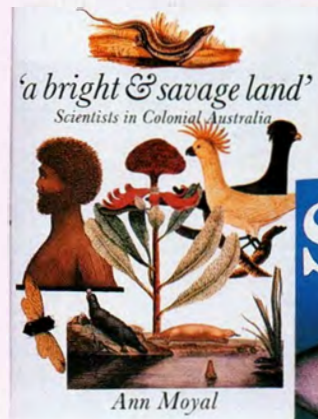
Australia is home to three species of *Pardachirus* flatfish, and at least two (*P. hedleyi* and *P. pavoninus*) also produce this toxin.

Although pardaxin itself would probably be too costly to collect or synthesise, there are inexpensive substitutes (such as industrial surfactants—detergent-like substances) that are supposed to 'mimic' the action of pardaxin. Once fully tested, such substances could be impregnated into or sprayed onto wetsuits, providing foolproof protection from sharks.

*Pardachirus* flatfish are not the only animals that repel sharks. Some sea cucumbers and sea hares, for example, also elicit aversive behaviour. The study of these natural shark repellents, in general and specifically, can only make the practicality of developing a chemical repellent more promising.

—G.H.

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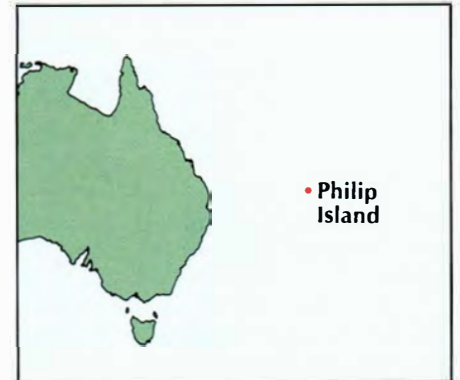
# RARE & ENDANGERED

## Philip Island Hibiscus



N. HERMES

Philip Island Hibiscus.



Philip Island



A. FOX

The Philip Island Hibiscus, *Hibiscus insularis*, is listed by the IUCN as one of the world's ten most endangered plants. However, recent work on Philip Island and the Australian mainland has dramatically increased this plant's chances of survival.

Philip Island is a 250-hectare, volcanic island, uninhabited by humans, eight kilometres south of Norfolk Island. Two hibiscus species occur naturally on the island group. One, the Palau (*H. tiliaceus*), is widespread in the south Pacific but is restricted to the main island of Norfolk. The other, the subject of this article, is endemic to Philip Island. A related tree, *Lagunaria patersonia*, grows on both islands and is known locally as White Oak. This tree is widely culti-

vated in Australia where it is sometimes, confusingly, known as the Norfolk Island Hibiscus.

The Philip Island Hibiscus survives in the wild in only two small patches—one 50 metres in diameter, the other ten. It grows naturally as a low woody shrub, reaching up to three metres in height. In more favourable sites it may have the potential to grow into a small tree. Its yellow-cream flowers appear in spring and, as they age, turn bright crimson. The wild plants only have adult leaves but when grown from seed the young plants display a distinctly lobed juvenile foliage. Recent work at the Australian National Botanic Gardens has shown that the adult foliage appears five years after seedlings are established but in some





Barren landscape of Philip Island.

cultivated plants the juvenile foliage has persisted for over ten years.

Philip Island was once a well-vegetated island. Early botanical records indicate that subtropical rainforest plants once occurred there in gullies. When the first penal colony was established on nearby Norfolk Island in 1788, however, pigs, goats and rabbits spread to Philip Island and, within a few decades, the natural vegetation was all but totally removed. Severe soil erosion occurred and the pigs and goats died, but the rabbits persisted and contributed to the creation of today's barren landscape.

The rabbits prevented survival of the hibiscus seedlings. They maintained a bare soil surface beneath the plants, presumably altering the soil moisture levels and fertility, and burrowed amongst the roots. Another threat to the hibiscus was the African Olive (*Olea europaea africana*)—an introduced woody weed that probably became established on the island over a century ago and is now the most conspicuous plant. By overgrowing the endemic hibiscus, it threatened it by limiting the plant's growth yet afforded it some protection from the destructive salt-laden winds.

In the early 1980s several actions were undertaken to protect the remaining wild plants. Seed and cuttings were collected and propagated at the Australian National Botanic Gardens in Canberra. Seedlings are now held by many botanic gardens around Australia and some plants are established in private gardens on Norfolk Island and one in the Royal Botanic Gardens in Sydney. The African Olive was cut back from the remaining hibiscus plants and a regular program of monitoring the olive established. Finally in 1981 a program to eradicate the rabbits from the island commenced. Eradication was achieved in 1986.

Ever since the African Olive was checked and the rabbit numbers started to decline, there has been a marked increase in the flowering of the wild hibiscus. It should now be possible for natural regeneration to occur—the first time, perhaps, for over a century. □ —Neil Hermes  
Environmental Consultant

# NATURE CONSERVATION

the role of REMNANTS of

# NATIVE VEGETATION

Over much of the world, "clearing" of land has removed most of the natural vegetation, leaving only small remnants of the original ecosystems. Areas that previously contained important biological resources have been among those cleared, so that many plant and animal species have become restricted to remnants, which may consequently hold a vital store of genetic material. Unlike large areas in which natural processes continue to function, the smaller remnants are often subject to a variety of disturbances that commonly cause a decrease in their number of species.

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Habitat of the Philip Island Hibiscus.





Influenza can be a serious threat to human life. Just after World War I the virus killed over 20 million people in a world-wide epidemic. Still thousands of people die each year from the virus. Influenza viruses can also infect and kill other animals, including birds.

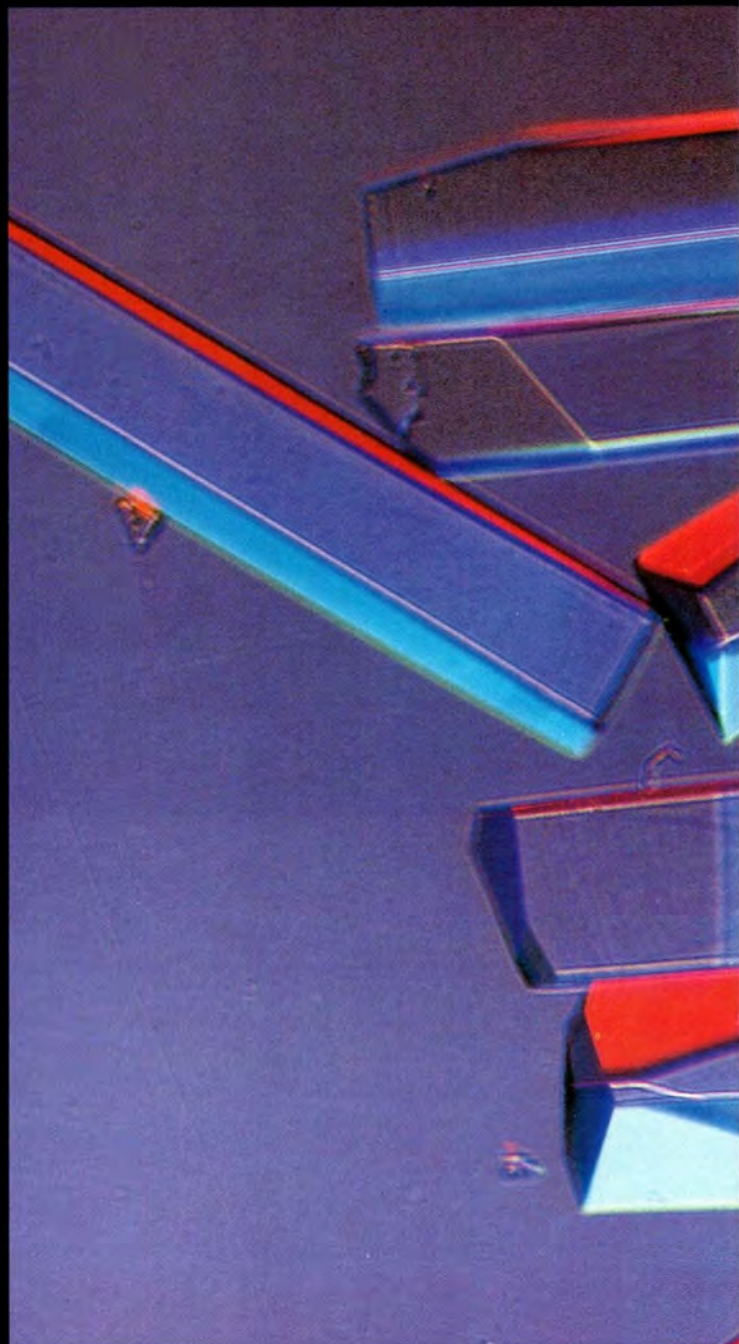
An inherent part of the virus is a surface enzyme called neuraminidase, which is needed to spread the virus around the body. Certain areas ('antigenic sites') on the surface of the enzyme stimulate the immune system to produce antibodies, which would normally inhibit the enzyme and stop the virus from spreading. The problem with the 'flu virus, however, unlike most other viruses, is that the antigenic sites keep changing, so that the virus is always one step ahead of the immune system. This ability to change itself constantly means that vaccines against the 'flu virus have so far been ineffective.

The exact shape of the enzyme and the way in which antibodies attach to it must be known before an effective vaccine can be developed.

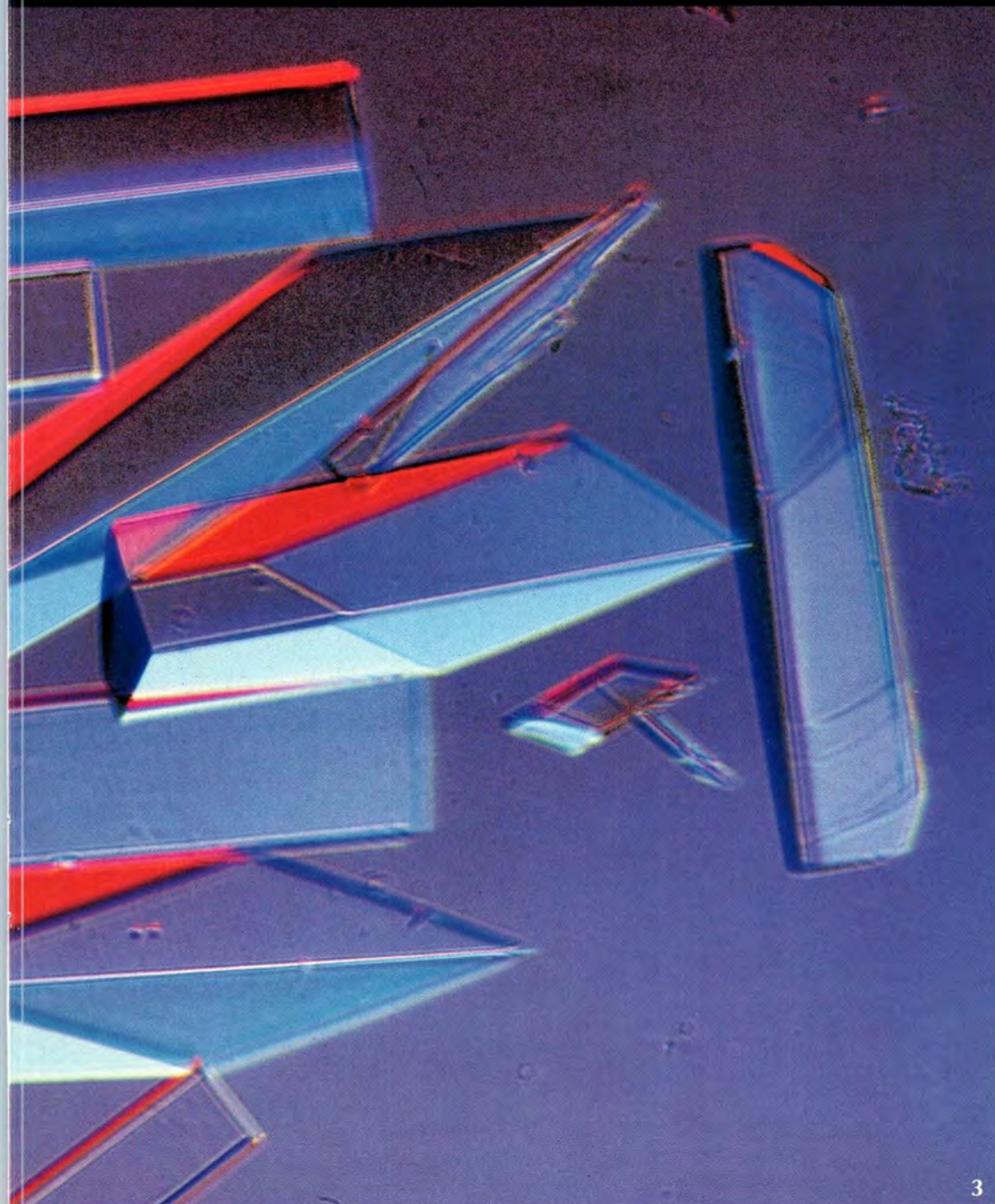
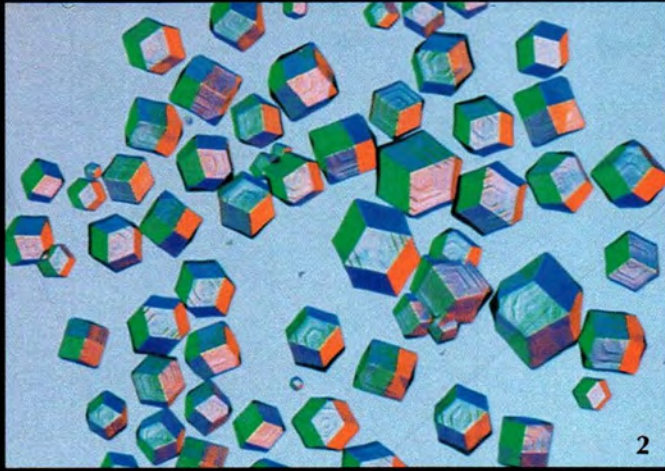
The photographs here show crystallised neuraminidase and

## INFLUENZA CRYSTALS

PHOTOGRAPHY BY  
STUART BUTTERWORTH  
AND JULIE MACKLIN







1, 2, 4. Crystallised neuraminidase from an influenza virus isolated from White-capped Noddy Terns (*Anous minutus*) on the Great Barrier Reef. 3. Crystals of antibodies complexed with neuraminidase from an influenza virus isolated from White-capped Noddy Terns (*Anous minutus*) on the Great Barrier Reef.

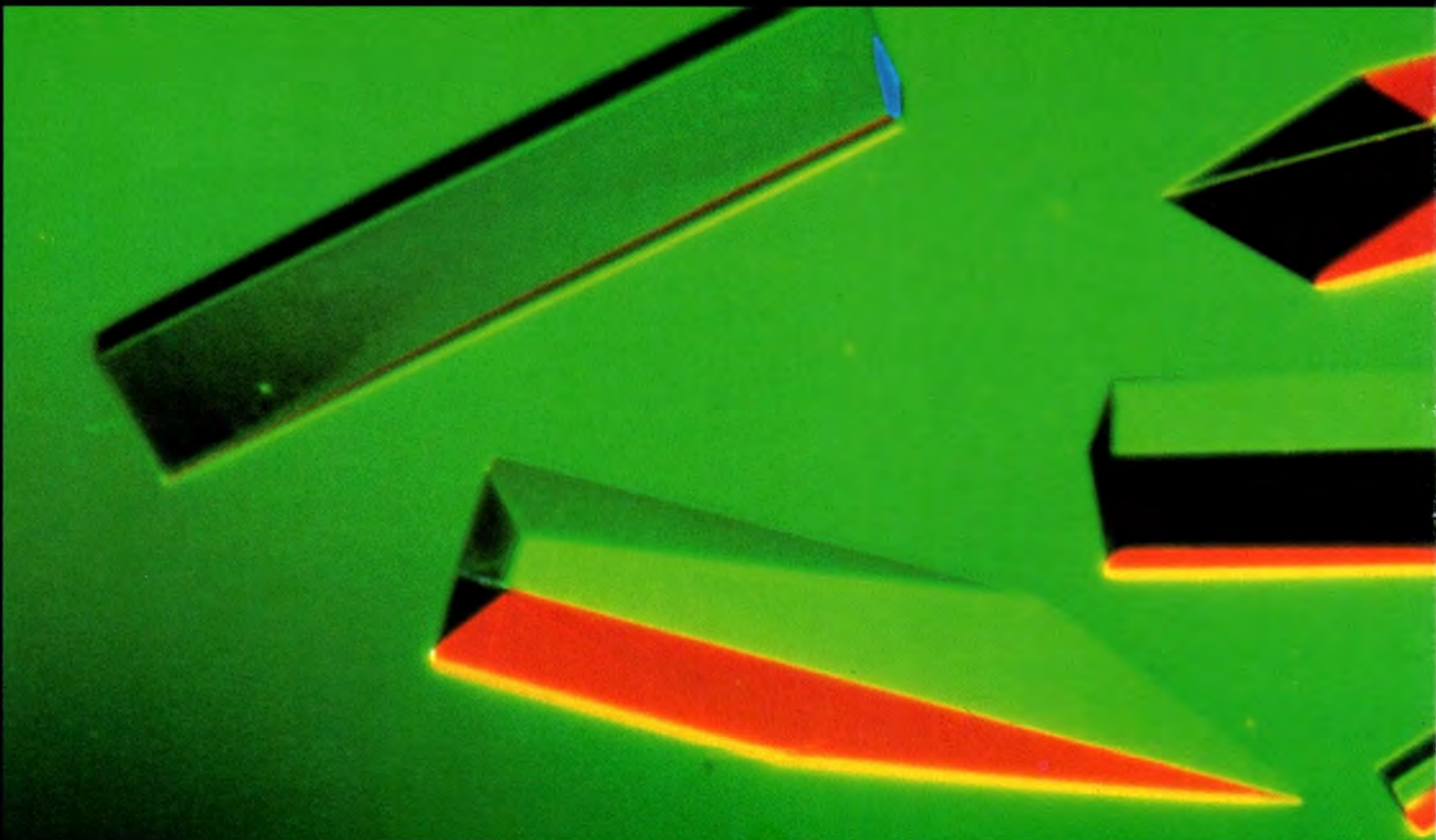
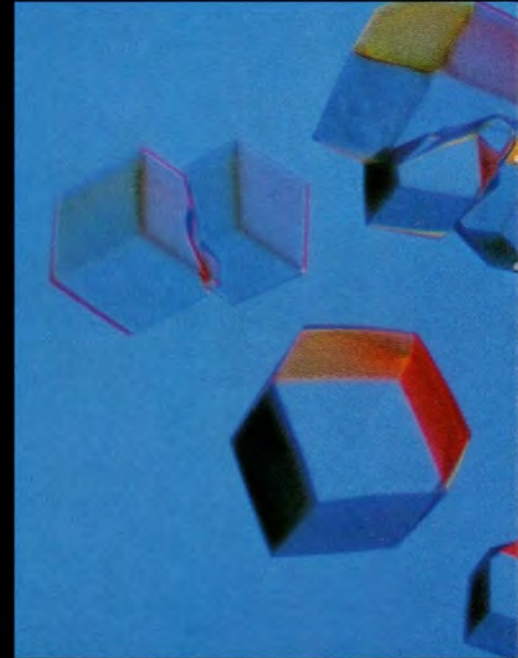


crystals of antibodies complexed with neuraminidase. When a beam of x-rays is passed through the crystals, the x-rays are diffracted by atoms in the crystal and, from the patterns obtained, a three-dimensional structure of the protein molecules can be determined. This work may also lead to a cure for 'flu.

When the exact structure of the neuraminidase is known, substances can then be made that will fit into the active centre of the enzyme, stop it acting and so stop the 'flu virus spreading in the body. This should provide a 'cure' for the 'flu. When the exact structure of the complex between antibodies and the neuraminidase is known, we will have a better understanding of how antibodies bind to the virus. This may point the way to the development of an effective vaccine against 'flu.

The crystals are about one millimetre in size and the photos were taken using transmitted light with several filters of different colour placed between the light source and the crystals and arranged in such a way that different colours lit up different facets of the crystals. □

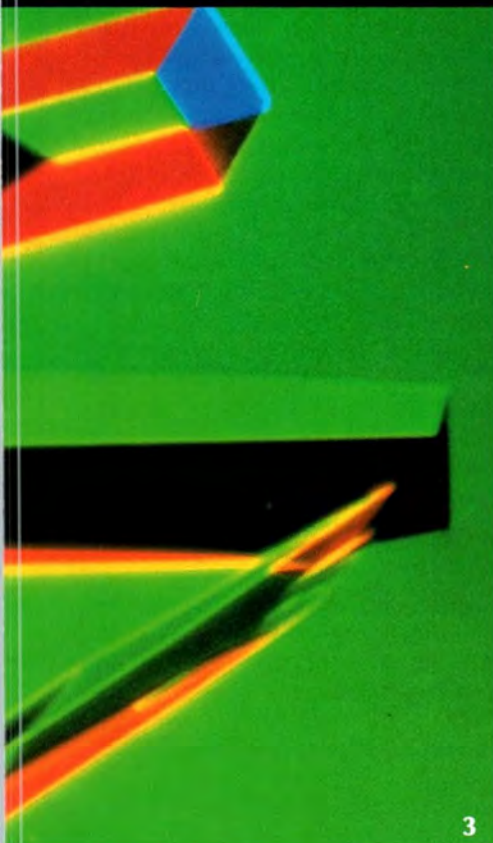
—Graeme Laver  
Australian National University



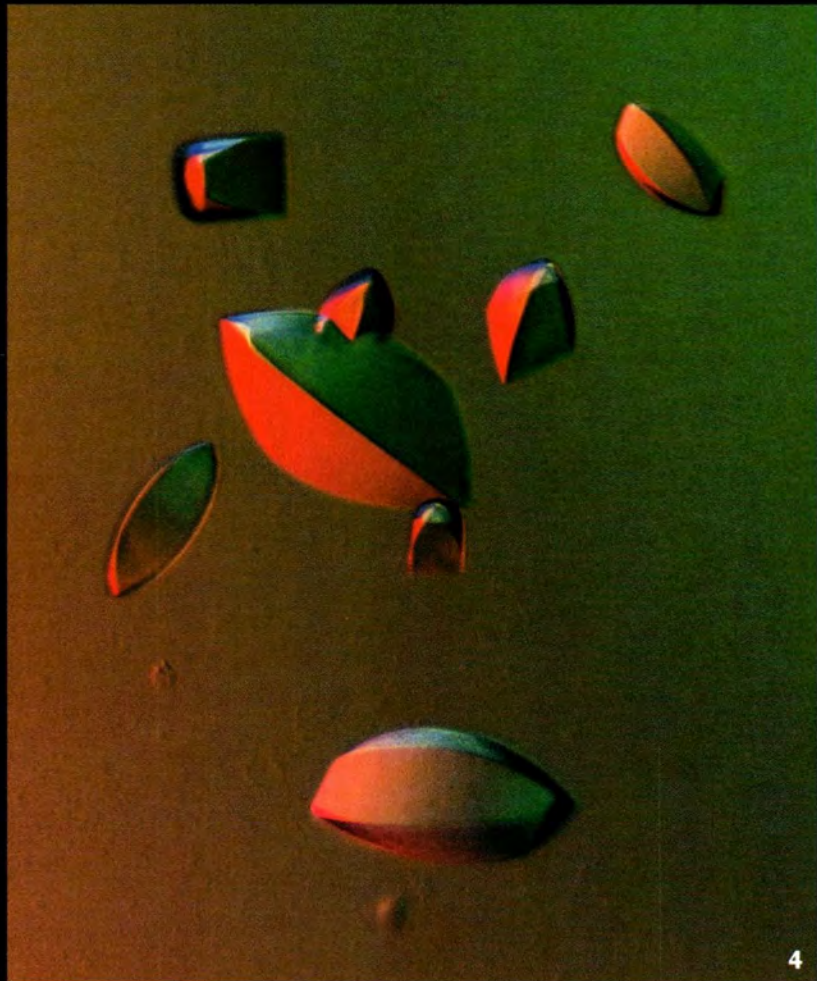




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2. Crystallised neuraminidase from an influenza virus isolated from White-capped Noddy Terns (*Anous minutus*) on the Great Barrier Reef. 1, 4. Crystals of antibodies complexed with neuraminidase from an influenza virus isolated from White-capped Noddy Terns (*Anous minutus*) on the Great Barrier Reef. 3. Crystals of antibodies complexed with neuraminidase from an influenza virus isolated from a pilot whale (*Globicephala melaena*) in the United States.



## The Abrolhos Islands

"I have seen many vast flocks of birds but I confess I was not at all prepared for the surprise I experienced in witnessing the amazing clouds . . . of these birds when congregating in the evening while they had their young to feed . . . Even those who had witnessed the vast flights of the Passenger Pigeon, so vividly described by Audubon, could hardly avoid expressing surprise at seeing the multitudes of these birds which at sunset move in one dense mass over and around the roosting place, when the noise of the old birds, the quack and the piping whistle of the young ones, are almost deafening."

This was written in 1843 by John Gilbert in a letter to John Gould, after a visit to the Abrolhos Islands off Western Australia. Gilbert was assistant to Gould, whose writings brought our natural history before a European public and who is honoured in the Australia-wide nature association for children known as the Gould League.

Forty years ago, when I read those words of Gilbert, I decided I must visit those magical islands. Situated some 70 kilometres off the Western Australian coast at Geraldton, they were first recorded by a Dutch captain, Frederik de Houtman. In 1619 he noted seeing "level broken country with reefs around it". A similar group of dangerous islands off the coast of Brazil had been given the name Abrolhos—from the Portuguese *abri vos olhos*, meaning 'keep your eyes open'. The island group on the other side of the world was given the same name, although not every skipper took heed of the warning.

In 1629 the ship *Batavia* was wrecked on a reef in the island group. The commander, Francois Pelsaert, left in a small boat to get help from the Dutch colonies in Indonesia. In his absence a mutiny led by Jerome Cornelius ended in the murder of



more than 130 of the survivors. Pelsaert returned to deal out justice to the mutineers, including marooning two of them on the nearby mainland, our first white 'settlers'.

This intriguing story of wreck, treasure, murder and retribution excited the folk back home in Holland where the story was published under the title *The Unlucky Voyage*. Wood-cuts convey the tragedies that took place on those lonely islands.

But it is the natural history, not the human history, that I am more interested in. The birds described by Gilbert are the Lesser Noddy Terns (*Anous tenuirostris*), which breed only here and across the Indian Ocean on the Seychelles. At least 17 other seabirds nest on the Abrolhos Islands. The huge flocks, and the number of different species that breed on Pelsart Island, the largest island of the group, make it one of the world's most famous seabird sanctuaries.

What makes these islands particularly interesting is that, in these

### Greeting a Sea Lion among the mangroves of Serventy Island.

waters, warm and cold currents mix to create the southernmost coral reefs of the Indian Ocean, where 157 species of coral co-exist with kelp beds. Coral and kelp are usually found in different areas, as coral is associated with warm waters and kelp with cold.

The islands not only provide a magnet for nesting seabirds but also for land animals such as the Tammar Wallaby (*Macropus eugenii*). Commander Pelsaert's notes on this animal represent the first description of an Australian marsupial to reach Europe:

"Besides we found in these islands large numbers of a species of cats, which are very strange creatures; they are about the size of a hare, their head resembling the head of a civet-cat; the forepaws are very short. . . resembling those of a monkey's. . . Its two hind legs, on the contrary, are upwards of half an ell [500 millimetres] in length and it



OF



# VINCENT SERVENTY



Since my first visit to the Abrolhos 40 years ago, I have been back many times, including a magical six months during which I lived in a small hut on Pelsart Island as a kind of scientific beachcomber. My last visit, made in January this year, was spent gathering data in an endeavour to convince the Western Australian

had been named Serventy Island in honour of my brother, my sister and myself, for our work in natural history and conservation.

A flotilla of three yachts, the Serventy Expedition, made a triumphant landing on our island where we were greeted by several Sea Lions (*Neophoca cinerea*) and many



Flock of Common Noddy Terns (*Anous stolidus*), which nest on Pelsart Island.



walks on . . . the flat of the heavy part of the leg, so that it does not run fast. Its tail is very long, like that of a long-tailed monkey”.

Pelsaert also created the myth that these animals grow out of the nipples of the mother. Even though zoologists knew better, it was not until this century, when photographs were taken of marsupials giving normal mammalian birth, that the myth finally became ‘extinct’.

Government that here is an island group whose natural history merits protection as a marine park and which is possibly worthy of World Heritage nomination. Dr Paul Lewis, an underwater photographer who has watched craypots landing on coral growths, estimates that the two million pots dropped each year destroy 2.4 square kilometres of the reefs. In addition, Tammar Wallabies and seabirds were used, in the early days of the industry, as bait for the crayfish; this, however, no longer takes place, at least with professional fishermen.

An additional attraction, for me at least, was that one of the islands

nesting Bridled Terns (*Sterna anaethus*). Clouds of Sooty Terns (*S. fuscata*) arose on another island, which was joined to ours at low tide, and further in the distance I could see clouds of Lesser Noddies rising from the mangroves.

Abrolhos was a name given as a warning to early sailors. Today it serves more effectively as an advertisement for one of the greatest natural history delights of Western Australia’s ‘Silver Coast’. Yet the name still serves as a warning, that is, unless action is taken promptly, unplanned development might cause irreparable damage to life both below and above its waters. □



## Seashells of Western Australia

Fred E. Wells and Clayton W. Bryce. *Western Australian Museum, Perth, 1985, 207 pp. \$17.95.*

Fortunately, the title of this book is somewhat of a misnomer, for not only are those molluscs with shells treated, but also those without—nudibranchs, octopods and their kin. And it is especially pleasing to see some attempt to cover the 'minor classes' of molluscs—the chitons, scaphopods, cephalopods and even bivalves, which have, until recently, been ignored in treatments of Australian molluscs, creating a tyranny of the gastropods with authors and publishers, and perpetuating a vicious circle of lack of information—lack of demand within the interested public.

The book itself is an excellent production, with high-quality plates by Clay Bryce and a lucid text by Fred Wells. There has arisen the usual problem of background so that some dark-coloured species merge into the black plates (for example plates 25 and 27), but no universal background exists for the vast array of colours in molluscs, at least not in the price range of this book. There is also the conceptual problem of a book limited to State boundaries, which don't approximate any zoogeographical division in Australia (apart from the New South Wales—Victorian border). The mixing of the temperate fauna of southern Western Australia with the tropical northern fauna does create a market outside its parochial title, and readers from most of Australia will find some elements of their local fauna treated.

Ignoring the inevitable taxonomic quibbles with a work of this scope, aplacophorans (page 13) do occur within

Australia but have only been described from New Zealand. A figure of a single chiton valve in the glossary might also have been useful in explaining what "pectination of the insertion plates" (page 30) means to the vast majority of readers unfamiliar with chiton anatomy. There is a small scatter of typographical errors ("vivalves" on page 21 gives an interesting connotation of liveliness to a usually sedentary group), but overall *Seashells of Western Australia* is an excellent work and hopefully a foundation for an expanded treatment of the fauna. It is well worth the moderate price of \$17.95.

—Ian Loch

## A Bright and Savage Land. Scientists in Colonial Australia

Ann Moyal. *Collins, Sydney, 1986, 192 pp. \$45.00.*

It has only been over the past decade that the study of the history of Australian science, once the preserve of elderly scientists, has gained a separate academic identity. Ann Moyal was an early pioneer of Australian history of science, both with her bibliographies and *Scientists in Nineteenth Century Australia: A Documentary History* (1976). She now gives us a breezy and somewhat breathless overview of the development of Australian science over the course of the 19th century.

As Moyal highlights, for most of the century Australian science was derivative of and dependent on European science. She explores issues (the Australian reaction to evolutionary thought), events (the inauguration of scien-

tific societies, and the advent of science in the university curriculum), individuals, and controversies (the geological debate between McCoy and Clarke, and disagreement over *Thylacoleo's* characterisation as a carnivore).

The real strength of the book lies in its splendid illustrations; unfortunately, the text is marred by defects. Interpretation of the historical record will always be contentious, but the idea that there was little acceptance of Darwinian theory in Australia prior to the 20th century is increasingly dated. More disconcerting, however, are the many glaring errors of fact found throughout the book. Both Cook (p. 17) and La Perouse (p. 29) would have been startled to find that they had sailed into Sydney Harbour (Port Jackson); Thomas Brisbane did not arrive in New South Wales until November 1821, so could scarcely have presided over the inauguration of the Philosophical Society of Australasia in June 1821 (p. 87); Australian correspondents of Darwin would have been surprised to find that he had none prior to 1859 (p. 145); and it was J.D. Lang who announced the discovery of fossils in the Wellington Caves, not Thomas Mitchell (p. 154). This list of errors is by no means exhaustive, and it indicates a hurried or careless production.

A second flaw of the book is Moyal's unmitigated advocacy of certain individuals. Is Gerard Krefft "now generally regarded as the best vertebrate zoologist of his day" (p. 98)? Moyal has already encountered problems with Krefft in her 1976 book by portraying him as correct in

his characterisation of *Thylacoleo carnifex*, the Marsupial Lion, as a herbivore. As she now acknowledges, the weight of scientific evidence indicates that *Thylacoleo* was a carnivore, as Richard Owen maintained all along. A second instance of personal advocacy is Moyal's apparent acceptance of a thesis claiming that Amalie Dietrich amassed "the most important collection made by a single person" (p. 109). While this may be good feminist history of science, it is of dubious veracity.

—Colin Finney

## Sharks: Silent Hunters of the Deep

Capricorn Press Pty Ltd, *Reader's Digest, Sydney, 1986, 208 pp. \$27.95.*

Because of their large size and potentially ferocious behaviour, the study of sharks has not developed to the same extent as the study of bony fishes. Sharks, generally portrayed as primitive vertebrates, may actually be highly evolved creatures; several species have even been classified as warm-blooded. Their sensitivity to even extremely weak electric fields appears to be one way in which they locate prey. These are just a few insights into the biology and behaviour of sharks gained from past and ongoing research, included in section one of this book. For the most part, the section is scholarly-based, although occasionally less than scientific objectivity gets hived off as evidence for refuting a theory. One example of this is the assertion (page 53) that "muscle action could hardly account for her



[the shark's] higher body temperature" following the insertion of a thermometer into a deep knife wound in the shark's back, three hours after it had been dragged to shallow water and had lain "practically motionless".

Section two is devoted to human interaction with sharks. From discussion of the possibility of Jonah's whale having been a shark to the latest attempts in developing an effective shark repellent, the chapter is studded with accounts of shark attacks on humans as well as human attempts at keeping sharks at bay. Although many of the incidents took place in countries other than Australia, the book is aimed at an Australian audience and Australian horror tales abound. The accounts are well chosen for their sensationalism and typical of most Reader's Digest books, the accompanying photographs are of high quality.

Section three contains a description of the 344 known species of sharks in the world and an analysis of the geographical distribution of attacks. The species list is derived primarily from *Sharks of the World* compiled by Dr Leonard Compagno, one of the pre-eminent shark taxonomists in the world and thus presents a list which is as up-to-date as possible. The geographic analysis of shark attacks is another monumental research feat and provides an illustration of shark attack patterns.

The contributors to the book include some well-established scientists in the field of shark research. With the other shark enthusiasts, they have managed to assemble a book well balanced in the biological and behavioural aspects of sharks, and facts and figures for the reader's interest.

—Denise Rennis

## Flora of South Australia

Ed. by J.P. Jessop and H.R. Tolkein. South Australian Government Printing Division, Adelaide, 1986, 4 vols, 2,248 pp. \$140.00.

J.M. Black's delightful *Flora of South Australia*, first published in 1929, was for over 50 years the standard text on South Australian plants. This compact user-easy flora was an indispensable companion for field trips in that State.

But floras date quickly, and the need for something new has at last been realised with the publication of this completely new edition.

Alas, I shall think twice before taking this new flora into the field, for each of its four hard-bound volumes is as big (and as heavy) as the complete edition of Black. The extra bulk is taken up by the more generous descriptions of each plant, the wealth of line illustrations and the inclusion of many more plants.

Indeed, the new flora depicts 30 per cent more plants, most of them introduced species established as weeds since 1957. Weeds are an index of environmental disturbance, and South Australia is faring badly, perhaps the worst among Australian States.

This new flora begins with an excellent illustrated history of botanical discovery in the State by D.N. Kraehenbuehl. One hundred botanists from around Australia have contributed to the text. Thirty-five new plants, including orchids and bluebells, are scientifically described. Distributions are listed by botanical region. Each volume has its own comprehensive glossary, printed on pink

paper for easy access.

I have two criticisms. Information on habitats is largely lacking. Only the orchids and a few other groups are well served; the vast majority of plants receive no more than a single phrase such as "sandy soils". The editors submit that "ecological notes have largely had to be omitted through lack of data" but I suspect the real reason was lack of time or conviction. Also, the illustrations tend to be crude and lifeless and occasionally unrecognisable.

Nonetheless, this is a milestone publication, and sure to be the envy of botanists in other States. The floras of Victoria and Tasmania are now out of date, and no other State has a complete flora, although the Western Australian Herbarium has just released a flora of the Perth region, another exciting addition to our knowledge of Australian plants.

—Tim Low

## Thomas Baines and the North Australian Expedition

Russell Braddon. Collins and Royal Geographical Society, Sydney, 1986, 160 pp. \$65.00

In 1855 Augustus Gregory took charge of an expedition to the north-western shoulder of Australia. In addition to exploring much of the environs of the Victoria River, to which the expedition had been transported by sea, Gregory's task lay in over-landing from that area to Brisbane. The expedition was successful in both these efforts, although less so in a subsidiary task—the search for information on the disappearance of Ludwig Leich-

hardt's expedition of 1848.

Braddon's book virtually ignores the larger context of the Gregory expedition and concentrates on the limited role played by Thomas Baines, artist-storeman and later leader of the support party. The explanation for this circumscribed focus is fairly obvious: the book is designed as a showcase for the illustrations produced by Baines during the expedition. It is unfortunate for both the book and Australian history that Baines did not accompany Gregory on his trek across the top of Australia.

In his research for the book, Braddon appears to have worked almost entirely from the diaries of the individuals on the expedition. Although this gives an immediacy to the text, it results in a number of problems, including Braddon adopting Baines' incorrect spelling of the names of New South Wales Governor William Denison and the expedition's botanist, Ferdinand Mueller. The other defect of this approach is that the book gives very little detail of the wider context of the expedition (Braddon makes the claim that the greatest achievement of the expedition was Baines' paintings) and prior investigations of the Victoria River (John Lort Stokes and John Wickam in the *Beagle*). Admittedly the book is about Baines, but his leadership problems are not significant enough to sustain the text of the book. What do carry the book are Baines' illustrations—the sketches and watercolours more so than the stylised oil paintings.


One last point, the sketch of a shark on page 126 which Braddon somewhat patronisingly dismisses, is a whale shark and therefore easily within the size range that Baines estimated.

—Colin Finney









# THE KESTREL

## AUSTRALIA'S SMALLEST FALCON

by Penny and Jerry Olsen

**T**he Australian Kestrel (*Falco cenchroides*) is probably our most commonly seen bird of prey. This small, pretty falcon has a rather distinctive habit of hovering almost stationary in the air while searching the ground below for prey. It is often found in close association to humans: nesting in suburban tree hollows and on tall city buildings;

hunting over wastelands, airports and open parkland; perching on roadside fence posts and electricity poles and their wires.

The early settlers called this bird the Nankeen Hawk because its colour reminded them of the yellowish-buff cotton cloth (nankeen) originally made in Nanking, China. Later, those who recognised

BABS AND BERT WELLS

A female Kestrel tends her chicks.



its affinities with a successful and geographically widespread group of typical kestrels renamed it the Nankeen Kestrel. More recently its common name has been changed again, to the Australian Kestrel, in acknowledgement of its regional stronghold.

## Distribution

*Falco c. cenchroides*, the Australian subspecies, is more or less ubiquitous throughout Australia, while the New Guinean subspecies *F. c. baru*, about which little is known, is confined to the highlands there. The Australian subspecies also occurs, apparently as a winter vagrant, in New Guinea and Indonesia. It is thought to have colonised Lord Howe and Norfolk Islands, 700 and 1,700 kilometres respectively north-east of Sydney, as recently as the 1960s. In the 1940s it reached the Australian territory of Christmas Island in the Indian Ocean, perhaps by hitching rides on ships operating in the area during the war. All three islands now support substantial breeding populations. The Australian Kestrel is most common on the main-

## The Falcons

The genus *Falco* is a group of small to medium sized, largely daylight-hunting birds of prey. Typically, they have short necks, long pointed wings and narrow tails. Their eyes are dark and many have a black moustachial streak running from beneath the front of the eye down past the corners of the mouth which may help to reduce glare. The beak is short, strong and hooked, with a tomial 'tooth' on each side—thought to be of use in snapping the necks of prey. Falcons' talons are long and curved and their toes are powerful. The hind toe is used to strike prey, while the hind and elongated middle toe are the main toes used for snaring prey. Falcons fly with strong wing beats and have great powers of diving ('stooping'). Males are smaller than females, particularly so in bird-catching species and less so in insectivorous species like the Australian Kestrel.

land, rare in Tasmania and, in the far north, is locally common during the dry season.

Smallest of Australia's six falcons (about the size of a slim magpie), the Kestrel is warm cinnamon brown with a buff breast. When perched the Kestrel's stance is upright, its long tail adding to this effect. In the air its long tapered wings and long tail are obvious in most situations, particularly when hovering.

Typically Kestrels are solitary falcons found in open, short grassland. However, they can tolerate a great range of ecological conditions and are found in most types of country from the rugged, treed slopes of Mt Kosciusko to the flat, almost treeless Nullarbor Plain. This adaptability is due to their catholic diet and mobility; as well as their flexibility in home range size, choice of nest site and hunting technique.

## Hunting and Food

Hovering provides a mobile perch and allows the Kestrel to hunt in treeless areas. Only the grey and white Black-shouldered Kite (*Elanus notatus*) can rival the Kestrel in its mastery of hovering. On spotting prey from its perch the Kestrel usually makes a short glide down onto its victim. Kestrels can also pursue and overhaul aerial prey in flight, snatch prey from trees or the surface of water, and run over the ground in pursuit of insects. They will eat freshly-killed animals hit by cars, steal food from other birds and take advantage of prey flushed by a third party such as a human or tractor. A pair of Kestrels will hunt co-operatively—one flushing or splitting a flock, the other following behind, snatching up the confused victim. Prey is seized with the feet, killed by reaching down and snapping the neck, and usually carried to a perch to be dismembered and eaten, although some prey is consumed in flight.

Most hunting is done in daylight but Kestrels may hunt crepuscularly (in twilight) and a similar kestrel overseas (the European Kestrel, *F. tinnunculus*) has been seen hunting by moonlight.

In one study, 82 per cent of 364 attempts to capture mostly insect prey were successful. Prey includes spiders, centipedes, moths, damselflies, water beetles, dung beetles, Christmas beetles, frogs, small reptiles, sparrows, starlings, pipits, un-



fledged pigeons, house mice, rabbit kittens and probably slugs and earthworms. The Fat-tailed Dunnart (*Sminthopsis crassicaudata*) is one of the few native mammals recorded in the diet, introduced vertebrates being common.

One study in south-eastern Australia revealed that while there were great numbers of invertebrates in the diet there was a greater mass of vertebrates. Prey is probably represented in the diet at least partly according to its availability (accessibility and abundance). Reptiles are eaten more in spring and summer when they are most active; mice become almost the sole item in the Kestrel's diet during mouse plagues. Kestrels have been seen flying while carrying prey weighing up to 60 per cent of their own body weight (the largest being a Stubble Quail, *Coturnix pectoralis*). They consume about 30 to 40 grams of prey a day (for example, three wild house mice) or one fifth of their body weight.

## Movement

Little is known about movements of Kestrels within Australia. Some movements are dispersive, some random and some seem to approach true migration. In certain areas, for example near Canberra and Mildura, one or both of a pair of Kestrels will stay in their territory all year round. Nevertheless Kestrels, especially young of the year and some adult females, leave their breeding territory in late summer-early autumn. In the south-east they appear to move further inland and also northwards up the east coast. At least some of this movement is altitudinal,





N. J. BIRKES

**A male Kestrel is caught on camera, seconds away from its murid meal.**

with movement down from the Great Dividing Range in the colder months and back again in spring. Kestrels are great opportunists and will gather in an area in times of plenty, for example during a mouse or locust plague, only to leave when the food source leaves or becomes exhausted.

### Territory

If absent during winter, Kestrels return to a traditional breeding territory in early spring. During the breeding season a male and female will defend a territory (by chasing and stooping at the intruder and uttering a defensive 'kee-kee-kee' call) against other Kestrels and potential predators such as larger birds of prey and sometimes humans. A breeding territory contains some hunting ground and one or several potential nest sites. However, some pairs are only able to obtain a suboptimal territory in which there is no nest site. The territory often also contains a few sheltered (usually from the south-west) roosts where the Kestrels sleep (often with one leg tucked up), preen themselves, or eat prey, and some preferred vantage point from which to search for prey. Territory size seems to be dependent on the available food supply (suitable prey in suitable hunting habitat), while territory shape seems to be determined by hunting terrain and the position of the nest site in relation to this. For example, where nest sites are clustered in a group of isolated trees in good hunting ground, Kestrel

pairs will nest close together but will hold separate triangular-shaped territories fanning out from the nest site. Pairs have been recorded nesting less than 100 metres apart and on three adjacent power pylons 450 metres apart. More usually, however, they nest kilometres apart and territories are irregularly spaced.

### Breeding

Breeding is strongly seasonal according to area. It has been suggested that Kestrels can breed any time of year under favourable conditions, but there are only a couple of records of these birds breeding out of season. They can delay breeding, within limits, and apparently do so, for example, when waiting for corvids (crows, ravens, etc.) to vacate their nests in areas where these birds build the only suitable nests. In poor years, during a drought or after a fire, Kestrels may not attempt to breed.

Nests are usually hollows in

trees, cliff ledges and potholes, or the stick nests of other birds. Man-made sites like buildings and quarries are also used. Nesting on the ground is uncommon presumably because of the increased risk of predation. Stick nests used are most often the open nests of corvids, although use of the enclosed nest of the Chestnut Crowned Babbler (*Pomatostomus ruficeps*), for example, is not unusual. In general a more enclosed nest like a pothole is preferred to an exposed one. No nest is built by the Kestrel but a scrape (shallow depression) is made by shuffling the body in the nest substrate.

Pairs perform courtship in the breeding territory, with much soaring, displaying and vocalisation. The male makes mock attacks at the female and the pair perform undulating flights together, often in high wide circles, giving a 'killy-killy' call. They 'play' aerial leapfrog and the male may make an aerial food pass to the female. Feeding of the female by the



P. AND J. OLSEN

**For study purposes, this juvenile Kestrel, which is 19 days old, is colour-marked for individual recognition.**



Kestrel eggs.

I. R. MCCANN, ANT



male, and its associated behaviour, is an integral part of courtship. The pair makes ritualised inspections of potential nest sites before making a choice. Often there is a high degree of nest site fidelity and one nest is used for many years by one or both of its previous occupants. Mating takes place often and well before egg-laying commences. Although Kestrels are monogamous some promiscuous mating may occur between neighbouring pairs.

A single clutch of eggs is laid, usually in September or October—earlier in warmer inland and more northern areas. Between one and seven but usually four eggs



N. N. BIRKS

## Hovering

The hovering Kestrel is stationary relative to the ground but is actually flying forward at a pace adjusted to the speed of the head wind. Its head remains steady, while the wings absorb the buffets of the wind, allowing it to pinpoint prey on the ground below. In light wind, when the airspeed of the Kestrel is low, the bird spreads its tail to increase the area of its lifting surface. By depressing the tail, the angle at which the air strikes it is increased, giving further lift. In strong winds the Kestrel must fly harder to maintain its position and its tail does not need to be fanned to provide extra lift. In suitable wind the bird can remain effortlessly in the same position. By partly closing its wings the Kestrel can glide down against the wind, then, by altering the angle of its wings, rise with apparent ease and hover in a new position.

are laid at roughly two-day intervals. A second clutch may be laid if the first is lost. Each of the rounded oval, freckled brown eggs weighs about ten per cent of the female's body weight. Incubation starts after the laying of the second or third egg. Both birds incubate although some females appear to 'allow' their mates more involvement in incubation than others. A male and female have even been seen incubating the eggs together.

The chicks hatch after about 28 days and, because the start of incubation is delayed, usually hatch over two to four days. The brood size is most commonly one less than clutch size as one egg is often infertile, or one chick fails to hatch or dies soon after hatching. A dead nestling may be eaten by its siblings or parents. Nest life is peaceful with no aggressive 'Cain and Abel' struggle, in which a weaker chick may be eaten by its stronger sibling as occurs in some other raptors, and only minor squabbles over food.

The nestlings hatch in a coat of sparse white down, which is replaced between four and nine days of age by a thicker coat of creamy white down. This second coat remains and is covered by feathers before the chick fledges at about four and a half weeks. At fledging the chicks have reached their full (adult) weight (males 160 grams, females 180 grams) and their flight feathers are almost full length.

During the nestling period prey is dissected by the female and fed to the chicks. A soft 'chup' by her elicits an open-mouthed, food-begging response from very young (blind) chicks and the female places slivers of meat in their mouths. Later the sight of her offering food is sufficient stimulus and the chicks take the food from her. By three weeks of age the chicks are capable of feeding themselves, but prefer to be 'spoon-fed'. The male usually provides food during the early nestling period, later both parents hunt. At one nest a pair brought food (mainly insects and four small skinks) to the nest 74 times in about four hours. The parents continue to provide at least some food to their young after they have fledged, and the family group remains together for one to two months.

## Moult and Plumage

Kestrels moult annually, taking about four months, during spring and

summer. Birds in their first year are russet brown with buff underparts and are speckled and streaked with black; their brown tails are barred with black. They are similar to the adult female but tend to be more heavily marked with black. Kestrels are sexually dichromatic, adult males, in contrast to females, have powder-grey tails with only one (subterminal) black band, and often have a powder-grey head. Nevertheless, colour may occasionally be a deceptive means of identifying the sexes as females seem to lose their tail barring (except the subterminal band) with increasing age, and some have a slight grey wash on the tail as well as indistinct barring.

## Post-breeding

After spending spring in pairs, Kestrels become more gregarious in summer and may be seen in family groups and loose aggregations of first-year birds, particularly in areas where food is plentiful. In such areas a variety of raptors may congregate with little apparent conflict, although piracy of someone else's prey is not unusual. During autumn, groups disperse as winter territories are established.

## Mortality

There have been no studies done on mortality in Australia. Probably only about one third of fledglings survive their first year. The longest surviving Kestrel known was at least eight years old, but a maximum life expectancy of about 15 years may be possible.

Starvation and humans, both directly or indirectly, are probably the biggest single causes of Kestrel death. Kestrels have been found drowned in water tanks, shot, caught in snares or by dogs and cats, poisoned by pesticides and are often hit by cars. They fall prey to larger raptors like Wedge-tailed Eagles (*Aquila audax*) and Peregrine Falcons (*Falco peregrinus*). One nestling died, trapped by its neck in a narrow part of its nest opening.

In spite of their associated perils, roadsides with their fences and power poles, and cleared farming land, have opened up new habitat for Kestrels, and species introduced by humans, like starlings, house mice and agricultural insect pests, provide an abundant food source in some areas. □



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