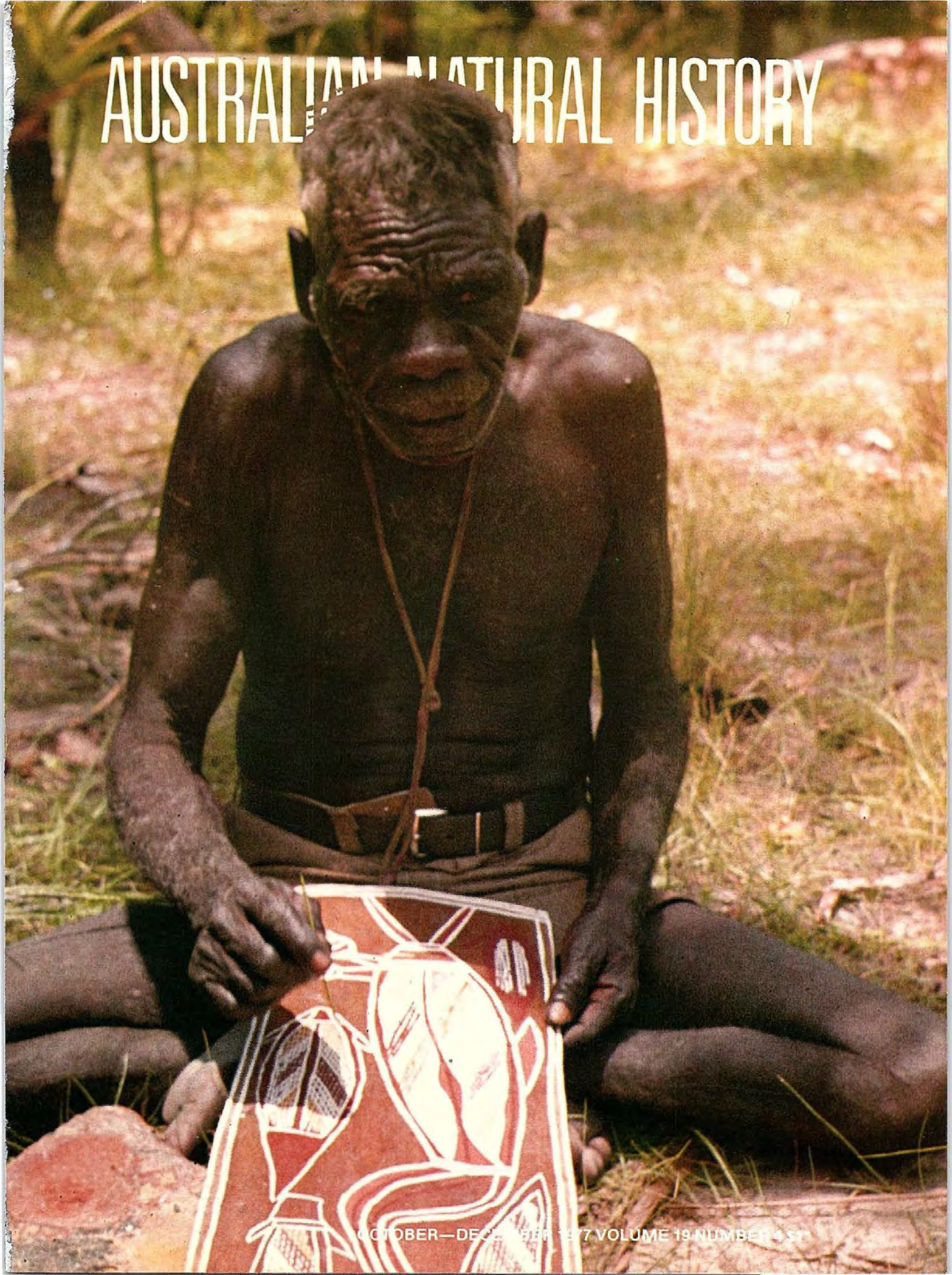


# AUSTRALIAN NATURAL HISTORY



OCTOBER—DECEMBER 1977 VOLUME 19 NUMBER 4 \$7

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Such increases are bound to occur from time to time, the last having been in March 1975. It is worth pointing out that by purchasing multiple-year subscriptions you ensure that you will not be affected by subsequent price rises until your subscription next expires. Payment is accepted up to three years in advance.

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We sincerely regret having to pass these increased costs on to our readers, but The Australian Museum Trust is unable to increase its subsidy to AUSTRALIAN NATURAL HISTORY without impinging on funds allocated for the Museum's important research and education programmes. We feel sure that most of our readers will be happy to support the Museum by helping to pay for increased production costs and by encouraging their friends and associates to subscribe to AUSTRALIAN NATURAL HISTORY.

A handwritten signature in dark ink, consisting of a large, stylized 'N' followed by the name 'Smith' in a cursive script.

Editor

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Figure of a gigantic Octopus, from De Montfort's 'Histoire Naturelle générale et particulière des Mollesques', Tome II, Paris, 1804.

COVER: Mick Magani, a famous old Arnhem Land artist, painting at a homeland centre on the Blythe River in eastern Arnhem Land. (Photo: P. Brokensha).

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# SIRENS OF TROPICAL AUSTRALIA

BY GEORGE HEINSOHN AND HELENE MARSH

Sea cows belong to an obscure order of aquatic mammals known as the Sirenia. There are only four surviving species of sea cows, comprising three species of manatee, genus *Trichechus* in the family Trichechidae, and a single species of dugong, *Dugong dugon*, in the family Dugongidae. Another species of the family Dugongidae, Steller's sea cow, *Hydrodamalis gigas*, was hunted to extinction within about thirty years of its discovery in 1741 in the Bering Sea. Although only four species of Sirenia exist today, the order has an extensive fossil record.

Sirenians are believed to have evolved from terrestrial herbivores about sixty million years ago and it is generally accepted that elephants and Sirenians have probably descended from the same terrestrial ancestors. Except for Steller's sea cow, all Sirenians, both fossil and living, have been confined to tropical and sub-tropical waters. Living species are sensitive to low temperatures. They are shallow-water, near-shore-dwelling animals as a result of their dependence on aquatic plants which only grow in these areas.

The manatees are eastern American and West African in distribution. The dugong ranges along the coast of East Africa into the Red Sea, along the coast of southern Asia to as far east as the Solomon Islands, and along the northern coasts of Australia from southern Queensland to sub-tropical Western Australia. Dugongs have been found as far south as the Sydney area.

Adult dugongs reach weights of about 400kg and measure up to three metres in length. Their smooth thick skin is grey although animals tend to look brown when observed from aircraft. The skin carries sparsely distributed, short, bristle-like hairs and the massive body is streamlined, tapering back from the head to a large, notched, horizontally-flattened tail-fluke rather like that of a whale or a dolphin. The dugong's forelimbs or flippers are paddle-like and, unlike those of manatees, have no externally discernible digits. Hind limbs are absent but small rudimentary pelvic bones serve as a reminder of the dugong's terrestrial origins.

The head of the dugong is remarkable because of its huge snout, which is covered with large bristles and smaller stiff hairs. The eyes are small and situated on the sides of the head and, externally, the ears are present only as minute holes. The nostrils, which are closed by valve-like flaps when diving, are placed on the top of the front end of the snout, allowing the dugong to breathe when quickly surfacing with only the top of the snout exposed.

Two to six cheek teeth are present on each side of the jaws in both male and female animals, the number of teeth depending on age. Mature males also have slightly protuberant tusks, the function of which is not known. The tusks could be of limited value in defence against predators.

The dugong is undoubtedly the basis of the mermaid legend, but even though the female dugong has protuberant mammary glands in approximately the same position to those of a woman, other features could lead one to conclude that the medieval mariners who initiated the legend must have been at sea for extended periods.

Little is known about dugongs. We do not know how long they live, how fast they grow, when they become reproductively mature or how often they bear young.

They are difficult animals to study and are now considered to be rare over much of their range and approaching extinction in some areas. They spend almost all their time under water, surfacing to breathe for one to two seconds, approximately every two minutes. They can remain submerged for at least eight minutes. Dugongs often occur in muddy water where underwater observation is impossible. There have been few successful attempts at keeping dugongs alive in captivity and they have not been bred in captivity. Like most work on marine mammals, dugong research is difficult and expensive.

Recently, a technique to observe dugongs from light aircraft has been developed, which provides a means of assessing the sizes of the dugong populations and of locating areas which are important dugong habitats. Counts and other observations are made from a high-wing aircraft cruising at 130 to 170 kilometres per hour at a height of 275 to 300 metres above the sea. Conducted since 1974, these surveys have shown that dugongs frequent shallow bays and channels which are protected against strong winds and heavy seas and that there are sizable populations of dugongs in the shallow seas around tropical Australia where extensive beds of the seagrasses on which dugongs feed occur. It is likely that northern Australia is the main reservoir of dugongs in the world and one of the best places to study them. It is hoped that this information will be used by governments to establish Marine National Parks and other reserves to conserve these mammals.

The seagrasses eaten by dugongs are generally intertidal and subtidal, growing to a depth of six to nine and a half metres below zero tide mark. Marine algae are occasionally eaten, probably when seagrasses are scarce.

GEORGE HEINSOHN is Senior Lecturer in Zoology at James Cook University of North Queensland (Townsville) where he teaches courses in animal ecology and vertebrate zoology. He has been studying dugongs since 1969. HELENE MARSH, a Research Fellow in Zoology at James Cook University, has been involved in the dugong project since 1974.





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Invertebrate animals such as crabs, snails, hydroids, sea cucumbers and tunicates are sometimes eaten as well, probably taken incidentally with seagrasses. Studies in northern and central Queensland suggest that dugongs prefer to feed on sparsely distributed seagrasses rather than dense old stands.

The digging activities of feeding dugongs produce trails in the seagrass beds from nineteen to twenty-six centimetres wide and from one to fourteen metres in length. They are usually dug to a depth of three to five centimetres and are thought to be caused by the action of the snout, grubbing seagrasses from the bottom. Each track follows a serpentine course and appears to represent the continuous feeding effort of a single dive. Dugongs remove an average of about sixty-three percent of seagrasses from their feeding trails. They feed against the current presumably to minimize the ingestion of bottom sediment. During aerial surveys dugongs are often located by the conspicuous mud streaks produced when they feed on muddy bottoms. If the plane circles for long enough, a dugong can usually be seen surfacing at the head of each streak.

The alimentary canal of the dugong is well adapted to digest seagrasses. This animal has a simple stomach and most of the digestion is carried out by bacteria in the large intestine. The quantity of food required by dugongs under natural conditions is not known. Two captive dugongs at Mandapam Camp, India, ate fifty to sixty kilograms (wet weight) of seagrasses per day. On this basis, assuming an average grazing efficiency of sixty-three percent removal of seagrasses along feeding trails, an area of about three and a half hectares of the sparsely distributed seagrasses in areas such as Cleveland Bay near Townsville would be required to support one dugong for a year.

The daily movements of dugongs are largely determined by tides and, to a lesser extent, by weather. They feed on inshore seagrass beds at high tide and move out to offshore beds at low tide. They are only observed moving or feeding along exposed coastal areas in calm weather.

Very little is known about seasonal movements including their possible migrations. Results of aerial surveys in Queensland indicate that dugongs undergo extensive movements. Large differences in numbers have been observed at different times of the year along a 230 kilometre stretch of coast between Townsville and Hinchinbrook Island, indicating that they may be migratory. Aerial surveys of the Wellesley Island Group in the Gulf of Carpentaria, carried out at different times of the year, suggest that dugongs are both migratory and



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resident, with some animals remaining in a given area as residents and others migrating to other islands within the group. The annual pattern of these migrations is, however, well known to the Aboriginal dugong hunters who live in the area.

If dugongs do undergo extensive migrations along the Queensland coast, each shallow, protected bay with seagrasses would be a critical habitat of importance to the survival of the species because of the long stretches of coast that are not suitable as feeding grounds. The number and sizes of Marine National Parks and other reserves that need to be established along the Australian coast to conserve dugongs will depend on whether the animals undertake long distance or local migrations. A tagging programme in conjunction with continued aerial surveys is being developed in north Queensland to determine the extent and nature of their movements and to define the areas where large populations occur.

Quite large herds were reported in the past. In July 1893, a herd in Moreton Bay was recorded as extending over a length of nearly three miles by a width of three hundred yards. Recent aerial surveys have resulted in the rediscovery of large numbers in Moreton Bay, including a herd of about two hundred animals. Five to six hundred were observed along a thirteen kilometre





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stretch of coast north of Cooktown in November 1976. Large herds have also been observed in Shoalwater Bay (near Rockhampton) and in the Wellesley Islands. The effects of such large aggregations of dugongs would be to greatly reduce the ability of seagrass communities to support them. Single seagrass beds could not sustain the grazing pressure of such large herds for very long, and the herds would have to move constantly from one area to another. This phenomena has been observed by Aboriginal dugong hunters on seagrass-covered sand flats near Lockhart River Aboriginal Community on the Cape York Peninsula.

Cyclones have reportedly had a deleterious effect on dugong numbers both in India and in northern Australia. Cyclone Althea passed through the Townsville area in December 1971. The subsequent wet season was very heavy and severe wave action, shifting sand, and low salinities caused extensive damage to seagrass communities. This resulted in a change in the dugong's diet from seagrass alone to a mixture of seagrass and marine algae. Further, it produced more extensive, or at least unusual movement patterns that were reflected in higher-than-usual accidental captures and drownings of dugongs in shark nets, set to protect swimmers at some public beaches. In contrast, Cyclone Ted, which passed

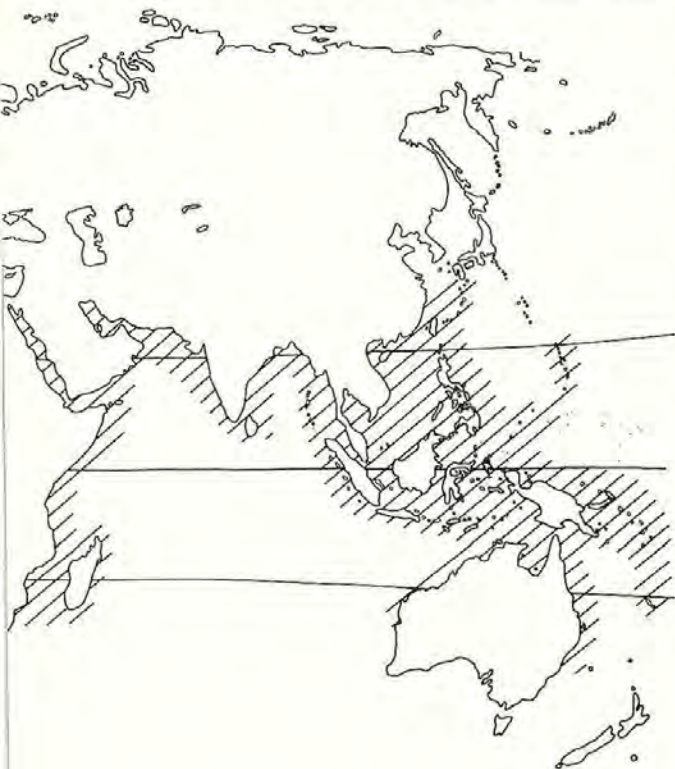
through the Wellesley Islands in December 1976, appears to have had little effect on the numbers and distribution of dugongs in the area, although Aborigines reported that two dugongs were stranded in a freshwater creek near the Mornington Island Community by a tidal surge following the same cyclone. Dugongs were seen in similar numbers and with the same pattern of distribution during aerial surveys conducted in the Wellesley Islands in April 1976 and April 1977.

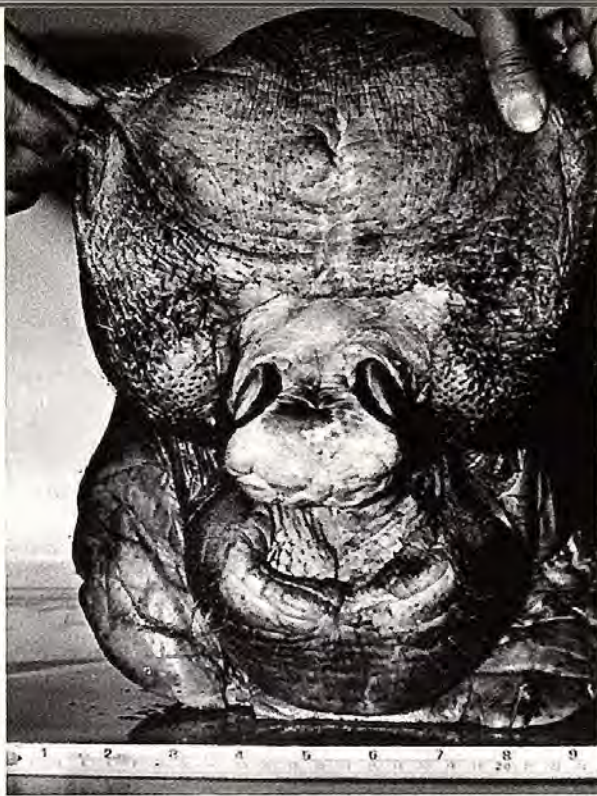
Dugongs interact with other species basically as a result of the effects they have on seagrasses and seagrass communities. They have a direct effect on seagrasses by removing them for food and an indirect effect on other organisms which are dependent on seagrasses as food or as shelter and areas of attachment.

It is thought by some that marine turtles and dugongs compete for seagrass as food.

The green turtle, *Chelonia mydas*, is known to feed extensively on seagrasses and is extremely abundant in Queensland waters. Although dugongs and turtles are often seen in the same areas during aerial surveys, the largest concentrations of the two are very often separate. Marine turtles utilize a much wider range of habitats than do dugongs. For example, turtles are commonly seen along rocky shores, along exposed sections of coasts, on coral reef flats, and around reefs and islands away from the coast, whereas dugongs mainly occur within sheltered inshore areas. While there are similarities in the foods taken by dugongs and green turtles, the overall feeding habits of the two species are quite different. Turtles crop and eat only the leaves of seagrasses, whereas dugongs dig up and eat the entire plants (leaves, rhizomes and roots). Stomach contents of green turtles from Cape York and Torres Strait contained large amounts of algae, but no seagrasses. The less selective food preferences of turtles compared to dugongs, differences in feeding methods, and the wider range of habitats utilized by turtles greatly restrict food competition between these animals.

Although large sharks, killer whales and saltwater crocodiles are reported to eat dugongs, particularly young ones, man is by far the most important predator. Past exploitation, mainly through hunting and netting by native peoples, has reduced dugong populations to their present low levels over most of the species' range. In Queensland, much of the past exploitation, which lasted into the 1960s, was commercial, being primarily for dugong oil. The animals became legally protected in this state from commercial and most other forms of exploitation in 1969. With the gradual cessation of commercial exploitation over the last few decades, followed by





almost complete protection, the southern Queensland populations are probably increasing. Dugongs are also legally protected in Western Australia and in the Northern Territory. However, Aboriginal people in Queensland, Western Australia and the Northern Territory are allowed to take dugongs under prescribed conditions. The rate of dugong exploitation by Aborigines is possibly declining as traditional hunting methods are gradually abandoned and as the need for dugongs as a food source declines. This may, however, be offset by increased hunting efficiency through the use of modern equipment such as power boats to find and chase the animals.

Dugongs are taken illegally in northern Australia, particularly in isolated areas but the extent of illegal hunting is unknown as poachers are rarely apprehended. The permit system which allows Aborigines living away from reserves in Queensland to apply for permission to capture dugongs is particularly open to abuse and should be amended.

Large nets set off swimming beaches ostensibly to catch sharks for the protection of bathers have been responsible for killing large numbers of dugongs near Townsville in northern Queensland. Eighty-two dugongs were killed in this manner in 1964-65, the first year of netting, and over two hundred dugongs have been killed to date. Shark netting has undoubtedly led to serious depletion of dugong stocks in other areas along the Queensland coast as well. The accidental netting and drowning of dugongs in commercial fishing nets, in particular gill nets, has probably also been responsible for the drop in numbers. However, the total effects of such commercial netting in northern Australia would be almost impossible to evaluate due to lack of information. Reports indicate that net fishing has greatly reduced dugong numbers in Sri Lanka and Kenya as well.

The inshore habitats required by dugongs, particularly seagrass communities, are particularly vulnerable to

human disturbances. Dredging and other disturbances of bottom sediments increase material suspended in the water which reduces light penetration and photosynthesis; accelerates sediment deposition, which smothers grass; changes the chemical reactions occurring within sediments; and releases toxins from sediments. Areas of seagrass beds have been destroyed in Moreton Bay (the southern most major habitat of dugongs in eastern Australia) through the deposition of sediments. In Cleveland Bay near Townsville, another important dugong area, seagrass beds are reported to have been damaged by increased siltation resulting from harbour dredging. Proposed sand-mining on North Stradbroke and Moreton Islands poses an equally serious threat to dugongs in Moreton Bay. Sand-mining for titanium and zirconium is very extensive along the east coast of Australia but fortunately sand-mining on Fraser Island which is adjacent to Great Sandy Strait (an important dugong habitat) has been stopped by Australian Government action.

Large-scale clearing of land for agriculture and over-grazing by livestock have occurred in northern Australia resulting in extensive erosion and the deposition of sediments into offshore areas. Large amounts of sediments resulting from mining are also carried into the sea. Seagrass beds in Hinchinbrook Channel, an important dugong habitat north of Townsville, may have been adversely affected by dredge spoil from tin mining which is carried by the Herbert River during annual wet seasons.

The direct effects on seagrasses of toxic substances, such as pesticides and other chlorinated hydrocarbons, petroleum derivatives and heavy metals, are generally unknown. Such waste material usually impinges more directly on animals than on plants. As part of a study by James Cook University on the long term effects of heavy metals and pesticides on marine organisms, the concentrations of these substances are being monitored in meat, fat and certain organs from dugongs caught in shark nets near Townsville and by Aborigines and Torres Strait Islanders near Reserves in other areas. Effluent being dumped into the sea from a recently completed nickel refinery could result in heavy metal pollution near Townsville. Two additional threats to dugong habitats are oil spillage from tankers and drilling, and thermal pollution from electricity generating plants, both of which are known to have caused extensive damage to tropical seagrass beds in other regions. Oil exploration using explosives for seismic work would also be expected to kill or injure dugongs.

Recreational boating is considered to have a disturbing effect as well. Monthly aerial surveys indicate a possible decrease in the numbers of dugongs seen in Missionary Bay, a major dugong habitat north of Townsville, since the opening of a resort in the area, which has resulted in increased pleasure boating activities. Injuries caused by collisions with boats and their propellers are believed to cause at least half the known accidental deaths to manatees in Florida, USA.

The most important aim in dugong research and management should be to conserve the species over its entire range. In areas where dugongs are rare or close to extinction, management should be aimed at increasing



population size. In northern Australia where large numbers still occur, dugongs and their habitats need to be protected from the various threats facing them such as commercial net fishing, shark netting, illegal hunting, disturbance from power boats, pollution, and oil exploration and drilling. Limited traditional exploitation by Aborigines should be allowed with accompanying efforts made by scientists to collect from them, dugong data and specimen material. We are currently obtaining data and specimen material from dugongs taken near Aboriginal settlements on Cape York, Mornington Island and the Torres Strait Islands. Extensive Marine National Parks or other types of reserves should be established to fully conserve dugongs and other marine life and their habitats. Aboriginal people and Torres Strait Islanders in Australia and indigenous people in many other coastal regions prefer dugong meat to many other kinds. The dugong should also be studied as a source of high-quality protein. To evaluate the dugong as a protein source, factors in addition to the palatability of the meat need to be considered. Such factors include growth rate and reproductive rate which are currently being studied at James Cook University. Unlike most other animal species fished commercially from the seagrass ecosystem, dugongs consume seagrasses directly. Most commercial fish are carnivores and obtain the nutrients from seagrasses only after they have passed indirectly through several steps in the food chain, beginning with herbivores and finishing with other carnivores. Therefore, in comparison with most edible fish, dugongs should be very efficient in terms of utilizing their food resources. This is because the food energy and nutrients from seagrasses are being directly converted into meat, fat, and other body substances in a single step. Now that dugongs and turtles are greatly reduced in numbers throughout much of their ranges, huge areas of seagrasses remain uneaten over a wide area of tropical waters. Rational and managed exploitation of rebuilt populations of dugongs could, potentially, be of real value in terms of meat production for man over a wide

area including many protein-starved third-world countries.

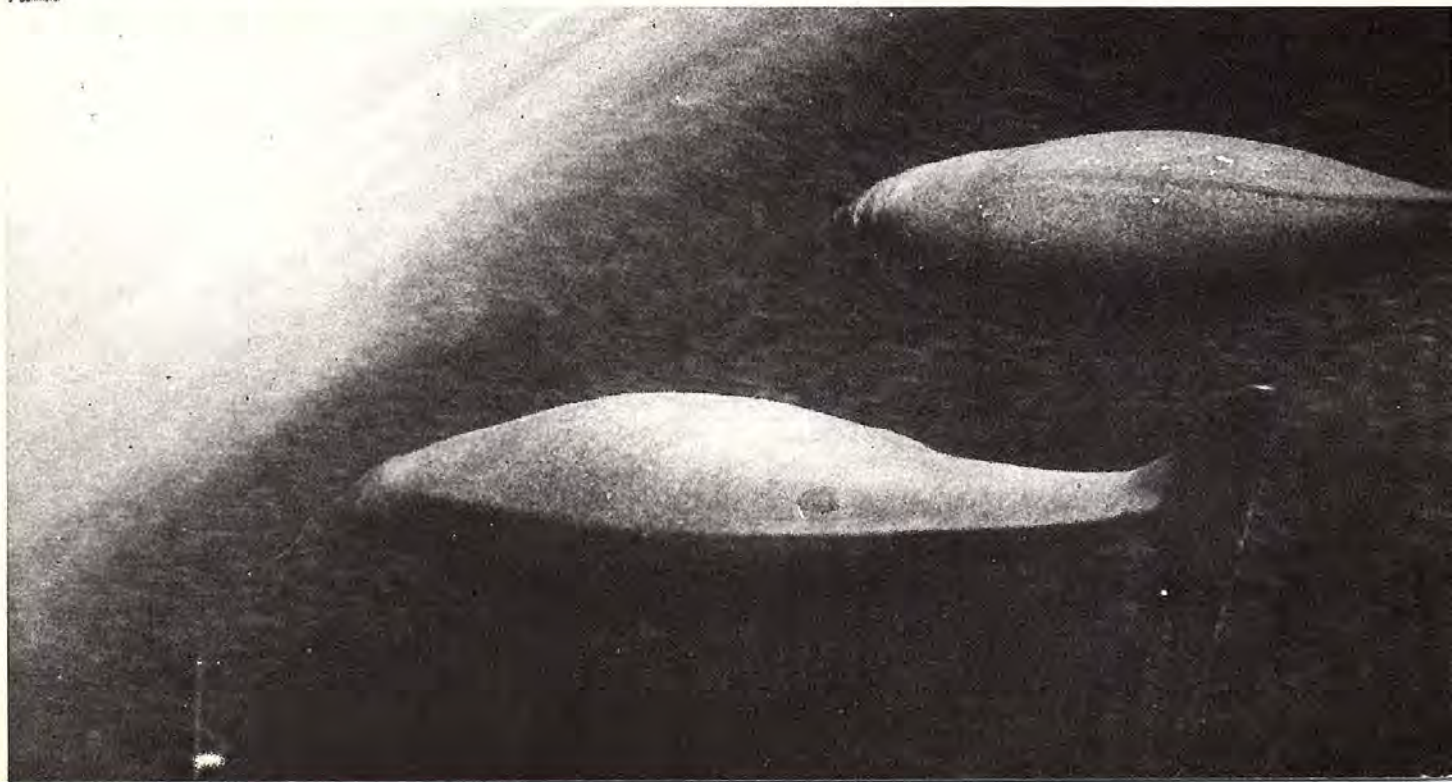
About twenty to twenty-five percent of the total weight of a dugong consists of useable meat. This is somewhat less than in cattle. However, the total biomass of dugongs in herds occurring in the northern Australian area is huge. Using a mean weight of two hundred kilograms per individual, the total biomass of the dugongs caught in shark nets off Townsville alone since the netting programme began in 1964 would have been about 42,000kg which would have consisted of 8,400 to 10,500kg of useable meat.

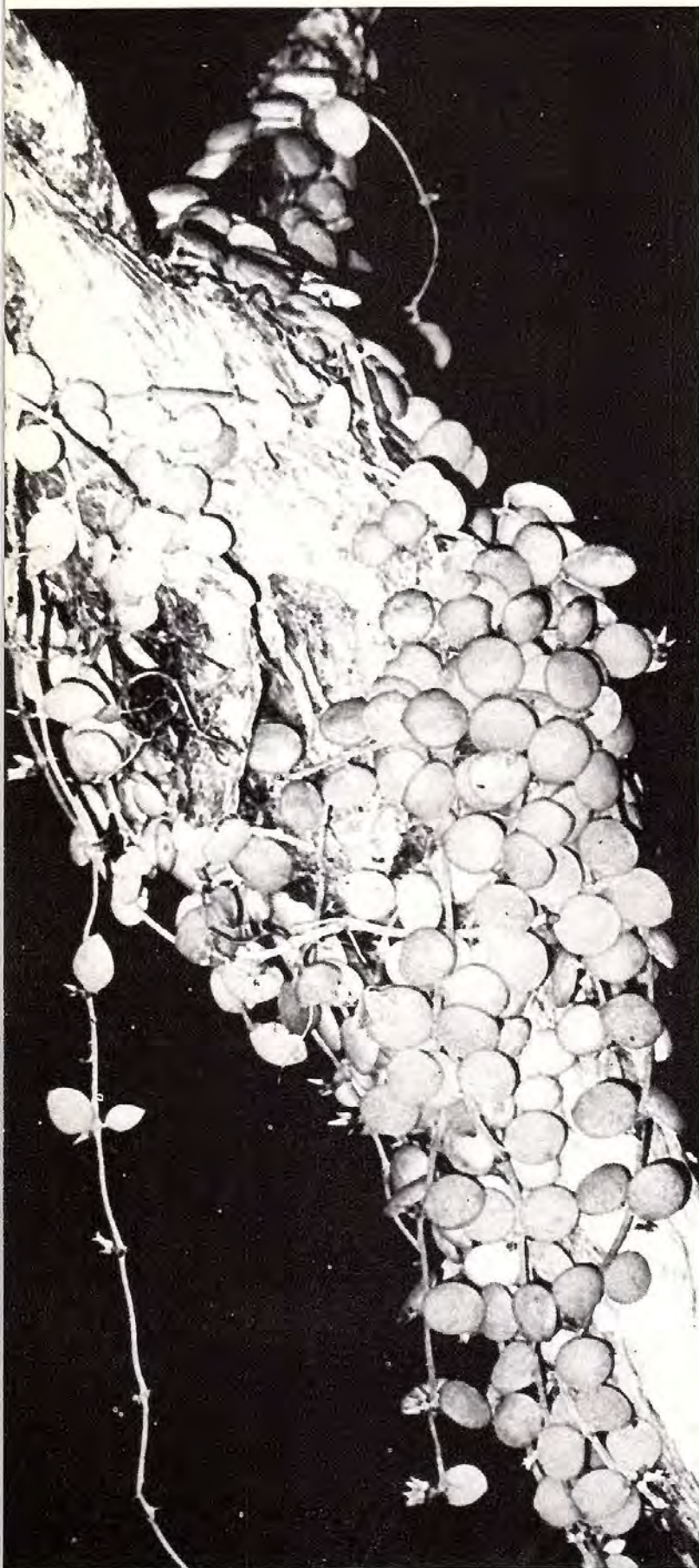
A large amount of research is required on the dugong. It should be studied as a species that could be utilized on a sustained yield basis either through careful management of wild stocks or through aquaculture on artificially developed seagrass pastures. Research needs to be aimed at both species conservation and managed utilization. Studies in other locations, of a similar nature, to those currently being conducted in northern Queensland, would be particularly valuable.

Dugong research at James Cook University is being supported by the Australian Government through grants from the Department of Environment, Housing and Community Development, and the Australian Research Grants Committee.

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The word epiphyte comes from the Greek *epi*, upon, and *phuton*, a plant. It refers, not surprisingly, to those plants which perch on others and get by in this world without any contact with the ground. The name carries with it the inference that, unlike the parasites, epiphytes do no harm to the host plants which provide them with a place to grow.

Although I was brought up in an area rich in epiphytes, my earliest memories of the existence of plants that could grow without any connection with the soil came from my childhood visits to Sydney. In those days any suburban garden worth its salt had, as well as a giant clam shell under the tap, at least one staghorn or elkhorn fern (*Platycerium* species) tied to the trunk of the camphor laurel. As likely as not, there were others, wired to rectangles of board and hung up like living pictures against the wall of the house. Prominently displayed nearer the ground there tended to be a mass of declining rock lilies, *Dendrobium speciosum* and a bird's nest fern, *Asplenium nidus* or two, sitting in soil in halves of forty-four-gallon drums painted bottle green. This style of gardening reached its apogee on railway stations. The one at Telegraph Point, NSW, used to be the best example. It probably still is.

The bird's nest ferns got the best deal, presumably because their vertical orientation made imitation of their epiphytic habitat impossible. But the poor staghorns, like the young people today, were not properly understood. The same went and still goes for those epiphytes that get called 'air plants', because they grow up in the air, sometimes hanging from branches by only one or two roots. So people hang them up in all sorts of unlikely places, believing that, because they are getting plenty of air, just like they get at home, all will be well. If only their curators knew more about them.

The majority of epiphytes grow attached to the trunks, branches, and leaves of trees, usually in rainforests. In a forest with a continuous canopy, these are the only places where small plants with relatively high light requirements can grow. The advantages of good illumination can only be obtained in a situation where there is no soil and the water supply is, to say the least,

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# ERED CANOPY OF TANGLED GREEN

BY PETER VALDER

precarious. In spite of this, that they manage very well is evidenced by the mass of algae, lichens, mosses, liverworts, ferns, and flowering plants which inhabit trees in many parts of the world.

As one might expect, epiphytes are most abundant in forests where conditions are moist for much of the time, or where at least the intervals between rainfalls or mists are not great. Such conditions are found in montane and subtropical rainforests, such as those found on the seaward side of the Great Dividing Range of eastern Australia. When winds from the sea encounter a mountain range the cooling of the air masses, which are forced to ascend, results in the formation of clouds and rain. In some parts of the world, for example the Malaysian region and parts of South America, there are altitudinal belts which are rarely free from mist and rain.

Even so, many epiphytes have to be able to survive marked intervals, often of several weeks duration, between showers and mists. Thus they must be able to tolerate desiccation, as do many mosses and lichens, or they must store water, as the succulents of dry regions do. It is interesting to note that some of the cacti are epiphytes, for example the Brazilian *Schlumbergera gaertneri*, which has cerise flowers and is often grown as a basket plant. Many other epiphytic plants, including most of the orchids, are succulents. Not only must epiphytes be able to withstand drought, but they must be well adapted to obtain minerals from the soil-less environment of the tree tops where the scarcity of free inorganic ions is accentuated by the leaching action of frequent heavy rain.

Unlike the climbers, which germinate in the soil and

*Dischidia nummularia*, an epiphyte, able to grow in a fairly dry niche within the monsoon forests and rainforests throughout the southeast Asian and Australian tropics. *Sarcochilus falcatus*, an epiphytic orchid grows best in the more exposed areas of humid communities such as rainforests.

B. Wallace



*Agapetes hosseana*, an epiphytic shrub belonging to the heath family, photographed by the author at 2500 metres on Doi Intanan, Thailand.

make their way up to the light, epiphytes have dispersal mechanisms which ensure that they start off in the right place to begin with. Almost without exception they have either very light spores, seeds which become wind-borne, or seeds or fruits fitted for dispersal by animals. The cacti and bromeliads, for example, produce fruits with a sticky pulp which helps attach the seeds to bark. In tropical America it has been observed that not only are the seeds of bromeliads deposited in large numbers on telegraph wires, but they actually germinate there.

By far the most remarkable of the plants producing very light, wind-borne seeds are the orchids. A single orchid capsule may contain as many as three million seeds each weighing as little as 0.000003g, so the chances of at least a few lodging in suitable habitats high in the trees are considerable. Orchid seeds face an additional problem, however, since they are so small that their food resources are inadequate for germination and establishment to take place without aid. Under natural conditions this aid comes from fungi which grow into the seed and supply it with organic nutrients. This is an example of the type of association between fungi and plants which is known as mycorrhiza. The roots of most epiphytic orchids remain mycorrhizal throughout the life of the plant.

Flowers of *Peristeranthus hillii*, a shade loving epiphytic orchid, ranging from the mountain rainforests of northeast Queensland to the lowland coastal rainforests in northeast NSW. The flowers of this specimen are about 5mm in diameter.

Once they have germinated in a suitable position, epiphytes must face the problem of getting water and minerals. On the basis of their adaptations to this situation, four main types of epiphyte have been distinguished — proto-epiphytes, nest and bracket epiphytes, tank epiphytes, and hemi-epiphytes.

Proto-epiphytes have no special structures for collecting water or humus and do not send down aerial roots to the soil. Most Australian epiphytes belong to this group, which is the least specialised and the least protected from drought. The simpler epiphytes, the algae, mosses,



P. L. Vahsen

lichens, and filmy ferns are all proto-epiphytes, able to survive quite extensive periods of drying. Many of the larger proto-epiphytes have a structure similar to that of plants growing in dry places on the ground. They have water-storing organs of various types, succulent leaves and stems being common. Many of the orchids have swollen internodes known as pseudobulbs. In some proto-epiphytes the rapid absorption of water is assisted by a special tissue layer around the roots, the velamen. In mature roots, the cells of the velamen are dead, behaving like blotting paper when exposed to rain or mist. In dry weather they contain air and are thought to act as an insulating layer. As well as being mycorrhizal, the roots of epiphytic orchids almost invariably have a velamen.

In nest and bracket epiphytes the plant is so constructed as to accumulate humus and debris from which the roots derive water and mineral substances. The bird's nest, staghorn and elkhorn ferns are examples of this type. In the bird's nest fern the humus accumulates in the centre of the whorl of leaves. The staghorn and elkhorn ferns develop laterally on trunks and large upright branches where they form two types of leaves. One type is broad and bracket-like, with its base and sides pressed against the trunk or branch, the other narrower and standing away from the host. The broad leaves soon die, remaining as a basket for humus collection, while the narrow green ones photosynthesise and produce spores. In species of the Malayan flowering-plant genus *Conchophyllum*, all the leaves are convex and adpressed to the bark, and debris accumulates in the spaces between. This protected space often provides a home for ants. Even more extraordinary are the ant plants, small epiphytic shrubs of the genera *Hydnophytum* and *Myrmecodia*, species of which occur in northern Queensland. In these plants, the stem forms a tuber honeycombed by cavities which are invariably inhabited by ants. The cavities are not produced by the ants as they are formed equally abundantly when the ants are excluded. Presumably the plants absorb nutrients from the faeces and other debris which accumulate in the cavities.

The tank or cistern epiphytes are all bromeliads,



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members of the flowering-plant family Bromeliaceae. Bromeliads occur only in tropical and subtropical America, but have become popular throughout the world as pot plants. In most of these plants the stiff leaves form a rosette, the sheathing bases overlapping to form a reservoir. In large plants this may hold as much as five litres of water. Insects and other debris accumulate as well, and absorption takes place through scale-like hairs on the leaf bases. The roots appear to have only the mechanical function of anchoring the plant to its host. This efficient system of collecting and absorbing water and nutrients makes bromeliads largely independent of their substrata, and is one of the reasons for their success in habitats in which few other epiphytes can establish themselves.

The last class, the hemi-epiphytes, develop long roots which eventually reach the ground. Once the connection with the soil is established they no longer have difficulty in obtaining water and nutrients, though they never become mechanically self-supporting. In short they achieve the same ends as climbers do, but their development takes place in the reverse direction. Likewise there are climbers which become epiphytes. Most of these climb by producing clinging roots from their stems and eventually the connection with the ground is lost. Such plants can often be seen in rainforests on the trunks of tree ferns.

The so-called 'stranglers' have a type of development similar to that of hemi-epiphytes. The best known are the figs, of which some of the eastern Australian species are good examples. The seeds germinate far above the ground, often in a fork between the trunk and a large branch. The seedling becomes a small bush which sends aerial roots down to the soil. These roots branch and fuse with one another until the trunk of the supporting tree is encased. After a time the host tree usually dies and rots away, leaving the fig in its place, as a hollow but self-supporting tree.

Another interesting case is that of the leaf-inhabiting plants, or epiphyllae as they are called. Such plants can develop only where there are long-lived, evergreen leaves and where conditions are constantly damp and mild to warm. Algae, liverworts and lichens occur commonly in such communities, though mosses are rare. Sometimes even the seeds of flowering plants may germinate but they never get far, as ultimately the leaf is shed and the life of the little community comes to an end. The shading effect of these epiphytes has not been shown to be detrimental to the leaf, though some have been found to be hemi-parasitic. For example the alga, *Cephaleuros virescens*, though green, causes a leaf spot on tea and other plants. It is occasionally recorded on evergreen leaves in Australia. Also, certain of the leaf-colonising lichens are known to penetrate the outer layers of host leaves. There are of course very much larger hemi-parasitic epiphytes, such as the mistletoes. Although green and photosynthetic, these plants form an attachment to their host through which water and minerals are extracted. Thus they are independent of an external water supply and extend into semi-arid wooded areas.

Most epiphytes, however, appear to do their hosts no harm, even though their abundant development on a

plant, particularly when the population consists largely of lichens, is often interpreted as being harmful. This misconception arises because plants in poor health often have a sparse cover of leaves and hence much more light reaches the branches than would be the case in a healthy plant. Thus ailing plants provide more sites suitable for epiphytes than do healthy ones.

The habitat of epiphytes is to some extent similar to that of plants growing on rocks. In both there is little soil and the water supply is usually intermittent. It is therefore not surprising that the flora of the two habitats is much alike and that some epiphytes are found growing on rocks as well. In fact, some epiphytes grow quite well on the ground if they get the chance. In New Guinea many of the epiphytic rhododendrons have been found growing on roadside banks and on areas cleaned for gold mining. Ordinarily, however, sites on the ground would not be available to them.

Just as the colonisation of newly-exposed rock surfaces proceeds in a sequence, so does the epiphytic flora of a

*Sarcochilus olivaceus*, is a moisture loving orchid, usually confined to moist, sheltered sites in rainforests and similar communities. This species is found from the Atherton Tableland district of northern Queensland to southeastern NSW. The leaves on this specimen are 5cm-8cm long.



The 'Birds Nest' fern, *Asplenium nidus*, from north-eastern NSW. Its fronds are about 100cm long.

tree change as it ages. The algae, lichens, mosses, and liverworts which appear first accumulate debris and provide the 'soil' in which larger plants can take root. In a forest densely populated by epiphytes the epiphytic humus can amount to several tons per hectare. Not only does the epiphytic population of a tree change with age, but the distribution of epiphytes within it is very often related to distance from the ground and degree of shading. The epiphytes typical of shaded habitats are found in the lower regions, or on the side of the trunk away from the sun. These epiphytes are often much less drought tolerant than those in sunny situations in the upper parts of the tree, many of which can lose over fifty percent of their fresh weight of water without harm, while the mosses and lichens of the topmost branches and twigs survive almost complete drying without injury.

As well as all this, it has been observed that there are very great differences between the floras of different species of tree. One result of this has been that the popular names of certain epiphytes incorporate the names of the trees on which they are usually found, for instance the beech orchid (*Dendrobium falcorostrum*), which occurs mainly on *Nothofagus moorei*, and the ironbark orchid (*D. aemulum*), usually seen on ironbark eucalypts. The epiphytic populations are sometimes so characteristic that they can be used to identify the trees.

*Peperomia tetraphylla*, is usually found in moistureless exposed sites, in and near rainforests. It grows on both trees and rocks. The leaves are about 1cm in diameter.



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Whether the tree has rough or smooth bark is of considerable consequence to colonisation and growth. Also, the regular shedding of bark, as occurs in many eucalypts, must prevent colonisation. In addition to this, it is believed that chemical as well as physical factors must be involved, whether it be the chemical composition of the bark or of the drainage water on its surface. Both favourable and antagonistic effects may be involved. It is noteworthy that epiphytes which grow in large accumulations of humus show little preference for any particular species of tree.

It has been shown that the leaves of many plants excrete considerable quantities of calcium, potassium and other ions. These, together with various substances leached from leaves and twigs by rain, must be very important sources of nutrients for epiphytes. In addition, the rain itself brings down dust and nitrate from the atmosphere. The first water to reach epiphytes after it commences to rain is the richest in nutrients and this, of course, is the water they are most likely to absorb. Most epiphytes can take up water only while it is actually raining, and, once saturated, further rain is of no use to them. Frequency of rainfall is therefore of much greater importance than the absolute quantity of rain. Hence the abundance of epiphytes in regions of frequent showers and mists.

One of the most successful epiphytes is Spanish moss





*Platycerium bifurcatum*, with its fern ally, *Psilotum nudum*, which is growing from the nest formed by the sterile fronds of the *Platycerium*. These specimens were photographed in the subtropical rain-forests of northeastern NSW. The fertile fronds of the *Platycerium* are between 40cm and 50cm long.

*(Tillandsia usneoides)*, which is neither Spanish nor a moss but a bromeliad which festoons trees in the tropical and semi-tropical Americas. It gets its botanical name from its remarkable resemblance to *Usnea*, the old man's beard lichen. It has none of the adaptations of its tank epiphyte relatives, it does not have water storage tissue, and it does not collect humus. It has no roots but takes up rain water through the shield-like hairs which cover much of its surface, depending upon this and the minerals washed from its host plant in the first of the run-off.

The obtaining of adequate mineral nutrients is certainly a major problem for epiphytes. For terrestrial plants growing under natural conditions this is problem enough, and the majority of them enter into mycorrhizal associations which ensure an increased supply. Except for those of the orchids, little is known of the extent of the occurrence of mycorrhizas in epiphytes. It may well be that they are of more significance than is at present realised.

While there is still much to be learned about epiphytes, there can be no doubt as to their ability to survive and grow in an environment which would be fatal for most of the plant kingdom. This toughness has certainly been the undoing of some of them as well, as they can be snatched from their natural habitat, transported long distances, and established elsewhere without the taking of any particular care.

The worst excesses of this sort involved the removal of tens of thousands of orchid plants from the forests of Asia and South America in the second half of the last century and the early part of this one. Thousands of trees were felled to obtain them, the orchids being shipped to Europe and sold to be grown in the stove houses which had become so popular. Similar activities no doubt denuded the foreshores of Sydney harbour of rock lilies

and brought the bird's nest, staghorn and elkhorn ferns to the gardens where I first saw them. And the less said about the giant clams the better.

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An epiphytic community in the rainforest at Mount Wilson, NSW. A moss, a lichen, a succulent fern, and two species of orchid can be distinguished.





P. Brokensha

Young boy of the Madarrpa clan painted for his initiation ceremony.

He is carrying a special dilly bag to which are attached tassels of feathered string.

It has been estimated that when the first white settlers arrived in Australia in 1788 there were some three hundred thousand Aboriginal people living throughout the continent. They were divided into about five hundred tribes, each with its own distinct language. The size of individual tribes varied from about a hundred to fifteen hundred and density of population differed throughout the continent in a relationship with the local environment. Most of the Aborigines were concentrated around the tropical northern coastline, along the major river systems the Murray and the Darling, and beside the rich marine environment of the east coast.

The Australian Aborigines were a nomadic people who lived by hunting animals, catching fish, and gathering edible seeds and fruits within the areas over which they ranged. These varied from a few hundred square kilometres in rich coastal areas to tens of thousands of square kilometres in desert environments. These areas were not the exclusive property of the tribes that inhabited them, as in time of drought or scarcity in one area, or abundance in another, neighbouring groups would exploit the natural resources to support them where they were available.

However, all Aboriginal groups had one important thing in common. Each had a particular relationship of ownership with a particular estate which contained sacred sites that were both the symbols and the essence of an abiding religious faith which revered the deeds of their ancestral heroes. It is through these deeds and the symbols the ancestors left within the landscape that Aboriginal men could understand the mysteries of

creation and could learn the laws of conduct laid down in the Dreaming for them to follow for all time. These sites and the land around them is, to an Aborigine, his true homeland. This relationship between an Aborigine and his homeland goes far beyond the European concept of home or ownership; it is indeed difficult for Europeans to begin to understand the depth of this man/land relationship.

As European settlement of Australia expanded in the late eighteenth and through the nineteenth century, more and more Aborigines were forced from their homelands. This removal was, in the populated areas, rapid and final and, by the end of the nineteenth century, the total Aboriginal population had been reduced to about fifty thousand. Belatedly, the conscience of European Australia was stirred. It was generally believed that the Australian Aborigines were a dying race and that the only thing to be done for them was to 'smooth their dying pillow'. The policy in the first quarter of the present century was to create reserves with the basic idea of 'protecting' the Aboriginal remnants. Missions and Government settlements were established on these reserves and progressively

C. McGugan



For centuries the Pitjantjatjara women have spun human hair and kangaroo fur to make head bands and pubic coverings using a simple twig spindle.

A Pitjantjatjara craftswoman at Pipalyatjara Homeland Centre is still practising this old craft.

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# LISTEN TO THE DREAMING

## THE ABORIGINAL HOMELANDS MOVEMENT

BY PETER BROKENSHA AND CHRIS McGUIGAN

Aborigines were taken from or induced to leave their homelands to live and receive food and supplies at these missions and settlements. By 1950, there were very few Aborigines living on their true homelands, but the Aboriginal population was increasing at a remarkable rate due to improved health services and to the growth of some hope for the future.

During the 1960s several groups made attempts to return to and live on the homelands but these failed through lack of official support. The desire of Aboriginal groups for decentralisation was opposed by many Europeans on the philosophic grounds that it was a regressive step away from the 'civilising' influence of settlements and missions, as well as on the economic grounds that it would be more costly to service decentralised groups with basic facilities. However, tribal Aboriginal people were becoming more and more concerned at the disruption to their social organisation as European population and facilities at settlements increased; problems of health and conflict between age groups as well as between different tribal groups forced to live together grew progressively more disruptive. Unaccustomed access to alcohol intensified these

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problems. The tribal Aborigines also became concerned at more frequent incursions onto their lands by European prospectors, miners and tourists. In a number of cases, desecration of sacred sites occurred.

In the early 1970s, spontaneously and almost concurrently, Aboriginal groups in Arnhem Land, Western Australia, central Australia and northern South Australia started moving back to their homelands to live in small decentralised groups. This movement gained impetus after 1972 when a new Government with an avowed policy of granting self-determination and land rights for Aborigines was elected. Official opposition to decentralisation was withdrawn and limited financial support was given for the provision of the basic facilities of bores, tanks, the supply of stores and some medical services.

The situation today is that, particularly in the reserves in Arnhem Land and the central areas of the continent, up to half of the tribal Aboriginal population has left the

A Pitjantjatjara tribesman working on his garden at Puta Puta Homeland Centre in the Tomkinson Ranges.

Pipalyatjara Homeland Centre in the Tomkinson Ranges, South Australia. In its early stage of development.

missions and settlements and returned to live in smaller, generally kin-based, groups in their true homelands. While some homeland centres are very rudimentary, the Aboriginal people living in them are now, in their own words, "standing up straight". There is less conflict, health is better through easy availability of 'bush tucker' and the Aboriginal people are exhibiting greater confidence and self-reliance in themselves determining the course of their own destiny. Above all, they are able to re-establish the relationship with their own landscape, which is the very foundation of their religious and secular life.

All societies express their world view through the arts. Not having a written language, Aboriginal people have always done this effectively and dramatically through a rich cultural tradition of song, dance and the visual arts. Nowhere is this artistic tradition being better expressed than by the Aborigines who have moved back to their homelands.

The Western Desert craft is produced principally by the Pitjantjatjara, who now live in their homelands in the Mann and Tomkinson Ranges in the far northwest corner



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which were a consequence of the provision of Government funds. The pioneering old men and their wives have now been joined by young men with their families, so that the population of both these homeland centres at times exceeds a hundred.

The Aboriginal people are very happy to be back in their homelands, but are ambivalent about the provision of additional buildings and European assistants. On the one hand, the women particularly are concerned about the provision of health and education services, but on the other they fear that the growth of their homeland centres will lead to a repetition of the dependent institutionalisation which they experienced on major settlements.

Valid discussion by Europeans of the lifestyle of the Pitjantjatjara in their homeland centres is hampered by our predilection to compare this with our own lifestyle and to make value judgements about how 'we' think 'they' should live. By our standards, the material aspects of Pitjantjatjara life are primitive. Shelter is provided by what we would call 'humpies' which are an adaptation of the traditional bough shelters covered not with brush, but with a nondescript assortment of tarpaulins, blankets and old galvanised iron. These shelters have a dirt floor and no furniture beyond a pile of blankets. In cold or rainy weather, the camp fire is transferred inside the shelters, which are generally about three metres long by two metres wide and a metre and a half high. In the long term, the Pitjantjatjara will develop a desire to live in more comfortable and hygienic shelters as, indeed, has already happened at some of the larger settlements. At this stage, however, housing is low on the list of the Aboriginal priorities at decentralised settlements. The people are more concerned with re-establishing their relationship with the landscape and adapting their traditional forms of social relationships and control to cope with modernisation and self-determination.

Because the people have acquired a desire for European foods and facilities, particularly vehicles, they no longer wish to return to a totally nomadic life of hunting and gathering, even if the landscape could support this, which is extremely doubtful. The major problem facing them is how to acquire these goods and services without remaining completely dependent on the undignified and unreliable handouts of the European society.

Given access to vehicles, dependent on the season, the Pitjantjatjara can and do supplement their food supply by hunting and gathering—an activity in which they are still extremely proficient and which they enjoy. Where there are minerals which can be extracted by small scale



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The location of the Pitjantjatjara Homeland Centre Pipalyatjara in the rugged Tomkinson Ranges, north-west South Australia.

of South Australia. During the past three years, over two hundred Pitjantjatjara have left Amata, Ernabella and Fregon settlements to re-establish their own homeland centres. These are located at Yalu Yalu, Puta Puta, Pipalyatjara, and Kuntjanu in the far northwest of South Australia and at Irruntju and Kataala over the border in Western Australia. The pattern of establishment of these camps has been similar. Firstly, the old men who are the ceremonial leaders return with their wives. They have often taken this step when there were absolutely no facilities available beyond a bore and a hand pump. These groups were serviced on a fortnightly basis from Amata settlement. A truck would bring out stores and pension cheques for the old people, they would sell the craft they had made and immediately purchase food and supplies. When they have demonstrated their firm desire to return and remain in these homelands, the people of some of the camps then receive further assistance. Pipalyatjara and Irruntju now have windmills and tanks, their own small store and a supply truck as well as, at their request, a European community advisor to assist in the administration and book-keeping responsibilities

operations, this is being done and is spasmodically providing a valuable community income source. Vegetable gardens have been established at Irruntju, Mount Davies Bore and Puta Puta. As the Aboriginal people develop further expertise in the management of these gardens, they will expand and provide a valuable food source and income supplement.

However, it is craft that provides the Pitjantjatjara with their most important source of income; but it is more than just that—it is an activity which reinforces the people's pride in their own abilities and their own culture. The Pitjantjatjara still make their weapons, implements and utensils to virtually the same pattern and in the same manner as they have always done. There have been some innovations and adaptations both in the tools used — steel tools have replaced stone — and in the development of new forms of wood sculpture. There is no special group within Pitjantjatjara society who are artists and craftsmen: virtually all the people have the ability to sculpt in wood. The men make the traditional multi-purpose Western Desert leaf-shaped spear-throwers, spears, incised boomerangs and shields and sculpt life-size Perentie lizards (*Varanus giganteus*). The women sculpt from solid logs of mulga (*Acacia aneura*) a whole range of carrying bowls (coolamons) which they used traditionally to carry food and water, as digging dishes or as winnowing bowls to separate the chaff from the seeds of native grasses like kaltu kaltu (*Panicum decompositum*). A relatively recent innovation has been to decorate the backs of these bowls with elaborate poker work designs depicting traditional women's 'medicine' stories. A further innovation has been to sculpt a whole range of semi-abstract and rather whimsical representations of desert animals, dogs, cats, etc.

The Pitjantjatjara who have returned to their homeland centres have done so in the face of considerable hardship since the environment of the Western Desert is often harsh and unreliable. Whether this initiative succeeds will not depend on their determination to remain, which is unswerving; rather it will depend on whether European society and its administrators can restrain a desire to follow the groups out to their homelands with all the trappings of our society to 'civilise' them before the groups themselves have time to determine the types of organisation and lifestyle to which they themselves aspire.

Yirrkala is an Aboriginal settlement situated on the Gove Peninsula, northeastern Arnhem Land. It has come to be the centre for people whose traditional land lies in the area north of Blue Mud Bay and east of Arnhem Bay. Within this area there are twelve main clan groups, each owning distinct territories. The clans are divided into two moieties—Yirritja and Dhuwa. The languages of these clans are closely related. All clans refer to themselves as 'Yolngu' which means Aboriginal person in all the languages. At present there are slightly more than eight hundred people associated with Yirrkala.

The Methodist Mission at Yirrkala was set up in 1938 as a result of growing concern for the safety of the Aboriginal people of the area. They were subjected to several punitive expeditions prior to 1938 and it was

A typical Homeland Centre dwelling at Kataala in the Bell Rock Ranges, Western Australia.



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thought that, with the opening up of the territory, further attacks on Aboriginal people could be expected. Very quickly the Yolngu life came to centre on Yirrkala because of the supplies available there. The mission provided a trade store selling basic items such as food, tobacco, knives, axes, clothes and blankets. Gradually, dwellings were constructed, a school was established and a garden was begun. All of these activities provided employment and some measure of training. Prior to the mission starting, the Yolngu were able to obtain trade goods from fishing boats that visited the coast. These boats were mainly from Macassar in Indonesia, and came in search of trepang. This form of trade had existed for possibly as long as four hundred years, but the Australian Government put a stop to it in 1910.

Northeastern Arnhem Land has remained a fairly remote part of Australia. There are no roads into the area. However, there has been an airstrip at Gove since the Second World War. The Eldo Tracking Station was established in the late 1950s and, after that, mineral exploration began. This culminated in the establishment by Nabalco of a mining and treatment plant and the building of the town of Nhulunbuy which now has a population of four thousand.

The development of this bauxite project and the influx of a large number of non-Aborigines, with the extensive

A Pitjantjatjara craftsman at Puta Puta Homeland Centre shows that he has lost none of his skills of making and using a traditional spear-thrower and spears.



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A group of Pitjantjatjara women at Pipalyatjara Homeland Centre making craft around their camp fire.

infra-structure to support them, has had a profound impact on the way of life of the Yirrkala community. The Yolngu saw the whole project as a threat to their traditional system, which is based on spiritual relationships to the land. They therefore mounted the Yirrkala Land Rights Case which resulted in Justice Blackburn's decision that the Yirrkala people had no right under British Law to the land in question. However, the evidence was such as to compel the Australian Government to recognise the justice of the Aboriginal claims, and in January 1977, the Aboriginal Land Rights Act was passed granting legal title to land which the Yolngu of Yirrkala have always known to be theirs.

Donald Peterman, a Pitjantjatjara craftsman from Mount Davies Bore camp in the Tomkinson Ranges of northern South Australia.

In the past five years the people of Yirrkala have initiated moves to re-establish themselves in their own

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homeland clan territories. In 1938 they were brought into Yirrkala for their own protection. Now, in the 1970s, the Yolngu leaders believe that their survival is dependent upon returning to their former homelands. As one of the clan leaders put it, "We belong to the ground, it is our power and we must stay close to it or maybe we will get lost. If you do not stay close to the ground you don't know what you are anymore. Maybe balanda (white man) or maybe Yolngu, who knows".

This initiative has led to the establishment of ten homeland centres. Those asterisked have built airstrips to enable them to receive supplies of food, to fly out traditional crafts for sale and to get medical treatment.

Homeland Centre	Clan	Distance from Yirrkala
Yalangbara	Rirratjingu	65 kilometres
*Wulwulwuy	Djapu	170 kilometres
*Garrthalala	Djapu	130 kilometres
*Gangan	Dhalwangu	320 kilometres
*Gurrumuru	Dhalwangu	250 kilometres
Djarrakpi	Manggalili	300 kilometres
*Baniyala	Madarrpa	320 kilometres
*Gurka'way	Marrakulu	200 kilometres
Biranybirany	Gumatj	170 kilometres
*Dhalinbuy	Wangurri	170 kilometres

These homeland centres are being established as independent communities. Each homeland centre is in contact with Yirrkala by radio. Dwellings have been constructed using bush timber and sheets of galvanised iron. Some older men have built dwellings out of bark. Each homeland centre group has a recognised headman. In some cases he is a very old man and he has delegated responsibility for general administration to a younger man—usually his first son.

he is a very old man and he has delegated responsibility for general administration to a younger man—usually his first son.

Five centres run stores which sell food and other items to the community settlements. Six settlements have a trained Aboriginal teacher who runs a school, assisted by the Northern Territory Department of Education. The centres are visited at least once a month by an art

advisor, resident at Yirrkala, who buys traditional craft produced by the community. The income from craft is used to purchase basic food items to supplement their diet of bush foods and to pay for community needs such as upkeep on a four-wheel drive vehicle. Travel to the homeland centres is possible by four-wheel drive vehicles during the dry season (May-November). However, the Missionary Aviation Fellowship provide the main means of transport all year round. They have a Cessna 205 based at the Gove airport and two full-time pilots resident at Yirrkala.

The choice of location for the homeland centres is indicative of the significance the move has for the Yolngu people. Gangan, the main Dhalwangu centre, is the place where all the clans of the Yirritja moiety were founded. Yalangbara, the Rirratjingu centre, is at the place where Djangkawu, the founder of the Dhuwa clans, first landed.

The establishment of the main Djapu centre at Wulwulwuy helps illustrate the significance the move has to that clan. The main ancestor of the Djapu clan took the form of a shark. He travelled inland to Wulwulwuy where he changed into a tree. The tree remains as a reminder of his presence. The dwellings at the centre are located roughly in an oval representing the outline of a shark. Each Djapu family is related to a particular part of the shark. The leader lives at the head, others are at the dorsal fin, the tail and so on.

During the early part of 1976, the marketing of craft from Yirrkala ceased. This meant people in homeland centres were unable to obtain any cash income and so were unable to purchase any food. This set-back served only to strengthen the resolve of those living in the bush and they decided to revert to a nomadic way of life, hunting game and collecting bush food. This situation has now changed and the people are able to produce and sell their rich and significant art and craft.

Many have argued that the homeland centre movement is a step backwards—that the Yolngu must



P. Brokensha

inevitably become part of the dominant society, and that they should not be running away from it but rather becoming more involved and more like the rest of Australians. The Yolngu, however, want the right to retain their cultural identity by living on the land of which they are a part and to move into the wider context at their own pace and on their own terms.

A Pitjantjatjara craftswoman shaping a carrying bowl from a solid log of Mulga at Pipalyatjara Homeland Centre in the Tomkinson Ranges, South Australia.

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The early stages of a Pitjantjatjara Homeland Centre. Art and craft is sold and stores purchased with the proceeds on regular visits of the supply truck.

P. Brokensha





I. Tattersall

A female greater dwarf lemur, *Cheirogaleus major*. Her large eyes betray her nocturnality.

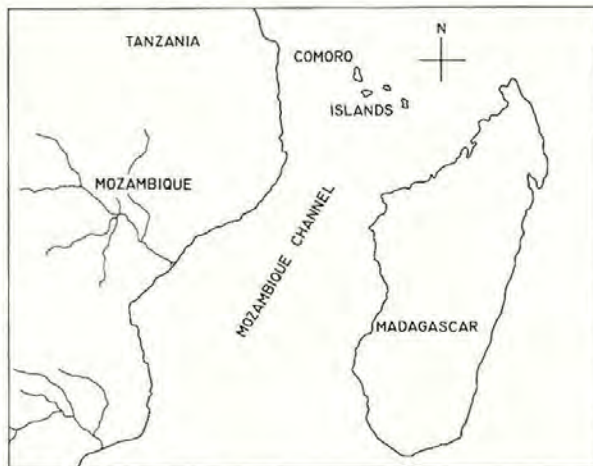
At first glance, Madagascar and Australia do not appear to have a great deal in common. Both, of course, are large, southern, insular landmasses; but this is hardly an unusual distinction. Each, however, is of particular fascination to zoologists, since each is home to a unique and highly varied insular fauna: Australia to the marsupials and monotremes, and Madagascar to the lemurs.

And just what, you may well be asking, are the lemurs? Whilst the so-called 'higher' primates, the monkeys and apes, are well known to almost everyone, relatively few people have even heard of man's other

cousins, the lemurs. Certainly, the lemurs less closely resemble man than do the monkeys and apes; but they are the closest living analogues to the primates which flourished during the Eocene epoch, around fifty million years ago, when primates of modern aspect were becoming established. They are thus critical to our knowledge of primate origins and early evolution; and without a proper understanding of what it means to be a primate, it is probably impossible fully to comprehend what it means to be human. This is why The Australian Museum's new travelling exhibit, 'Man, A Peculiar Primate', begins not with a consideration of man's closest living relatives and of his most immediate precursors, but with an overview of Primates, man's own zoological Order, as a whole.

So what, then, does it mean to be a primate? Recent research seems to indicate that it means both more and less than we have traditionally believed. Less, because the evidence is increasing that the 'lower' primates, especially the lemurs, are not so dissimilar to the 'higher' primates as has been assumed; and more, because we are at last beginning to appreciate the adaptability and behavioural complexity exhibited even by animals usually considered to be among the most lowly of the primates.

The lemurs, with over twenty extant species and a dozen more only recently extinct, are a remarkably diverse group. Traditionally, it has been supposed that all are descendants of a single ancestor, isolated on



Infant female (left) and male mongoose lemurs, *Lemur mongoz*, both about six weeks old. Both show the colouration typical of the adult female; in several weeks, the white cheeks and throat of the male will begin to turn a reddish brown.

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# MAN'S FORGOTTEN COUSINS

## THE LEMURS OF MADAGASCAR

BY IAN TATTERSALL

Madagascar during the Eocene when all primates were 'lower'. It now appears, however, that the pattern of descent of the lemurs is considerably more complex than this. Unfortunately, no appropriate fossil record exists either in Madagascar or in Africa, whence the lemur

ancestors must have come. Our knowledge of the evolution of the lemurs is thus largely confined to comparative studies of the living forms, and it is only relatively recently that such studies have seriously begun.

The first intensive study of the behaviour of lemurs

J. Tattersall





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*Indri indri*, the indris, the largest of the surviving lemurs, and among the rarest.

was published barely a dozen years ago, by Alison Jolly. Although this study dealt only with two lemur species at a single location, it clearly revealed that the social organizations of the maki, *Lemur catta*, and of the sifaka, *Propithecus verreauxi*, though differing somewhat from each other, bear all the basic hallmarks of the type of social organization exhibited by the higher primates. For instance, the lemurs studied all lived in stable groups

containing multiple adults of each sex, along with immature animals at various stages of development. Within the group complex social interactions took place between individuals: in one case (the maki), social relationships were expressed in a well-defined 'dominance hierarchy', in which each animal occupied a definite place; whilst among the sifakas social relations were more easygoing, at least outside the breeding season.



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*Lemur catta*, the ring-tailed lemur. This species is perhaps the commonest in zoos of all lemurs, but it is less common in the wild.

Knowing that the lemurs provide the closest living analogue to man's Eocene precursors, and accepting the prevailing view that the lemurs are exceedingly 'unintelligent' when compared to the higher primates, Dr Jolly proposed that the appearance of 'typically primate' social organization preceded that of 'typically primate' intelligence in the evolutionary history of the Order, and that the former would thus have played a significant role in channeling the evolution of the latter. However, a recent review of the existing (and inadequate) literature on factors such as learning and discrimination abilities among primates has revealed that the lower primates are, in fact, far from unintelligent—that in many ways they are a match for 'more evolved' forms.

This is not necessarily to say that Dr Jolly's hypothesis may not be right; but the evidence does strongly suggest that the acquisition of a characteristically high level of intelligence may have been a much earlier event in primate history than has generally been thought. One cannot, of course, ignore the fact that the lower primates which we know from the Eocene of North America and Eurasia had smaller brains relative to their body size than have their surviving counterparts. But it is nonetheless evident that, even if the modern lower and higher primates acquired their enlarged brain/body ratios independently, their smaller-brained common ancestor must already have possessed in a well-developed form the proclivity for increased intelligence upon which its various descendants have capitalised.



Given, then, that the lemurs are turning out to be a lot smarter than we had thought, we should hardly expect to find them displaying the stereotyped behaviour which was once assumed for them. And indeed we don't. We find a satisfyingly wide variety of behaviour patterns—a variety which is all the more remarkable when one considers how little we actually know about this aspect of the lemurs. Only a handful of species have been studied in any detail, and about many species we have only anecdotal information, or none at all.

Yet one's impression of lemur behaviour is above all one of flexibility, of variety, of adaptability. For instance, whether it is active during the day or the night is usually considered to be a pretty fundamental aspect of the behavioural repertoire of a species. But I have found some populations of *Lemur mongoz*, the mongoose lemur, to be active during the night (probably the 'normal' pattern for the species), while others, in a different environment, are active during the day. Further, within this same species one encounters considerable variation in social organization. Usually, the mongoose lemur lives in family groups consisting of an adult male and female together with their immature offspring. But in at least one region one may find both family groups and larger ones containing several adults of each sex, possibly as a result of seasonal social changes permitting consistently optimal exploitation of changing resources.

An equally impressive case of variability in behaviour came to light as a result of my most recent field trip. A study by Robert Sussman of one subspecies of *Lemur fulvus*, the brown lemur, had shown this form to feed on a relatively restricted range of plant species, and mainly to exploit leaves. Its social unit was a well-defined and exclusive group, containing on the average about nine individuals, and occupying a rather restricted home range. The animals were rather sedentary, rarely covering more than about a hundred and fifty metres in a day. My subsequent study of another brown lemur subspecies, however, revealed a behaviour pattern which in some respects could hardly have been more different. This lemur was a dietary generalist, sampling a wide



† Tattersall

variety of plant species, and mostly ate fruit. The groups which I saw were not consistent in composition; instead of being able to follow identifiable groups, I was faced with a constantly changing kaleidoscope of combinations of individuals. These animals, moreover, moved around a good deal, sometimes travelling over a thousand metres in the course of a day.

Obviously, many of the behavioural differences between the two brown lemur populations must have

A male black lemur, *Lemur macaco*, very easily distinguished from the female of the species.



† Tattersall

A female *Lemur macaco*, commonly known as the black lemur, although she is reddish brown, because of the colouration of the male. In only a few lemur species are there colour differences between the sexes.



I. Tattersall

A black and white ruffed lemur, *Varecia variegatus*. This striking lemur breeds well in captivity but is very rare in the wild.

been due to the basic difference in diet: leaves and fruit are very differently distributed within the forest and the individual trees, and dictate differing patterns of exploitation. But that this is so merely emphasizes the tremendous flexibility of response that this lemur species is able to make to differing ecological situations.

In parallel with this rich diversity of behaviour patterns, the lemurs offer a broad spectrum of different adaptive types, of which those species existing today represent only a part. Until the arrival of man on Madagascar little more than a thousand years ago, the island was a vast nature sanctuary, harbouring many more species than it does today. The living lemurs range in size from the tiny mouse lemur, *Microcebus*, weighing only a few grams, to the slender, long-legged indris, *Indri*, which stands more than a metre tall on its hind legs. Recently extinct lemurs expanded this range still further: one, *Megaladapis*, reached the size and bulk of a St Bernard dog.

The mouse and dwarf lemurs of the family Cheirogaleidae are small nocturnal forms of which we still know relatively little. Mouse lemurs seem to do well enough in secondary regrowth, where the forest has been destroyed but has regenerated, and are probably the least vulnerable to human incursions of all the lemurs.

Probably the most beautiful of the lemurs are the members of the family Indriidae, which includes the sifaka and the indris, as well as the nocturnal woolly lemur, *Avahi laniger*. All possess a spectacular type of locomotion: instead of running along the tops of horizontal or sloping branches as, for instance, the brown lemur prefers to do, these animals cling to vertical tree trunks and leap phenomenal distances between them,

propelled solely by the tremendous power of their elongated hind limbs. When a sifaka, for instance, is in a hurry, he will make a series of such leaps in incredibly rapid succession, appearing to ricochet from tree to tree through the forest.

Apparently related to the indriids is the aye-aye, *Daubentonia*, a strange-looking nocturnal lemur with rodent-like, gnawing front teeth, long coarse fur, and a

I. Tattersall





bushy tail. One of its most remarkable adaptations is its thin, elongated, clawed third digit, which it uses, among other things, for extracting insect larvae from the tunnels they burrow in dead wood. Unfortunately, many Malagasy regard the aye-aye as an evil omen, and as a result this fascinating animal is now close to extinction.

Which brings us to the most dismal part of the lemurs' story. It is easy to think of the extinct and the living

lemurs as constituting two entirely separate categories— as indeed, in one sense, they do. But in another sense both groups represent parts of a single continuing process: the confrontation between man and lemur. The first to yield in this unequal conflict were the most vulnerable of the lemurs—the terrestrial, the bulky, the slower-moving. The smallest of the vanished lemurs was as large as is the biggest survivor. But the process has not stopped, will not stop, there; as man steadily destroys the lemurs' habitat, and hunts them ever more efficiently, those species which held on until now will follow their larger relatives into oblivion.

Even now, several species are within a hair's breadth of disappearing forever: the red-bellied lemur, *Lemur rubriventer*, the hairy-eared dwarf lemur, *Allocebus trichotis*, and the aye-aye among them. Last-ditch efforts are under way to preserve as much as possible of the lemur fauna before it is too late. Let us hope that they will succeed, especially since we are only just beginning to realise how much there is to be learned about these unique, fascinating and beautiful creatures — and how much they can teach us about ourselves.

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*Propithecus verreauxi coquereli*, Coquerel's sifaka. No matter what the orientation of its support, the sifaka always prefers to keep its trunk upright.

A female *Lemur fulvus*, showing curiosity; lemurs have to learn their fear of man.



One of several remarkable things about the Cape Barren Goose is its ability to make a splash in the Australian national media. It was the subject of a brief open season on Flinders Island in April 1965, and again in February of this year; films and reports of the events aroused much comment. Public subscription was even invited to fund the purchase of a refuge for the embattled birds.

Why this popular concern about an animal that very few people can have seen? Perhaps it is simply that emotions are aroused by the very thought of a native species, and a rare one, being shot at.

I have visited all four of the main areas where the Cape Barren Goose occurs naturally and I can see how the suggestions about its rarity and possible extinction arose, but I can also assert quite firmly that while it may always have been rare, and at times very rare, it is not and probably never has been near to extinction, certainly not in historical times. There are sound biological reasons for saying this, reasons, to be fair, that were not known until a decade or so ago.

Firstly, geese eat grass, or rather any kind of pasture plant that is green, and the richer the pasture the better they do. Consequently, wherever man has altered their natural habitat in the direction of improving the pasture, as he has done on many of the breeding islands, he has made things better for the survival of the geese. This is in marked contrast to most problems of wildlife conservation where destruction of natural habitat also results in the destruction of the native animals inhabiting it.

Secondly, these geese breed only on small islands off the coasts of southern Australia. In early days, when much of the mainland was unexplored or impenetrable, these small islands, with their relative ease of access and communication by small boat, were inhabited and farmed, and the geese on them were easy quarry. With the opening up of the mainland and the improvement of land travel, the small islands were uneconomical to run and there was a drift of their population to the main centres. There are numerous deserted homesteads and relics of early farms on many of the islands now. The pasture remains improved but the molesting people have

gone, so the geese now have the situation greatly to their advantage.

Thirdly, and this point is of some significance, the species which was once enthusiastically hunted has now been protected by law for twenty years, except for the two occasions mentioned above.

These three circumstances have resulted in an upsurge in the populations of Cape Barren Geese. None of these circumstances seem likely to be reversed. Pasture will continue to be farmed, the islands will not be repopulated, and uncontrolled shooting will never again be permitted. The goose's future is assured.

But what saved it from extinction when the pressures were against it? At that time the geese's lives depended on their wariness, mobility and, above all, their remarkable capacity to survive on sparse and even salty vegetation in hard times. The wariness of geese is, of course, legendary, but it is not inflexible. I have seen Cape Barren Geese in a paddock allow a vehicle to approach to within fifty metres. By contrast, I have seen them fly in alarm at half a kilometre when a fishing boat dropped anchor off their island. I have also seen geese disturbed from one island, fly low across the water

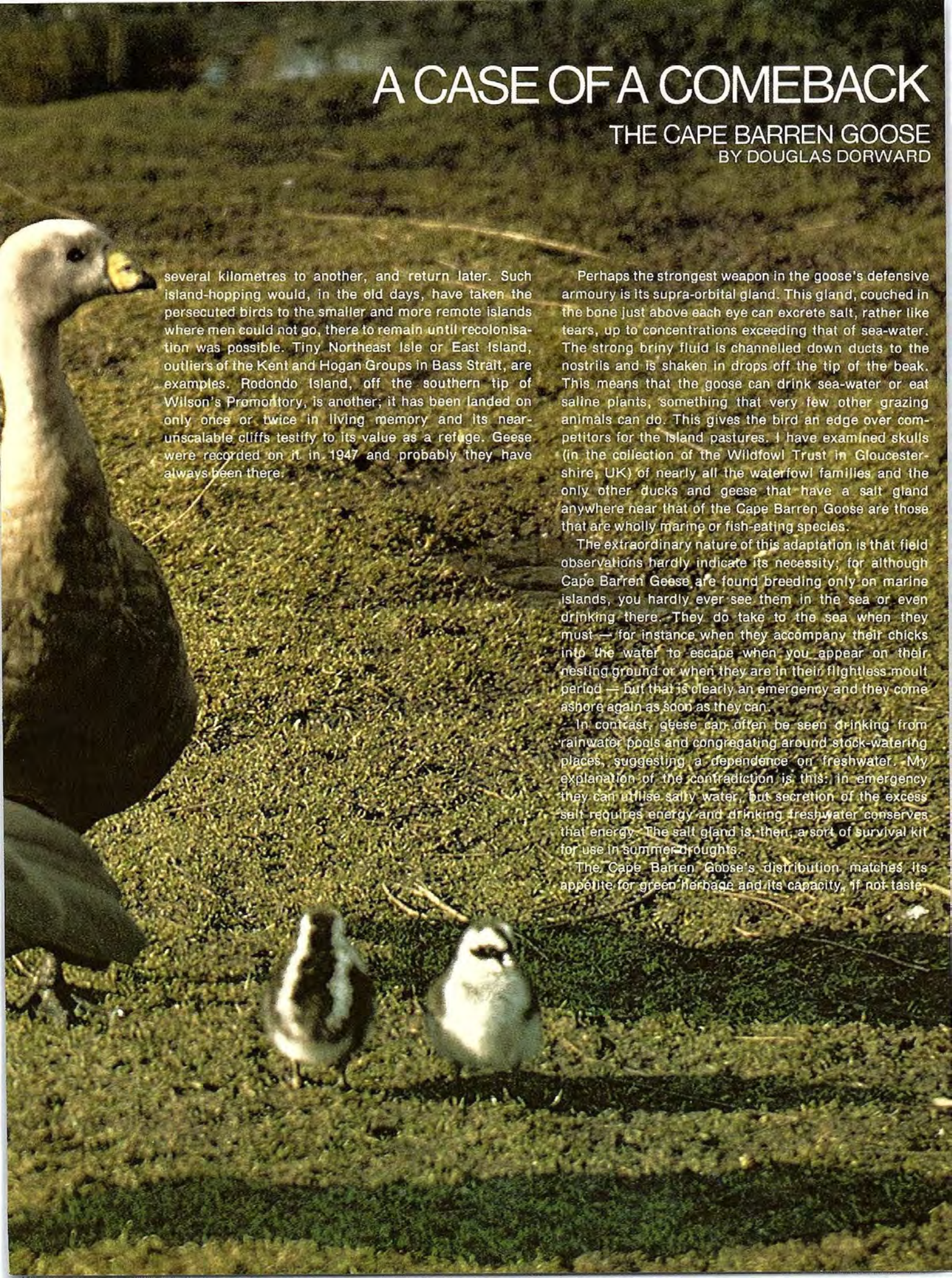
From the day of hatching, both parents are in constant and close attendance of the goslings. This pair is at the Wildlife Trust in Gloucestershire, UK, where they persist in their natural habit of breeding in mid-winter, in spite of the much more intense cold in Britain.



# A CASE OF A COMEBACK

## THE CAPE BARREN GOOSE

BY DOUGLAS DORWARD

A photograph of a Cape Barren Goose and its two chicks on a grassy field. The adult goose is on the left, facing right, with a white head and neck and a dark body. Its beak is yellow. Two small, fluffy chicks are in the foreground, one slightly to the left of the other, both facing right. The ground is covered in green grass and some dry twigs.

several kilometres to another, and return later. Such island-hopping would, in the old days, have taken the persecuted birds to the smaller and more remote islands where men could not go, there to remain until recolonisation was possible. Tiny Northeast Isle or East Island, outliers of the Kent and Hogan Groups in Bass Strait, are examples. Rodondo Island, off the southern tip of Wilson's Promontory, is another; it has been landed on only once or twice in living memory and its near-unscalable cliffs testify to its value as a refuge. Geese were recorded on it in 1947 and probably they have always been there.

Perhaps the strongest weapon in the goose's defensive armoury is its supra-orbital gland. This gland, couched in the bone just above each eye can excrete salt, rather like tears, up to concentrations exceeding that of sea-water. The strong briny fluid is channelled down ducts to the nostrils and is shaken in drops off the tip of the beak. This means that the goose can drink sea-water or eat saline plants, something that very few other grazing animals can do. This gives the bird an edge over competitors for the island pastures. I have examined skulls (in the collection of the Wildfowl Trust in Gloucestershire, UK) of nearly all the waterfowl families and the only other ducks and geese that have a salt gland anywhere near that of the Cape Barren Goose are those that are wholly marine or fish-eating species.

The extraordinary nature of this adaptation is that field observations hardly indicate its necessity; for although Cape Barren Geese are found breeding only on marine islands, you hardly ever see them in the sea or even drinking there. They do take to the sea when they must — for instance when they accompany their chicks into the water to escape when you appear on their nesting ground or when they are in their flightless moult period — but that is clearly an emergency and they come ashore again as soon as they can.

In contrast, geese can often be seen drinking from rainwater pools and congregating around stock-watering places, suggesting a dependence on freshwater. My explanation of the contradiction is this: in emergency they can utilise salty water, but secretion of the excess salt requires energy and drinking freshwater conserves that energy. The salt gland is, then, a sort of survival kit for use in summer droughts.

The Cape Barren Goose's distribution matches its appetite for green herbage and its capacity, if not taste,



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The wariness of the goose personified. This bird, flightless in its moult period, will take to the sea and swim out through the surf if approached any closer. Normally, however, geese are never seen in the sea.

for salt. In the east, its stronghold is the smaller islands of the Furneaux Group in Bass Strait. Oddly, it only rarely occurs on Cape Barren Island itself, which is large and has very little pasture. But Cape Barren is the easternmost point of the mountainous island and a prominent navigation feature, and the goose's name was probably given by early sailors.

It is the low, exposed, and hence tussock-covered, salty islets that the geese prefer. I believe about six thousand geese, perhaps half of the world population of this species, live here. Curiously, a few islands, for example Hummock Island (also known as Prime Seal) seem not to have any breeding geese. I was intrigued by the remark of a local farmer that sheep didn't "do well" on it; there may be some mineral or other dietary factor connecting the two cases. To the north, neither the Kent Group nor the Hogan Group seem to have more than occasional visiting geese, yet the islets fringing Wilson's Promontory have a regularly breeding population of a hundred pairs or so.

At the western end of Bass Strait, the Hunter Group and King Island both seem to have been naturally without geese and, although the birds have been introduced recently, it remains to be seen whether they will spread in a natural fashion or merely live there as a sort of free-flying domestic animal.

Further westwards the situation is more explicable. About four hundred birds at Flinders Chase on Kangaroo Island, SA, are also introduced and breed not on islets but in the paddocks where they were released. They have acquired a certain naturalness by joining the truly wild South Australian birds on an annual migration that seems to be the special peculiarity of this population.

Plastic collars have been placed on South Australian birds both at Kangaroo Island and on some of the other breeding islands in Spencers Gulf, and recognisable individuals from both places have turned up together in flocks on the mainland in the Lake Alexandrina region

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and near various lakes across the western district of Victoria. The longest such migration recorded is that of a South Australian bird which actually made the link to the eastern Bass Strait population by turning up in a flock near Wilson's Promontory, a flight of some eight hundred kilometres. An equal amount of collar-marking has been done in Bass Strait with the Furneaux Group population, but no marked bird has been seen away from the Group, and I am sure that the population is sedentary. The reason for this difference in migratory habits must be at least partly related to the rather poorer environment in the South Australian region.

I visited the Sir Joseph Banks Group from Port Lincoln, SA, one summer and found the islands very sparse in vegetation. I could hardly credit that geese had bred there at all, yet the banding records from previous winter breeding seasons were proof. Significantly, geese were by far the most numerous on two islands which were partly cultivated. They had some grain stubble, some sheep pasture and, most attractive of all (judging by the flock of geese nearby), a fresh-water catchment and a dam. The remainder of the geese from the Banks Group must have gone on the summer migration.

So, even though some of the highly adapted geese could clearly survive the summer on the South Australian islands, in terms of energy it was probably still better for others to fly eastwards than to sit it out. Another strategy, however, is now changing their traditional behaviour. Local records show that a growing flock is inhabiting some paddocks near Port Lincoln. It seems that wherever good pasture is developed near the breeding islands, sooner or later, geese begin to haunt them in slowly increasing numbers.

The South Australian population may number about four thousand now and the rest are to be found on the many islets west of the Eyre Peninsula, from the Investigator Group to Nuyts Archipelago near Ceduna, the most northerly part of the goose's breeding range. Here, as in the Furneaux Group, the historical association of man and goose seems to be one of molestation followed by recovery when human occupation declined.

I spoke with an octogenarian lady who had spent forty years or so on St. Francis Island near Ceduna, and she recalled seeing a flock of geese arrive one summer from the west ("Eucla way") which stopped a day, and went on again southeastwards. Now, the only population of

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The striped pattern of the goslings is an unusual feature that suggests Cape Barren Geese may be related to sheld-geese rather than the true geese. These 'cheepers' are only an hour or two old. They will follow their parents away from the shelter of the nest in a day or less and never return, even in the wildest winter weather. Note the tell-tale wisps of down on the surrounding tussock.

geese to the west is on the Recherche Archipelago, a thousand kilometres away and if what she saw was indeed a migration of the western geese to the east, she is the only person who has done so. It is not impossible that this might happen but we have as yet no means of knowing because the westernmost population of geese, though the first to be discovered, is by far the hardest to get at, let alone to study, and information about it is very sparse. We can only guess at the numbers there, but I think it can be no more than a thousand.

The half-dozen islands of the Recherche that I saw on a single summer's visit were very similar in their granite-based ecology to those of Bass Strait, two thousand kilometres to the east. Only a couple of islands off Esperance had been altered by the grazing of goats and had some pasture grasses. One of these carried by far the largest flock of geese — about thirty. The other six islands I visited were either bare or scrub-covered with only two or three pairs on each and these were mostly confined to the natural 'lawns' of pigface on the exposed headlands. These islands must be the nearest approach we have to the ancient natural situation of the species, a situation in which numbers must have been low. However, where mainland pastures existed, there also must always have been the chance for a larger population with migratory habits and, indeed, there is some evidence that a century ago there were many more geese in the Western District of Victoria than there are now. At any rate, although the Recherche population is clearly sparse, its security on these remote islands is sure, and I think the geese would take advantage of nearby mainland pastures if they were to be developed.

In recent bouts of interest in the Cape Barren Geese, attention has focussed on their distribution, numbers, and diet. What about the goose's life story? That story, until a decade ago, was very little understood. It has turned out to be a fascinating one, yet simple, orderly, and mostly very respectable by our standards.

The suitable habitat of each breeding island is precisely divided up into territories averaging about a hectare each. They are, to the geese, clearly bounded and, after a little careful observation, even to the human observer. One pair of birds lives within each territory and they are almost never seen away from it.

Depending on the habitat, such as the availability of suitable pasture and the size of the island, there may be one or two areas which are no-man's-land and there, the immature birds, up to three years old, wander and feed in a loose flock. They are fairly aggressive and there is a constant bickering and chasing amongst individuals in such a flock. These skirmishes are mild, however, in comparison to those of the grown-ups who are fiercely intolerant of any intruder into their territories. For the most part, these adults confine their aggressiveness to running at intruders with ruffled feathers, outstretched necks, and much trumpeting. During the breeding season on quiet days (and moonlit nights) you can hear these territorial demarcation disputes going on at intervals all the time. You can also tell the boundaries by seeing where the aggressors turn back from their charges at each other, each stopping and withdrawing before an actual encounter takes place. Rarely are the bounds and boundaries of respectful neighbourly



C. D. Maloney

disaffection overstepped, but occasionally I have seen two pairs come to blows on a boundary and lock together with flailing wings and thumps of the knobbed metacarpal bone.

The established pairs on the islands live, feed and procreate faithfully in exactly the same area year after year. The nest is always started in late autumn, about May or June in Bass Strait, and is usually placed in the shelter of a tussock or rock or on the edge of a bushed area, and, usually, in a slightly different place each year, perhaps only a few metres distant. The male chooses the site, usually near a tussock and at an eminence or

Cape Barren Geese, Glennie Island, Wilson's Promontory, Victoria. Their true native habitat is tussocky grassland amongst the granite boulders, also occupied by the nesting burrows of the famous Short-tailed Shearwaters 'mutton birds'.



M. C. Hill

A banded goose returns to her nest. She covered the eggs with down before leaving.



© DORRIS

look-out point. He tramples a slight hollow, then over three or more weeks builds the shallow nest of whatever grass stems or twigs are within reach. In the last few days, the female helps a little then, when she lays the first egg, she plucks her breast down to line the nest. Each day she lays another, leaving them covered until the clutch (four to six) is complete. She then begins to incubate. Thereafter, unless disturbed, she rarely leaves the nest for more than a few minutes a day, while the male stands on guard nearby. A lone 'watchman' in a territory is a good sign of a nest with eggs, not far away.

Even so, the nest and the motionless, sitting female are often hard to spot, but on these windswept islands, tufts of down are whisked from the nest and catch on twigs and tussocks nearby. After spotting the gander, my next clue to finding the nest has often been a wisp or two of fluttering down-feathers.

For four and a half weeks, the quietness of the incubation routine is broken only by the male's occasional warning honks or sallies out to the boundary against intruders. Observation of captive birds shows that during this period the birds may lose weight, the female, especially, dropping by about a kilogram (some twenty percent) from a peak reached just about laying time, to a level below her normal. All the eggs hatch over a few hours, and, for a few hours more, while the goslings dry out, the female covers them on the sheltered nest. Then, and remember this is about the shortest day of winter, the female leads her tiny balls of stripey black and white fluff out into the open. Occasionally during the day, and at night, and wherever in the territory they happen to be, she sits on them for a spell but, despite wind or weather, they never again return to the shelter of the nest.

The gander now joins them and, for the next three months, no member of the family will be more than a few paces from the others. If the male has to do a territorial foray, his flight outstrips his family straggling along behind but he quickly comes back to rejoin them before they have gone too far and there is much neck-stretching and head-pumping to greet the victorious father before grazing is resumed. There is no parental feeding to be done because the chicks can crop grass from their first day, but the shepherding and care by the two adults is touching to watch. An invisible bond seems to link them all together. Cold it may be when the geese lay their eggs, but this is when the young grass is sweet, the right time for goslings, like lambs, to come into the world.

Graham Poley



Geese in their adopted and preferred (but unnatural) habitat, a paddock near Wilson's Promontory, Victoria. Pastures such as these are the only places where the birds can be readily seen on the mainland and reserves of this sort should be created and maintained for them, because otherwise they can be an agricultural nuisance.





D. Dorward

They grow rapidly and continue to do so through the spring unless an early dry spell slows the plant growth and curbs their progress.

At about eight weeks of age the goslings are as big as domestic chickens and have become an overall grey colour, much like the adults, though their feathers have not yet appeared. The beak is still a metallic grey too, but traces of the yellow-green to come show on the cere. Still the family ties are tight and remain so for the next six to eight weeks. During this time, the feathers come through the down, the pinions grow to full size, the cere becomes fully coloured and the grey legs begin to take on the strong pink of the adult. The birds begin to run with wings outspread and then to fly. They still stay close to their parents who, at this time, have moulted their wing feathers and are flightless too. Soon after this, the family ties, so intense since birth, break down. The goslings fly from the territory and join other young and the one and two year-olds in the itinerant flocks. They are all indistinguishable in appearance except that for a few more weeks, the young of the year still have the cheezy voices of their babyhood. By now it is well into summer, and the young may leave the islands to join the flocks on other pastures, where they seem to lose contact with their siblings, unlike the true geese of the north where the family group is maintained through migration and the first winter.

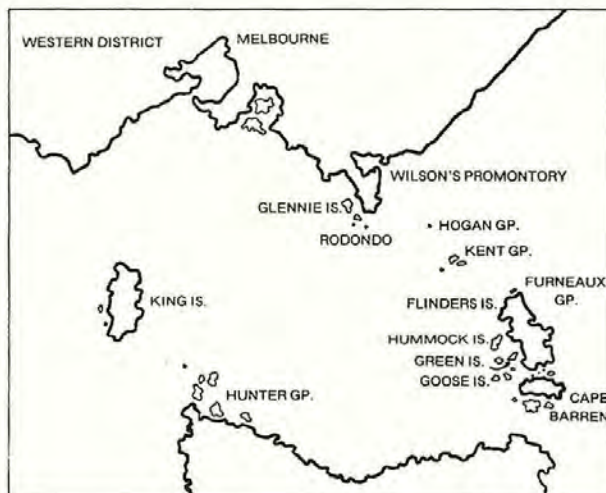
The story of the Cape Barren Goose still has many gaps and there, I suppose, lies part of the problem associated with its status as a rarity, an object for sport or gastronomy, and a pest. What should be our attitude in the inevitable controversy surrounding its management? At the very least we ought to be common-sensical and well informed. These two views tell us that the species is in no danger and that in some places it becomes an unreasonable burden on already hard-pressed pastoralists (farming on Flinders Island, for example, is no economic picnic). But it is also unique and beautiful and could give pleasure to many. We should ensure that some of its breeding islands are maintained as reserves and that some of the mainland areas it visits may likewise be kept as reserves — where people may enjoy seeing it and to which the flocks may retire in safety if it becomes

necessary to scare them away from other paddocks. The Tasmanian National Parks and Wildlife Service and the Victorian National Parks Service have already declared some islands as reserves and the former is attempting to create some pasture areas for the geese on Flinders Island, but the management programme in both states is still incomplete. If your taste is hunting, and if that ancient sport is carefully controlled and carried out in a civilised way, then I, as a biologist, should also say that there is no scientific reason why the species should not be cropped in that manner without detriment. About the ethics of shooting there may always be controversy. Let it be a reasoned and unheated controversy, with the good of the species as the common goal.

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Cape Barren Geese, Glennie Island, Wilson's Promontory, Victoria.



# OCTOPUS

BY LINDSAY JOLL

**T**he octopus! It is a name which strikes fear into the heart of some, revulsion into the minds of others. The strange appearance of the 'devilfish' and its reputation for attacking and drowning divers have developed a picture in the popular mind which is difficult to dispel. There are also sufficient authentic accounts of attacks by octopuses to prove that they can be dangerous to man. But closer examination of octopuses will almost certainly win respect for these highly evolved invertebrates. Their well developed eyes and large, intelligent brains make them very responsive creatures, while their colour-changing ability is a delight to the eye.

Cephalopods\*, the class of the phylum Mollusca to which octopuses belong, have a long and fascinating evolutionary history. The first fossil records of cephalopods date back four hundred million years to the upper Cambrian. They subsequently radiated into many species, reaching their peak in the Mesozoic era, seventy million to two hundred million years ago. In those days, most cephalopods were armoured with shell, making their kinship with other molluscs more obvious. The fossil remains of these cephalopods, many with bizarre shell shapes, are now important geological indicators. Today, the only living representatives of the shell-armoured cephalopods are several species of *Nautilus*. Evolved from them are the modern cephalopods — the octopus, the cuttlefish and the squid.

Octopuses, as the name implies, are eight-legged (or eight-armed) creatures. They form a separate group from the squids and cuttlefish which have ten appendages, eight short arms and two extensible tentacles which strike out and grasp prey. They are soft-bodied and

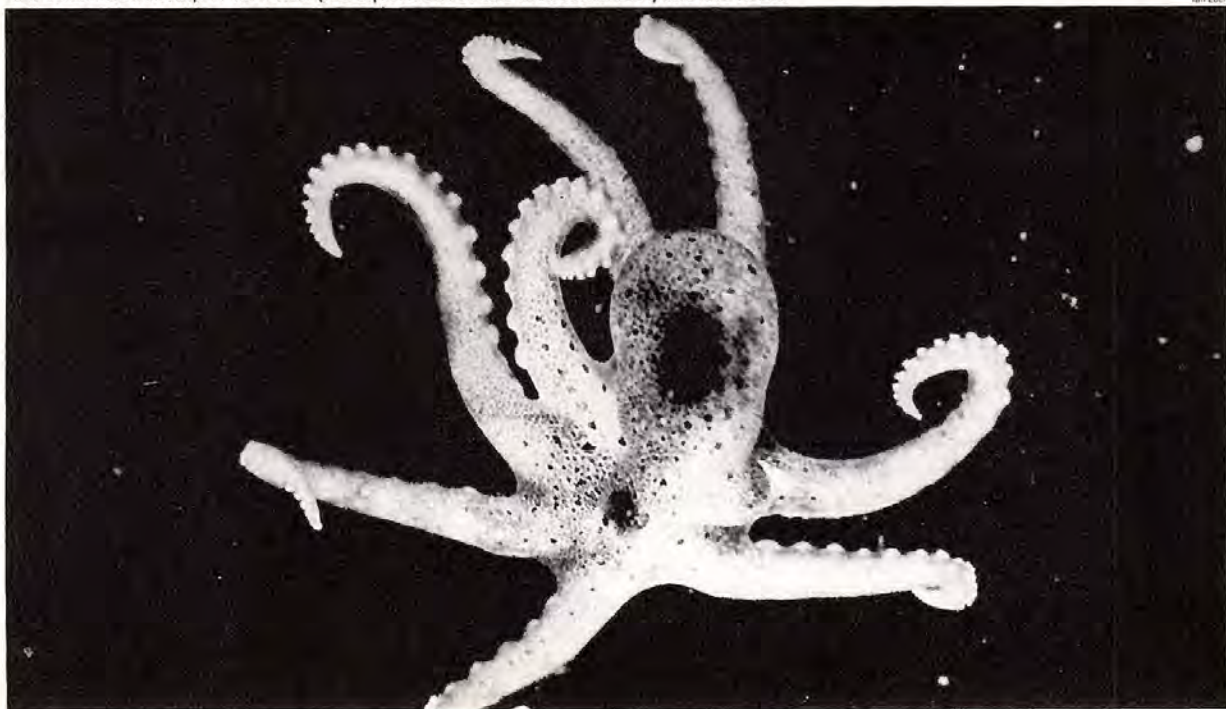
unarmoured except for a sharp, chitinous beak in the centre of the circle of arms. The arms bear many cup-like suckers which allow them to grasp and pick up objects. Most octopuses have two rows of suckers per arm, but species of the genus *Eledone* have only one row of suckers on each arm.

On either side of the head are the most obvious and remarkable sense organs of the octopus — the eyes. The octopus eye is highly developed and comparable in many respects to the vertebrate eye. It has a cornea, iris, lens and retina. However in octopuses, the optic nerves leave the eye from directly behind the retina rather than through a blind spot as in vertebrates. Enclosed within a cartilaginous capsule between the eyes is the brain. Compared with other invertebrate animals the modern cephalopods have very large brains. Scientific testing of octopuses has shown that a large proportion of the brain is concerned with the capacity to profit from experience.

Behind the head, in a globular sac (the mantle) are the vital organs — the gills, the heart, the gonad and the digestive organs. The gills are regularly ventilated by expansion and contraction of the muscular mantle. Expansion of the mantle causes water to be drawn in through large apertures below and behind the eyes. The apertures are then sealed and the mantle contracts, forcing the water through a narrow muscular tube (the funnel) underneath the head. Rapid, forced expulsion of this respiratory current through the funnel results in jet-propelled swimming. Ink, contained in a special sac within the mantle cavity, can be ejected along with the respiratory current to provide the octopus with a protective 'smoke screen'.

\*The word cephalopod derives from the Greek *kephale* = head and *pous, podos* = foot (i.e. head-footed animals). The name describes the close relationship of the arms (the equivalent of the molluscan foot) and the head.

Juvenile octopus  
from the south side  
of Fly Point,  
Cape York.





Octopus showing eight arms and suckers.

Octopuses are relatively common in the shallow coastal areas of the tropical and temperate areas of the world, but they have been recorded from antarctic waters and from depths down to five thousand metres. They range in size from the small blue-ringed octopus, *Hapalochlaena maculosa*, which weighs around fifty grams, to the giant octopus of the north Pacific, *Octopus dofleini*, which sometimes reaches fifty kilograms in weight. The body and arms of *O. dofleini* are thick-set so its span is only several metres. Another octopus of the Pacific Ocean, *O. hongkongensis*, has long thin arms, giving large specimens a span of up to ten metres. The oceanic squids of the genus *Architeuthis* are the largest cephalopods, sometimes reaching up to twenty metres in overall length! However this measurement includes the extended length of the two tentacles, so that the actual body length of these giants is only around five to six metres.

Although octopuses are predators, their chief foods being crustaceans (particularly crabs) and molluscs, they are also the prey of other animals. Predatory fish such as the schnapper, groper, shark and moray eel are particular enemies of octopuses. When not out hunting, octopuses shelter in rock holes and old shells, which afford protection from their predators. The common European octopus, *O. vulgaris*, is reported to do most of its hunting at night. In contrast, *O. cyanea* from the Pacific Ocean is reported to be a daytime hunter. The suckers of octopuses are extremely sensitive to dissolved chemicals (the marine equivalent of 'odour') and it appears that night-time hunters such as *O. vulgaris*, may rely on their sense of 'smell' as well as their eyes in the search for prey.

When out hunting, *O. cyanea* will make apparently

speculative attacks on rocks and coral heads where crabs and molluscs are likely to be found. It then feels underneath for any prey and draws them out. Crabs may sometimes unwittingly pass in front of octopus lairs. In such cases the octopus will shoot out an arm and draw the crab into its lair. Prey encountered in the open is approached slowly and cautiously until the octopus is within striking distance. It then goes into a jet-propelled leap and lands on the prey. As it lands, the web (an extensible flap of skin between each of the arms) is drawn out by muscular action, turning the underside of the octopus into an 'umbrella'. The prey is held firmly in this umbrella by the suckers and a poison called 'cephalotoxin' is secreted into the chamber by the posterior salivary glands. Prey animals which have just been killed by an octopus show neither bite marks nor puncture wounds and it appears that the poison is probably taken up through the gills of the prey.

The poison secreted by the octopus also contains some mild digestive enzymes. Once the prey has been completely killed the octopus begins to dismember it and feed. The digestive action of the poison allows the octopus to pull its prey apart very easily and to withdraw flesh from otherwise inaccessible areas. The soft parts of the prey are then bitten off in large pieces by the beak and passed into the crop by the radula (teeth). When the octopus has finished feeding, any inedible hard parts are pushed to one side or blown away with a jet of water from the funnel.

Octopuses have the capacity for spectacular changes of colour. If underwater diving had arisen earlier in our culture, the octopus would undoubtedly occupy the place traditionally accorded the chameleon. Not only is the octopus's repertoire of colours and patterns immense but the speed with which it, and other cephalopods, can

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change colour is unequalled in the animal kingdom. The secret of the octopus's colour change is the chromatophore. This is a small pigment-filled sac in the skin. The usual chromatophore colours are brown, black, red, yellow and orange-red. No octopus contains all the colours, three different pigments being the usual number. The skin of an adult *O. vulgaris* contains around one to two million chromatophores.

Attached to each pigment sac are a number of muscle fibres. Contraction of the muscle fibres causes the pigment sac to expand, producing an increase in colour. When the muscles relax, the elastic pigment sac returns to its former size. The degree of expansion of any of the chromatophores is under direct control of the central nervous system. It is the nervous control of the colour mechanism which accounts for the speed with which colour is changed. In addition to the chromatophores, octopus skin also contains small reflector platelets, the iridocytes, which reflect the background light. To further compound the octopus's variable appearance, the skin is capable of being drawn in irregular shapes or raised up in lumps and bumps called papillae and cirri, depending on their size.

The sheer variability of colours and patterns practised by octopuses is a handicap to any classification or description. The common Western Australian octopus, *O. tetricus*, will often sit for long periods in a general mottled pattern similar to army jungle camouflage. When attacking prey it will flash to a reddish-brown or orange just before the attack, flash to pale as it lands on the prey and then flash back to reddish-brown as it struggles with its prey. During feeding it will return to its general mottled appearance. If frightened it will turn quite pale. In situations of extreme fright it will produce the so-called 'dymanic mask' where a brown ring appears around the eyes and the exposed outer edges of the arms, while the rest of the animal remains pale. Resting octopuses will sometimes colour themselves like court jesters, with different colours on either side of the body, the dividing line down the centre being as straight as if drawn with a ruler. The small but highly venomous blue-ringed octopus exhibits its beautiful iridescent blue rings when disturbed or attacking. The appearance of these bright blue rings should be taken by anyone who encounters one of these little octopuses as a danger signal, and leave it well alone.

In octopuses the sexes are always separate, but it is difficult to distinguish the sex of any individual without close examination. The only common external feature which separates the sexes is the presence in males of the hectocotylus, an arm modified for the transfer of sperm to the female. In some species, older males also develop some disproportionately enlarged suckers which they use for sexual and aggressive displays. In octopuses, the hectocotylus is always the third arm on the right. How does one deduce which is the third arm on the right? The arms of octopuses are given numbers such that the front arm on either side of the mid-line (an imaginary line running down the centre of the octopus from between the eyes to the back tip of the mantle) is called the first arm, while the left and right sides of the octopus are the same as if you were the octopus. The arms are then numbered consecutively so that there are four left and four right arms.

The name 'hectocotylus' results from a curious zoological blunder. In the Paper Nautilus, *Argonauta argo*, (which is actually an octopod, not a nautiloid) there is a great discrepancy in the size of the two sexes, the male being very small. In *Argonauta* and a few related octopods, the hectocotylus breaks off the male at mating and remains in the female. Female argonauts were known to science in the early nineteenth century but males had not then been discovered. Examination of female argonauts revealed the presence of a small worm-like body resembling a cephalopod arm. An early nineteenth century naturalist concluded that it was a parasitic worm and named it as a new genus, *Hectocotylus*, meaning 'the arm of one hundred suckers'. A subsequent worker even went on to describe and draw the 'worm's' digestive, circulatory and respiratory organs! It was not until the mid-nineteenth century that the male argonaut was discovered and the blunder recognized, but the name hectocotylus is now permanently bestowed on the male cephalopod reproductive arm.

The hectocotylus can be recognized by a flap of tissue, an elongation of the web, which runs down its length. Turning back the flap of tissue reveals a brilliant white, muscular, semi-closed tube for conveying sperm packets (spermatophores) along the arm. The tip of the arm is modified into a small spoon-shaped organ, the ligula, which grasps the spermatophore when it reaches the end of the arm. The ligula is devoid of suckers, unlike the tips of the other arms. Male octopuses have a single testis which produces sperm. The sperm then pass to another organ, the spermatophoric organ, which packages them into elongate spermatophores. The spermatophores then pass into yet another special organ, Needham's sac, where they are stored. Each spermatophore contains millions of sperm and each male octopus carries fifty to one hundred spermatophores, depending on its size. When octopuses mate, a number of spermatophores are placed in the female tract and the male then makes more spermatophores to replace those lost at mating.

Females have a single ovary and two oviducts which pass forward to the opening of the mantle cavity. A short way along the oviducts from the ovary are the oviducal glands. These spherical organs are responsible for the storage of sperm and the hardening of the egg capsules when the eggs are laid. Female octopuses lay eggs only once in their lifetime but they may mate many months before they are ready to lay their eggs. The sperm from these matings are stored and nourished in special pouches in the oviducal glands until they are required to fertilize the eggs.

When octopuses mate, the hectocotylus of the male is extended across to the female, enters the mantle aperture, and the ligula inserted into one of the oviducts. The spermatophores, stored in Needham's sac in the male's mantle cavity must then be transferred to the female. To do this the male places the funnel under its web between the third and fourth right arms, at the head of the tube which runs along the hectocotylus. A violent exhalation from the mantle cavity dislodges one of the spermatophores from the extended exit duct of the Needham's sac and it passes out with the exhalant current to the tube on the hectocotylus. Peristaltic action of the muscles surrounding the tube pushes the spermatophore along the arm to the ligula within the oviduct. Exposure of the

The Blue Ringed Octopus, *Hapalochlaena maculosa*, the only cephalopod known to be toxic to man. It is plentiful along Australia's rocky coasts, occurring from the intertidal pool down to an average depth of 20 metres. It normally feeds on crustacea and other molluscs.

spermatophore to water causes it to rupture, spilling out its content of sperm. The sperm then swim up the oviduct and lodge in the oviducal gland. Mating may continue for varying lengths of time, with a spermatophore being transferred every five to ten minutes. While undisturbed in the aquarium, *O. tetricus* have been observed to mate for over six hours but mating is probably for a shorter time in the wild.

As females approach egg-laying they usually become more retiring and reduce their food intake. Eggs laid by species of *Octopus* fall into two main groups — small (two to four millimetre) eggs which produce a planktonic larva, and large (eight to twelve millimetre) eggs which contain a large amount of yolk and produce young which take up the adult mode of life as soon as they hatch. Females of species which lay small eggs usually produce large numbers of eggs (fifty thousand to five hundred thousand) while females of species which lay large eggs usually produce only a small number of eggs (fifty to two hundred). Octopus eggs are elongate-ovoid in shape with a stalk at one end. In species which produce large numbers of eggs the stalks are commonly intertwined to give a string of eggs which looks like a miniature bunch of grapes. The strings are attached at one end to the roof of the lair by a cement secreted by the female. They hang down into the lair where they are tended and guarded by the female. Species which produce small numbers of eggs either stick them on individually or carry them around on their arms.

Female octopuses give their eggs constant care and attention and cease feeding entirely after laying. Food given to egg-caring females of *O. tetricus* in the aquarium is pushed away by the arms or blown away by a blast of water from the funnel. Any creature which approaches is warded away with a sweep of an arm. Females constantly groom the eggs, cleaning and protecting them, while periodic jets from the funnel keep them well aerated.

Embryonic development begins at the end of the egg-capsule away from the stalk. Early in development, the embryo changes its position in the capsule so that it lies at the stalk end. This allows the yolk to assume a more spherical shape in the wider, free-end of the capsule, leaving the embryo a greater length in the capsule in which to grow. Development continues at the stalk end and within two weeks of egg-laying the embryo reaches a stage where it is recognizable as a young octopus. Just prior to hatching the embryo turns again in the egg-capsule, regaining its original position.

During development the embryo obtains its nutrition from the yolk store within the egg. By the time it undergoes the second change of position the yolk is almost completely consumed. The yolk sac is fully consumed at hatching although some internal reserves of yolk are available to tide the young octopuses over the first few days of their new life. The mouthparts and suckers are functional by the time the octopus hatches and the young begin feeding on small crustacea within a

few days of hatching. Large chromatophores develop towards the end of the embryonic period and these too are functional in newly hatched octopuses. In *O. tetricus* and *O. vulgaris*, the larval chromatophores are lost after settling and replaced with smaller adult chromatophores.

Embryonic development usually takes between twenty-five and one hundred days, depending on the particular species and the water temperature. As brooding females do not feed, they are usually starved and quite emaciated by the time the eggs hatch. Even after all the eggs have hatched, females still refuse to feed and usually remain within their lair. In the aquarium, female *O. tetricus* die within one or two weeks of the completion of hatching, despite being offered the choicest of foods. Females of other species of octopus also die within a relatively short time (up to two months) of the young hatching, although one individual of *O. vulgaris* has been recorded as surviving as long as six months. Studies by a Japanese researcher indicate that the enzymes of the posterior salivary gland and the digestive system are not produced in brooding females, making them unable to kill or assimilate food.

Octopuses kept in the aquarium and fed as much food as they will eat exhibit very high rates of growth. In some cases they can double their weight within a month! Information on the growth rate of octopuses in their natural environment is meagre but the available data indicates that wild octopuses also grow rapidly on their natural level of food supply. Life history studies suggest that octopuses are relatively short lived. *O. vulgaris* and *O. cyanea* are thought to have a life-span of one to two years. The blue-ringed octopus *Hapalochlaena maculosa* has been shown to have a life-span of around seven months while that of the small Caribbean octopus, *O. joubini*, is around six to eight months.

The excellent eating qualities of octopus have given rise to special octopus fisheries, particularly in the Mediterranean and the seas around Japan. However in some fisheries the octopus is regarded as a pest species. In Western Australia, *O. tetricus* is responsible for the destruction of over \$300,000 worth of rock lobsters per season. Octopuses enter fishermen's pots and attack the trapped rock lobsters. Often the octopus slithers out from the pot again before the fisherman hauls it to the surface, making the fisherman doubly angry. While the fishermen's rage is understandable, it is not easy to condone the actions of people who sometimes kill or harass these mostly harmless and gracious creatures because of popular prejudices.

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Embryonic development of the common Western Australian octopus, *O. tetricus*, from left to right: Newly laid egg. At this stage the embryo is a flat disc of cells. The embryo has now changed position and lies at the stalk end of the capsule. The large eyes are particularly prominent and small arms with suckers are beginning to appear. The dark mass at the free end of the capsule is the yolk sac; the yolk sac is now considerably reduced in size while the embryo occupies the greater part of the capsule. Newly formed embryonic chromatophores are visible on the head and body surface; the embryo has again reversed its position within the capsule and is approaching the time when it will hatch. The moment of hatching. The embryo dissolves away part of the egg capsule and squeezes out through the narrow slit produced. Free at last! The newly hatched larva swims around in a jerky manner as it adjusts to its new environment. The dark area in the centre of the mantle is the larva's yolk store for its first few days of life.



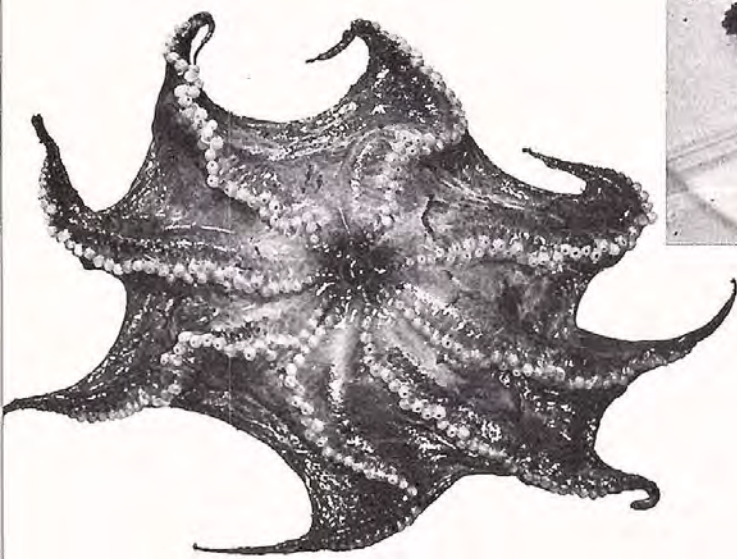


An octopus with a clutch of eggs, photographed in 10 metres of water off Edithberg, South Australia.

This unidentified octopus, half the size of a man's fist was found off Terrigal, NSW.



The underside of the 'Blind Octopus', a deepwater species usually found at about 100 metres, off the NSW coast. It is adapted for life on the muddy sea bottom.



A small tropical reef octopus, well adapted for collecting food from rocky areas. Its soft flexible body allows it to escape into small crevices when threatened.



