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● **FRONT COVER: Aboriginal ceremonial regalia on the west coast of Cape York Peninsula, near Mapoon Mission. The carved heads represent crocodiles. There is obvious influence from Torres Strait in this type of mask. The photo was taken by W. E. Roth, who was Protector of Aboriginals in Northern Queensland in the late 1890's and the early years of this century. An article on his work and his remarkable collection of Aboriginal artefacts from northern Queensland appears on the opposite page.**

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THE STORY OF THE ROTH ETHNOGRAPHIC COLLECTION

By KATHLEEN POPE, Museum Assistant, and DAVID R. MOORE, Curator of Anthropology, Australian Museum

IN 1906 the Australian Museum acquired one of the most complete and well documented collections of ethnographic material ever assembled from a particular region. This was the Roth collection of Aboriginal artefacts from north Queensland. The story of how this remarkable collection was gathered and how it came to the Australian Museum is a fascinating one and it brings to life vividly the unhappy situation of the Aborigines in north Queensland at the turn of the century.

Dr Roth and the north Queensland Aborigines

Walter Edmund Roth was the youngest of six sons of an English surgeon, and two of his elder brothers, Henry Ling and Reuter Emerich, who preceded him to Australia, were respectively an ethnologist and a physician. Having graduated from Oxford with an honours degree in biology, W. E. Roth first came to Australia in 1884 and was successively an assistant master at Brisbane Grammar School, Director of the South Australian School of Mines and Industries, and assistant master at Sydney Grammar School. In 1890 he returned to England to further his study of medicine.

Roth came back to Australia in 1894 with the qualifications M.R.C.S. and L.R.C.P. and was appointed surgeon to Boulia, Cloncurry, and Normanton hospitals in Queensland. During the four years he held these appointments he developed a very real and intense interest in the Aborigines of the region, and this resulted in the publication in 1897 of his *Ethnological Studies Among the North-West Central Queensland Aborigines.* This remarkably detailed and well illustrated monograph established him as an ethnographer of note and resulted in his appointment in the following year as Protector of Aboriginals in Northern Queensland.

In explaining the duties of this new appointment, the Queensland Commissioner of Police (under whose jurisdiction Roth then came) wrote:

Directly you have proper and sufficient equipment you should proceed to Cooktown, make all possible inquiry concerning local aboriginals, numbers, disease, present condition, measurements, photographs, etc. Collect all information re their "walkabouts" and trade routes so as to learn the boundaries of their territories, gather all particulars concerning friendly and hostile neighbours, making from time to time such local collection of ethnological and anthropological interest as is possible . . .

He also mentioned that the appointment was "largely owing to the fact that the enthusiastic interest in the welfare of the blacks you have displayed, gives great promise of the proper performance of the humanitarian work implied . . ."

Roth immediately moved to Cooktown and began to travel by pack-horse over the vast area of his responsibility, which took in the whole of Cape York Peninsula as far as the southern shore of the Gulf of Carpentaria and included the channel country on the west; on the east coast it extended as far south as Rockhampton. (See map.) He was horrified at the callous exploitation of Aboriginal labour which he found to be the norm almost everywhere. Among other early recommendations, he advised the Commissioner of Police that no permits should be issued to publicans for the employment of Aborigines, because they were paid in liquor and their women were kept as prostitutes to decoy men being paid-off from boats. In the bêche-de-mer trade he found that Aborigines were being atrociously exploited and swindled out of their wages. He was also appalled at the trade in opium and cheap liquor with the Aboriginal people of the coast.

Naturally Roth quickly made bitter enemies among the exploiters. Early in his term of office he wrote of the Aborigines around Cooktown: "At present none of them will come near me, some malicious reports having been circulated that I have come here to drive them from their homes and destroy them." However, he was a big man, in both physique and temperament, and was not easily intimidated. During the following six years he covered an enormous area in great detail and made close personal friends of hundreds of Aboriginal people.

It was in this way that he was able to gather the huge collections of more than 2,000 specimens, with elaborate documentation, now held by the Australian

The main centres in W. E. Roth's huge area of responsibility as Protector of Aboriginals in Northern Queensland. [Map by Kathleen Pope and Elvie Brown.]

Museum. These collections include not only every possible type of Aboriginal weapon, tool, plaitwork, basketry, and suchlike, but also specimens at various stages of manufacture, together with full accounts of how the objects were made; also included are extensive skeletal material and documentation on foods, language, sign language, ceremonies, legends, posture, physique, diseases, and even such esoteric matters as attitudes towards birth, marriage, death and so on.

The first three of Roth's *North Queensland Ethnography Bulletins* were published by the Queensland Government in 1901 and the succeeding five between 1902 and 1906.

Roth's relationship with the Aborigines (one that was virtually unique at that time) is well shown in a letter written to him in their own language by a group of young Aboriginal girls at Cape Bedford (later Yarrabah Mission), near Cairns, in May, 1898:

Dauun antanun Mr Roth,

Antan nila nanu kapan balkal. Antan karbunmanuti nundu antanungal kataigu gura

Three little Aboriginal girls at Yarrabah Mission, near Cairns. These may well have been the children who taught Dr Roth string games and wrote the letter to him which is included in this article. The photo was taken by Dr Roth himself.

nundu antanun dauun tjir natetchi. Gura ditchultchir ninggai gura kokodir ngangoigo antanun dawangati. Dauunbutongo nundu antanun ninggal. Namongu antan dirlen nanu gari milka ngandaya gura nina milkan nama. Diral nanu galmba gari milka ngandaya. Dauun antan nunu merelil wangar yendu antan yimidir natelmilgo dauunt jirbutongo kataiga gura nundu antanungal botur kundo barbiga, gura nundu antanun ngutongu merelinga. Dirlen galmba antan nanu kapan mangulbego merelin. Namo nanu thanks gural. Nundu garko gurabuto katanu bera go namo ngaba nundu koko antanun nama.

Dauun nanu, etc.

A literal translation of this reads:

Friend of us, Mr Roth,

We now to you letter make. We glad were you us-amongst came and you us as friend looked at. You smiled and soon called on us to talk with you. Friend real you to us are. Therefore we in return do not forget and of you think. Wife yours also we do not forget. Friend of us, to you we say, White man another we similar to you do not know. Truly friendly you came and us-amongst nights (days) three stayed, and you to us games showed. In return also we to you "cat's cradle" on hands showed. Therefore to you thanks we say.

You by-and-by again will come certainly. By that time perhaps you language-of-ours will speak.

Your friends, etc.

Hostility from employers

The more the Aboriginal people loved and trusted Roth, the more the hard core of exploiters schemed to put a stop to this interloper who was putting stupid ideas about fair play and fair wages into the thick heads of the blacks. Matters reached a climax at a meeting held at Cooktown on

W. E. Roth with the tallest Aboriginal woman he ever met (over 6 feet). The photo was taken near the Mitchell River Mission.

10th July, 1905, which resulted in a petition for Dr Roth's dismissal from office on the following grounds:

The office was unnecessary, and the cost of it should be saved.

That Dr Roth was instrumental in over-ruling the local administration of the Acts by the Sergeant of Police, and in causing uneven enforcement of the law.

That Dr Roth was instrumental in preventing needed alteration of the law.

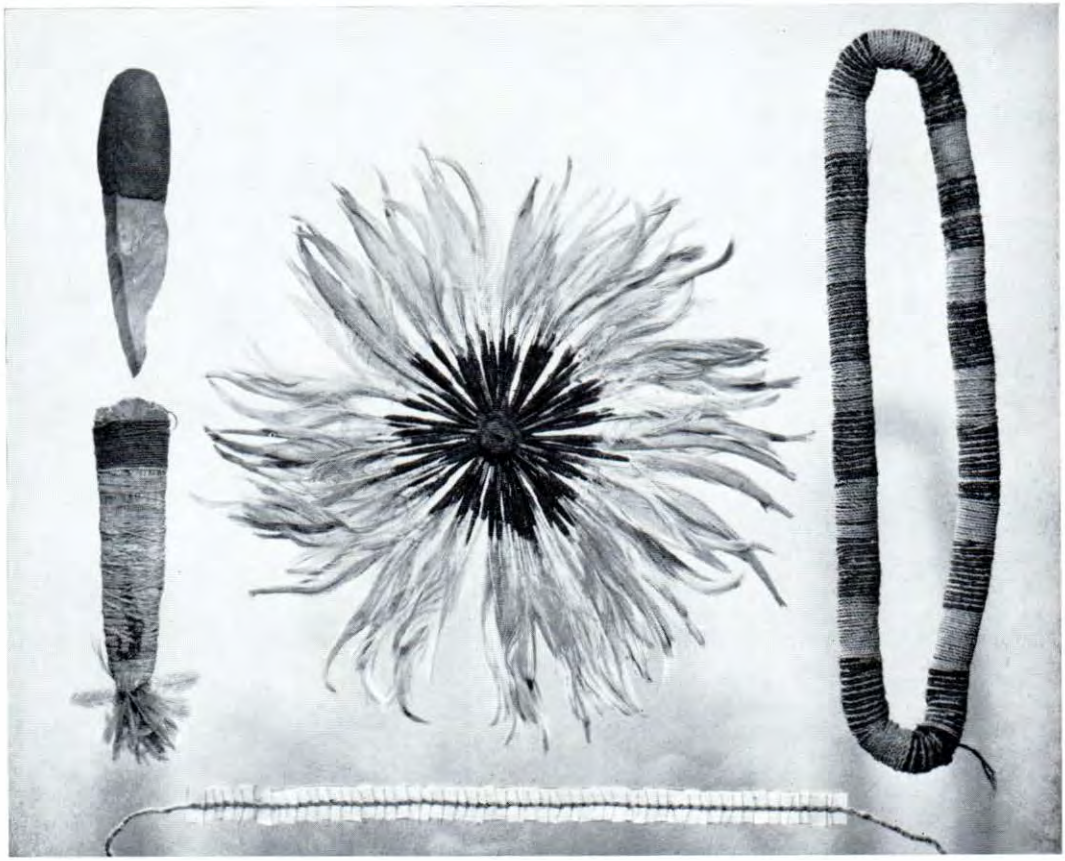
That Dr Roth did not place himself in contact with the Aborigines, or treat them medically.

However, the resulting Parliamentary investigation carried out by the Under Secretary for Public Lands found:

I came to know from my conversations with the Police Magistrate, the Clerk of Petty Sessions, the Subcollector of Customs, and others, that there is a strong element in Cooktown favourable to Dr Roth and his work, and that I had encountered the whole strength of the antagonistic opinion.

Roth himself was quoted in the same document as saying:

I am well aware that the general opposition to my administration and to myself personally is mainly due to my interference with what has for many years past been considered as a vested interest in the flesh and blood of the native. As a matter of fact, the opposition exhibited on these grounds is one of the greatest compliments that could have been paid to me, and my happiest satisfaction lies in the knowledge that I have invariably treated all employers of aboriginals' labour alike, without fear or favour.



Examples of north Queensland artefacts in the Roth collection: Flake knife with sheath of paperbark, Barclay Downs; ceremonial head-dress of cockatoo feathers, Bloomfield River; waist belt, made from the soft down of possums and worn by males, Mackinlay, northwest Queensland, and (below) necklace of ground pieces of Nautilus shell, Cape Grafton. [Photo: C. V. Turner.]

These specimens show Roth's interest in manufacturing processes: a partly made and a completed typical north Queensland bicornual-type basket, from Atherton. [Photo: C. V. Turner.]

In 1905 Roth was appointed Royal Commissioner to inquire into the conditions of the Aborigines of Western Australia. Presumably it was during this period that he decided to leave Queensland and applied for and received appointment as Government Medical Officer, Stipendiary Magistrate, and Protector of Indians in the Pomeroon District of what was then British Guiana. There, in later years, he also carried out notable ethnographic and humanitarian work.

The subsequent fate of the Roth collections

Before he left Australia to take up his new post, Roth deposited part of his collection at the Queensland Museum, but the bulk of it was purchased by the Australian Museum, which also published the remaining ten *North Queensland Ethnography Bulletins*.

He wrote to the then Curator of the Australian Museum, Robert Etheridge, junior, from British Guiana in 1910:

> Re my specimens being laid out in your new premises for public view—how I long to come and have a look at them again! I have a proposition to make to you, and upon your advice, would then write to you officially. It is this, if my specimens are exhibited and handed down to all time, as the Roth collection of North Queensland Ethnography, etc., I will make your Museum a donation of all the Australian literature [in my possession.]

Etheridge was not very sympathetic to this quite understandable wish. On the relevant file, he noted: "Dr Roth is labouring under a very serious misapprehension: his specimens are not laid out as a 'Roth Collection', and such was never intended to be the case. . ."

Many Roth specimens have been viewed by the public at various times among the regular Aboriginal exhibits, but the bulk of the collection has remained in the Museum's collection cabinets, seen only by experts and students. Now, more than half a century later, Roth's wish is to be fulfilled, for the whole collection is being reassembled and recatalogued.

The mud zone of the eulittoral area at Dudley Point, Darwin. Brain corals dominate the scene, alternating with muddy shallow pools in which are many interesting animals. This reef is about half a mile wide. [Photo: Author.]

The Shore Reefs of Darwin

By ELIZABETH C. POPE

Curator of Worms and Echinoderms, Australian Museum

IN Australia, when coral is mentioned, one thinks immediately of Queensland's Great Barrier Reef, but there are other parts of our tropical north where well-developed beds of corals and associated organisms may be found, either as a fringe to the intertidal zone or as offshore patch reefs. Such a coast is found near Darwin in the Northern Territory, where the 26-foot fall of the low spring tides uncovers large expanses of rather muddy shore which may stretch, in places, out to sea for half a mile or more. This drably coloured intertidal zone looks far from inviting to the would-be naturalist, whether he is viewing one of the dark rocky reefs, an expanse of battered-looking dead coral boulders, or the wide flats of muddy sand. Also the vast expanses of shore fringed by mangroves, with their attendant sandflies, mud and possibility of crocodiles would seem to offer little to attract a zoologist. How wrong such an impression can be was found during a field trip made in October, 1965.

In the vicinity of Darwin both air and sea temperatures are equable, as one would expect in latitude 12° 26′ S, the sea temperature rarely going below 70° F, even in winter. There are a "wet" and a "dry" season rather than a summer and winter, the former beginning in late October or November and lasting through till approximately March or April.

Shore zonation on the rocks

As on most shores, the plants and animals at Darwin show a horizontal banding into zones, with the species best able to withstand longer periods of exposure to high

temperatures and desiccation living nearer high-water mark. This has resulted in the establishment of a regular pattern of zonation in which the highest part of the rocks, known as the *littoral fringe* because it is only submerged occasionally during the high spring tides. is populated by animals or plants which spend more time in the air than they do under water. Below this fringe is the true *eulittoral zone*. which twice daily is drained of. and flooded by, the sea-water. The inhabitants here have evolved all sorts of structures or behavioural patterns to enable them to withstand the rigours of their changeable environment. Finally there is an area which is uncovered only occasionally, during the lowest of spring tides. Its inhabitants more properly belong to the community of organisms that live permanently submerged, in the *sublittoral zone*.

Some of the most prominent of these animals (the so-called zone marking species) are shown in the full-page diagram, which depicts them vertically above the section of the shore rocks where they are most likely to occur. It must, however, be realized that the drawing represents somewhat idealized conditions and that the tremendous width of the eulittoral zone made it necessary to leave a section of the reef out of the diagram in order to fit it into a page. Some of the mobile animals also range widely within their shore zone, especially over the wide flats of the eulittoral area, and this could not be shown.

The most obvious animals on the high rocky shore are a band of oysters, *Crassostrea amasa*, and, at a slightly lower level, the inch-high, grey barnacle *Tetraclita squamosa*, whose rough shells are reminiscent of tiny volcanoes. Both these species are found in great numbers on suitable substrata, but they are limited in their distributions to rocks situated fairly near the top of the true littoral zone.

Inhabitants of the littoral fringe

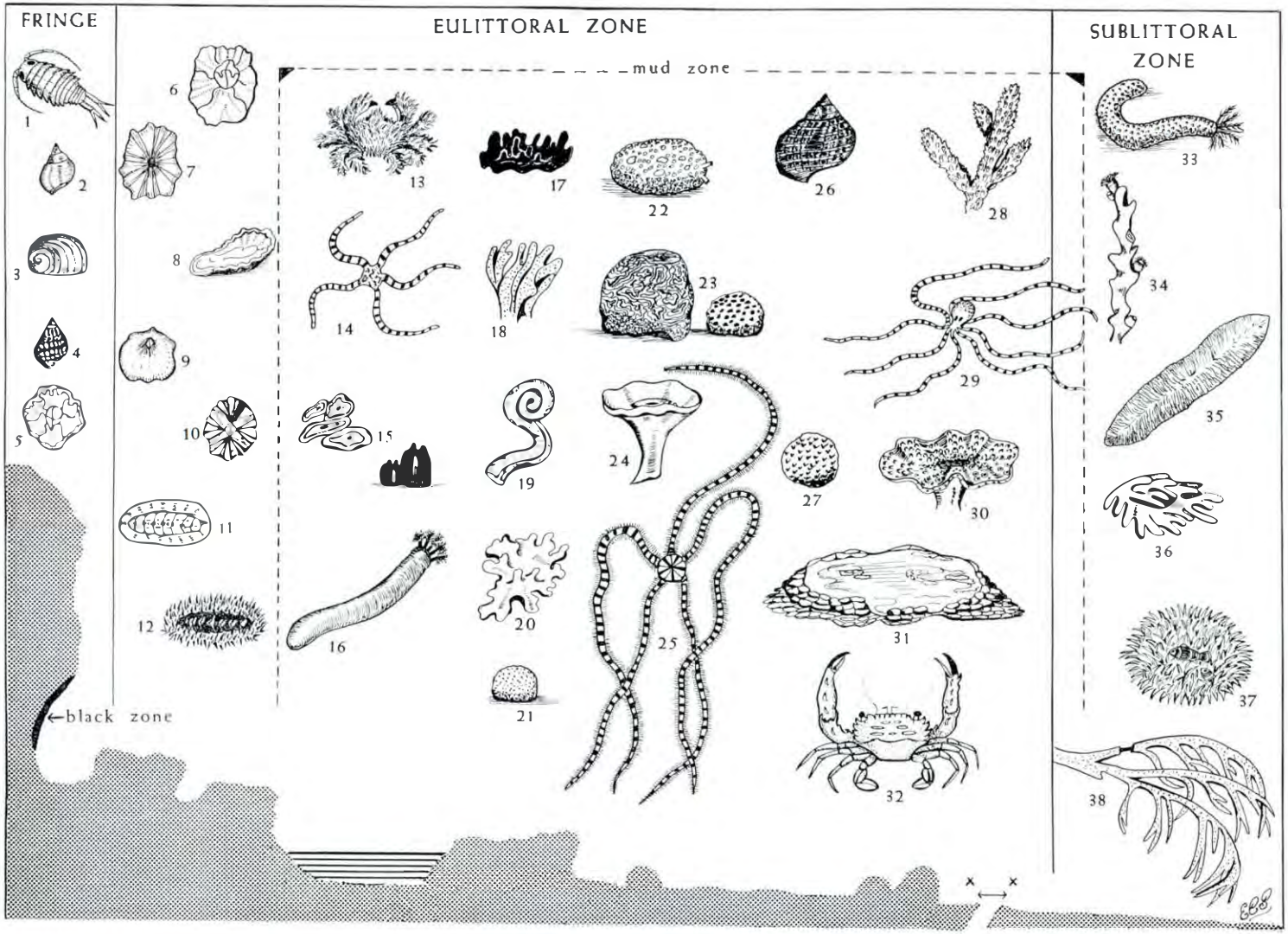
Other animals are, however, present above the oysters and barnacles just mentioned, but they are mostly small and less obvious species and are only revealed when a careful search is made along the backshore rocks. The littoral fringe dwellers include small molluscs, like the knobby littorinid *Nodilittorina pyramidalis*, the flecked *Melarapha scabra* and the pale nerite *Nerita striata*. Their colouring makes them unobtrusive and their habit of sheltering, tucked away in holes or crevices or under overhanging ledges, makes them easy to overlook. Also in this area is a small, brown-coloured barnacle, with a slatey-blue bloom over its shell, *Chthamalus withersi*. It is found sporadically, wherever a suitable rock surface occurs with the right aspect for the barnacles. Several hundred may be found in a patch and no more for quite a distance along the rocks until another patch of suitable habitat offers—generally in a shaded place.

As one moves about on these rocks, agile isopod crustaceans (a species of *Ligia*) can often be seen scuttering about. Looking rather like leggy versions of the common slater or wood louse, they retreat warily as one approaches and dive for shelter into a crevice or a crack in a boulder.

Towards the base of the cliffs, and also on some of the highest boulders on the beach, the shore is darkened by a furry vegetable growth (probably a lichen or a blue-green alga or a mixture of both). This black zone is a feature of the intertidal zone throughout the world and it is interesting to find that the Northern Territory's tropical reefs are no exception. Well-known writer, Rachel Carson, has said: "Wherever rocks meet the sea, the microplants have written their dark inscription, a message only partially legible, although it seems in some ways to be concerned with the universality of the tides and oceans". It is best seen at Darwin in places like Fannie Bay or Dudley Point by going downshore from the cliffs for a few yards, and then looking back at the cliffs. This dark zone marks the boundary between the littoral fringe zone and the eulittoral areas of the reefs and it is shown as a dark patch at the base of the cliff in the diagram. Above it the commonest creatures found in the fringe are shown (numbered 1–5).

The eulittoral area

This part of the shore occupies a tremendous area near Darwin because of the rather gentle slope of most of the shore reefs. It is generally sharply subdivided into two—an upper area that is comparatively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free of silt and mud (this is colonized by oysters, barnacles, limpets, and chitons, numbered 6–12 in the diagram) and a wide lower part over which fine brown silt of a rather gluey consistency carpets almost everything to a depth of from a quarter to half an inch, whether it be the rocks and sand of the substratum or the living animals and plants. One might expect that the silt would greatly inhibit life in this mud zone. On the contrary, the whole area supports tremendous numbers of animals of a great variety of genera, ranging in types through the following groups: brain corals, sponges, alcyonarians, ascidians, ophiuroids, crustacea, trepang (bêches-de-mer), anemones and fish, to mention only the more prominent inhabitants, and only a few of the more distinctive of these can be represented in the diagram (numbered 13–32).

The clean rocks of the inshore part of the eulittoral, as mentioned above, generally carry broad bands of the oyster, *Crassostrea amasa*, and below the oysters is another band where the tough-shelled *Tetraclita squamosa* barnacles reign supreme. Careful searching of any rock surface not occupied by oysters will generally disclose ribbed limpets, *Patelloida paropsis*, or patches of squat, grey-coloured barnacles, *Chthamalus malayensis*, while under ledges two further species of barnacles may sometimes be found—a medium-sized one with a pale shell and ten distinct ribs, *Tetraclita costata*, and a third species of the genus *Chthamalus* (*C. caudatus*), which is not included in the diagram.

Two distinct species of chitons, the very spiky *Acanthopleura spinosa* and *Acanthozostera gemmata*, live on the rocks at a slightly lower level than the oysters but they do not venture down into the mud-coated area below, which will now be described in more detail.

Adaptations of some mud-zone animals

Many mud-zone dwellers are well adapted to their habitat and seem actually to turn the mud to advantage, either by using it as a food source (it is rich in organic matter) or by disguising themselves in a coating of the thickest brown "goo". It is suspected that some species may even be using the mud coating as a protection against harmful rays of sunlight or from desiccation during low tides.

Among this last group are certain sponges of the higher shore, such as the orange "fibreglass" sponge, the common reddish sponge and the green fluted *Pseudaxyinyssa* which are shaped like delicate vases. Many of the brain stone corals (belonging to the genera *Coeloria*, *Goniastrea* and *Symphyllia*,

---

OPPOSITE

Identification chart for some common animals of the Darwin reefs, with their distributions on the rocky shore (shown in the shaded section below). The break x←→x represents about 200 yards of reef omitted from the chart. Littoral fringe animals include: 1, Isopod crustacean (*Ligia*); 2, squat-shaped juvenile periwinkles (*Melarapha scabra*); 3, the pale nerite (*Nerita striata*); 4, the noddiwink (*Nodilittorina pyramidalis*); 5, Withers' barnacle (*Chthamalus withersi*). All of these live above the zone blackened by plant growths. In the truly intertidal or eulittoral zone are: 6, the Malayan *Chthamalus* (*C. malayensis*); 7, the ribbed limpet (*Patelloida paropsis*); 8, masses of oyster (*Crassostrea amasa*); 9, the volcano-shaped barnacle (*Tetraclita squamosa*); 10, the ten-ribbed barnacle (*Tetraclita costata*); 11, the short-spined chiton (*Acanthozostera gemmata*); 12, the spiky chiton (*Acanthopleura spinosa*). All these are found just above the very muddy part of the eulittoral zone. In the muddy sub-zone are: 13, the hairy crab (*Pilumnus vespertilio*); 14, the striped snake star (*Ophioplocus imbricatus*); 15, ascidian seasquirts, (left) the pale-green compound ascidian (*Leptoclinum molle*) and (right) the simple brown squirt (*Microcosmus australis*); 16, the black cotton spinner bêche-de-mer (*Holothuria leucospilota*); 17, black sponge (*Iotrochota baculifera*); 18, red sponge (*Spirastrella vagabunda*); 19, worm-snail (*Siliquaria ponderosa*); 20, leathery alcyonarian (*Sarcophyton glaucum*); 21, orange fibreglass sponge; 22, mud slug (*Onchidium*); 23, brain corals of two kinds; 24, green vase sponge (*Pseudaxyinyssa* species); 25, long-armed brittle stars (*Macrophiothrix longipeda* or *Macrophiothrix belli*); 26, rough-shelled *Lunella* (*L. squamosa*); 27, salmon fibreglass sponge; 28, staghorn coral (*Acropora*); 29, long-armed octopus; 30, *Turbinaria* coral; 31, microatolls of *Porites* coral; 32, the blue-nippered swimming crab (*Thalamita* species). Conspicious species in the much less muddy sublittoral zone are: 33, prickly bêche-de-mer (*Stichopus* species); 34, tube of zig-zag worm (*Eunice tubifex*), to which cling green zoanthid anemones (*Zoanthus australiae*); 35, canoe corals (a species of either *Herpolitha* or *Polyphyllia*); 36, purple and pink fleshy alcyonarians; 37, large disc anemone (*Stoichactis*) and its pair of clown fish (*Amphiprion*); 38, yellow-ochre gorgonid (? family, Plexauridae). [Chart drawn by Elizabeth C. Smith.]

to mention some of the commoner types), are often capped by mud, which may cake and crack during a prolonged period of emersion and thus form a protective coating. As these brain corals may occur in thousands, as shown in the general view of Dudley Reef, they add to the impression of extreme muddiness. It is only when sea-water once more submerges these colonies and washes away the mud so that the daisy-like polyps can stretch out to feed, that one realizes the colour that can occur here. The once muddy looking stones become transformed into massed bunches of delicate green or mauve "flowers".

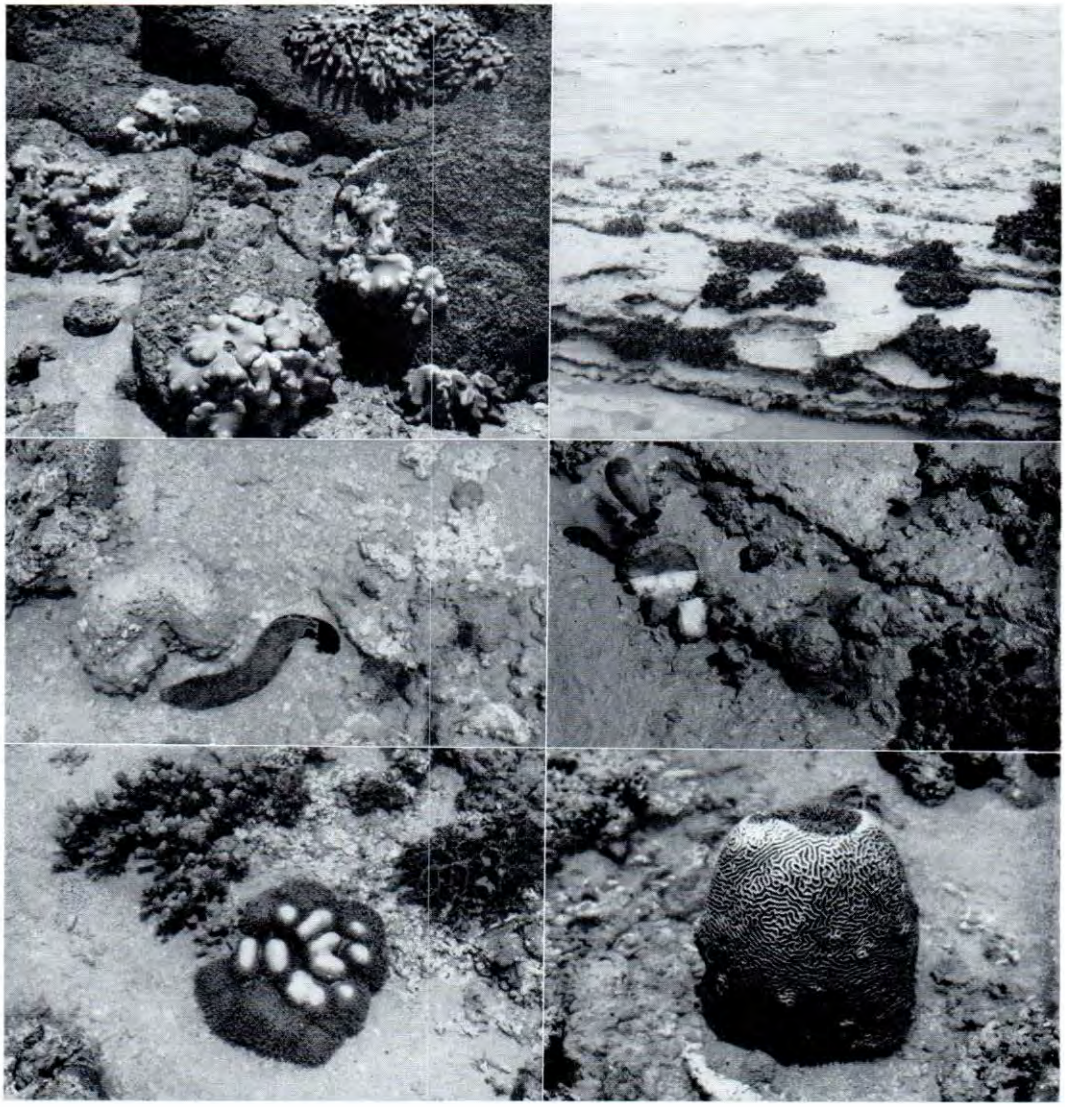
Certain of the black trepangs or cotton spinners, *Holothuria leucospilota*, when left high and dry by retreating tides, surround themselves with a mucus coat to which silt adheres, and this may protect them from desiccation or cut down the incidence of harmful rays in the sunlight. They lie around in this protective coat in the blazing sun, but, when returning water washes over them, they slough off their low-tide sun suit and crawl out of it, as shown in the centre left photo on the accompanying plate. The hairy crab *Pilumnus verspertilio* is, except for its under side and the inner side of the nipper limbs, covered by a dense hairy tomentum which holds a thick coating of mud. Only when it moves in a typically crab-like manner is it detected. When approached, the crab usually "freezes" still and its camouflage is so good that it looks like a pebble covered by muddy seaweed. In colour transparencies only the tracks left by its walking enable one to trace the crab on the mud.

Animals which swallow mud as a source of food include the black holothurians *Holothuria leucospilota* and *Holothuria atra*, many species of annelid worms and two species of sea slugs (*Onchidium* species). It is also probable that fine particles of mud in suspension are taken into the food canals of many of the colonial animals like the brain corals, some alcyonarians, and the small greeny-grey, oval compound ascidians *Leptoclinum molle*, which are so common in pools on this part of the shore. Many of them are to be seen in a number of the photographs as small, white-bordered, ovoid blobs of flesh on the rocks. Other animals flourishing in the mud zone which may also be feeding on organic matter in suspension are the red, black and green sponges, the orange "fibreglass" sponge, the large, somewhat leathery sea squirts (the simple ascidian *Microcosmus australis*), which hang under ledges or in shaded crevices, and several of the species of brittle stars—especially the ones with extremely long arms such as *Macrophiothrix longipeda* and *M. belli*, or the shorter armed spiny *Ophiothrix spongicola*, which lives curled up in hollows inside sponges during low tides. During high water, the arms of these brittle stars are extended and wave about in the water. They secrete a copious flow of mucus and can thus trap and hold passing food particles which are later conveyed to the star's mouth. Perhaps the very length of the spiny arms increases their efficiency as food catchers. A smooth-armed brittle star, with arms of a more conventional length, *Ophioplocus imbricatus*, which is also very common, feeds in the normal manner, moving actively over the reef, mouth downwards sieving food from the bottom deposits.

It was not till towards the end of our collecting that we recognized colonies of the red organ-pipe alcyonarian coral under a coating of silt in the muddy area of the reef but they were small and a little stunted compared with those of the Queensland coast.

On the whole, gastropod snails were not common in this muddy intertidal zone. One species, however, the worm-snail, *Siliquaria ponderosa*, whose shells are somewhat reminiscent of the serpulid tube-worms, has evolved a novel feeding adaptation, which helps it to survive in the muddy conditions. Its shell is fastened to the substratum or embedded in a particular kind of sponge with wickedly sharp, needle-like spicules. Towards the apex, its shell is normally coiled, as in all snails, but as growth proceeds the coiling becomes looser and the shape is more like that of a large corkscrew. The free end of the tube is fairly straight and from this the animal can protrude its gills to strain food particles from the water, in a manner rather similar to that used by the tube-worms that they superficially resemble.

Space will not permit even a brief mention of all the more important members of the fauna of this mud zone, but it is in this area in permanent pools that one sees



Animals from the muddy area of Darwin's intertidal zone. *Top left:* Leathery alcyonarians at East Point, with the elephant's foot species (*Sarcophyton glaucum*) in the foreground. *Top right:* Common black (*Iotrochota baculifera*) and brick-red (*Spirastrella vagabunda*) sponges at Fannie Bay growing at, or just below, the level of low-water neap tides. *Centre left:* With the return of the tidal waters, the bêche-de-mer (*Holothuria leucospilota*) sloughs off its low-tide suit of mucus and silt. The scattered light-coloured blobs are compound ascidians (*Leptoclinum molle*). *Centre right:* At left are two rounded orange "fibreglass" sponges (*Cinachyra australiensis*), coated with mud. One has been cut open to show its structure. *Bottom left:* A typical pool, containing branched coral (*Acropora* species) (top left), a colony of astreid coral (centre), a patch of brown "cork" sponge (*Xestospongia exigua*) (right), and many light-coloured compound ascidians. The white sections of the astreid coral are above water and therefore have their polyps retracted. *Bottom right:* One of the common species of brain corals from Dudley Point. [Photos: Author.]

thousands of crustaceans. Chief of these, in size and numbers visible, are the dark squillid mantis shrimps, the swift and pugnacious swimming crab (*Thalamita spinimana*) with vivid blue markings on its nippers, the strangely shaped porcellanid crabs and the alpheid pistol prawns. Large anemones with attendant clown fish are numerous too, and here and there patches of *Porites* coral form little microatolls. Various kinds of corals, apart from the many "brain" varieties, are also found in the deeper pools of the mud zone. They include species of *Acropora*, the "staghorn" coral of the locals, and the vase-like *Turbinaria* colonies with their delicate colouring of pink and green or yellow and brown. There are also many bivalved molluscs, such as the hammer oysters and the toothed pearl shells which live jammed in crevices.

In the deeper intertidal pools which are generally fringed by corals, alcyonarians of a rather fleshy, leathery type (*Sarcophyton glaucum*) and sponges, one occasionally comes across groups of mushroom corals (*Fungia*) lying openly on the bottom or aggregations of large anemones, like the greyish-coloured *Physobranchia* or the flat-disked *Discosoma*, which may be seen with their attendant clown fishes (*Amphiprion* species). Very common is *Xestospongia exigua*, called by us the "cork" sponge, because of its brittle consistency and its general corky appearance. In these pools small alert fishes dash for cover at one's approach—pipefish, blennies, gobies, demoiselles, cardinal fish and small reef eels can all be seen and caught if one is swift enough. Many of these animals (apart from the fish) are represented in the full-page diagram so that local naturalists can attempt with its help to recognize some of Darwin's commoner shore inhabitants.

The sublittoral zone

Extra low spring tides, during the third week of the trip, enabled us to invade the area normally visited only by skindivers, except during the brief periods of exceptionally low spring (king) tides—perhaps three or four times a year.

The bottom was much cleaner than it had been in the true or eulittoral zone above, although the waters bathing it were just as turbid as they had been inshore. It is a realm dominated by coelenterate organisms (corals, alcyonarians, anemones, stinging hydroids) and sponges, with many fascinating crustaceans, molluscs, fish and the peculiar eunicid worms, which build zig-zag tubes of a parchment-like consistency. There are comparatively few seaweeds.

So many interesting animals and plants inhabit this sublittoral zone that it would need pages to do justice to them and exigencies of space will not allow them to be included here. Some of the more common of the zoning animals found in the sublittoral are indicated and named in the diagram (Nos 33 to 38).

Much more remains to be discovered on these fascinating Darwin reefs and local naturalists should realize how lucky they are to have such exciting marine collecting so close at hand.

REVIEW

Checklist to the MATHEWS ORNITHOLOGICAL COLLECTION of the National Library of Australia.

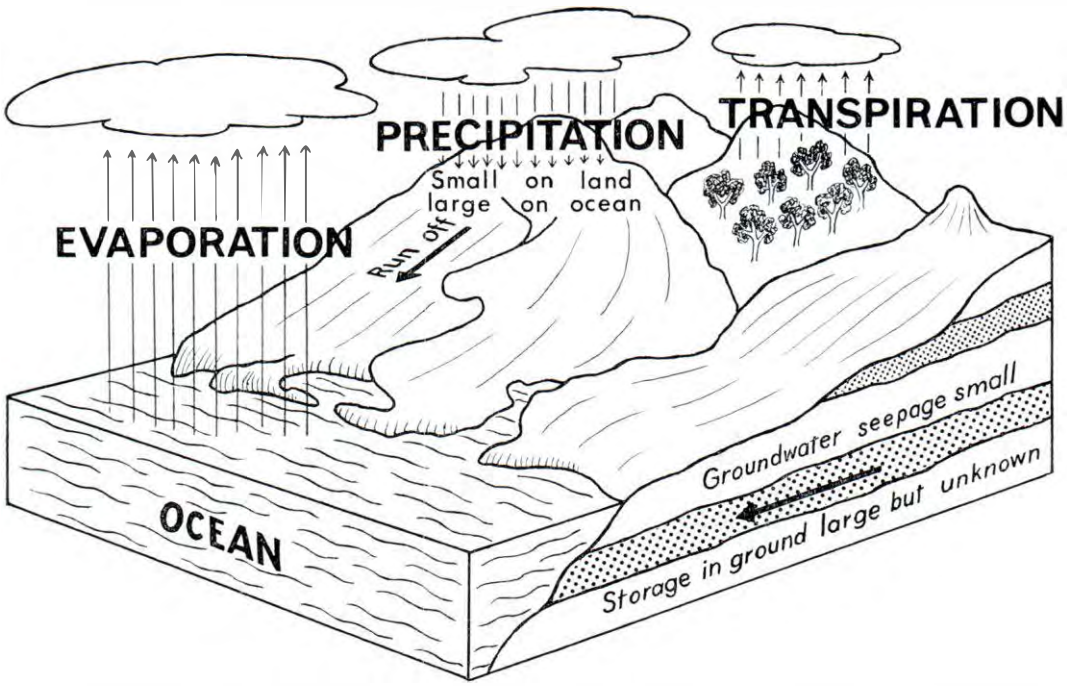
As pointed out by Dr D. L. Serventy in his introduction, much of Gregory Mathews' work has been criticized and attacked, but modern ornithologists would have an even greater job trying to get together information on Australian birds without the pioneer work of Mathews. Although his ideas on scientific names and classification do not agree with our own ideas, his great work, *The Birds of Australia*, has much useful information and the plates, including the colours of the soft parts, can rarely be faulted. If he and Tom Iredale had been able to complete the *Manual to the Birds of Australia*, a solid framework would have been built for all the future text books on Australian birds. We should all be grateful that his magnificant collection is in the National Library and that this checklist has been made available. All future workers will now be able to refer to many of the older works on birds without difficulty.

This checklist should be held by all libraries and serious workers in ornithology, and the National Library should be thanked for producing it.

H. J. de S. Disney.

LECTURES ON EVOLUTION

Lectures on evolution are being given by Mr R. Strahan, Director of Taronga Park Zoo, at the Australian Museum at 8 p.m. every Wednesday from 1st March to 3rd May. Admission is 25c per lecture.



The water cycle.

Water—And Our Thirsty Earth

By R. J. GRIFFIN
Senior Geologist, New South Wales Geological Survey

SO vital is water to our everyday living that man can say water means the difference between economic health or decay; it governs our standard of living. What he should realize is that, on this planet, without water there would be no life and without large quantities there would be no civilization as we know it.

Water—in rivers, lakes, glaciers or underground—has for millenniums markedly affected the trend of human affairs throughout the world. Most of us don't have to look for water. We grew up either in big cities where there was a public water supply, or in small towns or on farms where the water came from wells and bores.

As a vapour, water is diffused through all the atmosphere that envelops the earth. As a liquid or solid, it covers about four-fifths of the earth's surface. Not satisfied with pervading the crustal rocks as soil moisture and ground-water, it locks itself up in intimate chemical combinations with other minerals and forms a substantial part of the solid rock crust and interior of the earth. Moreover, all living matter, plant and animal, is largely composed of water. The earth is in fact unique among planets of the solar system in having a favourable balance between the gaseous, liquid and solid phases of its water—a happy cosmic accident that makes possible life as we know it.

With water seemingly plentiful all around us people are just becoming aware that there is more to the water problem than just turning on the tap, and that acute shortages are in the making in many parts of the world.

Water in usable form and amount is poorly distributed and often is not where needed most. For example, about one-fifth of all the world's fresh surface water is in the Great Lakes of North America and yet only 2,000 miles away is the "Great American Desert". This unequal distribution of water is one of its most striking characteristics, whether considered from a global, continental, or regional viewpoint. Massive accumulations of ice occupy the polar regions, while humid tropics circle the earth between desert belts to the north and south. Each of the continents has at least one large desert—the enormous Sahara Desert lies on the same continent with large lakes which contain about one-quarter of all fresh water in existence. Regionally, parched deserts lie literally in the shadow of snow-clad mountains.

What is water?

The answer to this question, far from being simple, is quite complicated. Chemically it is composed of hydrogen, oxygen, deuterium and tritium—the last two being so-called isotopes of hydrogen. The common formula for water, H_2O, need not be rejected; the important point to remember is that water is not a single, simple compound and that it has many unusual properties. It is the only substance on earth that appears in three distinct forms of matter within the normal range of climatic conditions. It can appear as a solid, a gas, or a liquid. When frozen it expands, therefore ice is lighter than water and lakes and streams freeze from the top down. This is fortunate because, if ice were heavier than liquid water, freezing would be from the bottom up and this would have a disastrous effect on fish and water plants. Another remarkable fact is that water's heat capacity is the highest of all substances in nature except ammonia. This enables the oceans to be high reservoirs of solar warmth and to keep our weather from going to great extremes of either hot or cold. In desert areas the blanket of water vapour is very thin so that the burning rays of the sun pour through in the daytime and warmth escapes rapidly at night. Perhaps water's most remarkable property is its action as a solvent. Given enough time, water can and does dissolve everything exposed to it.

Where did water come from?

At one time the earth apparently was a molten mass radiating heat into space. It was surrounded by gases and vapours which contained the essential ingredients of water. As the earth cooled and chemical changes proceeded, water was eventually formed. Ever since the seas formed, water has been working away on the earth, trying to mould it into a perfectly smooth surface. Other forces within the earth keep raising up new mountains and hills which prevent the earth from being covered by one vast shallow ocean.

The water cycle

Water has no fixed address; it circulates or moves from land to the oceans, to the atmosphere, and back to land again. This continual exchange between the earth and the atmosphere is called the water or hydrological cycle.

Throughout this cycle, some changes take place in the quality of the water. Since the world began, natural processes have influenced the chemical, physical and biological characteristics of water. Even rainwater contains small amounts of dissolved minerals, called salts, which have been transported by winds blowing across the ocean or land surface. Natural quality of water varies from place to place, with the season, with the climate and with the kind of rocks and soils the water moves through. Water quality is altered by wind- or stream-transported sediments, water temperature, soil bacteria, and evaporation. Living organisms exercise natural quality controls on both fresh water and sea water.

What is happening to water?

When populations were small and widely scattered, water was not a serious problem except in arid climates. In ancient times the productivity of arid regions was based largely on a meticulous adjustment to annually replenished water supplies. For example, the lands just east of the Mediterranean, once known as the Fertile

Crescent, supported at the time of the Roman and Byzantine empires a substantially larger population than they do today. The ancient peoples had ingeniously developed the lands by the intelligent use of meagre water resources. Their technique was mainly efficient storage of water in cisterns and in open reservoirs, supplemented by well-planned irrigation, terracing and tree planting.

Today few major areas have no water problem and some places are in serious trouble. Man's current concern over water reflects a serious world-wide shortage in the midst of plenty. Water supplies have been so used, misused and abused and the environment has been so widely polluted that many rivers can be used only for transporting wastes to the sea. They have become open sewers.

There isn't less water than there used to be, but there is more of everything else—more people, more use for water, more industry, more pollution—and by the year 2000, just over 30 years from now, water needs will have reached crisis proportions. Unlike any other mineral resource, the amount of water on our planet remains the same; man, not nature, has upset the balance. Man must have water but he must realize the consequences of water development in order to get the greatest benefit from his use of water.

We must not forget that the population of the world is increasing daily by hundreds of thousands of inhabitants, and by the year 2000 it will be double the present estimate of 3,000 million. Also, industry and agriculture (irrigation) need water in fantastic quantities and the demand is skyrocketing. Industrial demand in the U.S.A. has increased tenfold since 1900, although the population has little more than doubled. Industries are reported to use 700 gallons per person per day, whilst an individual in his home uses 50 to 60 gallons per day. Use of water from public-supply systems in a modern city is 150 to 300 gallons per person per day. After use this water is usually polluted.

Water pollution

It was the rise of civilization and the grouping of people in towns and cities that brought problems of water pollution. Man's wastes were dumped untreated into any convenient watercourse. The Romans had a horror of river water and did not hesitate, in order to water their cities, to build aqueducts which enabled them to carry the water from faraway sources.

Today most of the rivers of Europe and America are dangerously polluted—the Rhine is often referred to as the "sewer of Europe". At first the flows of these rivers diluted the wastes, but the natural or self-purifying ability of the running water was over-taxed, so that the rivers became turbid and sunlight could not penetrate deep into the water. The residual dissolved oxygen became inadequate and the result was odoriferous streams, fish kills and health hazards. It is a long time since English Parliamentarians could fish for salmon in the Thames during recess; and in 1965 a Presidential decree ordered that the Potomac (Washington, D.C.) be made clean enough to swim in.

The transport of wastes from the home, factory, or farms to the sea is a beneficial use of water, but when such waste disposal practices are abused we find that we are confronted by an abundance of debris and an insidious dilution of harmful and poisonous substances of all sorts. Realistically, the waste water problem consists of learning how to handle wastes, not how to stop waste disposal.

Some waste water problems

Newspapers and magazines currently contain many items about water pollution and problems caused by wastes discharged into waterways, primarily by industry. It is true that technological advances have introduced many new types of wastes into the earth's environment and no end is in sight. In many cases the position is undeniably grave, but what about the wholesale use of insecticides, pesticides, weed-killers and similar products on gardens, farmlands, bowling greens, and golf links? What chemicals are used in our forests and insect-breeding areas? Many of these organic compounds are complex in chemical structure and do not break down in water and disappear. Many people believe that long-term effects on man may be extremely serious—but no one is quite sure.

Water resources

Of the total world supply of 326,000,000 cubic miles, 97 per cent is found in the oceans and only 2¼ per cent is locked up in ice caps and glaciers. This leaves less than 1 per cent of the total world supply available to man, on, above or below the land.

Australia, the largest island in the world, is about the same size as the U.S.A.; both countries have about 80 per cent of their populations in the cities and major towns. The big difference is that the U.S.A. has a population of about 200 million and fantastic water resources, whereas Australia has a population of about 12 million and is considered to be the driest continent in the world.

Our rainfall is erratic, but it is accepted that over 50 per cent of Australia receives more than 15 inches of rain per annum, and about 15 per cent receives more than 30 inches. We can do a lot with this amount of water.

The economics of water utilization are continually a source of controversy, but people should realize that no area can be populated, let alone industrialized or irrigated, without a water supply. Therefore we, as inhabitants of the driest continent on earth, should be thinking in terms of our basic mineral resource—water.

LOST HOMING PIGEONS

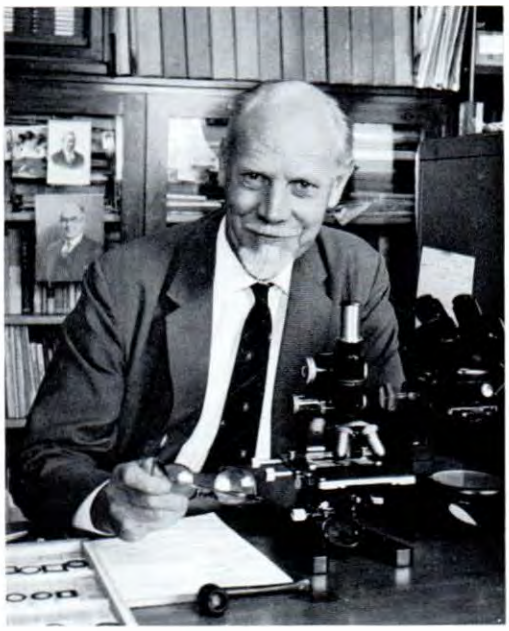
The Division of Wildlife Research, C.S.I.R.O., seeks the co-operation of *Australian Natural History* readers in its study of the fate of lost homing pigeons, as part of an investigation of the biology of pigeons.

The Division states: "During long-distance races many pigeons fail to return home. Some become exhausted because of bad weather, others meet with an accident or are taken by predators. When one of these birds is found, we would appreciate a letter advising us of the inscription on the leg band and of the date, time, location and circumstances in which the pigeon was found.

"If the bird is still alive, it should be allowed to rest, feed, and drink, whereafter it may continue on its way home. If it fails to survive, or is already dead when found, the band should be attached to the letter.

"We will use the information on the band to trace the owner and to find out from him the pigeon's last point of release. Analysis of the fate of many lost and stray homing pigeons will give us a better understanding of the hazards they face and of the methods they use to navigate."

VISITING KEEPER

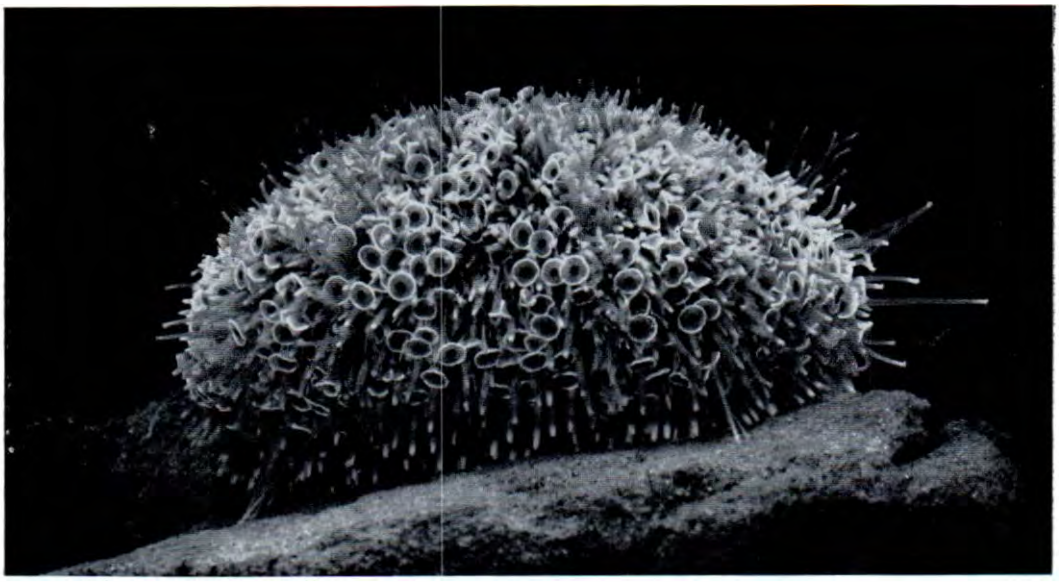


Dr J. P. Harding, Keeper of Zoology at the British Museum (Natural History), visited the Australian Museum last September after attending the 11th Pacific Science Congress in Tokyo. Dr Harding is a world authority on small freshwater entomostracan crustaceans, such as water-fleas and fairy shrimps, and is shown above examining the important collection of these animals from New South Wales made by Miss Marguerite Henry in the early 1920's.

As well as taking an active interest in research on similar animals being carried out at the University of Sydney, Dr Harding was able to visit and collect crustaceans from Warragamba and other major water supply dams of the Sydney area with Dr Hillary Jolly, biologist with the Metropolitan Water Board. Dr Jolly has worked extensively on freshwater Crustacea and other animals in Australia and New Zealand, and gave an account of the biology of Warragamba Dam in *Australian Natural History* (Vol. XIV, No. 3, September, 1962, pages 88–92).

NEW ENTOMOLOGICAL PUBLICATION

The Leafhoppers and Froghoppers of Australia and New Zealand, by Dr J. W. Evans, former Director of the Australian Museum, has been published by the Museum as its Memoir XII. The book contains 347 pages and 48 illustrations, and is available at the Museum at $5 ($5.16 posted).



One can readily appreciate why observers of live *Toxopneustes pileolus* sea urchins, which are venomous, liken their expanded pedicellariae to beds of flowers and remark how the short spines on the upper surface are almost obscured. This side view also shows the long, fine, sucker-tipped tube feet (especially clear to the right of the photo). Each expanded flower-like pedicellaria has a deep blood-red central spot and a distinct white rim, and the space in between is a pale flesh-colour. The spines are light green with white tips, which reinforces the general impression of looking at a bed of minute flowers. [Photo: C. V. Turner.]

VENOMOUS SEA URCHIN IN SYDNEY HARBOUR

By ELIZABETH C. POPE

During a dive at Camp Cove in Sydney Harbour in the winter of 1966, Mr C. Lawler and his associates of the Underwater Research Group noticed a sea urchin which was new to them, having its shortish spines almost obscured by greatly expanded, rounded pedicellariae which they described as looking like a bed of tiny flowers. Normally pedicellariae look like minute pincers, mounted on flexible waving stalks. Only a single urchin was seen but, fortunately, it was brought alive to the Australian Museum where it was at once recognized as *Toxopneustes pileolus*, a species known to be capable of inflicting severe "stings" by introducing venom into its victim by means of small curved teeth on the flower-like pedicellariae. The species is believed to have caused the deaths of several Japanese divers.

This sea urchin had never been recorded from Australian shores prior to 1961, when its finding the previous year in Moreton Bay, southern Queensland, was announced by Dr R. Endean in a short note in *The Medical Journal of Australia*. The present find extends its range some 450 miles further southward, into temperate seas. It is interesting to note that it was found in practically the identical habitat where its relative, the white and mauve sea urchin, *Pseudoboletia indiana*, was recently found in Sydney. *Toxopneustes pileolus* ranges widely through the Indian and west Pacific Oceans, so its occurrence in Australia was to be expected.

An adult male Australian fur seal, *Arctocephalus doriferus*, on Montagu Island, New South Wales. This species is being studied in Victoria.

Australian Seals

By B. J. MARLOW
Curator of Mammals, Australian Museum

ALTHOUGH seals are obviously closely related to the large order of Carnivora or flesh-eating mammals, they are so distinctly recognizable from all the terrestrial carnivores that many mammalogists now consider that they should be separated in an order of their own. This order is the Pinnipedia and is divided into three families, the Otariidae or eared seals; the Odobenidae or walruses, and the Phocidae or true seals.

The eared seals and walruses are fairly closely related to each other and are quite distinct from the true seals. In the latter group, the hind flippers remain outstretched behind the body when the animal is on land, and play no part in locomotion while ashore. Because of this, the true seals move slowly on land by hitching themselves along on their breast bone and pelvis in a caterpillar-like manner.

In contrast, the eared seals and walruses can rotate the hind flippers forwards when on land and use them to a considerable degree in walking. Thus with the fore-quarters supported on the fore flippers and hindquarters supported by the forwardly-directed hind flippers, the eared seals are able to break into an ungainly gallop, which can attain speeds similar to those of a man running. As the names would indicate, the eared seals possess small external ears which are lacking in both the walruses and true seals.

The relationships of the Pinnipedia

Certain details in the anatomy of the skull indicate that eared seals and walruses are closely related, while, at the same time, true seals are only distantly related to the former groups. The presence of the various structural modifications for swimming are due more to convergence than a close evolutionary relationship. It has been suggested with some justification that the pinnipeds have had a double origin, the true seals having arisen from some weasel-like or rather otter-like ancestor, while the eared seals and walruses originated from some common ancestor which also gave rise to the bears.

In general, pinnipeds are confined to the temperate and polar regions of the world and are poorly represented in the tropics. The walruses are found only in Arctic waters and will not be considered further here.

Eared seals

The eared seals or otariids are known popularly as sea-lions and fur seals, and are probably the most familiar members of the order.

There are four genera of sea-lions and two genera of fur seals; of these genera, two sea-lions and one fur seal are found in the Northern and Southern Hemispheres respectively.

The northern sea-lions comprise Steller's sea-lion, *Eumetopias jubata*, and the Californian sea-lion, *Zalophus californianus*. The latter species is the well-known animal which is often seen performing in circuses. Its ability to climb ladders while balancing a ball on its nose indicates the superior locomotion on land of the eared seals, since it would be quite impossible for one of the true seals to perform this feat.

The southern sea-lions comprise the genera *Otaria* and *Neophoca*. *Otaria byronia* occurs in large numbers off the coast of South America and the Falkland Islands, while *Neophoca cinerea* is found on the west and south coasts of Australia from Geraldton to Adelaide. The related species, *Neophoca hookeri*, is found in the sub-Antarctic islands of New Zealand, particularly the Auckland group. This latter species is placed in a separate genus *Phocarctos* by some systematists.

The Australian sea-lion or hair seal, *N. cinerea*, is a large animal, in which the adult males may grow up to a length of about 10 feet. It is easily recognizable by the patch of white hair on the crown and nape of the neck of the adult males. The throat and belly of the females are of a dirty yellow colour.

The fur seals are considerably smaller than the sea-lions, since the adult males normally only measure about 7 feet in total length.

The northern fur seal, *Callorhinus ursinus*, which breeds on islands in the north Pacific Ocean, is the basis for a considerable industry in sealskins which is operated by the United States in the Pribilof Islands. Unlike the sea-lions, fur seals retain a dense layer of woolly under-fur below the longer stiff guard hairs on the pelt. When these guard hairs are stripped out mechanically the remaining wool fibres form the sealskin of commerce. The hair of adult sea-lions consists only of guard hairs, and is thus of no value as a fur, although good-quality leather may be made from the skin.

The Australian hair seal, *Neophoca cinerea*, showing the characteristic white cap of the adult male. A colony of these animals exists on the south coast of Kangaroo Island, South Australia, where this photo was taken.

The fur seal populations on the Pribilofs were seriously depleted by over-exploitation, but in 1911 an intensive study of the biology of the species was undertaken. The protection of the breeding stock, coupled with controlled taking of 3-year-old bachelor bulls, has enabled the population to maintain itself at a satisfactory figure of about 1½ million animals. A total annual kill of about 60,000 bachelor males and 30,000 surplus females is made, which is worth about $1,000,000 to the United States Government.

The southern fur seals are all included in the genus *Arctocephalus*, of which there are about six species. The most northerly species is the rare *A. philippi*, of California and Chile, while *A. gazella* is widely distributed around the sub-Antarctic islands of the Atlantic and Indian Oceans. Off the coast of South America, *A. australis* extends from the Falkland Islands and South Georgia to the Galapagos Islands. The fur seal of South Africa, *A. pusillus*, is probably the best known species in the genus, since its biology has been extensively studied in connection with the fisheries industry of that country.

In the Australasian region there are two species of fur seal: *A. forsteri* is found off New Zealand and its neighbouring sub-Antarctic islands, while the Australian fur seal, *A. doriferus*, occurs around the southern coasts of Australia—around Recherche Archipelago in Western Australia and from Kangaroo Island, South Australia, to Seal Rocks, near Port Stephens in New South Wales. It also occurs around Tasmania. The systematics of fur seals in Australian waters are in a confused state, since some workers maintain that those animals around Kangaroo Island in South Australia are *A. doriferus*, while those in southern Victoria, New South Wales and Tasmania warrant separation as a distinct species, *A. tasmanicus*. The only difference between these populations is the relatively larger size of the eastern animals. Certain cranial characters have been suggested as being diagnostic of these two forms, and yet animals which show both these features have been found living together in the same breeding population. Further work is necessary on the taxonomy of Australian fur seals, but at the present time it would be better to retain the view that all the Australian fur seals represent a single species, until unequivocal evidence to the contrary can be produced.

There are thus two species of eared seals which are resident on Australian coasts, the Australian hair seal or sea-lion, *Neophoca cinerea*, and the Australian fur seal, *Arctocephalus doriferus*.

True seals

None of the true seals exist as resident animals in Australia today, although stragglers may occasionally come ashore on our beaches. The family Phocidae, which contains all the true seals, is divided into three sub-families. One of these, the Phocinae, is essentially northern in its distribution and contains such animals as the harbour seal, *Phoca vitulina*, and the grey seal, *Halichoerus grypus*. The second sub-family, the Monachinae, is mainly southern in its distribution and includes the monk seals of Hawaii, the Caribbean and the Mediterranean. The most characteristic members of this sub-family are the typical seals of the Antarctic, such as the Weddell seal, crab-eater seal, Ross seal, and sea-leopard. The Ross seal, *Ommatophoca rossi*, is extremely rare and is known from less than fifty specimens. There are no records of it from Australian beaches. The Weddell seal, *Leptonychotes weddelli*, is plentiful close inshore around the Antarctic continent. It does not appear to migrate very far north and is rarely found in the pack ice. There is a single record of a specimen coming ashore in South Australia. By far the most numerous seal in the Antarctic is the crab-eater seal, *Lobodon carcinophagus*, in which the teeth are remarkably adapted for a diet of krill, *Euphausia superba*, the small shrimp-like crustaceans on which the whalebone whales also feed. The teeth have complicated crenellated cusps which form a very efficient sieve when the upper and lower rows are interlocked. Several beachings of crab-eater seals have been recorded in Australia, included among which are Sydney, Portland (Victoria) and Tasmania.

The leopard seal, *Hydrurga leptonyx*, is a solitary seal which lives mainly in the pack ice of the Antarctic where it feeds on other marine vertebrates, such as fish, penguins, and other seals. Some specimens have been

The leopard seal or sea-leopard, *Hydrurga leptonyx*, is the species of true seal which comes ashore most frequently on Australian coasts. It feeds mainly on marine vertebrates, especially penguins, fish, and other seals.

examined in which the stomach was full of krill. During the spring, July to September, some of these seals migrate north to sub-Antarctic islands such as Heard and Macquarie, and at the same time some stragglers appear on Australian beaches. These are normally young animals in their first and second year. Of all the true seals, the leopard seal is the species which appears most frequently on Australian beaches and has been recorded from New South Wales, Victoria, South Australia, and Tasmania. The third sub-family of the true seals, the Cystophorinae, contains only two genera, *Cystophora*, the hooded seal of the Arctic, and *Mirounga*, the elephant seals of California and the sub-Antarctic.

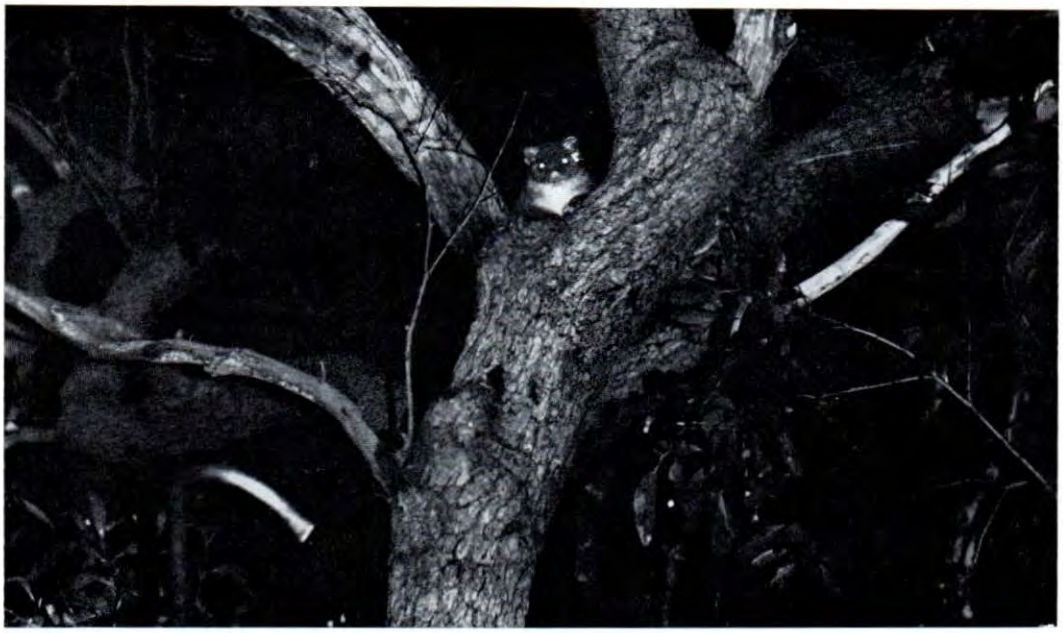
In former times, the southern elephant seal, *Mirounga leonina*, occurred in large numbers on King Island and Tasmania, but these colonies have now disappeared and only occasional stragglers appear in these areas. Large breeding populations of elephant seals still exist on Macquarie and Heard Islands.

Conservation

The only pinnipeds which are at present resident in Australia are the two species of eared seals, *Neophoca cinerea* and *Arctocephalus doriferus*, known popularly as hair seals and fur seals respectively. Isolated stragglers of various species of true seals occasionally occur.

Both the resident populations of fur seals and elephant seals were subjected to exploitation by sealers for skins and oil during the early nineteenth century, to such an extent that the elephant seals were completely exterminated and the fur seals reduced to a very low population level. At the present time, fur seals are completely protected and it would appear that their numbers are increasing. An intensive study of the biology of the Australian fur seal is at present being undertaken by the Fisheries and Wildlife Department of Victoria. Unfortunately little accurate data are available on the natural history of this species, and many individuals are killed illegally by fishermen either for crayfish bait or because of their supposed competition for fish of commercial value. It is to be hoped that the research mentioned above will produce valuable information which may be used for the successful conservation of the fur seal. Once its numbers have increased to a satisfactory level it may be possible to use these animals as the basis of a scientifically controlled sealskin industry which would provide a lucrative natural resource. The value of controlled utilization of fur seal colonies may be seen in the United States where the total cost of the purchase of Alaska from the Russians, $7,000,000, has been recouped in sealskins alone in a space of 7 years.

[*The photos in this article are by the author.*]



A Ring-tailed Possum looks at the camera after contemplating a hook (lower left) to be used to shake him from his perch. The tag at the bottom of the possum's left ear has a reflective pattern which is used to identify the animal without catching it. [Photo: Carina Clark.]

Ring-tailed Possums

By MICHAEL MARSH
Lecturer in Biology, School of Biological Sciences, University of Sydney

THE possum family, the Phalangeridae, contains a variety of forms which is rivalled only by the Dasyuridae (the marsupial carnivores) among marsupials. Members of this family range in size from the Feather-tailed Gliders and Pigmy Possums, weighing in the neighbourhood of 10 grams, to the koala, which may weigh well over 10 kilograms.

There are a number of feeding adaptations. Most of the smaller possums are "insectivores"; they feed on small animal life, mostly insects. These small possums also feed on the nectar and pollen of flowers. Among the largest possums which eat animal food are the Striped Possums of New Guinea and northern Queensland, and the Yellow-bellied Gliders.

Contrasted to these insectivorous forms are the larger herbivorous possums. These fall into two categories according to the structure of their molar teeth. The Brush-tailed Possums, the cuscuses and related forms have molars which resemble those of the insectivorous forms. The four cusps of such molars are convexly rounded on all sides. The Greater Glider, the Ring-tailed Possums and the koala, on the other hand, have crescent-shaped cusps, that is, the external face of each cusp is concave.

The diet of Ring-tails and their allies is more limited than that of members of the Brush-tail group. The koala and the Greater Glider thrive only on the leaves of a few species of gum tree. Ring-tails have comparatively broader tastes, and can live and

reproduce while feeding on the leaves of a variety of native trees and shrubs. In contrast to Brush-tailed Possums, however, they do not thrive in captivity if fed on foods such as cooked vegetables and meats, fresh fruit and baked foods.

All members of the possum family are characterized by the structure of their hind feet. The second and third toes are unusually slender, and are bound together in the same sheath of skin, a condition known as syndactyly. The bandicoots and the kangaroos also have syndactylous toes, which are used as combs for grooming the fur. Only the possums, however, have an opposable first toe. This makes an effective grasping tool of the foot.

All members of the possum family are more or less arboreal, the Brush-tailed Possums and the rock-dwelling Ring-tail being perhaps the most terrestrial of the group. Several members of the family have evolved the ability to glide like Flying Squirrels. This ability apparently has arisen at least three times, for the Feather-tailed Gliders, the Sugar Gliders and the Greater Gliders are each more closely similar in structure to non-gliding possums than they are to one another.

The Ring-tailed Possums are particularly interesting members of the family for a number of reasons. In the first place, they are relatively abundant in most metropolitan and suburban areas of Australia, and they usually make their presence known by building a characteristic nest, a ball about a foot in diameter, of twigs, bracken fern and leaves. Nearly all the other possums, by contrast, nest in hollows in trees or in other inconspicuous hide-outs. Thus the Ring-tails are the easiest of possums to locate for study.

Ring-tails are also of interest because they are widespread geographically. The single species, *Pseudocheirus peregrinus* Boddaert, extends from south-central Victoria to the Cape York Peninsula. This species has responded to local conditions so that populations breed at different seasons in different parts of the species range. Near Sydney, there are two breeding seasons per year, in May and November, while in Victoria Ring-tails often breed only in the winter. A sample of females examined near Atherton, in northern Queensland, had bred in late summer and autumn. The nature of the ecological conditions which govern these varied breeding patterns, and their consequences with regard to the rates of increase possible in the different populations, are currently being studied by the writer.

Distribution and life history

Ring-tails are found in varied kinds of woodland in south-eastern Australia. They occur in moderate to high densities in sclerophyll forest, favouring those sites where the trees are closely spaced, and include water-loving, mesophyllic species. They also occur in montane gum forests, in swamp forests of tea-tree and banksia, and at the edges of rain forests. Population densities may be as high as six per acre in small areas, but are usually much lower. However, it is a rare forest in New South Wales or Victoria which will not reward a spotlighter with a view of at least one Ring-tail in two or three hours of observation.

Ring-tails favour forests in which the canopy of trees is continuous, for they are adept at climbing from one tree to another. They use their weight to bring a branch close to that of another tree, then grasp the new branch with their front feet while holding to the old branch with their tripod of hind legs and prehensile tail.

There are several species of Ring-tails which inhabit very restricted areas of Australia. The Bunya Mountains Ring-tail, a strikingly red animal, lives in high-altitude rain forest on an isolated mountain range about 60 miles north-west of Toowoomba, Queensland. The Rock-dwelling Ring-tail, *Pseudocheirus* (*Petropseudes*) *dahli* (Collett), is found in parts of Arnhem Land, Northern Territory. A particularly interesting group of species is found east and south of Atherton, Queensland, in the cool rain forests on the plateau. This group includes a nearly black form, the Herbert River Ring-tail, *Pseudocheirus herbertensis* (Collett), a greyish-green form, the Green Ringtail, *P. archeri* (Collett), and the lemur-like Ring-tail, *Hemibelideus lemuroides* (Collett), which has a rich-reddish fur and a somewhat bushy tail. It would be of great interest to know how these three species

differ in their utilization of the environment, for spotlighting observations indicate that they are thoroughly intermingled in the rain forest. Many ecologists believe strongly that if two or more species with precisely similar habits occupy the same area, natural selection will eliminate all but one of them.

The maximum life-span of Ring-tailed Possums is something more than five years, but few of the animals in the population attain this age. Studies of populations near Sydney indicate that 45 to 75 per cent of

A male Ring-tailed Possum under observation in a "behaviour cage". [Photo: John Johnson.]

young possums die before they attain reproductive maturity, at the age of 18 months. Thus, if a population is to replace its losses, those females reaching reproductive maturity must each produce six to eight young on the average. As the litter size is usually two, and litters are produced every six months, this means that the average female who attains sexual maturity must live about three and a half years.

Thompson and Owen (1962) studied a population near Melbourne for two years. They found that there was only one breeding season in each year, and very few possums had two litters. In January, 1965, on the other hand, many females near Melbourne had a second litter. There had been unusually heavy rainfall in the previous spring.

Behaviour

The juvenile mortality referred to above occurs for the most part after the young are independent of their parents. The majority of young seem to survive the first six months of life quite well, in particular the three and a half months that are spent in the pouch. When the female has a second litter, she may still permit the older young to associate with her, and, in fact, they may share the same nest for a while. However, the interval from 6 to 18 months of age may be regarded as the critical period for young possums. It is during this period that they must find their own place to live.

Field observations are not yet extensive enough to show whether either sex maintains an exclusive territory which is defended against intruders. In a small population near Narrabeen, New South Wales, females were found to have nearly exclusive territories in each breeding season, while the home ranges of males overlapped those of two or more females. In a very dense population which is currently under study, however, there seems to be a great deal of overlap of the ranges of both sexes. Observations of caged animals reveal that there can be a great deal of aggression between possums confined together which may result in the death of one. It is usually the mature animal which initiates such aggression, if confined with a young animal, although young possums will retaliate frantically if they think they are being attacked. This information makes it seem likely that one of the most formidable difficulties facing a young possum in a dense population will be to find a home area which he can occupy in peace, and to defend himself against other animals while he is comparatively small. Obviously, a great deal more work needs to be done on the aggressive and territorial behaviour of this species.

The behaviour of possums towards their mates and their young is proving most interesting. Complete courtship sequences have not been observed yet, but an apparently receptive female handled a male's head with her forepaws and appeared to lick the insides of his ears. She was obviously ambivalent in her attitude towards him, however, and on several occasions when he approached her she struck at him with her forepaws.

Captive females with pouch young are very aggressive, even toward the fathers of their young, so that the two cannot be maintained in the same cage. However, field observations suggest that in the wild the pair bond may be maintained throughout the raising of a litter, and the father participates, in some cases at least, in the care and defence of the young. On two occasions pairs of possums were frightened from nests, and the male was observed to take the young on his back as he fled. On one of these occasions the male kept the young on his back, and later beneath his belly, for two hours at the top of a tall tree while observers worked underneath him. Usually it is the female who is seen with the young on her back.

An experience in the field suggests that both sexes respond to alarm calls of the young. A possum between 4 and 5 months of age, which had been seen with its mother on a low branch, was captured, but the mother escaped. The young was accidentally released before it could be examined, and one member of the field team recaptured it on the ground while the other stood nearby. The standing man noticed that a male possum was approaching the prostrate man who held the squealing baby. It came to within about 15 feet of him on a branch about 3 feet from the ground. While he was watching this possum, a second possum, subsequently judged to be the mother of the young animal because of her state of lactation, attacked the standing man without making a sound, by springing on his head from above. She clawed his face and bit his lip before she could be captured. We will undertake future research into the responses of the parents to calls of young animals and into other aspects of vocal communication among possums. Field observations have shown that the young can give a partly ultrasonic "lost call" at an age of about 2 months, over a month before they are due to emerge from the pouch. It will be extremely interesting to study the development of the behaviour of the female with regard to this call. Other studies of maternal behaviour have shown that the progressive changes in the behaviour and needs of offspring as they grow older are matched by changes in the patterns of response of their mothers.

A pouch young being measured. Its head length is closely correlated with its age, and estimates of breeding seasons of local populations are based on these measurements. [Photo: Carina Clark.]

Economically, the Ring-tailed Possum is a nobody, which is a good thing for him, of course. His flesh is sought neither by sportsmen nor by commercial hunters, and his skin is too thin for the fur to be of value. Aesthetically, he is of considerable value. As mentioned earlier, Ring-tails build conspicuous nests so that their haunts are easily recognized. Thus, they make good study objects for naturalists. They do not, with a few exceptions, make a nuisance of themselves by living in the roofs of houses. Scientifically, they can be of considerable importance in providing information concerning the general applicability of theories concerning the ecology and behaviour of animals, perhaps as well as stimulating the formulation of new theories.

LARGE ALPINE STONEFLY

Thaumatoperla alpina, the largest-bodied stonefly in Australia, is shown here on a leaf of Silky Daisy, *Celmisia sericophylla*, at an altitude of 5,500 feet on the Bogong High Plains, eastern Victoria. This recently discovered, primitive plecopteran is about 1¾ inches long, with a wing span of about 2 inches. The head is black, the thorax is light reddish-brown with a distinctive black patch, and the wings are black with dark-blue iridescence over a yellowish-grey abdomen. Stoneflies are insects with aquatic free-living larvae most frequently found in running streams clinging to the undersides of stones. The largest and most primitive Australian species are found in the south-east of the continent and in Tasmania. [Photo: A. Neboiss, National Museum of Victoria.]

AUTHOR'S COMMENT ON BOOK REVIEW

In his somewhat immoderate review of my book *Furred Animals of Australia* (8th edition) in the June, 1966, issue of *Australian Natural History*, Mr B. J. Marlow laboured under a misapprehension as to the popular scope and purpose of the book.

As with preceding books in this series (*What Bird is That*, by M. W. Caley, and *What Butterfly is That*, by G. A. Waterhouse), the publisher's basic requirement was the recording and figuring of every known species. Inclusion of material of university text-book standard was not acceptable.

The reviewer regrets that biological keys are lacking. Practising biologists, however, have agreed that synoptic keys would be incomprehensible to the "average Australian", and in a popular work superfluous to a competent mammalogist. It is also stated that "lack of adequate headings makes it extremely difficult to locate precise details of information easily". But, like the bird and butterfly books in the series, there is a detailed "Explanation of Plates", and a more comprehensive "Contents", plus an index of eight pages.

One gladly accepts the reproach of a "tendency towards sentimentality about certain animals", presumably marsupials! The book indeed formed the basis of a prolonged personal campaign in the cause of marsupial conservation. Eventually, foundation of the Wildlife Research Division of the C.S.I.R.O. (1949), initiated by a recommendation of the Biological Survey Committee of A.N.Z.A.A.S. (of which the author was honorary secretary), marked a turning point in biological control and conservation in Australia.

Finally, the review praises the popular science merit of the book by stating that "past editions have rendered sterling service in stimulating the interest and curiosity of the average Australian" in our remarkable animals. But the scientific validity of the book rests more equitably with the original review in the *Australian Museum Magazine* (1942) by Professor E. A. Briggs, and in the American *Journal of Mammalogy* (1943). And more recently by the selection of the book by the late Professor R. A. Stirton as "required reading" for his senior class in palaeontology in the University of California—*Ellis Troughton.*

WEBWORM, INSECT PEST OF THE WHEATLANDS

By L. E. KOCH
Curator of Entomology, Western Australian Museum, Perth

IN the wheat-belt areas of Western Australia and South Australia many a farmer walking through his fields in autumn pays little heed to the swarms of small drab moths that rise in short erratic flight from the dry grass in his path. He does not see the creamy, pinhead-sized eggs that the moths lay, or the minute caterpillars that hatch from the eggs. Even when the caterpillars have grown larger, he may not realize how many millions of them inhabit his farm. And yet these caterpillars, which originally fed on native grasses, are one of the worst insect scourges of Australian wheatlands, and have damaged thousands of acres of wheat, barley, and rye crops, and pastures of introduced grasses, particularly barley grass.

The caterpillars are known as webworm because they use silken material to make camouflaged tubes above the ground among their food-plants, and to line burrows in the soil. They eat the young plants during winter, leaving large patches of bare ground.

Identity and life-cycle

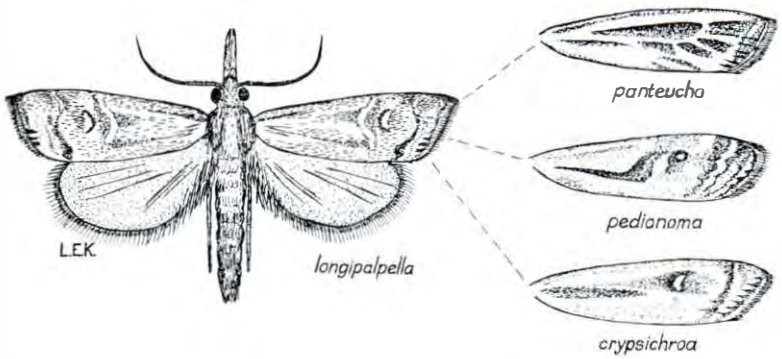
Four closely related species of moth, in the subfamily Crambinae, are involved; taxonomists have classified them mainly under the generic names *Talis* or *Hednota*. Their specific names are *panteucha*, *longipalpella*, *pedionoma*, and *crypsichroa*; *panteucha* seems to be the most numerous, and the most destructive.

The moths are brownish, and have a wing-span of about 1 inch. They can be distinguished from others very like them by their colour, size, and narrow elongated forewings; also, they have a beak-like projection in front of the head. The wings are closely folded around the body while the moths rest upright on grass stems among which they congregate during dry weather.

Adults of the four species can be readily distinguished from each other by the special markings on their forewings.

The eggs are laid on the ground, mainly in April. They hatch after about a fortnight into the caterpillars, whose depredations soon become obvious. The caterpillars are greenish-brown with dark heads; they moult six or seven times before reaching their full length of a half to three-quarters of an inch. Each caterpillar cuts off one blade of grass at a time and drags it into its tube or burrow. After denuding an area of an

Severe webworm infestation (the large dark patches on the ground) at Katanning, Western Australia, in late 1952. The uninfested area had been sprayed with DDT in the autumn of 1951. [Photo: M. M. H. Wallace.]



A webworm moth of the *longipalpella* species and the forewings of the other three webworm species, to show differences in markings. [Drawing by the author.]

inch or so, the caterpillar builds a new tube or burrow further on, and resumes feeding. Webworm caterpillars are much smaller than other pasture caterpillars, such as the stout-bodied armyworm and cutworm, which grow up to 2 inches long. Moreover, those caterpillars do not feed within silken tubes.

In early spring the full-grown webworm caterpillars cease making silken tubes, and dig final burrows about 3 inches deep among plants. They make silken caps over the entrances to the burrows, and remain underground through the hot, dry, summer months. During this resting stage the caterpillars are creamy-yellow, and their numbers are hard to assess because they cannot be seen without carefully digging away the hard soil surrounding their burrows.

Towards the end of March, the caterpillars metamorphose within the burrows into brown pupae, each a half-inch long. After some three weeks the pupae change into moths, which fly away from the burrows. After mating, each newly emerged female moth may lay as many as 550 eggs. The eggs hatch in about a fortnight, and a new generation of caterpillars is on the way at the time of the opening rains at the break of the season. Hence, webworm completes one cycle every 12 months.

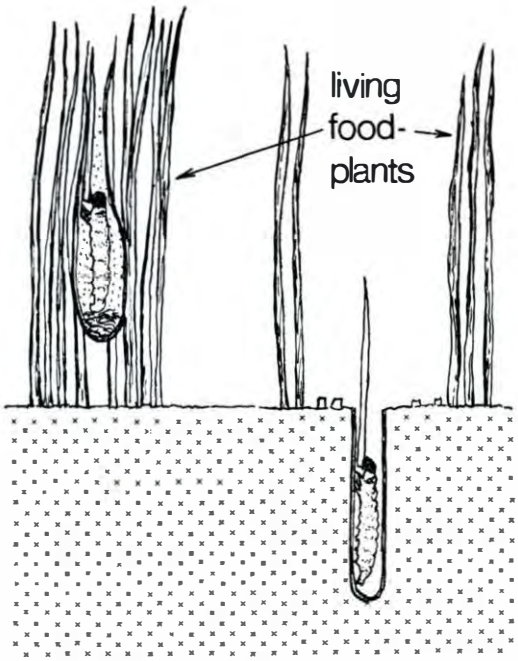
Webworm serves as a good illustration of the way in which a species adapts to its environment. The caterpillars of each species have to survive without food through the long summer. They do so by deepening their burrows, while the soil is still moist during August or September, and remaining in them for several months in a state of suspended development known as diapause. The full-grown caterpillar stage is the one most suitable for enduring the hot conditions because it contains a large reserve of body-fat. The sealed chambers, under a cover of dead plants, are at much lower temperatures and much higher humidities than the ground surface, where webworm would perish during the hot summer.

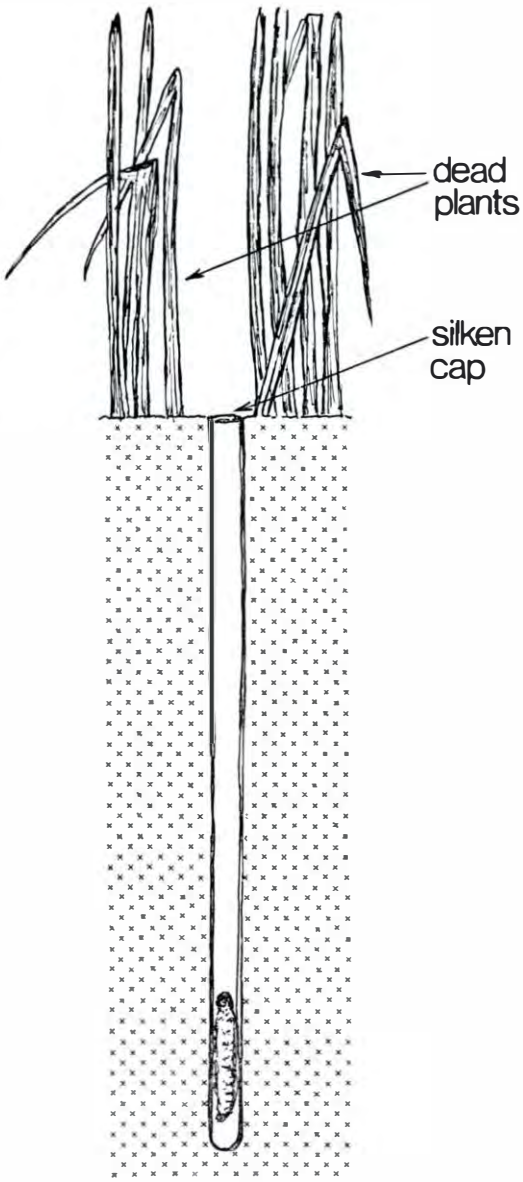
Defence by the farmer

The farmer turns over his pasture grass, and sows his cereal crops, when moths, eggs, and young larvae are abundant. The crops sprout and are attacked, and the farmer quickly seeks advice and may apply insecticide to the infested paddocks. DDT is effective at the rate of half a pound of active ingredient per acre, or at a slightly lower rate if Malathion is included. But much insecticide is wasted because the farmer usually has to resort to blanket spraying, even though his field has only patches of infestation.

Although webworm in cereal crops causes consternation, the farmer usually tolerates the pest in his pastures. He rarely treats areas of pasture grass with insecticide because the damage may be hidden by the growth of other plants such as clover or capeweed. In most areas, treatment is uneconomical in terms of increased profit from sheep and wool sales.

Many an enlightened farmer, in an effort to control the pests, resorts to fallowing: he turns the soil and grass in September and leaves it to lie over the dry months until it is time to seed at the break of season. This procedure has its drawbacks: it reduces both the dry feed available and the nutrient value of the topsoil. Late fallow, in February, is less useful in reducing webworm.





These illustrations show (above) a webworm caterpillar feeding in the winter in a silken tube among the plants and in a burrow in the soil and (right) resting over the summer in a deep burrow. [Drawings by the author.]

In autumn, cultivation reduces the fresh grass available to young caterpillars, and a delay of a fortnight or more between ploughing and seeding enforces their starvation.

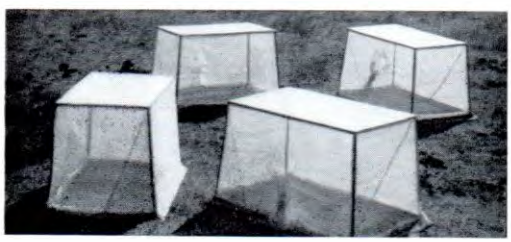
Thus, by chemical and agricultural methods, the farmer tries to control webworm. Sometimes, this may not be necessary: infestations rapidly decrease because of a change in weather conditions, and a crop may recover naturally without the farmer applying insecticide.

Natural control

Webworm has been recognized as a pest in Western Australia for 45 years; there was much damage to cereal crops in 1920, 1949, 1950, 1955 to 1959, and 1962. There has been less infestation in South Australia where fallowing is more common, but in recent years severe damage to wheat crops has occurred even there.

Because of the agricultural hazard of webworm, and the apparent irregularity of its attacks, entomologists have recently investigated the ways in which the numbers of these insects are maintained in nature. It is hoped that these studies may enable the prediction of imminent outbreaks.

Sampling by the author has revealed that more than 87,000 webworm caterpillars can live unnoticed in an acre of barley grass, thus



A light-trap (above) at Koojan, Western Australia, and field-cages (below), used by the author to catch webworm moths to estimate their numbers. Moths are attracted to the light-trap at night. Those emerging from pupae in the soil beneath the cages are trapped in them. [Photos: Author.]

constituting a great and hidden threat to crops that may later be planted there.

In the winter of 1959 the author discovered that a white fungus, *Beauveria bassiana* Bals. (Vuill.), envelops and kills webworm caterpillars. Fungi generally grow and multiply fastest when the weather is moist and warm, and *B. bassiana* kills most webworm under these conditions, when the full-grown caterpillars have made their final burrows for resting over the summer. The fungus is widespread where webworm lives, and in some years kills large numbers of webworm.

It is well known that man can use pathogenic fungi to kill insects; therefore, the possibility of controlling webworm by culturing the fungus and liberating its spores should not be overlooked. Laboratory trials on a small scale could test the practicability of this method of biological control.

The development of new farming areas could result in an increase in webworm numbers. But the frequency of serious outbreaks is greatly influenced by weather, which affects webworm survival not only in relation to fungal attack but also throughout the life cycle of the insect. A dry spell, when eggs and young caterpillars are present, greatly reduces webworm numbers; heavy rain during winter may drown caterpillars in low-lying areas; extremely hot summers kill diapausing larvae, especially those beneath bare ground and those in shallow burrows.

Man, by farming, has provided abundant food for the increase of webworm—now he must solve the problem that he has created, using the knowledge he has gained from research on the natural history of the pest.

OVERSEAS VISIT

Mr R. O. Chalmers, Curator of Minerals at the Australian Museum, was overseas from mid-July to the end of November, 1966. He visited a number of leading museums and other institutions in the United Kingdom, the U.S.A., Europe and Asia where there are important meteorite and tektite collections and where research in these fields is carried out. Because of the generous co-operation extended by the National Museum and the Charles University in Prague and the Department of Mineral Resources in Bangkok, he was able to make two short field trips in southern Bohemia and north-east Thailand to study tektite occurrences. He attended the general meeting of the International Mineralogical Association at Cambridge, England, and the International Gemmological Congress in Barcelona, Spain. At the congress he made a short contribution on Australian gemstones and ornamental stones.

STUDY OF INSECTS

Dr E. L. Mockford, of the Normal University, Normal, Illinois, U.S.A., paid a 10-day visit to Sydney to study specimens of Psocoptera. The Australian Museum's collection of these little-studied insects is one of the biggest in existence, containing extensive series of African and Australian species not available elsewhere.

ORNITHOLOGICAL CONGRESS

The Curator of Birds at the Australian Museum, Mr H. J. de S. Disney, was overseas on study leave from July to October, 1966. He attended the 14th International Ornithological Congress at Oxford and read a short paper on honeyeaters. He also visited several museums and research centres in England and America, discussing field taxonomic problems and examining overseas collections of Australian birds. The trip was very successful and much useful information was obtained on recording data and methods of determining age and sex in birds.

The Tasmanian Museum and Art Gallery. The old main entrance (on the left of the photo) and the small block immediately to the left of it are the original building, opened in 1863. The wing farther to the left was built in 1901. The wing at the right of the old main entrance was built in 1889 and was the first extension to the original building. The extension at the extreme right was opened in January, 1965. [Photo: Don Stephens.]

THE TASMANIAN MUSEUM

By W. BRYDEN
Director, Tasmanian Museum and Art Gallery, Hobart

HOBART was founded late in 1803 when Lt Bowen, R.N., with the ships *Albion* and *Lady Nelson*, formed a settlement at Risdon on the River Derwent. Early the following year it was decided to change the location decided on by the first group of settlers, and the present site of Hobart city was the one selected.

It is interesting to note that, even in the first ten years of settlement here, there were collectors—plants, animals, shells, insects, rocks and minerals all came under the eagle eyes of the interested and many specimens were sent back to Britain, where some may still be found in the British Museum.

In 1828 a small group of people, some with more specialized training, formed themselves into a scientific society and started their own museum. Two other societies came into being and considerable rivalry developed, but in 1843 the then Lieutenant-Governor of the Colony, Sir Eardley Eardley-Wilmot, called all three bodies together and it was agreed that a merger should take place, to cater for the interests of all three, by the formation of the Royal Society of Tasmania—perhaps the first Royal Society to be established outside Britain.

The Society took over the museum acquisitions, which were added to by further collections, gifts, exchanges, etc., and within a few years a fine though small museum was established.

The Royal Society had no permanent home at that time and had to depend, to a large extent, on the generosity of Government Departments for adequate space. The Papers and Proceedings of the Royal Society

of Tasmania became an integral part of the Society's function, and Volume I appeared in 1849 (Volume 100 was printed in 1966). Lectures were given, usually related to material in the Museum.

So the Museum development went on: the Society leased rooms in a fine old freestone building (demolished in August, 1965) and in January, 1863, moved into its own building on ground donated by the Government, the ground on which the present Museum stands. The initial building, in freestone, was of two storeys with two large rooms on each floor. One room housed the Royal Society Library and office, while the other three rooms became display areas for the Museum collection.

The organization flourished but costs mounted and, by 1884, with funds at a low ebb, the Council of the Royal Society of Tasmania decided it could no longer carry the burden. Accordingly, the building and contents were offered to the Government under the widest of terms. The gift was accepted and from the beginning of 1885 the Museum became a State instrumentality and has continued in that way ever since, with the Royal Society having two of the seven members on the Board of Trustees.

It is interesting to look back over the records, to see what acquisitions were made in the early years. Interestingly enough, in the first half of last century there was quite a band of Fellows of the Royal Society of London in Tasmania and they proved invaluable in assessing the worth of Museum specimens and in arranging for field parties to add to the collections. Art had its share of interest in the colony, too, and in the days before photography and in the early years of photographic development most educated people were taught to draw. The first art exhibition in Australia was held in Hobart; art schools were established, the result being that the Museum became the storehouse for many of the works produced.

Through such acquisitions, some aspects of the history of the State have been preserved; the work of the individual artists and many historically interesting scenes, some no longer in existence, have been preserved in this way. A start has been made to add to the historical records relating to artists and their work, and this field is providing a very rich area of study for the art staff.

Additions to the building were made in 1889 and in 1901, but it was not until January, 1965, that a much needed wing, to provide further exhibition space and adequate laboratory rooms for staff, became a reality.

Natural history collections are directed mainly to the Tasmanian fauna. This has become a deliberate policy based partly on finance and the size of the Museum, but also because, being the only truly isolated-boundary State in the Commonwealth, much of the fauna has quite an individual significance. To date not a very great deal has been done by way of biological surveys in Tasmania. The need is urgent and the Museum and other bodies interested in fauna preservation are deeply conscious of the need for complete biological surveys. It is pleasing to note that a start has been made in this work. Also, because of many factors, mainly lack of both finance and staff, relatively little research work on the native animals and problems related to their ecology has been carried out over the years. The need here is pressing and now that the Museum has better storage facilities, additional staff and some extra funds at its disposal, the research activity side must develop. It is interesting to note, in looking back over the records of the Museum, that in the early 1920's on one occasion the Museum was offered a number of thylacines for research purposes. A decision was made not to take the specimens as there were then plenty available and there was no need for urgency in such work! Would that we could get some now! This, I hope, will be a lesson to us, for, although other native animals seem to be in no immediate danger of extinction, it is wise to get on with the job with as little delay as possible.

It is true to say that, like other Museums in the Commonwealth, the Tasmanian Museum and Art Gallery has become aware of the great educational and scientific value of such an institution in the community—functions which the public is now rapidly appreciating and, as a result, a new approach to the Museum image has developed.

With these developments, which have progressed over the years sometimes slowly, at other times more rapidly, the Tasmanian Museum is now at the stage where a much fuller and wider research programme may be envisaged.

THE AUSTRALIAN MUSEUM

HYDE PARK, SYDNEY

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