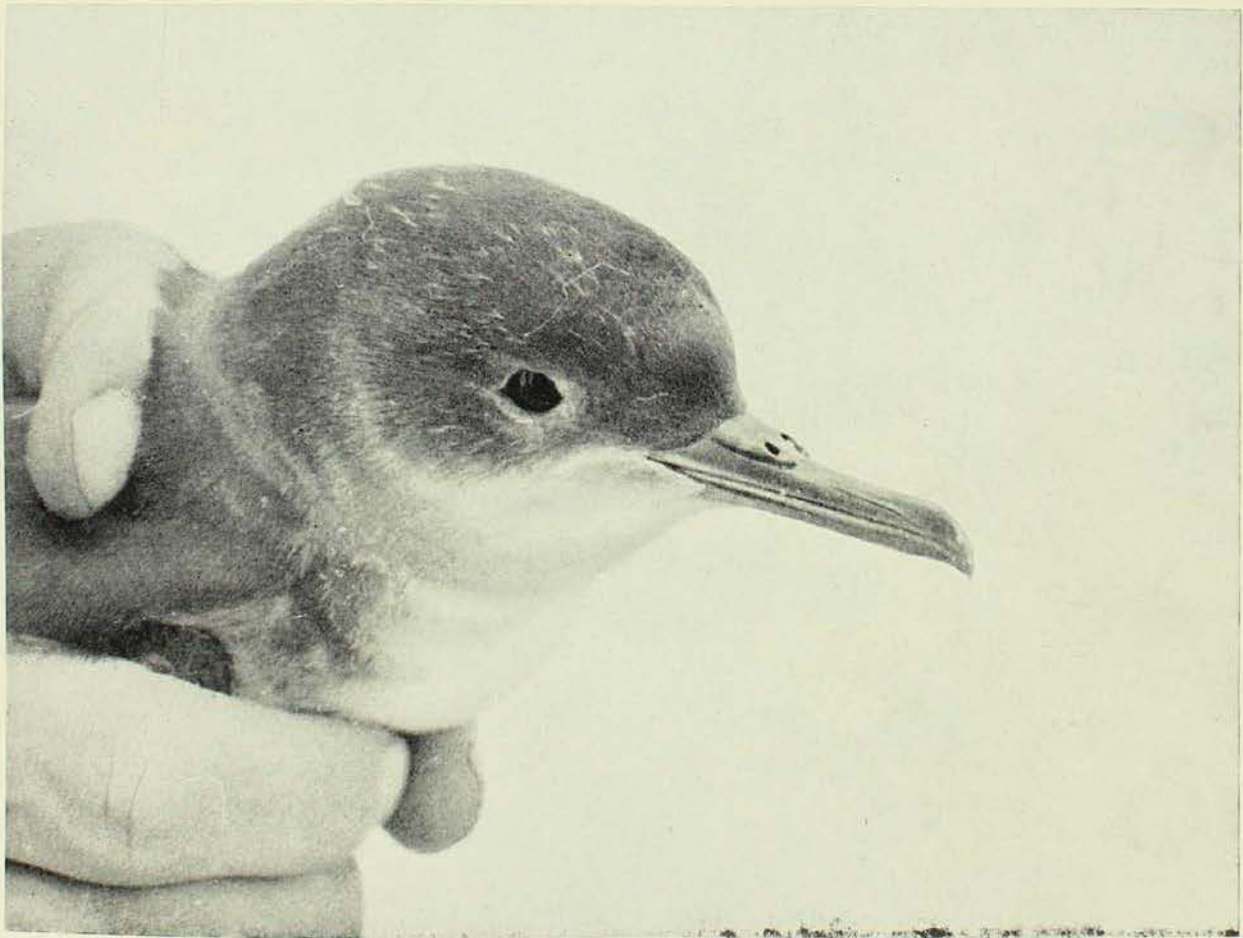


# *The* AUSTRALIAN MUSEUM MAGAZINE

Vol. XII, No. 3.

Price—TWO SHILLINGS.



The Fluttering Shearwater, an autumn migrant from New Zealand.  
Note the wisps of down that characterise a young bird.

(Article on page 75.)



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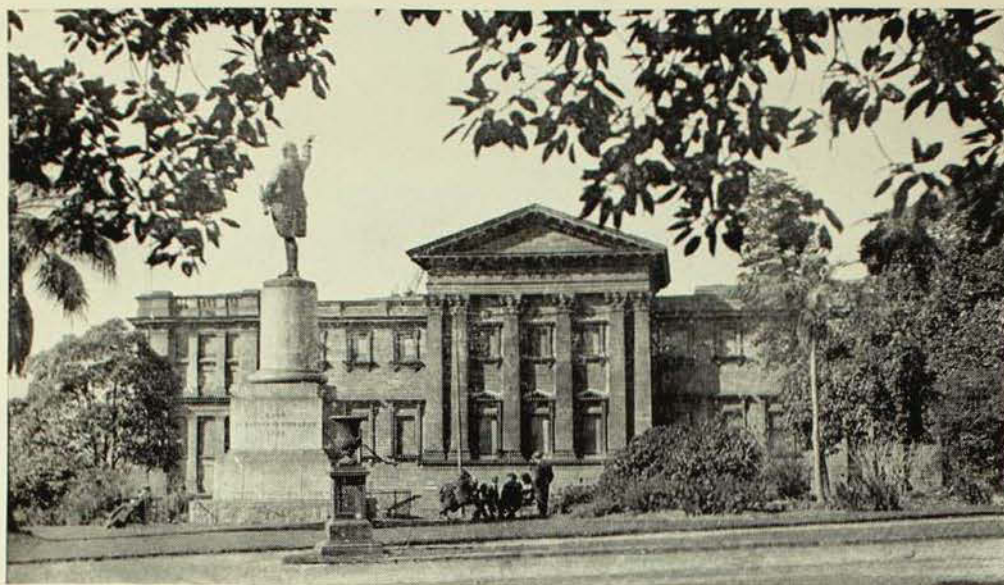
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# THE AUSTRALIAN MUSEUM MAGAZINE

A HOPI KACHINA DOLL .. .. .	Frontispiece
FUNGAL LIFE— <i>N. H. White</i> .. .. .	71
"CAROLINE," THE FLUTTERING SHEARWATER, COMES ASHORE— <i>Allen Keast</i> .. .. .	75
SOME ANCIENT BUGS— <i>J. W. Evans</i> .. .. .	78
NATURE QUIZ .. .. .	81
TRIGONIA—A LIVING FOSSIL— <i>Donald F. McMichael</i> .. .. .	82
BOOK NOTE .. .. .	84
METEORITES AND THE EARTH— <i>J. F. Lovering</i> .. .. .	85
MISS JOYCE ALLAN RETIRES .. .. .	88
LIFE HISTORY OF THE FRESHWATER EEL— <i>G. P. Whitley</i> .. .. .	89
NOTES AND NEWS .. .. .	94
AN ANCIENT REEF-BUILDING CORAL— <i>H. O. Fletcher</i> .. .. .	96
EXPLORING BETWEEN TIDEMARKS. III. SEASHORE ANIMALS AND THEIR FEEDING— <i>Elizabeth C. Pope and Patricia M. McDonald</i> .. .. .	98

(Photography, unless otherwise stated, is by Howard Hughes, A.R.P.S.)

● OUR FRONT COVER: A common offshore bird in the autumn and winter is the Fluttering Shearwater, a small denizen of the sea. Although delicate and dainty it is well equipped for its way of life, powerful in wing and with webbed feet that enable it to paddle through and over the waves. Food for the Shearwater comes from plankton, the vast drifting assemblage of small animals that live in the surface waters of the ocean. The photograph (by Allen Keast) is of a bird that came ashore, tired and exhausted, on the beach near Lake Illawarra.





One of the Hopi Kachina dolls exhibited recently at the Australian Museum. These dolls—the first of their kind to reach Australia—were lent by Mr. Ken Mayfield, an Assistant Preparator at the Museum. The one illustrated is a Snake Kachina, such as is hung in the stone dwelling of a tribal chief of the Hopi Indians of Arizona. To these Indians a Snake Kachina is responsible for the supply of suitable snakes for the big tribal ceremony of the year—the Hopi Snake Ceremony. Among other Kachina dolls are those representing the Badger, the Humming Bird, the Corn Maiden, and the Mudhead or clown, through which the god of amusement is propitiated. The dolls, all gaily coloured, are carved by the Indians from cottonwood roots.



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## Fungal Life

By N. H. WHITE

School of Agriculture, University of Sydney

THE fungi most familiar to all are the moulds that develop on foodstuffs, clothing and books, and the toadstools and puff balls found in the bush and garden. These, however, constitute only a small part of the whole group of fungi. There are vast numbers of species that pass unnoticed, seen only by experts trained to look for them.

Many readers will be surprised to learn that fungi are classified as plants. Some people think they are animals because specimens are sent to zoologists for identification. There are some, including botanists, who claim that the fungi are a kingdom of their own, but these are few. Fungi are considered to be plants because they possess in their microscopic structure a feature peculiar to the plant kingdom, which serves to distinguish plants from animals. The cells which go to make up the tissues of plants, including fungi, are surrounded by a non-living cell wall, whereas the cells of animals do not have a cell wall. Furthermore, fungi resemble plants in their mode of reproduction, especially in the development of spores which distribute the species in space and in time. The tissue of fungi is simple in structure, and consists of individual threads of microscopic dimensions

known as hyphae. Collectively the hyphae are referred to as mycelium and it is usual to speak of the vegetative body of the fungus as mycelium. This mycelium, which is usually seen with the naked eye, is the so-called "spawn" that is used in mushroom culture, and must not be confused with the reproductive units or spores developed on the fruit bodies.

The fungi differ very much from green plants in one important respect, and that is that they obtain their food for growth from plants and animals and their residues. In this respect they resemble animals whose food energy initially comes from the green plant. Many fungi obtain their food directly from plants or animals by living parasitically upon them, and in doing so cause disease. By far the greater number of fungi live upon the residues of plants and animals, and these play an all important role in converting dead plant and animal tissues into substances that can again be utilised by green plants. Such tissues are broken down to simple compounds by a succession of fungal species. One species of fungus prepares the way for the next. When leaves or branches fall to the ground they are first colonised by the sugar-loving fungi which rapidly



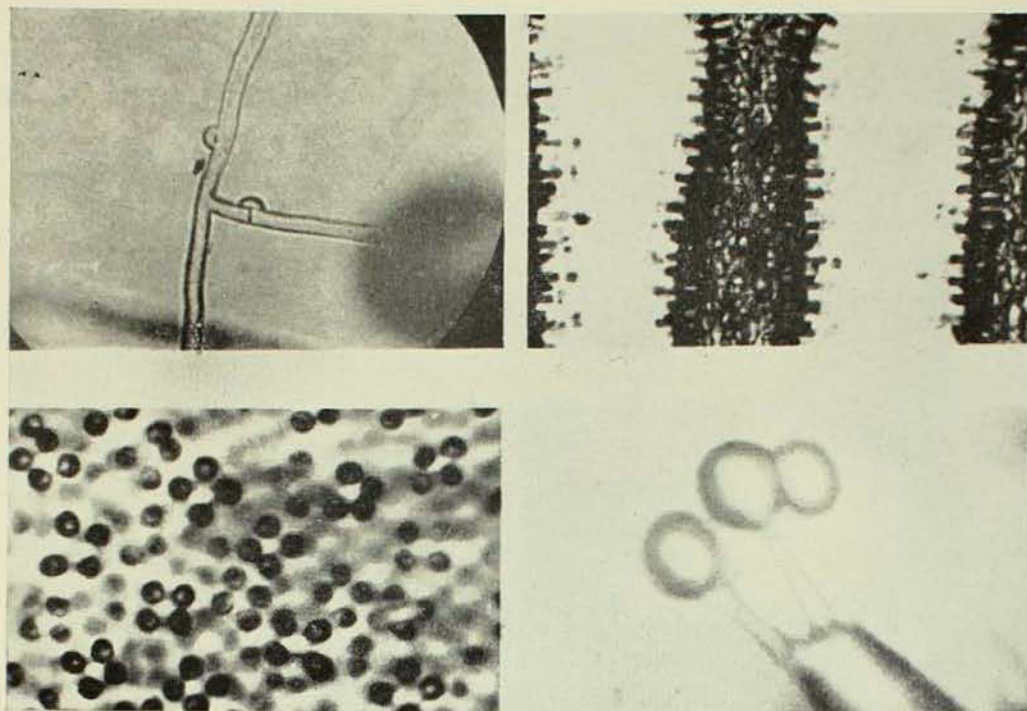


Fig. 1.—Microscopic studies of the gilled toadstool. *Top left*—Photo of hyphae. *Top right*—Section through gills showing basidia bearing spores on the surface of each gill. *Bottom left*—Surface view of gill showing groups of four spores. *Bottom right*—A basidium bearing spores on the tips of pointed stalks (very high magnification).

Photo.—Dept. of Illustration, University of Sydney.

remove sugars and starch from the tissues. Most of the mould fungi (*Mucor*, *Aspergillus* and *Penicillium* species) are sugar and starch-loving fungi. The removal of sugars and starch from dead plant tissues is usually rapid, and their disappearance prepares the way for fungi that utilise the celluloses. With the removal of the cellulosic substances the tissue consists largely of lignin, the hard woody material of plant tissues. This lignin residue is then colonised by the slow-growing lignin-destroying fungi belonging mostly to the toadstools and puff balls. These fungi complete the destruction of plant residues. A similar succession of species of fungi occurs on the forest floor, in lawns, and on the manure of animals.

The reader may well ask how do these plant and animal residues become so readily colonised by the different species of fungi? This is accomplished by spores that abound in the air, for prodigious numbers of spores are produced by different species of fungi in order to survive. Most of these fungi depend on the movement of the air for their dispersal, and once the spores are air-borne they are exposed to the greatest element of chance. There is obviously a great wastage of spores that are air-borne. In order to ensure successful arrival at the right place, enormous

numbers of spores are produced. Most of the toadstools and puff balls are air dispersed, and much of the morphological variation of these and other fungi is associated with spore production and spore liberation. Various devices for increasing the surface for spore production have been developed by the toadstools alone. The simplest forms are those that produce their spores on a relatively smooth surface as in the "Horn of Plenty" fungus (*Craterellus cornucopoides*). These surfaces are raised above the ground so that the spores can be readily launched into the air. The most successful way of increasing the surface for spore production appears to be in the gill formation found in the Agarics. We can assume this from the abundance of species of this group and from their geographic distribution. They extend from one polar region (Macquarie Island in the south and Alaska in the north) to the other. Spores are produced over the whole of the surface of the gills, which if laid on their sides and viewed under the microscope, can be seen to be covered with groups of spores in fours (Fig. 1). They appear in this manner because the spores are formed on club-shaped structures called basidia, and each basidium produces four spores borne on the tips of thin-pointed stalks. (Fig. 1. Bottom right.)



There are, of course, thousands of basidia on each gill, and there are as many as sixty to eighty gills on a single toadstool. It has been estimated that a single toadstool measuring two and a half inches across, will produce one thousand million spores! Any one colony of a fungus may produce thirty or more fruit bodies, as in a fairy ring often seen in paddocks or lawns. The raising of the gilled spore producing surface attached to a cap several inches above the ground by means of a central stalk facilitates the launching of the spores into the air.



Fig. 2.—The Chanterelle fungus showing the trumpet-shaped fruit body which produces spores on the folds on the outer surface.

Photo.—Author.

Other means of increasing the spore producing surface is by throwing the surface into ridges or folds as in the Chanterelle fungus (*Cantharellus*) (Fig. 2); by developing spines instead of gills as in the *Hydniums*, and by developing pores instead of gills as in the bracket fungi (*Polyporus*, *Trametes* and *Fomes*) (Fig. 3) and in the boletes (*Boletus*). The spore-producing surface has also been increased by developing much-branched cylindrical stalks which bear the spores on their surfaces as in the coral fungi (*Clavaria*).

The puff-ball fungi also exhibit a great variation in form determined primarily on spore production and dispersal. Most of these are air-dispersed, but some depend on insects, notably members of the *Diptera* (true flies) for the dispersal of their spores. These are the "Stink Horn",

"Carrion", or Phalloid fungi, which their extremely bizarre form and foetid odour. In these fungi the slimy spore mass is carried on a brightly coloured stalk with variously shaped appendages also brightly coloured. These features, together with the strong smell of carrion, attract flies which gorge themselves on the viscid spores and then fly away and regurgitate the spores on the forest litter. Members of this group of fungi are lignin-destroying and are found in parts where twigs and sticks are buried in the soil or forest litter.

The mould fungi, like the *Penicillium* blue and green moulds, depend on air for the dispersion of their spores. They too produce enormous numbers of spores. A piece of blue mould the size of a three-penny bit will produce four hundred million spores! It will be readily appreciated from what has been said that fungal spores of one species or another can usually be found in the air and are deposited on material that may serve as a food source.

Fungi may also invade plant and animal remains, making contact with the ground, from mycelium already growing in the soil. Many of the toadstool and puffball fungi grow perennially in the soil. This may be observed in the so-called fairy rings where toadstools and mushrooms form at the circumference of an ever-increasing ring each year. Also at regular times each year puff balls and toadstools will appear about the same position in lawns, gardens and the forest floor. The mycelium of these fungi perennates or hibernates in the soil and grows only when conditions of moisture, temperature and food supply are favourable. For the development of fruit bodies and spore production, quite a lot of energy is needed, so that these fungi must absorb food for a long time before they can produce their fruit bodies. Growth of the vegetative mycelium occurs sporadically throughout the year, and the mycelium continually explores for fresh sources of food, by invading new litter introduced into the soil. This exploration and colonisation of new food material is greatly facilitated by many hyphal threads combining together to form a root-like structure called a rhizomorph with a common growing point, or



just remaining as coarse mycelial strands. These are often encountered when the leaf mould of the forest litter is disturbed.

It has been found recently that the improved texture of soils through the addition of organic matter is due to the growth of the mycelium through the soil, which separates the soil particles, producing a crumbly texture so favourable to root development of the higher plants. These fungi that persist in the soil as mycelium do not occur as pure cultures in any one place. In any sample of soil, the mycelium of many species of fungi may be found. If one particular area is kept under observation the whole year round it will be found that fruiting bodies of different species will appear in succession. This may reflect the successive breakdown of organic matter in the soil, or it may result from environmental conditions favouring the development of different species; for example, in a forest area near Sydney it is found that species of the toadstool *Cortinarius* predominate in February and March. In the same area species of *Lactarius* or *Russula* will predominate in April and May, and in early spring the dominant genera are *Naucoria* or *Galera*.

The best time of the year for the development of a wide range of species of toadstools in Australia is from April to June, when there is abundant moisture and lower temperatures prevail. Some species will produce fruiting bodies a number of times each year. Others, like the tough bracket fungi, in which the fruiting bodies are perennial, produce crops of spores several times during the year. Each time another spore-producing layer is formed over the whole of the lower surface of the bracket, and the circumference is also increased, so that specimens of upwards of 20 inches in diameter may be found.

Many species of fungi have a world-wide distribution; this is particularly so amongst the toadstools and puffballs. For example, *Craterellus cornucopoides* occurs in all countries in the southern hemisphere as well as in Europe and America. There are, of course, some species of fungi peculiar to Australia. Some of these Australian species have near relatives in New Zealand,

and South America. This is so for the tree strawberry fungus, *Cyttaria gunnii*, which occurs on southern beech in parts of the eastern coast of the mainland and in Tasmania.

There is an urgent need for the study of the fungal flora of Australia; many amateurs could help in this work. There is, unfortunately, a paucity of books on Australian fungi. The earliest book was M. C. Cooke's *Handbook of Australian Fungi*, published in 1892. J. B. Cleland's *Toadstools and Puffballs of South Australia* was published in 1932, and recently J. C. Willis has published a booklet on fungi under the auspices of the *Victorian Naturalist*. For those who would like to take an interest in the toadstool fungi, E. M. Wakefield has just produced an excellent observer's book of the common fungi, and this is now obtainable in Australia.

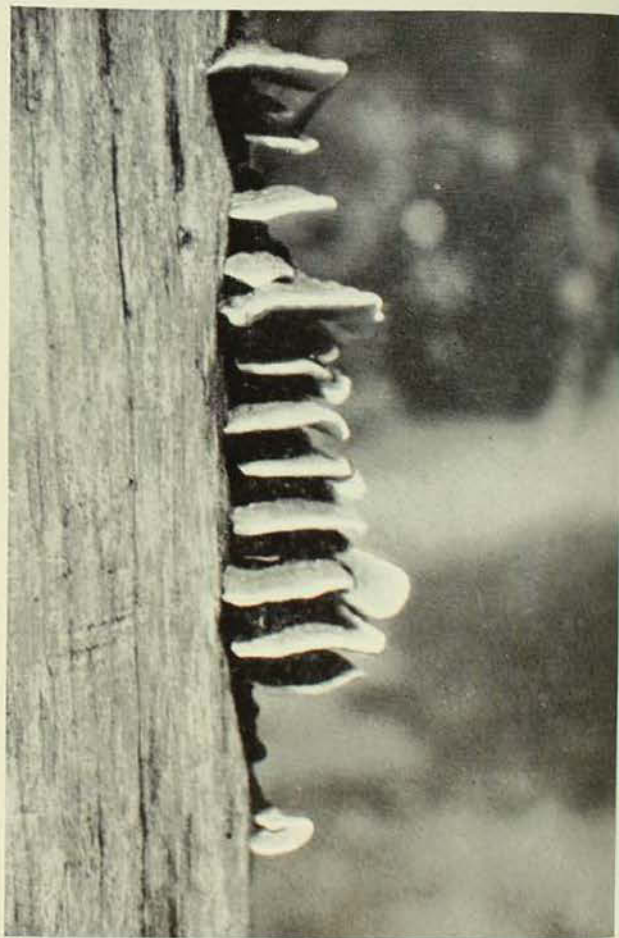


Fig. 3.—The bracket fungus showing a tier of fruit bodies growing out of a log of wood. The spores are produced in pores lining the lower surface of each bracket.

Photo.—Author.



# "Caroline," the Fluttering Shearwater, Comes Ashore

By ALLEN KEAST

THE Fluttering Shearwater, a small black and white inhabitant of the oceans, is something of a mystery bird so far as Australia is concerned. These birds are to be seen offshore almost all the year, gliding and fluttering over the waves, or bobbing up and down on the surface like so many ducklings. Sometimes the groups run into thousands. Yet the nearest nesting colonies of the Flutterer are on the islands off New Zealand. Surely, ornithologists reasoned, when they are so prominent and regular they must also nest in Australia—on one of the remote and desolate islets off New South Wales, perhaps.

In the period 1910-1915, A. F. Basset Hull, in his studies of seabirds, investigated nearly every island along the New South Wales coast. Again and again he thought he was about to find the nesting place of the Fluttering Shearwaters, but successive islands yielded nothing more than the familiar penguins, Wedge-tailed Shearwaters, and White-faced Storm Petrels. Once, on the Tolgates, a pair of rocky monoliths off Batemans Bay, he found empty burrows of a bird smaller than the Wedge-tail and larger than the Storm Petrel. Could they have belonged to a winter nesting group of Flutterers? Needless to say, this possibility has never been thoroughly investigated.

To-day the consensus of opinion is that all our Fluttering Shearwaters are, in fact, visitors from New Zealand for, with the passage of the years, it has been found that a great many different seabirds use our waters as feeding grounds for part of the year. Included in these are several from

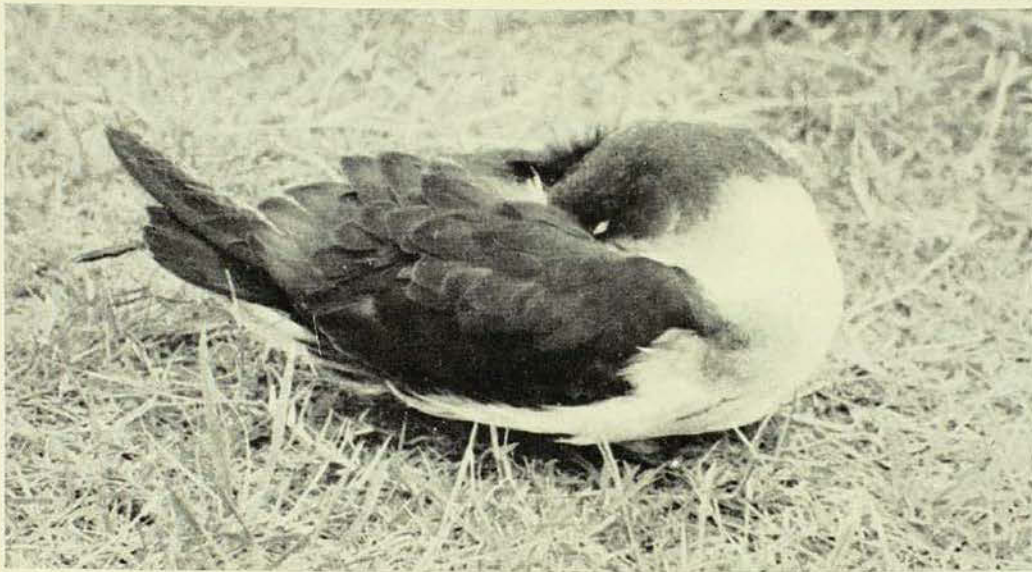
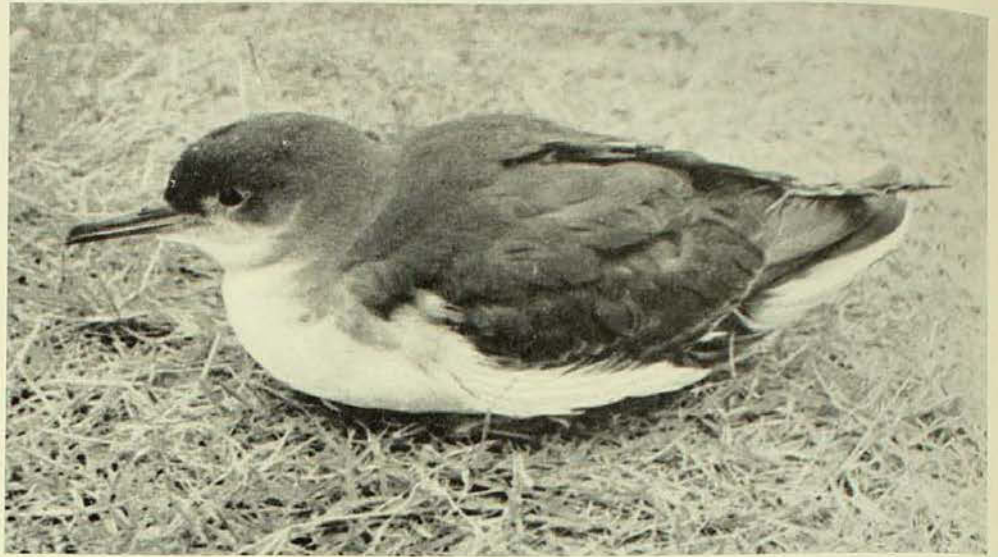
New Zealand (*e.g.*, Gannets), one of two from Lord Howe Island (Fleshy-footed Shearwater), and a number from the sub-Antarctic. Again, we now know that seabirds are remarkable wanderers, and that journeys of even thousands of miles are not beyond them. Notwithstanding all this, however, the little Fluttering Shearwater continues to intrigue our ornithologists, especially since it has now been found that, among them, is a long-billed form of unknown origin.

With a party of zoologists at Lake Illawarra in the middle of February, I had the interesting experience of making the acquaintance of a Fluttering Shearwater at close quarters. It was found sitting, apparently sick and exhausted, just above the high-tide line. The bird was obviously quite a youngster for the last traces of the juvenile down feathers were still to be seen on the top of its head. And it would have been hard to conjure up a more weebe-gone picture as it crouched there amongst the seaweed, delicate, docile, and with engaging dark eyes. Such feminine qualities (or, at least the qualities of some females) could not be overlooked and within minutes the name "Caroline", after the famous Manx Shearwater of Lockley's writings, had been bestowed on the waif.

"Caroline II" made only a half-hearted attempt to escape when lifted up on to the grass behind the beach. She immediately commenced to preen herself when put down (a proud girl obviously), whilst the photographers jockeyed with each other for the best position. Then, to the surprise of all she yawned, tucked her bill under her wing, and went to sleep. Again the cameras clicked. Minutes ticked by



"Caroline," the sick Fluttering Shearwater that came ashore on the beach near Lake Illawarra.



And so bored was she with the antics of the photographer that she tucked her bill under her wing—and went to sleep.

"Caroline" takes off for the sea again. Notice the powerful wing that enables Shearwaters to withstand the buffeting of the worst seas. The "nick" in the wing corresponds with absent feathers, for she was in partial moult.



Photos by the Author.



and Caroline continued to slumber peacefully. But the photographers were not satisfied. They wanted a close-up of the head and shoulders. So Caroline was wakened and lifted to a "more satisfactory" position. Such rudeness was more than a respectable lady could stand. Caroline fled down the bank, fluttered a few yards, and commenced a long wobbly flight across the beach. Two or three times it appeared that an undignified fall was in store but steadily she gained altitude until the offshore wind caught her and swept her rapidly out over the breakers. When last seen Caroline was bobbing about on the surface of the water, diving under the big waves that bore down on her, and steadily drawing away from the shore. Maybe Caroline wasn't so sick after all.

The Fluttering Shearwater is the Southern Hemisphere counterpart of the Manx Shearwater of England. The two are so similar that only an expert could tell them apart. In fact, some authorities regard them as no more than the northern and southern races of the same species. One of the most fascinating life history studies in the whole of bird literature is that by R. M. Lockley, of the Manx Shearwaters on the island of Skokholm off the Pembrokeshire coast. It is published as a book: *Shearwaters*. Lockley bought the storm-swept Skokholm in order to raise sheep and achieve a certain amount of peace and tranquillity. His old stone farmhouse dated back many centuries and for company he had rabbits, vast colonies of seabirds, and itinerant flocks of migrating landbirds.

No inhabitant of Skokholm intrigued Lockley more than the Manx Shearwaters. They came ashore in late spring to tunnel about the out-buildings, making the nights reverberate with their melancholy love-calls. Several pairs made their homes in the immediate vicinity of the garden. These he came to regard as personal friends and, in order that he could recognise them individually, gave each a band and a name. The first pair he called "Adam and Ada", the second "Carol" and "Caroline", and so on.

Each year the shearwaters came back and spent several months on Skokholm, raising a single young at the end of their long, earthen burrows. He made many notable discoveries about them. For example, the members of a pair took it in turns to spend up to ten days at a stretch in the burrow with the egg or young—ten days during which they neither fed nor exercised. One summer, fishermen in the Bay of Biscay caught a banded Manx Shearwater and it was found to be one of Lockley's birds. This was the first hint of a remarkable fact—that during the ten or so days that one bird stays behind its mate forages as far afield as the Spanish coast—a return flight of some 1,200 miles.

About this time biologists were becoming very interested in the subject of bird navigation, especially as to how birds found their way back to tiny nesting islets from far out at sea. Some people doubted that birds really did have a wonderful navigational sense. Reluctantly Lockley consented to a couple of the breeding birds on Skokholm being flown by air to Venice and released, not only on land (where they would normally never venture) but surrounded by the Mediterranean, an ocean that it was extremely unlikely any of the shearwaters had experienced before. The result was staggering. One bird not only found its way back but did so in the record time of fourteen days. The distance: 930 miles over the Alps (a route that a seabird would hardly follow), or 3,700 miles round the Straits of Gibraltar. Later, another bird returned from Boston, a distance of 3,050 miles, in 12½ days.

But to get back to Caroline—the original Caroline. Up to Lockley's time nobody had any idea as to how long shearwaters lived. Many of the birds banded by Lockley returned to breed on Skokholm for up to seven or eight summers. But one by one the original birds returned no more. Caroline came longer than all. For eleven years she shared the garden with Lockley, showing that she was twelve, if not thirteen years old when she disappeared. And during her occupation of Skokholm she had no fewer than four husbands: Carol I, Carol II, Carol III, and Carol IV!



## Some Ancient Bugs

By J. W. EVANS

EVERYONE knows that many strange and unique animals live in Australia. Of these, some are to be found nowhere else in the world. Others are of interest because, although they may have close relatives living elsewhere, they are among the few survivors of the faunas of former geological epochs.

Most people, who have an interest in Australian animals, limit their concern to the larger ones and are either unaware there are many lowly forms of life of equal interest, or else perhaps they fail to regard such creatures as worms, insects and shrimps as "animals" at all.

This article is about a group of insects of which the representatives are so small that as many as fifteen could sit on a three-penny piece and which have no beauty of form or colour to distinguish them. Although they have a pair of wings they are unable to fly, and they cannot even run or jump, but merely walk with a slow ungainly motion. Finally, they lead such an obscure life in remote places that they are never likely to be seen by the ordinary observer.

These animals nevertheless are of great scientific interest because of their great antiquity; their isolated position in the scheme of insect classification; because they retain certain archaic structural features long lost by other insects and because of their geographical distribution. They are sucking bugs (Hemiptera) and belong to a family known as the Pelorididae.

While representatives of this family have been known to science for a little over half a century, until comparatively recently they have been regarded as great rarities and very little indeed has been known about their habits and structure.

The first of these bugs was found towards the end of last century in Tierra del Fuego, the island which lies at the southern extremity of South America. Some ten years later another was found close to the northern shores of Magellan Straits. In 1924, two specimens, an adult and an immature form, were found in the North Island of New Zealand and at about the same time three more specimens were found in the entomological collections of

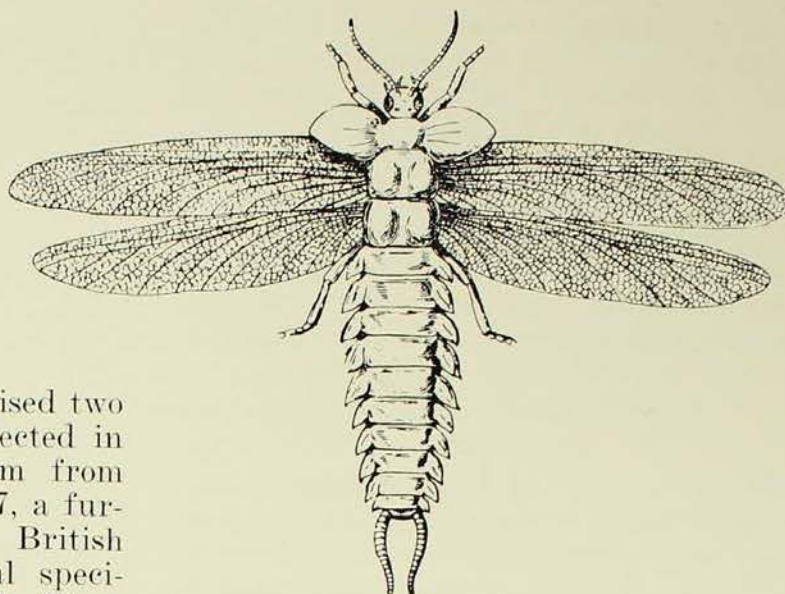


A Peloridid Bug (*Hemiodocus fidelis*) found in the National Park, Tasmania. The insect is greatly magnified in this illustration; its actual length is about one-eighth of an inch.



A reconstruction of an ancient winged insect.

After Handlirsch.



the British Museum. These comprised two adult insects, which had been collected in Tasmania, and an immature form from Lord Howe Island. When, in 1927, a further search was made in the British Museum collections, an additional specimen from Patagonia was discovered. Thus, in thirty years immediately following the original discovery of a representative of the group, only six adult insects and two larvae were known in the entomological collections of the world.

Up to this time the relationships of the family with other sucking bugs were obscure, but in 1929 Dr. W. E. China and the late J. G. Myers studied the detailed structure of an adult specimen. As a result they formed the opinion that the family was an extremely isolated one of very great antiquity. Nothing was known at this time of the habits of the insects nor was it even known on what plants they fed.

Then, in 1932, three specimens of another species were taken in the McPherson Ranges in Queensland and it was believed by the collector that he had obtained them by beating the branches of an Antarctic Beech tree (*Nothofagus*). This occurrence provided the first clue to a particular plant association and for a time it came to be supposed that the insects fed on beeches, since these trees grow also in South America, New Zealand and Tasmania. However, a year later this supposition was proved to be incorrect when several more specimens were collected in Queensland and all were found feeding and living in moss.

Following this discovery the pace began to quicken and in 1936 I found a single specimen of a new species in a private entomological collection in Melbourne. This

had been taken some years previously in Beech Forest, Victoria, another locality where beech persists.

At this time I was living in Tasmania and decided, since information was now available about the food plant of the bug, to make a determined search for representatives of the Tasmanian species. Several attempts proved fruitless; but at last I was fortunate, though the discovery was not of the insect I expected to find.

It happened like this. My wife and I were spending a week-end in the Tasmanian National Park and at the end of a day's fruitless search for these insects it came on to rain and we took shelter under some stunted beech trees. Whilst we were sitting there, my wife suddenly announced that she had found a Peloridiid, not in moss but just walking about in the open; and so she had, though it was not a representative of the species formerly described from the island but of an entirely different one.

It is now known that these bugs, can survive only in a saturated, or almost saturated, atmosphere, and the reason that one, or rather several, of them were found in the open away from the moss was because it was raining at the time.

The particular species found in the Tasmanian National Park is shown in the accompanying illustration. It is only about one-eighth of an inch long, flattened in



shape and greenish-brown in colour. When sitting on moss it is very hard to see. It cannot fly, since it lacks hind wings, and it moves very slowly indeed, and unlike many plant bugs cannot even jump.

The discovery of abundant material of this insect made possible a more detailed investigation of its structure than had formerly been undertaken. This disclosed several interesting features of which the most striking was the nature of the flaps at the side of the body, between the head and the front wings.

The earliest known fossil winged insects have been found in rocks of the Carboniferous period, which ended some 250,000,000 years ago. Several of these early insects had, in addition to wings on the second and third segment of the thorax, a pair of non-functional lateral flaps on the first segment of the thorax. A reconstruction of such an insect is illustrated. It is supposed that before insects had acquired powers of true flight they were able to glide with the aid of lateral expansions of all these three segments. In time the two hindmost pairs of flaps came to be replaced by movable wings, but never those on the segment of the body immediately behind the head. These, however, were retained for a time by some groups of early winged insects.

It is believed that the lateral expansions on the sides of the front part of the body of Peloridiid bugs are of the same nature as those occurring on some primitive winged insects. This is of very great interest and, though there are other insects living to-day with superficially similar expansions, they are in every known instance of quite different derivation.

Of recent years an additional species of Peloridiid bug has been found in South America and, as well, several in New Zealand. Although these bugs do not feed on evergreen beeches, yet they have the same pattern of geographical distribution. Hence it can be anticipated that further species remain to be discovered in such places as the Barrington Tops area in New South Wales and at high altitudes in New Guinea and New Caledonia.

Evidence derived from several sources suggests that up to the close of the Mesozoic geological epoch, which was the period when huge reptiles inhabited the earth, the southern continents, including Antarctica, formed a single land mass. If this was so then it would serve to explain how these flightless, moisture-loving insects come to live in lands now so widely separated.



A spear ordeal in the Nepean district, N.S.W., is the subject of the third wall painting to be displayed in the Aboriginal Gallery of the Australian Museum. Mr. F. J. Beeman, who is in charge of the Museum's Department of Art & Design, painted the three murals under the direction of Mr. F. D. McCarthy, Curator of Anthropology, and is now at work on a fourth. There are to be six murals in all.



## Nature Quiz

**M**UCH of the activity of a museum centres around inquiries. The curious as well as the more serious seekers of knowledge are constantly asking questions of the specialists. Some queries are simple and direct; others call for lengthy answers which are partly met by the information contained in a number of printed pamphlets. Over the years, the Australian Museum has gathered a list of popular queries having a wide public appeal. Their proved interest has prompted the presentation to readers of "Nature Quiz," in question and answer form. It is intended that this feature will continue for several issues of the magazine.

*Q.: Is a Crayfish a Lobster?*

*A.:* No! But most Australians use both names indiscriminately. "Marine Crayfish" is the best term, and is one which avoids confusion with our Freshwater Crayfish. There are no lobsters in the seas of the southern hemisphere; the several kinds of large commercial marine crustaceans fished in Australian waters belong to an entirely different family, only remotely related to their northern counterpart. Furthermore they lack claws or nippers. Lobsters have powerful claws and are found only in the far North Atlantic and adjacent seas. Early Australian settlers called our marine crayfish "lobsters" and the name has persisted. The French have a distinctive name—langouste—for a Mediterranean and Eastern Atlantic relative of our marine crayfish. Its adoption in Australia would remove all cause for argument, and is much to be preferred to the American compromise of "Spiny Lobster".

Australian Freshwater Crayfish possess a pair of big claws, and two giants of the freshwater family are occasionally, though incorrectly, referred to as "Murray River Lobster" and "Tasmanian Lobster".

*Q.: What is responsible for the fascinating variety of colours in living corals; colours which so quickly fade when the growths are taken from the sea?*

*A.:* The colours of the reef-building corals to be seen along the Great Barrier Reef occur in the delicate fleshy parts of the growths. These parts quickly die when taken from the water, and lengthy exposure completes the bleaching process so

that only a dead-white skeleton of carbonate of lime remains. In the living flesh there are present certain lowly forms of marine plants (algae), and mostly it is through them that colour is given to the corals; the flesh itself is rarely tinted. Once corals die nothing can preserve their varied hues; for exhibition the bleached skeletons must be artificially coloured.

*Q.: Is that scavenger of suburban gardens, the Slater, an insect?*

*A.:* Although loosely called an insect, the Slater is far removed from that class of animal life. It is a crustacean, and as such could be expected to belong to the sea or at least to a pond or a stream. There are other land-living relatives of the Slater and all are grouped with the Sea Lice, so plentiful in all oceans. Another name for the Slater is Woodlouse which suggests some connection with its marine cousins. As a migrant from the sea the Slater shows a remarkable adaptation to a land existence. Instead of breathing through gills its method of absorbing oxygen is comparable to that of insects. At the end of the body, on the underside, are conspicuous white tufts of fine branching tubes whereby air is brought directly in contact with the blood circulation.

*Q.: Do Alligators occur in Australia?*

*A.:* Although the name "alligator" is in common use, both as a place name and in speech, there are none of its kind in Australian waters. Alligators are found mainly in the Central American and northern South American region; outside this



area there is one small kind occurring in some of the streams of China. "Crocodile" is the correct term for Australia's giant reptiles, which are of two kinds. One (the smaller) lives only in the freshwater streams and lagoons of far northern tropical parts; it is harmless and grows to a length of about 6 feet. The name Johnston's Crocodile has been given to it in memory of its discoverer. It is the Indian or Estuarine Crocodile, the larger of the two kinds, which is dangerous. Examples have been killed measuring 24 feet in

length. In tropical parts the species ranges from India, through the East Indies, to the coasts of north and north-eastern Australia. Compared with the conspicuously broad muzzle of an alligator, that of a crocodile tapers to a narrow extremity. There is, in addition, a notch on each side of the upper jaw near the snout, which accommodates an external fourth tooth when the jaws are closed. None of an alligator's teeth is visible when the mouth closes.

## Trigonia—A Living Fossil

By DONALD F. McMICHAEL

MILLIONS of years ago, about the time that the sandstone rocks on which Sydney is built were being formed, there lived in the oceans of the world a group of bivalve shells. They were quite triangular in shape, and thus were given the scientific name, *Trigonia*. Their shells accumulated over the years in the silts and sands of the ocean bottom, and eventually became fossilised in some of the rocks which formed during the ensuing millenia.

At the close of the Mesozoic era (about 60 million years ago), this group of shells gradually became less abundant in European seas and, to all appearances, soon became extinct. Their shells do not occur as fossils in the rocks formed during Tertiary time, and scientists were convinced that they had died out. Imagine then, the surprise of the French naturalist, Peron, when with his fellow collectors on the voyage of the French exploration ship *Geographe*, he found on a beach in southern Tasmania a shell which seemed to be the same as the well known fossils. Back in France, the great zoologist Lamarck described the shell as the first living *Trigonia*, calling it *T. margaritacea* because of its beautiful iridescent interior.

Instructions were given to the next French scientific expedition to search out this living fossil, and to bring back a specimen of the animal which formed the shells. So two other great French naturalists, Quoy and Gaimard, who sailed with the *Astrolabe*, searched high and low for a living specimen. In King George's Sound, and in Westernport, Victoria, occasional dead valves were found, but none was taken alive. Then one night as the *Astrolabe* lay becalmed in Bass Strait, a few hauls of the dredge were made and there, among the deep-sea animals and debris, was the object of their search—the first living specimen of this ancient fossil group. One can imagine the excitement as Quoy and Gaimard examined it carefully under the light of a flickering ship's lantern. Many more specimens were then secured, and so one of the important aims of their expedition had been accomplished. But this was not the end of the tale. The *Astrolabe* sailed north up the coast of Australia, continuing her explorations and scientific investigations, until she reached the Friendly Islands, where the ship was in danger of being wrecked on the reefs at Tonga. Despite the peril he was in, Quoy rushed back to his cabin to save his precious specimens,



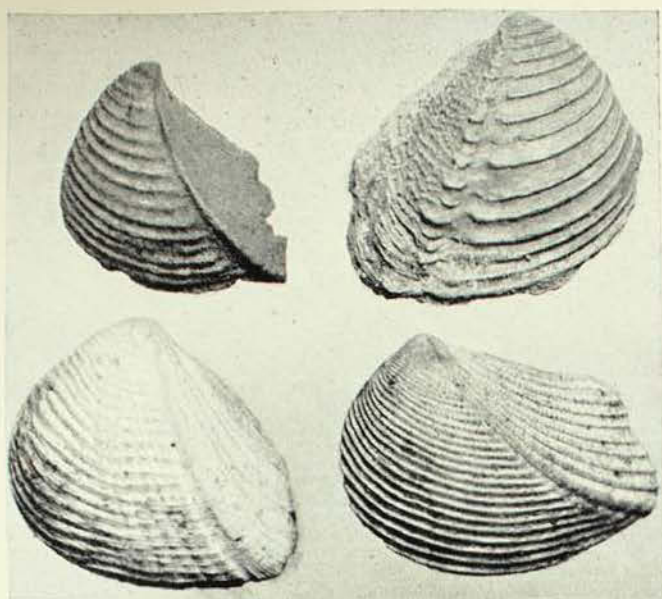


Fig. 1.—(Above) Top Left—*Trigononia elongata* from the Jurassic clay at Launoy, France; Right—*Trigononia moorei*, Jurassic, from Geraldton, Western Australia. Below are two species of the fossil genus *Eotrigonia* from the Tertiary rocks of Victoria. Left—*E. tatei*; Right—*E. semiundulata*.

Fig. 2.—(Right)—Fossil and Recent *Neotrigonias*. Below, left—*N. acuticostata*; Right—*N. howitti*, both from the Tertiary of Victoria. Above are two living species related to these fossils. Left—*N. bednalli* from South Australia; Right—*N. margaritacea* from Tasmania.

which he prized above the rest of his collection, declaring that he would not dare to return to France without them.

This discovery must have excited as much interest at the time as did the finding of a living coelacanth fish off the coast of Africa a few years ago. And it was just as important from the scientific point of view, for the anatomists were able to dissect the animals of a group of shells which had lived unchanged for millions of years, and thus learn something of the position of these molluscs in the evolutionary sequence.

The shells are placed in a separate family, the Trigoniidae, which includes a number of different genera, and many distinct species. Of these, only six are living to-day, and all are found along the Australian coast. Later research has revealed that the shells do occur as fossils in the tertiary rocks of Australia, where alone they have persisted since Mesozoic time.

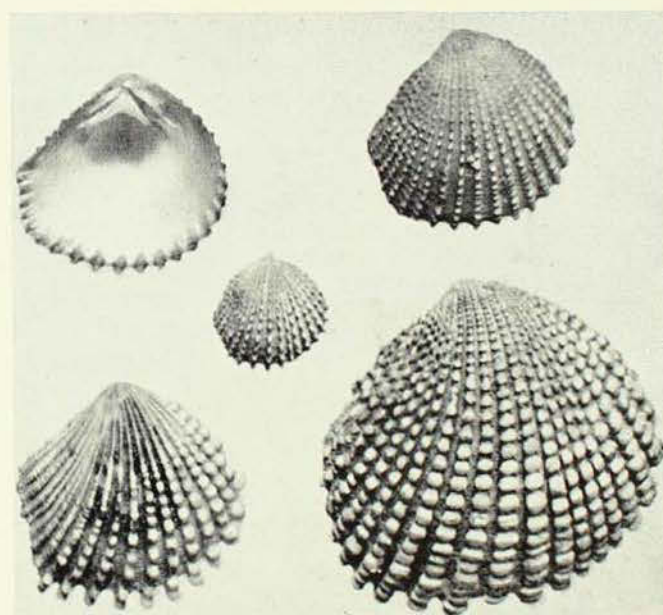
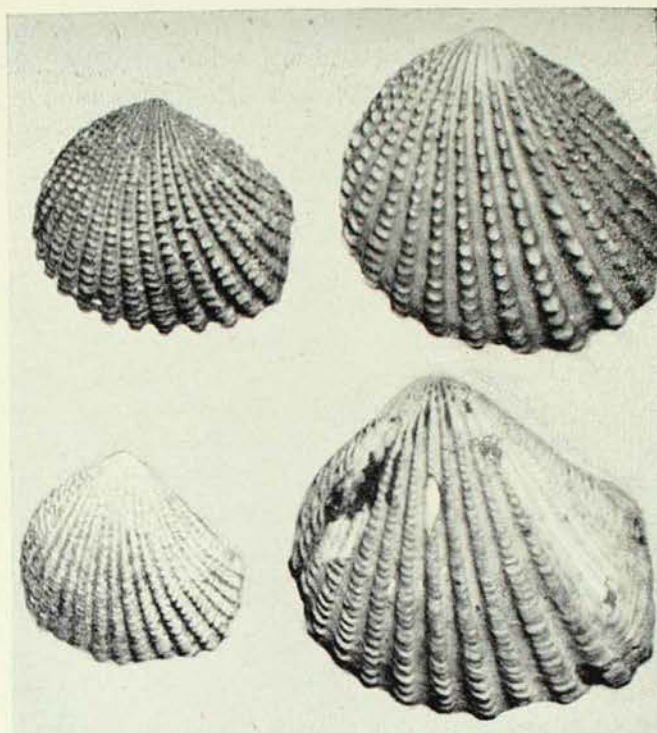


Fig. 3.—Recent *Neotrigonias*. Two top figures—*N. lamarkii* from Sydney Harbour; Centre—*N. gemma* from deep water off the New South Wales coast; Bottom left—*N. uniophora* from Queensland; Bottom right—*N. strangei* from New South Wales.

The present day species are placed in the genus *Neotrigonia*, which means “new trigonia” to emphasise their present day existence, as well as certain minor differences in the appearance of the shell. The common name for them is Brooch Shells because of their delightful lustre, and they are used for shell jewellery. The exterior of the shell is marked with a series



of radiating ridges and nodules and the hinge "teeth" are large and strongly serrated; these features are characteristic of the group.

The commonest of the living species, which was first found by Peron and by Quoy and Gaimard (*N. margaritacea*), is the largest, reaching about 1½ inches in length, and it occurs along the coasts of Tasmania, Victoria and into southern New South Wales. There are several other living species recognised and these are all illustrated in the accompanying figures, where their names and ranges are given. The Australian tertiary fossil species are mostly classified in the genus *Eotrignonia*, which seems to represent the transitional stage between the true *Trigonia*s of Europe and the present day species. Some of these fossils are also illustrated, to show the resemblance between the fossil and living forms.

All the living species of *Neotrignonia* occur in fairly deep water, between 10 and 100 fathoms, and only dead shells are

seen on the beaches after storms. The common species in Sydney Harbour, which can still be taken alive is *N. lamarcki*. There is a most amusing story connected with the discovery of this species, which was first found alive by Mr. Samuel Stutchbury, while dredging in Sydney Harbour. Three specimens were brought up and placed carefully on the seat of Mr. Stutchbury's boat. While his attention was diverted for a few moments, two of the animals extended their feet and, gripping the wood with a sort of suction disc which their feet can form, gave a twist and a jump and disappeared over the side, clearing a height of about 4 inches. While Mr. Stutchbury stared in amazement, the third animal followed suit and joined his escaping brethren. It was many days before more specimens were taken, but meanwhile the story of the fugitive shells was quickly noted by the scientific world and is still recounted in textbooks to illustrate the amazing activity of these unique Australian "living fossils".

## Book Note

ISLANDS OF MEN: INSIDE MELANESIA, by Colin Simpson, Angus and Robertson, Sydney, 1955, 248 pp., 25s.

This book, the third in the series written by the author on the Melanesian natives, takes us further afield than the other two books on central New Guinea. The latter island is mentioned in the descriptions of the Sepik River and of Maprik village with its great House-Tamberan full of colourful carvings and bark paintings, and also in the story of Shangri-La, or Lavani Valley, in which the customs of the Huri, of the Wig-men at Tari, and neighbouring peoples are described.

There is a critical review of the Condominium in the New Hebrides and of the difficult, sometimes ludicrous and incredible methods of administration which the joint French and British administration provides.

A critical assessment of fire-walking by the Fijians of Bengga adds to the value of the fascinating chapter on this practice in the Pacific

and elsewhere. The story of the girl Malua on Vaituli is typical of brown women and white men in the Pacific, but it illustrates well the human touch with which Colin Simpson likes to beguile his readers. Thus the native police sergeant, Kaikai, who hates to arrest anybody, is a likeable character in the opening chapter about Mer Island, Torres Strait, and the fertility god, Waict. Simpson, too, is a thoughtful writer on the culture-contact situation in the Pacific islands, and the future of the natives there is a problem of great concern to him, as his analysis of the Cargo cult in the New Hebrides well illustrates.

*Islands of Men* is a book of considerable interest to the island resident, government official, traveller, missionary, anthropologist and general reader. It is full of detailed observation and thoughtful criticism. It is well illustrated—the colour plates were provided by Sir Edward Hallstrom and there is a charming series of line drawings by Claire Simpson.

—F. D. MCCARTHY.



# Meteorites and the Earth

By J. F. LOVERING

Department of Geophysics, Australian National University, Canberra

ON June 30, 1908, at 12 a.m. (G.M.T.) a huge explosion somewhere in Siberia started earthquake-recording instruments jiggling all over the world and caused a shock wave that was felt in western Europe. The mystery surrounding this explosion was not solved until several years afterwards when a party of Russian scientists searching the swampy forested country near the Tunguska River in Siberia came upon a fantastic scene of devastation. The forest had been almost completely destroyed over a zone extending from 18 to 25 miles in diameter in which all the trees had fallen radiantly outwards from a large number of craters up to 180 feet wide and 13 feet deep. Sporadic damage to the forest extended as far as 75 miles away. Although no actual fragments were found, it is generally agreed that this catastrophe could have only been due to the fall of a huge meteorite. Estimates of its size have ranged from a hundred thousand to ten million tons.

Although this is the only catastrophic fall in historic times, there are twelve localities of craters of definite meteoritic origin spread over the earth's surface. It is perhaps significant that four of them are found on the Australian continent. The largest meteorite crater in the world is found at Canyon Diablo in Arizona, just a few miles off Highway 66, the main highway which crosses the United States from west to east. From the air it has a more or less square outline and is about three-quarters of a mile across in its widest part and 570 feet deep. Estimates of the size of the mass vary from 5,000 to 25,000 tons. Even the combined weight of fragments of iron meteorites found scattered around the rim totalled over 30 tons. It is generally agreed now that there is no buried main

mass. The colossal energy of impact would have been sufficient to disintegrate and vaporize most of the mass.<sup>1</sup>

The largest Australian crater was discovered in 1947 by a party of oil geologists flying over Wolf Creek, in the Kimberley District of Western Australia. This circular crater is over a half a mile across and 160 feet deep. The other Australian craters are on Box Hole Station, Plenty River and at Henbury, in the McDonnell Ranges of the Northern Territory. Another small crater was found at Dalgara in Western Australia.

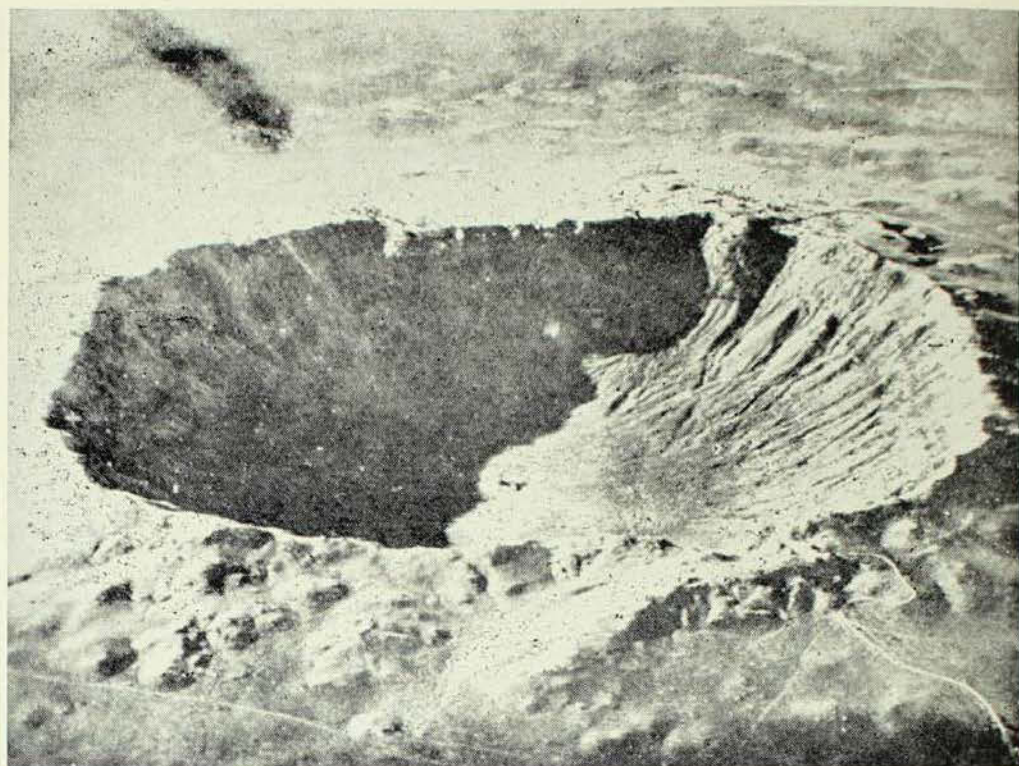
When faced with their destructive effects, the man in the street starts to wonder just what are meteorites? Where do they come from? Is it likely that a large meteorite will fall in a populated region and cause more havoc than an H-bomb? To the scientist some of the answers are important because he believes that meteorites are the only direct representatives of the heavy element fraction of the primordial material from which the planets of our solar system have formed. In particular he wants to know more about our own planet, earth, and meteorites can give him quite a lot of information about the composition of our planet's interior. The question of where the various elements are concentrated in the earth can aid us in the search for ore deposits, and certain fundamental studies on the distribution of elements in the various phases of meteorites has given us a better picture of the reasons why elements concentrate themselves as they do.

Where do meteorites come from? It seems certain that meteorites are part of our solar system and most likely had their origin in the region between Mars and Jupiter, about 200 million miles from the earth. This region is now occupied by

<sup>1</sup> See also Chalmers, R. O. *THIS MAGAZINE*, ix, 2, 1946; 55.



Meteorite Crater at Canyon  
Diablo, Arizona, U.S.A.



a great number of small bodies called the Asteroids. All told there are about 30,000 of them, usually with diameters less than 50 miles. The largest Asteroid, Ceres, has a diameter of 480 miles. The Asteroids are almost certainly composed of meteoritic material so that the origins of both Asteroids and meteorites are essentially the same problems.

One of the most controversial points of issue between scientists interested in the origin of the solar system is concerned with the question, whether the Asteroids and meteorites were part of a disintegrated planet, much the same size as Mars, or whether they were never part of a single mass but were formed as a number of smaller masses much the same as they appear to-day. It is hoped that present-day studies on meteorites will give some information which may settle the question. The available evidence suggests to the writer that meteorites had their origin in either a single planet-like body or else in a few bodies of smaller size but identical structure and composition.

What do meteorites look like? The meteorites we observe striking the earth are but a very small fraction of the number which actually enter the earth's atmosphere. Most of them are too small to sur-

vive the frictional battle with the atmosphere and vaporize in a flash of light. The result is a "shooting star". Only the larger meteorites actually reach the earth's surface where they range in size from fine dust particles to the huge masses which have caused the craters. The largest known single meteorite was found at Hoba in south-west Africa and weighed 59 tons.

Meteorites are usually classified into stony and iron meteorites according to the main mineral phases which are present. The stony meteorites are composed mostly of silicate minerals, much the same as are found in certain of the rarer type rocks on the earth's surface. The iron meteorites are composed almost entirely of an alloy of iron and nickel in which the nickel content varies from  $5\frac{1}{2}$  per cent. to 62 per cent. These iron meteorites are particularly interesting. Some of them, when etched with an acid, show a regular pattern of intersecting bands called Widmanstätten bands. These structures have been studied by metallurgists in an attempt to get some idea of the temperatures and pressures at which these alloys solidified.

A third type, the stony-iron meteorite, is much rarer than the other two, and consists of equal quantities of metal and silicate minerals.



The Binda aerolite (stony meteorite) showing fusion crust and flight markings. It was seen to fall near Crookwell N.S.W. in 1912.



Another problem is raised by the origin of the dark, glassy, curiously shaped objects known as tektites which have been found in isolated regions on the earth's surface. Although a tektite has never been observed to fall, their curious shape and widespread distribution have suggested a meteoritic origin. Tektites have been subject to a considerable amount of study in recent years and, particularly as a result of age determinations, it now seems that their properties are more consistent with those of volcanic material ejected from earth volcanoes and transported for considerable distances by air currents.<sup>2</sup>

What can we say about the origin of these various types of meteorites? About  $4\frac{1}{2}$  thousand million years ago, at least some of the planets of the solar system be-

gan to melt and the stony and metallic material which formed part of the primeval planetary accumulations began to separate out under gravity with the metal sinking to the core and the stony material forming a rocky crust. In the case of the meteorites, either they formed a single planet or else a few separate smaller but similar bodies in which much the same sort of processes went on. Because of their smaller size and their limited gravity fields, separation of crust and core was not complete in the parent bodies and a transition zone of incomplete silicate and metal separation formed between them. Then, because of collisions amongst themselves, or else collisions with other bodies, the parent meteorite bodies broke up. The fragments of the stony crust became stony meteorites, the fragments of the core became the iron meteorites and the fragments of the crust-core transition zone became the stony-iron meteorites.

<sup>2</sup> Remarks supporting the currently held Australian view of the cosmic origin of tektites, were made by Hodge-Smith, T. THIS MAGAZINE, v, 7, 1934; 225.



It appears, from data provided by the geophysicists who study earthquake records, that the heavy core and the lighter crust of the earth formed by a similar sort of process, and that the core is very probably metallic iron while the crust is stony (i.e., silicate) material.

What chances are there of a city being struck by a giant meteorite? Such an occurrence at this stage in the evolution of the solar system, would be very unlikely. To begin with about 71 per cent. of the earth's surface is covered with water, so that the chances of a body hitting land are correspondingly reduced. Also the chances of a body hitting a heavily populated region are further reduced when we consider that so much of the earth's available land surface is sparsely populated. Certainly in the past the earth probably was bombarded with many meteorites, but it is likely that

most of the available meteorites have long been swept up by the earth-moon system or the other planets. Perhaps the surface of the moon reflects what the surface of our planet may well have looked like if all traces of past bombardments had not been wiped out by water erosion, a process which is characteristic of our planet. Then, too, the armour-plating effect of our atmosphere has certainly reduced the numbers of meteorites which reached the earth's surface.

There is, then, no cause for alarm about large-scale destruction by meteorites. But there is considerable cause for excitement in the results which have already become apparent from recent studies on meteorites. You could materially aid the study by submitting to Museums any unusual looking rock or metal specimens which you consider could be a meteorite.

#### MISS JOYCE ALLAN RETIRES.

Miss Joyce Allan (Mrs. H. W. Kirkpatrick), Curator of Shells at the Australian Museum, retired in June because of ill health. Miss Allan joined the Museum as a scientific cadet, being the first woman member of the scientific staff. She concentrated on molluscs and received her training in this field under the late Mr. Charles Hedley and Mr. Tom Iredale. She rose to the position of Assistant Conchologist and was appointed Conchologist (the title was changed later to Curator of Molluscs) when Mr. Iredale retired in 1944.

Apart from scientific and "popular" papers (her particular field is the study of Nudibranchia and Cephalopoda), Miss Allan is the author of two books—the well known *Australian Shells* and, more recently, *Cowry Shells of World Seas*. She has also collaborated with Mr. G. P. Whitley, the Museum's Curator of Fishes, in the preparation of another, smaller work, *The Seahorse and its Relatives*, which is now with their publisher.

All three books have been illustrated by Miss Allan whose ability as an artist has also been put to good use in her own and other scientists' papers, to the number of some 7,000 illustrations. These have appeared in Australian Museum publications and other scientific periodicals such as the *Australian Zoologist*, *Victorian Naturalist*, *Australian Encyclopaedia* and *Junior Encyclopaedia*; also in the British Museum Report of the Barrier Reef Expedition.

Due to her initiative, the collections of shells on view at the Museum were arranged as a popular display "with a story to tell", rather than as in-

dividually-named specimens, and she found this arrangement paid handsome dividends to her department in gifts of interesting material to add to the collections.

During her years with the Department of Molluscs, Miss Allan undertook considerable field work in New South Wales, at Lord Howe Island, and in New Zealand. In World War II she was seconded to the Department of National Emergency Services as personal assistant to the Supervisor of Training. In this post her Museum experience with 16 mm. instructional films was put to good use in the development of an important film section for ARP training.

Miss Allan was the first woman to be made a Fellow of the Royal Zoological Society of N.S.W. and is patroness of the Malacological Society of Victoria. She has been a delegate to a number of science congresses including the International Congress of Zoologists in Denmark, 1953, and during the same period attended the Colloquium on Zoological Nomenclature as the Australian representative. While abroad she studied at the British Museum and other European museums and made many notes for her book on cowry shells.

Writing for the Press, broadcasting and lecturing also found a place in Miss Allan's career and, as her health improves, she intends to continue her research work and other of her activities, including the writing and illustrating of another book.

At a farewell to Miss Allan the Museum Staff presented her with a muffineer set on a silver salver. The Trustees of the Museum have appointed Miss Allan an Honorary Zoologist.



# Life History of the Freshwater Eel

By G. P. WHITLEY

ONE of the most romantic of Dame Nature's secrets, and one which she has been particularly slow in revealing, is the mystery of the life story of freshwater eels (*Anguilla*). Their method of propagation has, until quite recently, been a great puzzle to naturalists, because no eels have been observed breeding in fresh water.

## HISTORICAL

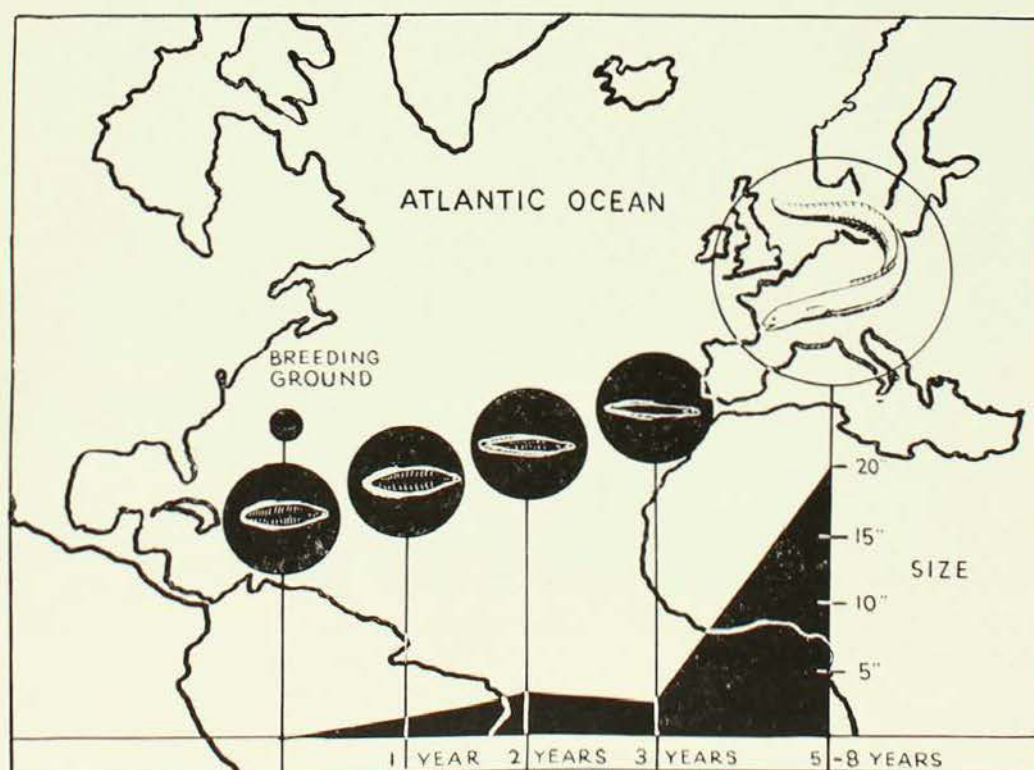
Long ago, Aristotle, the father of natural history, noted that eels could crawl on dry ground, that they made their way down from marshes and rivers to the sea, and that they were neither male nor female, having no eggs at all. He thought that eels arose from the "entrails of the earth", i.e., worms. Curious worms known as *Gordius* are sometimes found in ponds and streams; they are like long tangled black threads, and some live, when young, as parasites in insects. On the death of their hosts they

make their way into water where they lay their eggs. Observing these aquatic worms, the ancients came to believe that horse-hairs, if soaked in water, would eventually give rise to eels, a belief which is still prevalent in some of the more obscure rural districts of Europe.

Large eels were assumed to be females, although the inconspicuous ovaries with their minute contents were not discovered until 1707. The males were not recognised until Dr. Syrski, an Italian naturalist, identified them in 1873.

## THE "TADPOLE" OF THE EEL

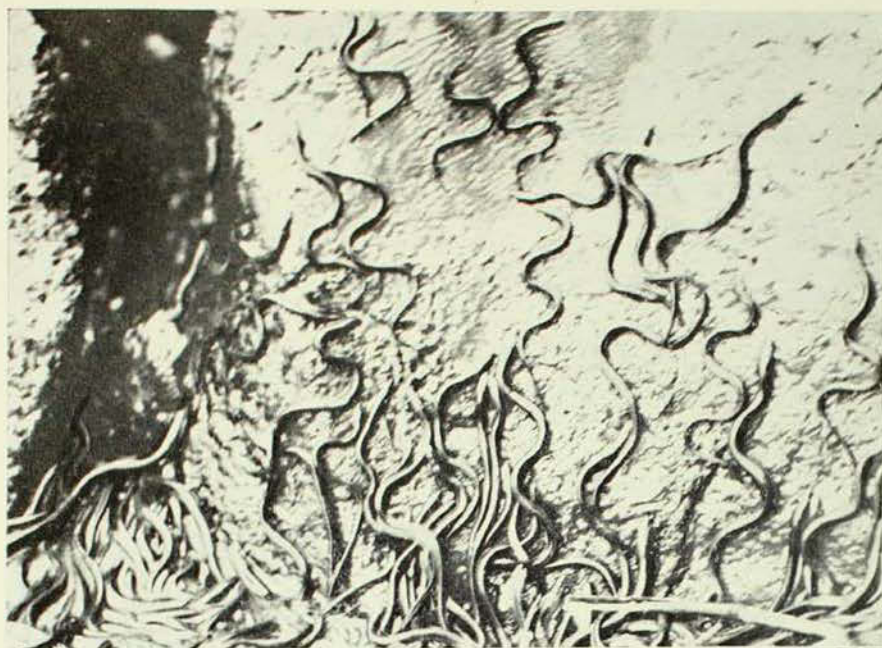
It has long been known that eel fry, about 2½ inches long, termed elvers, make their way from the sea into the mouths of rivers, which they ascend at certain seasons in great numbers, forming what is known as an eel-fare, but, for a long time, no earlier stage in their life history was known.



Map of migrations of the European Eel.

Modified from Clarke & Smith.





Left—An eel-fare in Victoria. Elvers wriggling up the rocks below Hopkins Falls.

Copyright Photo.—F. Lewis.

Below—The author collecting *Anguilla reinhardtii* at Prospect Reservoir, New South Wales, in June, 1925, for Professor Schmidt's researches.

Photo.—J. W. Morris.

At intervals, however, curious, transparent leaf-shaped fishes, called "glass eels" or *Leptocephali*, were obtained in the Mediterranean Sea, and, whilst evidently related to eels, were regarded by some naturalists as freakish little monsters whose development had in some way been arrested. Some seventy years ago, however, a French zoologist, Yves Delage, kept a glass eel in an aquarium, and was surprised to find that it shrank in size, lost its transparency, and eventually developed into a little conger. Later, two Italians, Grassi and Calandruccio, had a similar experience with another species of *Leptocephalus*, which became a typical elver. Thus was discovered what Sir Ray Lankester has called the "tadpole" of the freshwater eel.

Since all the glass eels obtained up to the end of the nineteenth century were collected from the Mediterranean, it was supposed that the European eel spawned there, and at that time such an hypothesis was quite feasible. But in 1904, two were captured in the Atlantic Ocean, and an unexpected complexity confronted those who thought that an answer to the "eel question" had been found.

#### LIFE OF THE EUROPEAN EEL

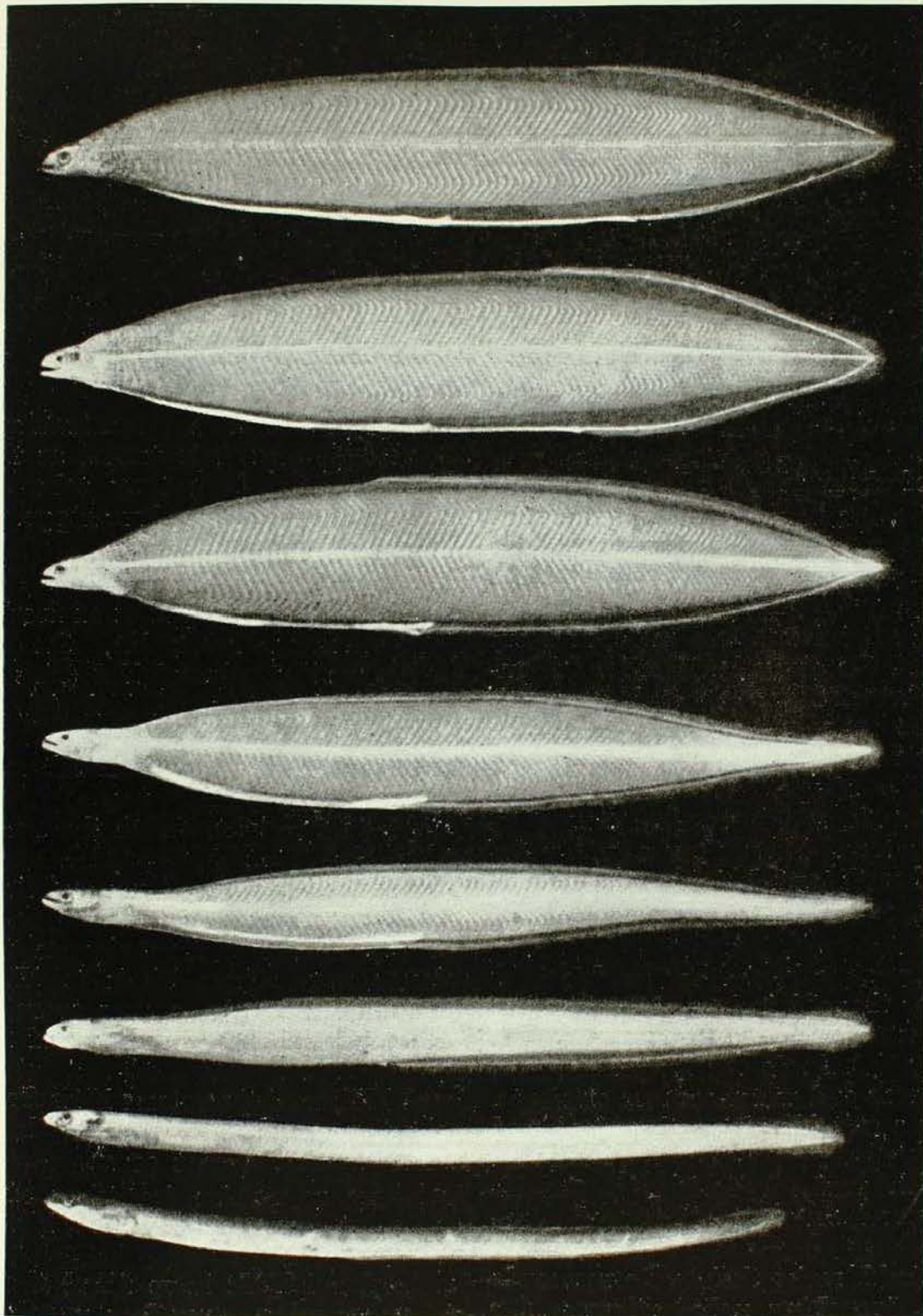
As eel fisheries are of great importance in Denmark, the Danish Government selected Dr. Johs. Schmidt of the Carlsberg



Laboratory, Copenhagen, to investigate the problem in detail. This he accomplished, after many years of patient and difficult work. Briefly stated, the following is the life-history of the common eel of Europe (*Anguilla vulgaris*) as traced by Dr. Schmidt.

The eels, having attained a large size in fresh water, seize the first opportunity to migrate to sea, and guided by instinct, make their way to a locality, hundreds of miles from their home streams, situated in the western Atlantic Ocean, north-east of the West Indies. Here, the eggs are evidently deposited (it is claimed that a 6 lb. eel produces nine million eggs), but there is no record of the survival of the parents, which having fulfilled their destiny, are seen no more.

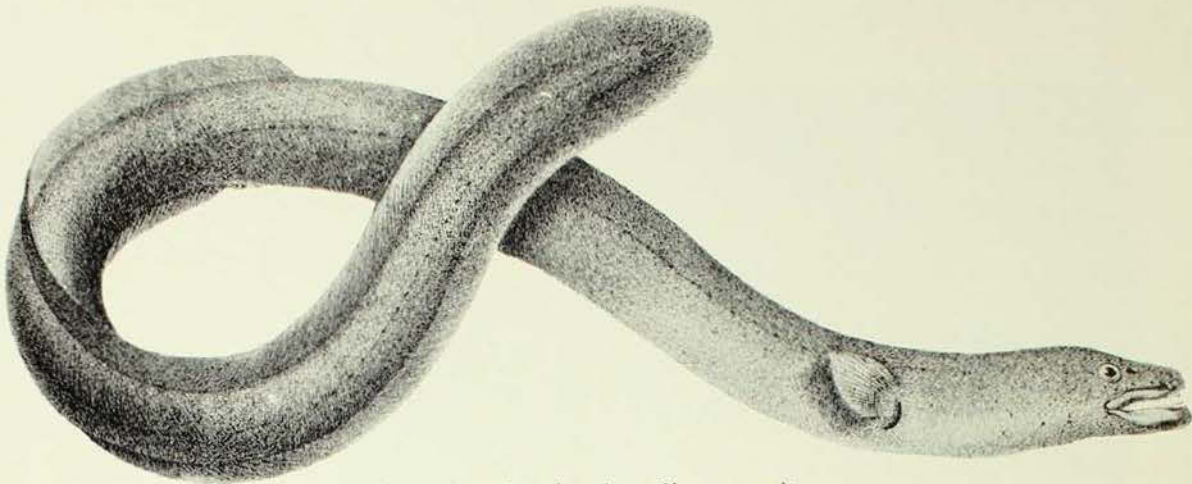




The topmost fish is a full-grown "glass eel" or *Leptocephalus* from the Atlantic; the two at the foot of the illustration are elvers. The intermediate stages in the change of these larvae are clearly shown in this series. Natural size.

After Johannes Schmidt.



Short-finned eel, *Anguilla australis*.

After J. Richardson.

The newly-hatched glass eels, one-quarter to half an inch long, live for a few months at depths of about 650 to 950 feet. After growing to a length of about one inch, they come to the surface and commence their long journey to the coasts of Europe. At the end of a year, the little travellers are about two inches long, and most of them have reached the central Atlantic. Thousands are devoured by fishes and other animals on the way, but, a year later, the survivors, still retaining their transparency and leaf-like shape, are nearly three inches in length, and have almost reached their destination. Next, they actually decrease in length and height, assume the elver form, and make for the mouths of rivers.

The males stay in freshes, and rarely grow longer than 18 inches. The females, however, ascend even the smallest streams, penetrating hundreds of miles inland, stocking rivers and water-courses en route. Arrived at a suitable place, they feed and grow as "yellow" eels for a number of years, which varies according to conditions. When nearing maturity they become fat and silvery and, the migratory instinct asserting itself, make their way seawards once more, travelling nobody knows for how long, to the far-away waters of the western Atlantic, there to lay their eggs, and there to die.

The American freshwater eel (*A. rostrata*) has a similar life-history. Its breeding place is a little to the south-west of that of the European eel, but the larvae of the two species intermingle in some places.

The glass eels of the American species have not nearly so far to travel as those of the European, so that they take only about a year to attain the elver stage.

#### AUSTRALIAN FRESHWATER EELS

There are four species of freshwater eels known from Australia, the commonest being the Long-finned Eel (*A. reinhardtii*) and the Short-finned Eel (*A. australis*), distinguished by the extent forwards of the dorsal fin and by their coloration. These grow (exceptionally) to about 5½ feet long and 36 lb. weight. With the exception of a few eels caught at Roebuck Bay, and others introduced into the Swan and Avon Rivers, Western Australia, freshwater eels are known in Australia only on the eastern slopes from Cape York to Victoria and around Tasmania, a few trespassing over the south-eastern boundary of South Australia. Eels have been caught at Bourke and Wilcannia, western New South Wales, but they probably travelled by land and water from the east coast.

Many seaward migrations of eels from Prospect Reservoir, Sydney, have occurred. At comparatively long intervals, when abnormal rainfalls have filled the reservoirs to overflowing, countless numbers of eels, up to fully 15 lb. weight, escape over the by-wash at Prospect Dam, and make their way down the creek to George's River and thence, probably, to Botany Bay. Some idea of the magnitude of these migrations is conveyed by the fact that many cart-loads of eels used to be collected from shallow pools along the creek, their weights



ranging from 3 lb. upwards. As a rule, the overflow is of short duration; one occurred on 25th June, 1925, and lasted only a few hours, but eels weighing approximately half a ton were then collected for Dr. Schmidt. One female, *A. reinhardtii*, represented by a cast in the Australian Museum, had millions of eggs in its ovaries, so that it was due to breed shortly, had it completed its interrupted journey to the sea.

#### GLASS EELS AND ELVERS IN NEW SOUTH WALES

At various times, "glass eels" have been washed up on our beaches; practically nothing is known concerning them at present, but some of them are the young of marine eels.

Mr. F. A. McNeill, of the Australian Museum, was the first person to collect elvers in New South Wales, and he preserved them for scientific use. He found them under flat stones between tide-marks at Coogee Bay in March, 1922, not far from the outlet of a storm-water pipe which opens on to the beach. Though no water was running at the time, the elvers perhaps detected faint traces of freshwater which had percolated through the sand, and were evidently waiting for an opportunity to leave the sea for inland waters.

It is recorded that hundreds of small eels, about the size and thickness of a lead pencil, were observed during the 1917 Christmas holidays, climbing up the concrete face of the Goulburn water-supply weir, whilst a similar occurrence was witnessed in 1912 at Moonee Moonee Creek, Hawkesbury River, where large numbers of small eels climbed the slippery face of the rocky fall which prevents further inland encroachment by sea-water. Elvers have also been observed travelling up a stream which enters the sea at Maroubra. Other eel-fares have been reported from Parramatta<sup>1</sup>, after rain, in January to April in various years.

The late Dr. Johs. Schmidt recommended the following methods for collecting:—

"Elvers can be caught with a shrimp net in the following manner. Hold the net pointing downwards as for shrimping, with the straight, front side pressed well down, following the bottom so closely as always to bring up some of the sand or other material, as the elvers bury themselves some way down in the bottom.

"The net must also be pushed along at a pretty good pace, so that the water flows through the meshes briskly. After walking a little way in this manner, lift the net *smartly* out of the water, otherwise the elvers will escape.

"In order to use the shrimping net, the bottom must be fairly level, whether it be sand or grass.

"Elvers can also be caught in other ways, by lifting stones that are settled fairly deep in the sand. The stone must be lifted away with a quick movement, and there may at times be a number of elvers in such a spot, so that quickness is essential. Where there are many, they can be bailed up with the hands, for instance, scooping them over into the net, which must be placed in readiness beforehand close to the stone to be removed.

"They can also be taken with tweezers before they have again burrowed down into the sand or gravel where the stone was embedded; this, however, can only be done where there are few; if there are many, it is better to scoop them up by hand into the net.

"Where small waterfalls occur, one may often find elvers crawling up the stones at the side of the fall, where the water splashes over; in such cases, it is best to take them with tweezers.

"Elvers are found as a rule at the outlet of all fresh water channels flowing out into the sea, also far up in little streams and ditches."

Elvers evidently pass up the streams for only a few days in each year, and if any of our readers should secure a hundred or so and send them, packed in moist rags, in tins or bottles, with full particulars as to place and date of capture, to the Director

<sup>1</sup>Whitley, *AUST. MUS. MAG.* iii, 10, 1929, p. 348.  
Walford, *AUST. MUS. MAG.* iv, 4, 1930, p. 139.  
Powell, *Aust. Naturalist*, viii, 1930, p. 38.  
Ege, *Dana Rept.* xvi, 1939, p. 83.



of the Australian Museum, they will materially assist scientific investigation. From such specimens, valuable data may be gleaned, and a further stage forward will be reached in the unravelling of the life-history of a fish which is not only of interest scientifically, but which may, in the future, be more highly esteemed as food.

Dutchmen and other New Australians are making use of the freshwater eels of Australia for table delicacies and export.

According to the *Sydney Morning Herald*, 29 June, 1956, p. 1, engineers of the Snowy Mountains Authority are attempting to prevent eels from coastal streams entering the western rivers system. Eels threaten to pass through tunnels of the Adaminaby and Jindabyne Dams and are proving difficult to combat, some eels having passed through pressures

of up to 500 lb. per square inch in tunnels, which is hardly surprising when we consider the great variety of conditions each eel is accustomed to throughout its life. If eels enter our western waters they are expected to affect the native and introduced species there, just as they have injured the trout fishery in New Zealand. Man upsetting the balance of Dame Nature again!

The life-histories of our Australian eels have not yet been traced, but the north-western Australian eels (*A. bicolor*) probably breed to the west of Sumatra. A young Short-finned Eel has been caught south-east of New Caledonia<sup>2</sup>, so it is thought that Australian and New Zealand eels may go near there to breed.

<sup>2</sup>Jespersen, *Dana Report* 22, 1942, pp. 13, 100 and 106.

## Notes and News

### Records of Sailfishes from Australia.

The article *Sailfish Ahoy!* by G. P. Whitley, published in the December, 1955, issue of this Magazine, has drawn appreciative comments from Mr. Archer Russell, Darling Point, Sydney, who kindly included in his letter details which he felt could be added to the List of Records of Sailfishes from Australia, published as part of the article. Mr. Russell gives E. J. Stuart's book, *A Land of Opportunities* (John Lane, The Bodley Head, London, 1923) as the source of his information and quotes the following extract from Page 135.

"The specimen shown in the photograph [facing Page 138] was 7 ft. 9 in. long and was caught [in the vicinity of Barred Creek] on the trailing line with a piece of white rag attached to the hook. The fin on the back was 3 ft. long and 2 ft. wide, and stands up exactly like the mainsail of a schooner. It was a beautiful bright blue in colour with brown spots about the size of a shilling. Underneath the belly there were two fins 15 in. long, while it had a beak like a huge garfish, a very fine swallow tail, and two powerful side fins about 10 in. long. The fin on its back had two stripes on each side, with a number of silver spots, and when this extraordinary provision of Nature was furled it fitted completely into a socket. D'Antoine the Frenchman [an old North-west coast identity of that time] had previously told me about these peculiar

fish and stated that although he had never caught one, he had seen them in a dead calm travelling along on the surface of the water with the sail set, and that immediately they were approached they closed it down with a snap."

*A Land of Opportunities* is described by Mr. Russell as "an account unvarnished and authentic, of the author's expedition (known as the North-west Scientific and Exploration Expedition) to explore the north-west coasts of Australia in the schooner *Culculla*."

### Authority on String Figures.

Mrs. Rishbeth, daughter of the famous anthropologist the late Professor A. C. Haddon, of the University of Cambridge, visited the Museum in recent months. Mrs. Rishbeth is an authority on string-figures, a game widespread among primitive peoples of the world, and one on which she has published a book and a number of papers. She examined the extensive collection of 227 string figures from Yirrkalla obtained by the Museum's Curator of Anthropology during his visit to Arnhem Land as a member of the American-Australian Arnhem Land Expedition.

### Tasmanian Field Naturalists' Club.

Long sustained and increasing interest in the delightful flora and fauna of Tasmania is shown by the progressive policy and enthusiastic membership of the Naturalists' Club, with headquarters in Hobart. Complete equipment, to the last tent-peg,



Preparator K. Gregg tries his hand at modelling a coral polyp.



has been assembled over the years for the annual Easter camp-out, to which a guest of honour is invited from the mainland.

The Curator of Mammals at the Australian Museum, E. le G. Troughton, was the guest of the Club at this year's camp-out on Safety Cove, several miles south of Port Arthur, in the historical and zoologically interesting region of the Tasman Peninsula. Some eighty adult and junior members were "under canvas" and Mr. Troughton joined other specialists in giving a series of nature talks to evening assemblies in the large dining tent.

Back in Hobart, Mr. Troughton delivered an illustrated lecture on *Australian Mammals—Their Past and Future*, to more than one hundred Naturalists' Club members. This lecture was afterwards repeated in Launceston for the Northern Branch of the Royal Society of Tasmania.

#### Honour for Curator.

The Curator of Anthropology, Mr. F. D. McCarthy, has been elected President of the Royal Society of New South Wales for the ensuing year, and President of Section F (Anthropology) at the congress of the Australian and New Zealand Association of Science to be held in Dunedin, New Zealand, next January.

#### Rock Carvings in Suburban Garden.

The Curator of Anthropology, Mr. F. D. McCarthy, recently inspected portion of a group of aboriginal rock engravings in the garden of a house in Ben Boyd Road, Mosman, Sydney. The figures still visible include portions of an ancestral spirit figure of a unique type, a kangaroo and other figures, and the complete figure of a little man with his hair rolled up into a dunce's cap coiffure. Mr. Bergraff, a reporter from the *Sun-Herald* informed Mr. McCarthy that as a boy he had lived on this property, which was then much bigger, and his grandmother had told him that there were some very fine carvings under the house, which is now about one hundred years old. It is

extraordinary that these carvings could be visible in a garden for such a long period and yet remain unknown scientifically, but such is the case. As a result of the newspaper publicity reports were received of other rock engravings in suburban gardens at Northbridge and Caringbah.

#### Visitors from New England and Jerusalem.

Dr. John le Gay Brereton, University of New England, spent two weeks at the Museum on his return from the University of Oxford, where he studied at the Bureau of Animal Population. At the University of New England he will be lecturing on ecology, the interesting subject which deals with the abundance and distribution of animals within a community. Dr. le Gay Brereton visited several departments of the Museum to identify Australian animals and study Australian invertebrate fauna.

Professor G. G. Witenberg, parasitologist at the Hebrew University, Jerusalem, recently examined the Australian Museum reference study specimens of parasitic round and flat worms. He was particularly interested in the microscopic slide preparations of type species described by the late Prof. S. J. Johnston, University of Sydney, and the late Prof. T. H. Johnston, University of Adelaide.

#### New Exhibit.

An exhibit entitled *The Beginnings of Civilization* has been installed in the Museum's Anthropology Gallery. Its aim is to illustrate the elements of culture and technology which formed the basis of modern industrial achievements. In the space available, the exhibit demonstrates with specimens the progress from stone to bronze implements, the making of pottery, weaving, the grinding of cereals, the origin of writing, and the development of art. In a colourful frieze the use of the specimens is illustrated, as are the beginnings of agriculture, domestication of animals, village life during the Neolithic period in the Middle East, and, further, the scribes, metal workers, sculptors and traders of the Bronze Age, with their ships, wheeled cart, and army.



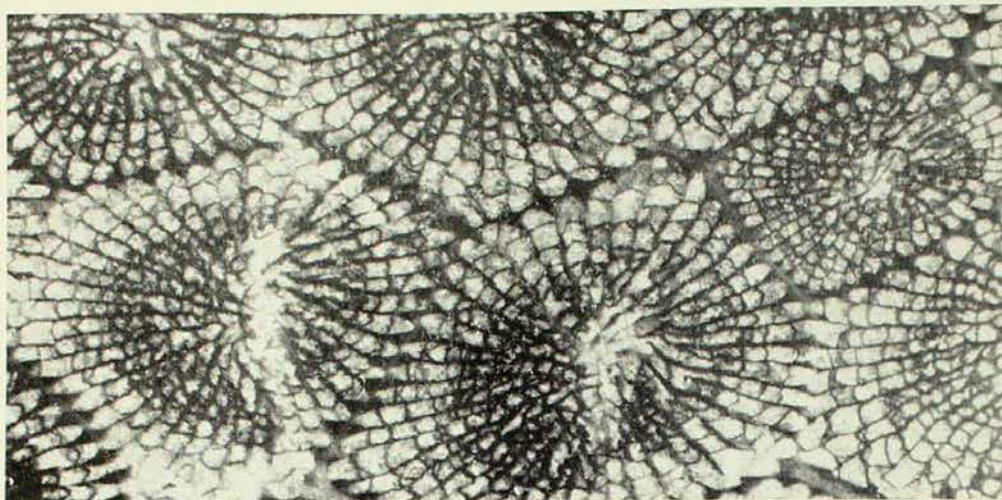


Fig. 1. (Left)—An enlarged section of individual corallites of a corallum showing radiating septa, dissepiments, and other diagnostic characters.

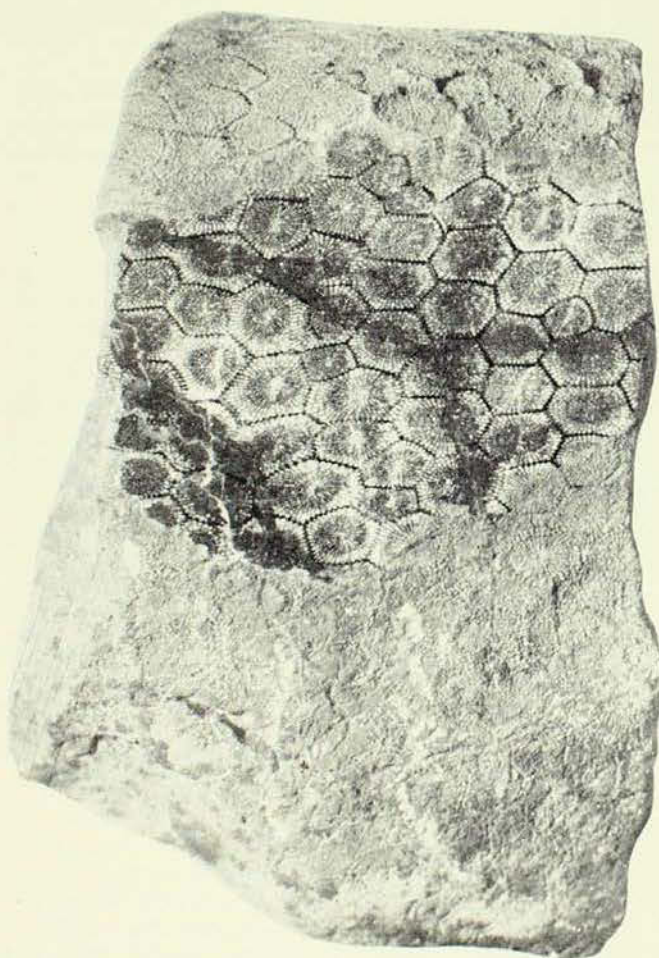


Fig. 2. (Above)—A Lower Middle Devonian coral, *Xystriphyllum mitchelli* (Etheridge), with a portion of the corallum polished and showing structural characters.

## An Ancient Reef-building Coral

By H. O. FLETCHER

THE beauty and romance of coral reefs are known to most people. Lying in tropical and sub-tropical seas such reefs lure tourists from all parts of the world who stand amazed at the brilliance of colours and exquisite designs of the numerous living coral species.

All coral animals belong to the Class Anthozoa, a name referring to the flower-like appearance of the polyp when it has its tentacles extended. It consists of five sub-classes and of these three are extinct and are found only in the fossil state. The three great extinct groups which disappeared from the geological record are the Tetracoralla, the Tabulata and the Schizocorallia. They were outstanding rock builders in Palaeozoic times but no more so than their living relatives who are playing a similar role in the building up of tremendous coral deposits in present-day seas. A bore recently put down on a coral atoll passed through 4,154 feet of dead



coral material before reaching the basement rock, indicating without any doubt a very slow subsidence in that area.

Reef-building corals first came into existence in seas of Lower Ordovician age, about 450 million years ago. They did not assume any importance, however, until the succeeding Silurian geological period when great coral reefs were built up in all parts of the world. In Australia a coral reef, rivalling in size the Great Barrier Reef, extended at intervals for at least 2,000 miles from what is now North Queensland, through New South Wales and Victoria into Tasmania. Reef-building continued into the following Devonian times on a similar grand scale although a large number of the coral species were replaced by others.

Since those days great earth movements have lifted these vast coral reefs, now forming limestone deposits, from the bed of the Silurian and Devonian seas. To-day they form a large part of the highlands of the Australian Continent, towering well above sea-level and far removed from the existing sea. Well known caves, including Jenolan, Wellington, Wombeyan and Buchan, have all been formed in these middle Palaeozoic limestones.

There is no reason to doubt that the beauty of modern coral-reefs was reproduced in the ancient Palaeozoic reefs or that the coral animals had the same limitation of depth and temperature of sea-water as living species of coral.

At the close of the Palaeozoic Era, in Permian times, two great groups of corals became extinct and the Tetracoralla and the Tabulata disappeared entirely from the geological record. A few stragglers of the Schizocorallia persisted into the Mesozoic seas although the main reef-builders of the group were by this time extinct. The stragglers were never important at this period of their existence and they very soon disappeared.

It has been estimated that there are at least 10,000 species of extinct anthozoa, including the reef-building corals. These have all been named and figured in scientific literature and even though they lived countless years ago their structural characters and relationships are as well known as species living in existing seas.

An example of an extinct coral species of the Sub-class Tetracoralla which flourished in Devonian seas is illustrated, (see Fig. 2). It is a specimen in the collection of the Australian Museum and has been partly polished to reveal the structures of the individual corallites of the corallum, or colony. It is a compound type as distinct from solitary corals which consist simply of one corallite.

The specimen was collected from an ancient limestone of Lower Middle Devonian age at Cave Flat, a locality at the junction of the Murrumbidgee and Goodradigbee Rivers, near Yass. The same species has also been found at other localities in rocks of the same geological age in the Murrumbidgee River area.

For a more detailed examination of the corallite structures, horizontal and transverse thin-sections are cut and mounted on slides for use under a microscope. In this manner even the most minute characters are revealed.

The coral specimen illustrated as Fig. 2, was described sixty-four years ago as *Cyathophyllum mitchelli* by the late Robert Etheridge, Curator of the Australian Museum. In 1941, Dr. Dorothy Hill of the University of Queensland, a world authority on Palaeozoic corals, redescribed the species and placed it in a new genus *Xystriphyllum*, introduced by her for certain corals with definite distinguishing features. The original name of *Cyathophyllum mitchelli* Etheridge, thus becomes a synonym of *Xystriphyllum mitchelli* (Etheridge). The author's name is now placed in parentheses to denote that the first or generic name has been changed since the original description of the species.

In compound corals the corallum is composed of numerous corallites in which the individual animals lived. In *Xystriphyllum*, as shown in Fig. 1, these corallites are crowded together and are four to seven-sided and unequal in size. The radiating septa consist of major and minor types, the former extending to the wall of the corallite, the latter about half the distance. Between the septa are cross-bars or dissepiments. All these and many other structures and variations of them are the means by which scientific workers classify the innumerable extinct coral species.



# Exploring Between Tidemarks

## III. Seashore Animals and Their Feeding

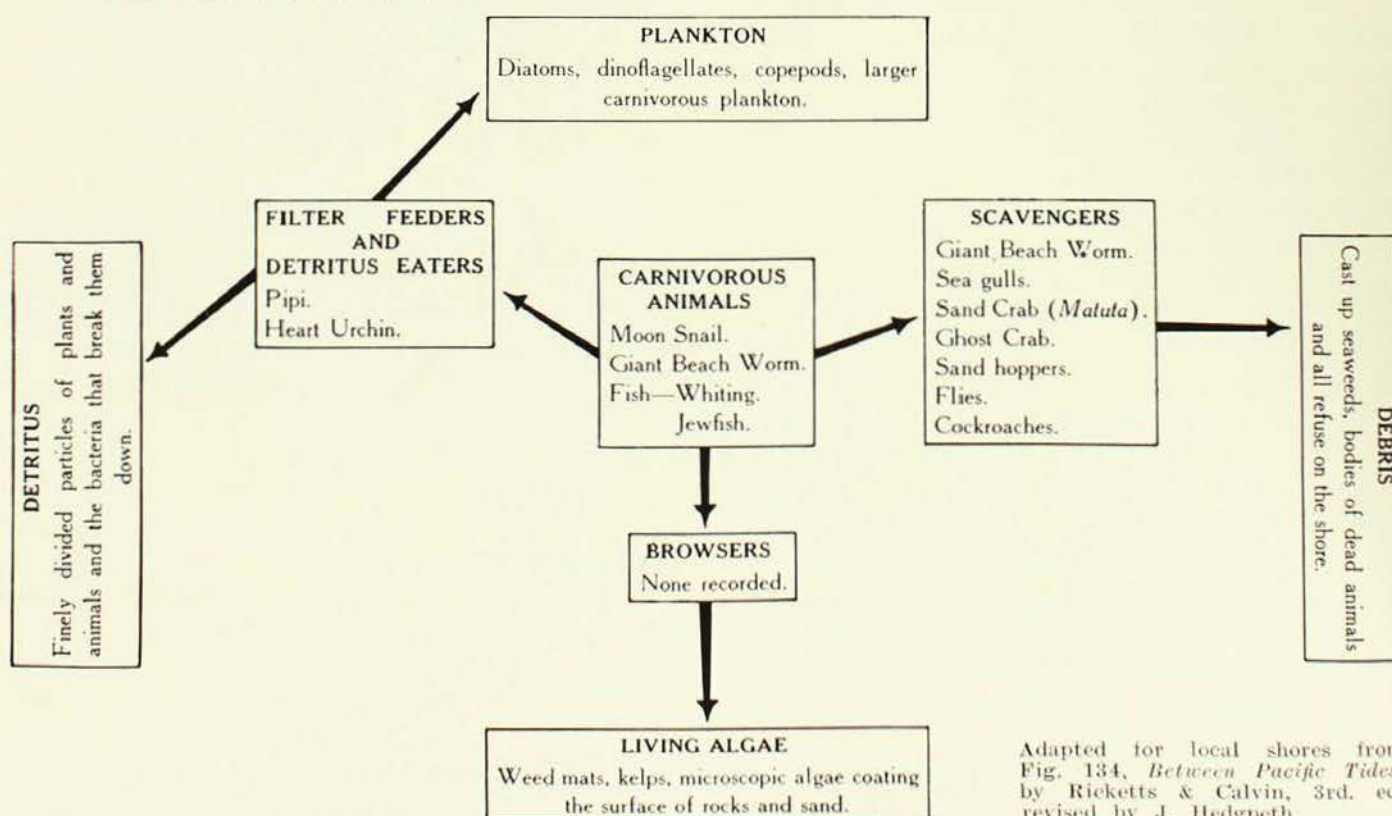
By ELIZABETH C. POPE AND PATRICIA M. McDONALD

SO far in our explorations between tidemarks we have been looking at the shore animals and plants more as individuals than as members of animal communities. How and where they occur has been noted and the degree to which they have become adapted to their environments and to the kinds of lives they lead. As investigations progress, however, it soon becomes apparent that no one kind of animal or group of animals can live entirely unto itself—each species depends in one way or another on its neighbours. Perhaps it is a relationship of predator to prey, or two species may be rivals for the same food supply or for an area of shore on which to settle down and live in the

attached state. One species may depend on another one to provide it with suitably sheltered conditions in which to live.

Such influences are of great importance in any environment and are known as biotic factors as opposed to the physical factors such as temperature, light, water currents, etc. The biotic relationships of the seashore animals are, therefore, well worth the attention of the would-be explorer of shore life. Some of these biotic relationships will now be discussed—more especially the interdependence of organisms in connection with food-gathering, for the obtaining of sufficient food is the most important occupation of any animal or plant. Only when enough food has been

### FOOD RELATIONSHIPS OF ANIMALS ON THE SANDY SURF BEACH



Adapted for local shores from Fig. 134, *Between Pacific Tides*, by Ricketts & Calvin, 3rd. ed. revised by J. Hedgpeth.



gathered can the animal proceed to its other functions, of which breeding is probably the next in importance.

### CLASSIFICATION OF ANIMALS BY FEEDING HABITS

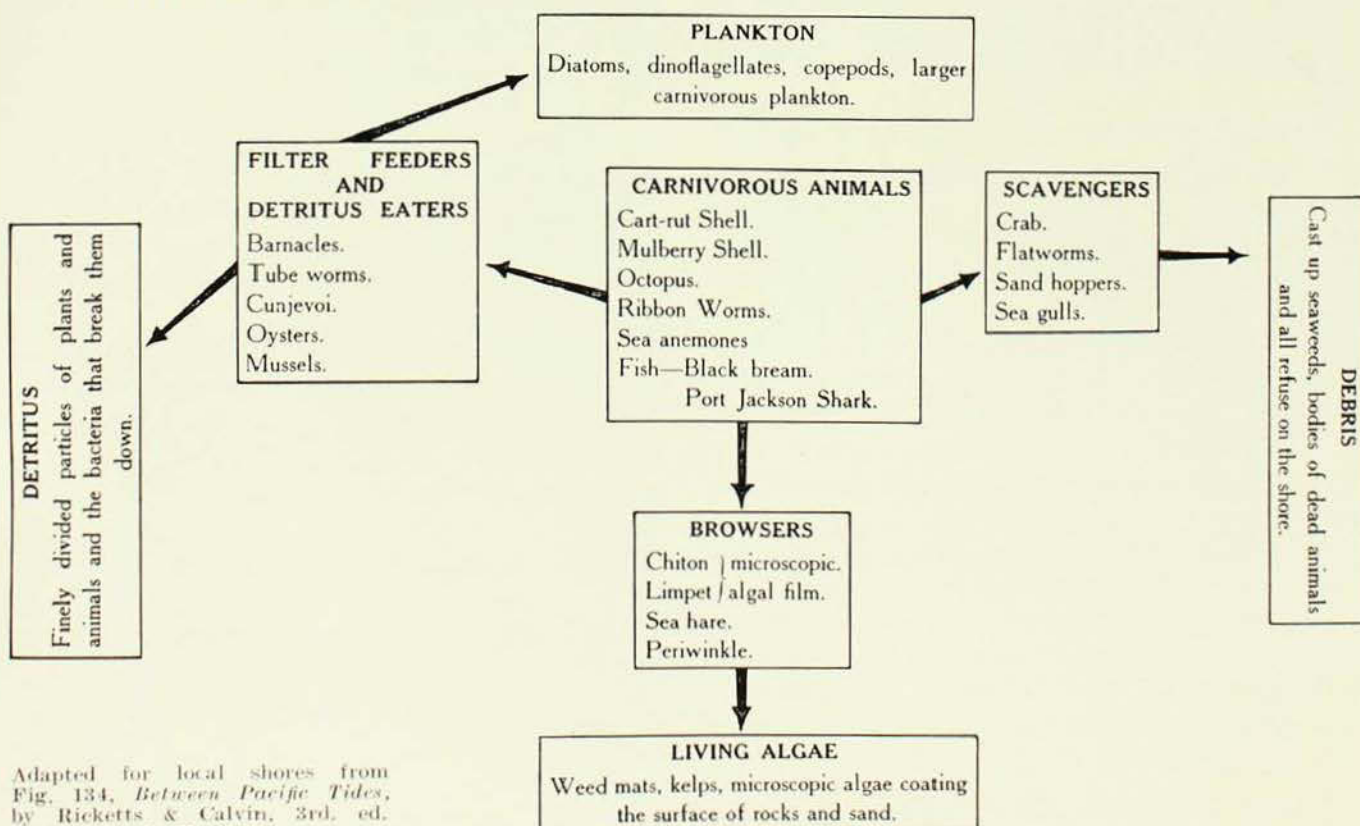
In spite of the somewhat bewildering diversity of species living between high and low water marks and their many and varied ways of gathering and eating their food, there are comparatively few categories of nutriment available to them. Besides the inevitable herbivores (plant eaters), carnivores (flesh eaters), mixed feeders and scavengers found in any animal community there are two very important additional categories of feeders on the shore. These are the sievers of plankton (the floating and drifting life of the ocean) and the eaters of detritus.

Detritus may be defined as a kind of scummy ooze that is deposited from suspension in the sea on to the surfaces of rocks, sand or mud flats. It is composed of bacteria together with the finely divided remains of plants and animals which are

being broken down by the action of the bacteria, and a film of surface-dwelling, microscopic green plants called diatoms. Contrary to what one might expect, detritus is an extremely rich food and many lowly creatures feed exclusively on it, cramming the oozy material indiscriminately into their gut, which extracts the nutriment and passes through their bodies the indigestible sand grains and other useless components. Some typical detritus feeders are nereid worms, the sulphur-coloured Acorn Worm (*Balanoglossus*), the heart urchin (*Echinocardium*), and some small gastropod molluscs which scrape the surface scum and its contained diatoms off the rock surface.

The term "plankton" is the group name given to all the drifting plant and animal life in the sea, regardless of size, and comprises creatures ranging from giant jelly fish twenty feet long (like *Cyanea*) to microscopic plants like diatoms. Within the plankton group one finds creatures that live all their lives in the open sea being drifted about at the mercy of winds and currents. These are the permanent

### FOOD RELATIONSHIPS OF ANIMALS ON THE ROCKY SHORE



Adapted for local shores from Fig. 134, *Between Pacific Tides*, by Ricketts & Calvin, 3rd. ed. revised by J. Hedgpeth.



plankton, *e.g.*, jellyblubbers, bluebottles, copepods, worms, diatoms and dinoflagellates. Other creatures join the great company of plankton during only part of their lives—usually as larval stages—and here are found the young stages of many of the intertidal species like barnacles, *Galeolaria* worms, *Cunjevoi*, prawns, worms, crabs, etc. The plankton has been picturesquely summed up as being both a pasture and a nursery for marine animals. Typical plankton feeders are barnacles, *Cunjevoi* and *Galeolaria* worms. The barnacle's "plankton net" of hairy fishing feet has already been described in another place.\*

With some shore animals it is hard to tell whether they prefer plankton or detritus as food for both types of food are strained from the water and it is not certain whether both are actually consumed. These are regarded as mixed feeders. Typical of this group are the mussels and perhaps the pipis of the sand beach.

Other animals enjoying a mixed diet are the 8-rayed seastar (*Patiriella calcar*) which consumes algae, small molluscs and crustacea, and the Giant Beach Worm (*Onuphis teres*) which eats flesh but does not seem to discriminate between live flesh (carnivore) or decaying debris (scavenger).

Typical scavengers (feeders on debris) are sea gulls, crabs, sand fleas and some shrimps. The nature of detritus and of debris might at first seem exactly the same. The distinction between these classes of food is merely one of size, debris being the larger. Carcasses of dead animals and rotting seaweeds, or portions thereof, are debris even if they are being broken down by bacteria.

As distinct from flesh-eating scavengers which eat dead animals there are some organisms which actively prey on live animals, capturing and consuming their victims in a number of intriguing ways. These are the carnivores. Some are mobile hunters like the Ribbon Worms (Nemerteans), which lassoo bristle-footed worms in a most

expert way by means of a long sticky proboscis shot out from a sheath in front of the head; others are stickfast species like anemones which trap any prey that happens to brush against their tentacles. These tentacles are armed with batteries of microscopic stinging cells which shoot out small threads. Some of these are barbed and can inject a paralysing poison into the prey, while other threads merely serve to entangle the prey and bind it to the anemone's tentacles until it can be passed along to the mouth and swallowed. On first thoughts it may seem preposterous that an apparently fixed and sluggish creature like an anemone can capture a fast moving and wary prawn, but the injected poison of the stinging threads which disable the prawn tips the balance in the anemone's favour. While the poison from most anemone stinging cells has no harmful effect on our skins, we have only to think of similar types of poison from the Bluebottle (*Physalia*) and its dire effect on human victims in the surf, to understand the anemone's success as a hunter. Other prominent carnivores on the shore include the flat, leaf-like Wafer Worm (*Notoplana australis*) which can wreak havoc on the oyster lease, and the Octopus which pounces on unwary crabs or fishes and grabs them by means of its long flexible arms with their clinging sucker discs. There are also a number of carnivorous sea snails like the Cart-rut Shell (*Dicathais orbita*), the Mulberry Shell (*Morula marginalba*) of the rocky reefs, and the Moon or Sand Plough Snails (*Uberinca* and *Uber conica*) of the sandy beaches. These molluscs can drill holes through the shells of their victims whether they be barnacles, mussels, oysters or other bivalves, by means of their file-like tooth ribbons (radulae). They can then protrude their probosces through the holes and extract the soft flesh of the victim. Careful observations of the feeding behaviour of shore animals in rock pools and small home aquaria will prove entertaining as well as enlightening to the would-be explorer.

There are surprisingly few consumers of a diet consisting solely of non-microscopic algae, in other words herbivores. Some that one would think of as herbivores turn

\* AUST. MUS. MAG. XII (2), 48-49.





Left—A frond of Dwarf-kelp (*Ecklonia*) showing the tissues eaten by the sea urchin, *Holopneustes*. Newly eaten areas (just above the stipe) appear pale in the illustration.

Above—The sea urchin (*Holopneustes pycnotilus*) which "roosts" in the kelp while it scrapes off the plant tissues, hanging on by its tube feet.

out on investigation to be detritus feeders. The Sea Hares, such as *Aplysia angasi*, with its black-tipped foot, or the squat common *Dolabrifera brazieri*, may be classed as true herbivores and to them may now be added the round, burr-like sea urchin *Holopneustes pycnotilus*, which lives attached to the fronds of *Ecklonia* kelp or other algae, scraping off the tissues with its five sharp teeth. There are probably other herbivores but our observations have not yet disclosed them.

#### SEDENTARY AND AGILE FEEDERS

An interesting side-reflection of life on rocky shores is that the purely sedentary existence of such hosts of animals like barnacles, mussels or oysters is only possible because there is available to them a wealth of food in the form of floating plankton and detritus grains. These animals merely sit tight and wait for their food to come to them, filtering the nutritious particles from the water which covers them during high tide. Some, like the barnacles and Galeolaria worms, "net" their food particles from the water as it flows

by.\* Others such as the Cunjevoi, mussels, oysters and sponges, draw a current of water through their bodies and sieve off the particles internally. The feeding mechanisms of these animals are well described in most standard textbooks of zoology. Many exponents of this method of feeding, like sponges or compound Ascidians, have no definite shape and seem to sprawl attached over the rock surface in a most untidy way. Some of the attached animals have radial symmetry or an apparently radial arrangement of the body organs (anemones, hydroid zoophytes, etc.), for when food is brought in by water currents there is little advantage in having an agile body with good locomotory powers, a well developed conning-tower-like head bearing sense organs such as eyes, tactile organs and sharp jaws. Such adaptations are more use to carnivores which have actively to seek out, chase and capture other animals for food. Thus carnivores are generally bi-laterally symmetrical, have more acute senses and good powers of locomotion, e.g., the Giant Beach Worm (*Onuphis teres*),

\* AUST. MUS. MAG. XII (2): 48.



fishes, octopuses and carnivorous snails. The anemone and certain kinds of seastars (notably *Astropecten* of the sand and mud flats) are interesting exceptions to the above.

#### FOOD REQUIREMENTS OF SHORE DWELLERS

Although there is a wealth of food available in the open sea in the form of plankton and floating detritus (stirred up by wave action) it should be remembered that such a food source is available to intertidal organisms only when the tide is high enough to cover the area of shore where they live. In the highest part of the shore (where, for instance, the barnacle, *Chthamalus antennatus*, lives), the water flows over the rocks during the high water of spring tides which occur only twice a month for a period of three or four days. During these brief periods the *Chthamalus* can feed and breed normally, the rest of the time their life processes are at a low ebb—a condition akin to aestivation (dormancy in drought) in land dwellers. Occasional storms or splashing of waves on to the higher shore areas may bring a few extra minutes of feeding time each month but that is all. In spite of this the *Chthamalus* barnacles survive in surprising numbers. One should remember in this connection, however, that these typically fixed intertidal animals have lower food requirements than land dwellers for the following reasons: As a rule their supply of water (a prime necessity of life) is adequate and is brought to them along with their food.

The densities of the flesh of marine animals and that of the seawater that surrounds them are nearly the same and therefore less energy is needed to keep their bodies supported in the right positions, whereas land animals are much heavier than air and have continually to use energy to overcome the effects of gravity and to move about in search of food and a living. Movement through water is, of course, more difficult than movement through air but most successful shore dwellers are sedentary so that this factor does not affect them unduly. Also, if the shore animal lives low enough between tidemarks to spend most of its time surrounded by water, then it lives in a very equable temperature and is subjected to less fluctuation of heat and cold than an air breather. All these factors help to explain the success of sedentary animals on intertidal parts of the shore.

Some of the inter-relationships of the animal communities which live on an exposed rocky shore and those of the sandy surf beach are set out on pages 98 and 99. In these diagrams the animals are broadly classified into groups, but as yet little research on food webs and food chains of seashore animals has been done in Australia and information is scanty. Keen observation is needed, and careful, patient dissection and examination of the gut contents of shore dwellers after a period of feeding. The recording of results of such investigations of the common shore dwellers is work that could well be carried out by school biologists under good direction.

*Next Issue:* Some Interesting Animal Communities of Rocky Shores.

•Specimens of minerals, fishes, insects, etc., sent to The Australian Museum for identification, should be packed carefully in strong containers, marked "Natural History Specimens," and addressed to: *The Director, The Australian Museum, College Street, Sydney, N.S.W.* Despatch should be arranged so that perishable specimens do not arrive in Sydney at week-ends. When fragile specimens are forwarded the containers should be lined with an appropriate soft packing.