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Kookaburra.

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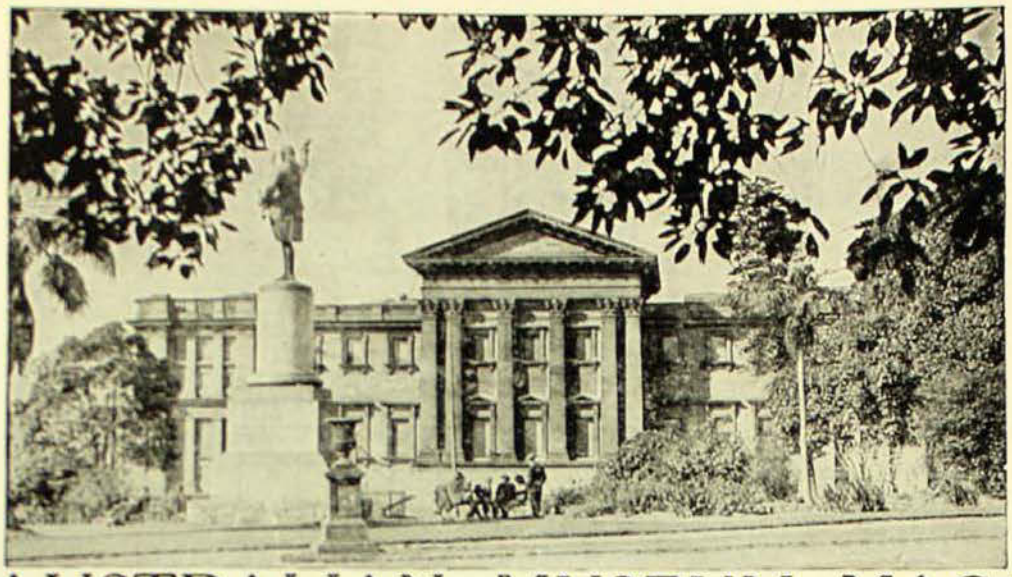

THE AUSTRALIAN MUSEUM MAGAZINE

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(Photography, unless otherwise stated, is by G. C. Clutton.)

● OUR FRONT COVER. The Kookaburra (*Dacelo novaeguineae* Hermann) is by Lilian Medland. It is one of a series of post cards issued by the Australian Museum.

The Kookaburra first came into the hands of a traveller named Sonnerat during a voyage to New Guinea before eastern Australia was discovered by Cook. It was given the above scientific name, which is unfortunate, since the Kookaburra does not live in New Guinea, and scientific procedure will not now allow us to alter it.

The Kookaburra is the largest of the Kingfisher tribe in the whole wide world, but it does not catch fish. It lives on small snakes, lizards, and the larger insects, as well as creatures like centipedes and earthworms when it can get them. It ranges from Queensland to South Australia, being replaced in the north by related species. It has recently been introduced successfully into south-western Australia.

The wild burst of laughter is so well known as to need no description. One is often forced to laugh in sympathy, as well as at the cocking of tails which accompanies this mad chorus. The bird lays three or four shining white eggs in a hollow branch, or, more often, in a chamber dug out in a termites' (white ants') nest.

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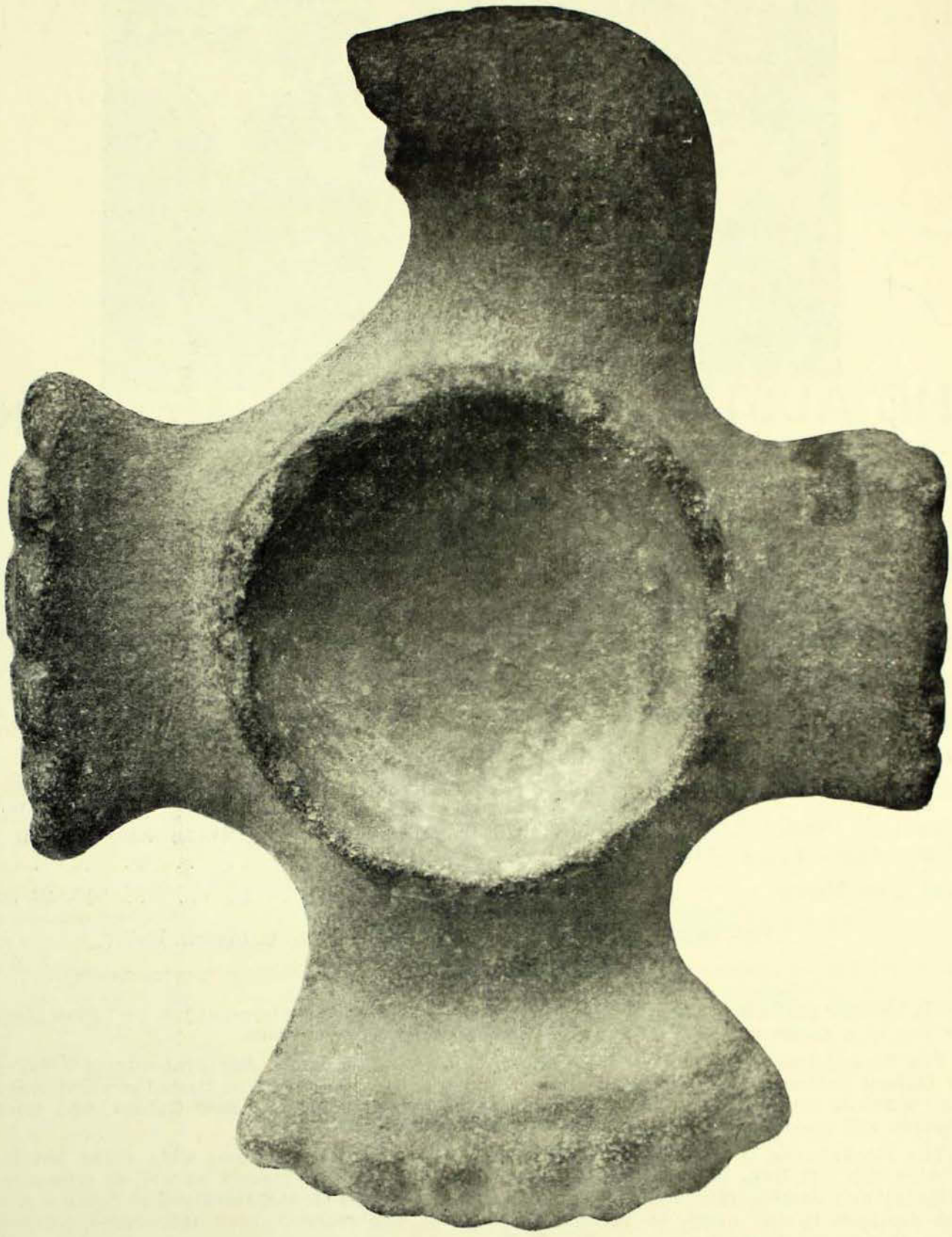

A prehistoric stone mortar, from New Guinea, shaped in the form of a bird. Its size and solidity may be gained from its weight, 50 pounds. It measures 14½ inches across the wing tips, 19 inches in length, and stands 5½ inches high. The greatest depth of the depression is 2½ inches. Australian Museum exhibit. (See page 40.)

THE AUSTRALIAN MUSEUM MAGAZINE

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Vol. VII, No. 2. September–November, 1939.

Recent Work in the Museum

Of late considerable progress has been made in various branches of museum work, particularly as regards display in the galleries, which form the "front windows" of the institution. Provision of cases designed on new lines, attractive backgrounds, and other accessories, entail considerable cost and much work, so that improvements can be introduced only gradually, but much has been already accomplished.

During the visit of Mr. Frank Tose, California Academy of Science, and while he was conducting a class here for Australian museum preparators, three fine habitat groups were constructed featuring the Red Kangaroo, Rock Wallaby, and Native Bear. Subsequently a striking group was completed illustrating the habits of the Platypus, and three old groups are now being reconstructed on more modern lines, with new backgrounds and improved lighting.

The North Wing, the oldest part of the building, has taken on new life. This was inadequately lighted and, particularly in the winter months, the exhibits were not seen to advantage. The old wooden floor has been covered with an attractive flooring composition and part of the space has been set aside as a "rest room", which is much used by visitors. The new lighting system installed by the Department of Works has effected a striking transformation, which is enhanced by the attractive new cases in which the bulk of the collection of minerals is now displayed. The collection of fossils is being arranged to show the evolutionary history of life on the earth, and special exhibits illustrate the principal fossils found in the Sydney district and other selected phases of the life of the past.

On the top floor a most attractive display tells the story of the Molluscs, their structure and habits, illustrated by many diagrams and paintings. For this gallery also some striking groups have been prepared to show in an appropriate setting the life history of certain insects. In the reptile gallery much work has been done in the direction of providing suitable backgrounds for the specimens in conformity with their modes of life.

In the ethnological section many improvements have been effected. A new exhibit, "The Story of Man", features various races of prehistoric men of which remains have been found in various parts of the world. A number of photographs illustrating the industries and customs of various native races have been interspersed among the exhibits. Particularly striking is a fine series of photographic enlargements in colour of Maori life, the gift of the New Zealand Tourist Bureau.

It will be seen, therefore, that the trustees of the Australian Museum are alive to the necessity for keeping the institution abreast of the times and that the staff have already made substantial progress in this direction.

Prehistoric Stone Objects from New Guinea

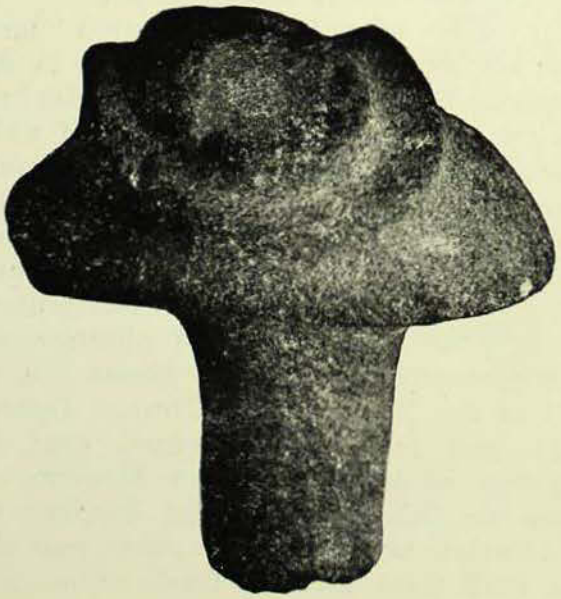
By ELSIE BRAMELL, M.A.

AN ancient stone mortar of unique design has been placed in our galleries as part of our exhibit of prehistoric stone objects found in the Pacific islands. It has been fashioned in the form of a bird with outstretched wings, and its body forms the bowl.[1]

It is yet another of the mysterious remnants of a megalithic culture which once flourished in Oceania. The unearthing of stone objects, such as mortars and pestles, club heads and axes, blades and carved figures, and the far-scattered ruins of stone structures, would point to a prior occupation by a stone-working people whose crafts have been replaced by new practices. The objects are usually made of a hard igneous rock, some being of crude workmanship and others showing high artistic skill, and are finished off by means of hammer-dressing or polishing.

As indicated in a previous issue of this MAGAZINE (Vol. vi, No. 4, 1936), which announced our acquisition of a stone mortar with scalloped edges from the Bulolo district of the Territory of New Guinea, these objects have been unearthed either by the natives themselves, or in river gravels during mining operations, and often at a considerable depth below the surface. In the former case, use is frequently made of them by the natives, who can, however, volunteer no explanation as to their origin. The mortar here depicted is said to have been found by native gardeners in the Wahgi Valley of the Territory. The tip of the beak is, unfortunately, missing.

This bird bowl has been deposited in our Museum for an indefinite period by the Administration of the Territory of New Guinea. So, too, has the other mortar



[1] *See* Frontispiece.

This life-like cockatoo head and another head of uncertain identity were discovered in a river bed after fourteen feet of overburden earth had been removed. The distance between the lower unbroken portion of the beak and the last spur of the comb of the cockatoo is 3½ inches, which also is its vertical measurement. The face of the other head is 2⅞ inches in length. Australian Museum exhibit.

Another interesting mortar, the outer surface of which has carved upon it a bird-like figure with long tail and outspread legs. Its diameter is 8½ inches, height 6¼ inches, and weight 13½ pounds; the bowl depression is 4¾ inches wide and 5 inches deep. The mortar has been tilted so as to show clearly the wings and tail of the creature, but only two out of the five bosses. Australian Museum exhibit.

here illustrated, which was dug up under similar circumstances. On the outer surface of the latter is carved in relief a bird-like figure with long tail and outspread legs. The margin is studded with five bosses, and the projections interposed by the stump tail and the angles of the bent wings.

The largest mortar in our own collection was acquired only recently. It weighs 74 pounds, has a diameter of 15¼ inches, and its upper margin is encircled by 14 low bosses.

Similar mortars, though generally of plain design, are used today in parts of the Dutch East Indies. In the Celebes they are associated with megalithic structures considered to have been erected in the late Neolithic and early Bronze Ages; the hammer-dressing technique is attributed to the early Neolithic period.

There was figured in *Man* of May, 1938, a series of objects carved from stone and found in river gravels of the Watut River, Territory of New Guinea, by Messrs. G. V. and R. V. Wild. They include a bird's head, a small conventionalized and problematical head with large eyes, a pestle and mortar found together, pine-apple and disk club heads, several small axe blades, and a smoothly ground slate blade 29 inches long. The two heads are particularly interesting. One is that of a cockatoo, judging by the serrated comb, with wide open beak. It is about life-size, and is supported on a "ringed" neck. The other head is hard to classify. Attention is drawn chiefly to the eyes, which are hollow and outlined by a prominent ridge. Both are shaped with great skill and artistry, and the craftsman was apparently quite at ease with his medium. It is not unlikely that they may have been the decorative handles of pestles, for their bases are sharply broken off. The long slate blade is new to Australian collections, though similar specimens from Dutch New Guinea are to be seen in the museum in Batavia, and probably elsewhere. It was broken into halves by the

force of the water during sluicing, but the two pieces obviously fit together. The finish is smooth and the section thin and brought to sharply ground edges.

The frequent occurrence of the bird motif in the stone objects so far discovered suggests an adherence to a bird cult, and is of interest because the cockatoo figures prominently in the art of the Sepik area today; there is not, of course, any necessary connection between these occurrences. The number and variety of the pieces that have been coming to light in recent years indicate that an interesting field of research lies ready for the archaeologist in the Pacific.

Slate blade, green-grey in colour, and 29 inches in length. It is thin in section and brought to a sharp edge at the sides and the narrow end.

The Coals of Your Fire

By R. O. CHALMERS, A.S.T.C.

(This is the substance of a broadcast talk delivered to school children.—EDITOR.)

COAL is not one of those learned sounding words that take such a long time to explain. It is a very simple and a very old word in our language, much older than the beginnings of geology, which is the science dealing with the rocks of the earth's crust. It is with the help of geology that I will try to tell you how coal was first formed, and how it comes to be found today, deep in the earth.

Coal is a simple and at the same time an important word. It is important because it means any substance that when burnt gives out heat and light, and this, in a cold country, is as important as life itself, for without it life could not exist.

The name did not always apply to the familiar, black, shining substance we know today. Hundreds of years ago this was known as "pit-cole" and was very little used, the principal fuel being charcoal made by slowly heating wood. Charcoal-burning was once quite an important industry. However, as "pit-cole" came to be mined more, and charcoal became less readily obtainable owing to the forests being cut down, the word coal came to mean only "pit-cole".

You may say that in the old simple days it was necessary to have coal fires. In our modern houses and flats we do not want to have to shovel dirty, dusty ashes from the grate every morning. We have our gas-fires and electric radiators. I am supposing that you are all very modern children, because many people, including myself, think there is nothing like the old-fashioned fire.

Let me say that coal is used today much more than you think. I am going to show you how by means of those miracles that chemists and engineers are able to perform, the humble, black and

A restoration of plant life in a Carboniferous swamp forest, consisting of giant club mosses, horse-tails and ferns.
Courtesy of Field Museum of Natural History, Chicago.

uninteresting coal is used to make the gas and electricity of which you are so proud and which you think so modern. Some of you might like to try an experiment. Get a clay pipe, put some chips of coal in the bowl and seal with clay. Heat the bowl, gently at first, and a whitish-yellow smoke will be seen coming from the mouthpiece. Put a match to this and it will light. On cooling, remove the clay, and examine what is left in the bowl. It is ordinary coke.

Now imagine many large metal tubes, or retorts as they are called, containing coal which is heated. The gas passes through numerous tanks and towers, where it is purified. Then store it in huge containers and have miles and miles of pipes to convey it to gas-stoves and gas-fires everywhere in the city and suburbs. Now you have a picture in your minds of a modern gas-works.

Have any of you ever been lucky enough to visit Bunnerong Power House on the shores of Botany Bay? What a surprise Captain Cook would get were he to sail into the bay today. You can just hear him say: "Well, Sir Joseph, the spot where I landed has changed but little in the last 169 years, but what is that huge building over there with the rows and rows of black chimneys belching out smoke unceasingly?" Someone could then inform him that there huge turbines with ceaseless droning make nearly all the electricity for this great city of Sydney. Steam drives the turbines and coal is used to heat the water in the boilers to make steam. At Bunnerong thousands of tons of coal are used each week. So you see gas-fires and electric radiators are not very distant cousins of the old-fashioned coal-fire.

Not only is coal still useful for keeping us warm. It is used in numerous industries. It still drives railway engines and great ocean liners. Somebody may point out that oil and petrol are coming to be used more and more and that coal is gradually falling into disuse. There is some truth in this, but just as I showed you how gas-fires and coal-fires are cousins, so I could show, were the time not limited, that coal and oil are also related.

Now I must tell you something of how coal is formed. First of all, as some of you may know, the marks of leaves and other parts of trees and plants are often found in coal, and these are known as fossils. The leaves and branches no longer exist, but

they have left their impressions on the coal. From this it is certain that coal once consisted of masses of branches, leaves, stems, roots, and all sorts of plant life. Let me take you to the Great Dismal Swamp of Virginia in the United States of America. It is forty miles long and twenty-five miles broad. A great many trees and shrubs grow in this swamp, and as they die they fall into the swampy ground. So many dead and dying trees have gathered and are still gathering in this way that today the soil in the swamp is black and does not consist of ordinary sandy and clayey material like most soils; it consists largely of decayed plant material of all sorts.

Let us visit, again in the imagination, parts of Scotland, Ireland, Europe, North America, in fact almost any cold climate country, and we will be certain to see the farming people cutting peat in the spring so that they will have a supply of fuel for the winter.

Peat forms in bogs and marshes in the same way as the black soil of the Great Dismal Swamp, only it is made up largely of mosses and small plant life rather than leaves and branches. In some small islands, such as Orkney off the coast of Scotland and the Falklands off the coast of South America, which are so wind-swept, cold and barren that there are no trees, peat is the only fuel available unless coal is shipped there. In the spring it is cut in the form of large oblong pieces like the turfs of buffalo grass used to make lawns in this country, and since it still contains a large amount of water it is stacked all through the summer to dry and then burnt in the winter.

How does this muddy, wet material formed in swamps and in peat-bogs ever turn into coal which is black, hard and shining? Rome was not built in a day and Nature's wonderful work is seldom carried out in a year, in a hundred years, or even in a thousand. Millions of years are needed before this swampy peaty material loses a great deal of water and is squeezed hard enough to become coal.

Two hundred and fifty million years ago the spot where Sydney now stands was in the centre of a swamp that must have resembled very much the Great Dismal Swamp except that it was about three times as big, and the kinds of trees that grew in this swamp are either not found on the earth at all at the present, or, if they do occur, they are much smaller now than they were then. As time went on the swamp began to sink and a lagoon

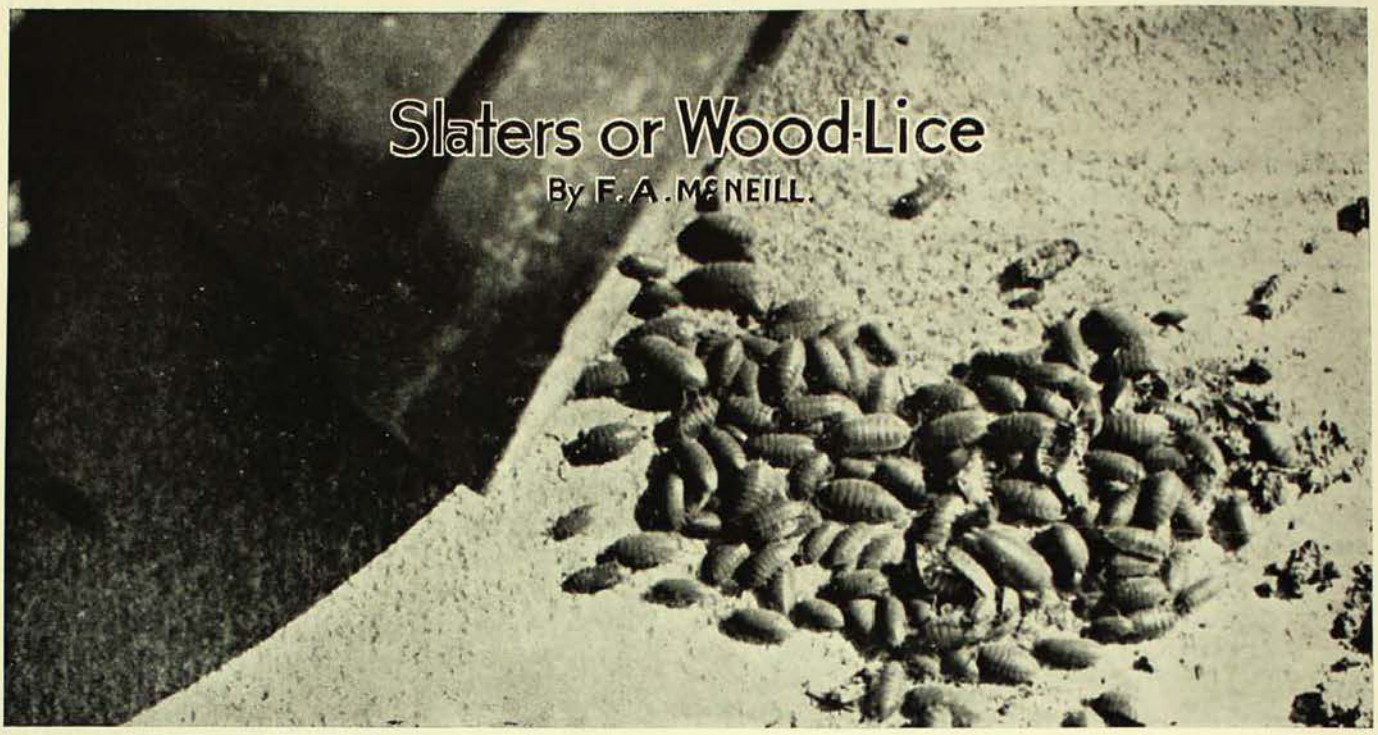
Cutting peats, Orkney. This is a 3-peat "bank" where three pairs operate: the men slicing the moss with the "tuskar", the women "taking off" the peat and placing it on edge to dry. The man at extreme left operates the "flaying spade", that is, slices off the surface covering of grass or heather.
Photo.—Thos Kent.

formed with an entrance to the sea. The surface of our earth is never really still. It is either moving up or down, only so slowly that neither you nor I can notice it. The amount of movement can be measured only with most delicate instruments. To return to the lagoon, mud, sand and clay were then brought in by streams and covered all this dead plant life that had gathered just as it does today in the Great Dismal Swamp. Then it became quite silted up and turned into a swamp again. Then once more it started to sink and another covering of sand and mud was added. This went on for millions of years until finally it became a freshwater lake, in which a great quantity of sand was laid down. Since that time it has been dry land and the hand of time has converted the various layers of decayed vegetable matter into the seams of coal for which New South Wales is justly famous. Do not forget that all the processes I have just outlined must have taken millions of years to be carried to completion. From what we know of the rate at which the black soil gathers in the Great Dismal Swamp it must have taken about 50,000 years for the material to gather which today forms the Greta coal seam in the Cessnock district. So you see the geologist is somewhat of a detective. From the few clues that Nature gives us at the present day we are able to go far back into the past and unravel some of her most tangled secrets. The layers of mud and sand that were laid down between the coal seams in the Sydney Swamp are found today as beds of shale and sandstone separating the coal seams. The final large quantity of sandy material laid down has been changed into the massive sandstones that are found in the Sydney district and that also form the great vertical cliffs of the Blue Mountains.

Sydney today is actually in the centre of a great coal basin. As I told you, the surface of our earth is never still. It will bend like anything else if too great a strain is imposed on it, and such was the weight of overlying sandy and clayey material that the centre of the swamp gradually bent down and down, the black soil slowly being compressed to form coal all the time, until today at the Balmain coal mine we have to go down almost 3,000 feet before the top seam is reached, and yet this same seam is found on the surface of the ground at Newcastle, Bulli and Lithgow. It must also occur to the east somewhere in the Tasman Sea, for in the days when the swamp first formed the New South Wales coastline extended much further to the east than it does today.

You have heard how coal is formed. You have heard of the many uses to which it can be put, and mention should also be made of the many risks run by mine-workers as they toil and labour to bring one of Nature's greatest gifts to the surface for the use of mankind. The next time you light a coal-fire or a gas-stove, switch on a radiator, travel in a tram or train, remember that all the energy that was stored by Nature in a huge swamp millions of years ago is being released today in countless ways for the benefit of the people of Sydney. The heat and light that you enjoy in your homes is really the sunshine that caused plant life to grow so abundantly in the Great Sydney Swamp many millions of years ago.

The Royal Zoological Society of Victoria, in order to stimulate research on the fauna of Australia, has determined to offer a prize of £25 for an essay on any scientific aspect of Australian fauna. This prize will be open to all interested persons, and competitors should forward their essays to the Secretary of the Society, at 80 Swanston Street, Melbourne, on or before December 30, 1939.



Slaters or Wood-Lice

By F. A. McNEILL.

BACK in century-old literature one discovers that the Scotch knew as "sclaters" those little pests of Australian gardens which are such a problem to the horticulturist. Although of European origin, the slaters boasted a world-wide distribution even before that period. They have travelled with the emigrant and colonist to all parts except the cold regions of the two hemispheres. Man has been the innocent disperser, giving the creatures safe sanctuary in the closely tended plants and seeds which he has taken to new lands.

Slaters are adaptable creatures, and it is interesting to note how accounts of habits in other lands so closely agree with those of the local slaters. An example is to be found in a work by a Dr. Asa Fitch entitled *First Report on the Noxious, Beneficial, and other Insects of the State of New York*, Albany, 1855. This authority recorded that slaters were "everywhere common about the roots of trees, under logs and stones, in the crevices of the foundation walls of our buildings, and in our cellars; and they are particularly numerous under any logs or billets of wood. They occur, in short, in all situations that are damp, cool and dark. Frequently by night, in wet weather, they crawl about the rooms in our dwellings".

The title of the work above draws attention to the popularly confused identity of slaters. They definitely are not insects, but crustaceans, and closely related to the Sea Lice, which abundantly infest all oceans. In fact slaters often have the name wood-lice applied to them. The migration to the land was a gradual process over aeons of time and a question concerned with evolution. Phase by phase the transition was assisted as organs and other physical modifications enabled the slaters finally to divorce themselves from the marine world. Interesting examples of such a transition are at the present time to be seen in several common varieties of Sea Lice which live along the high tide line and are neither of the sea nor the land.

While the sea-living crustaceans breathe by way of gills, the slaters' mode

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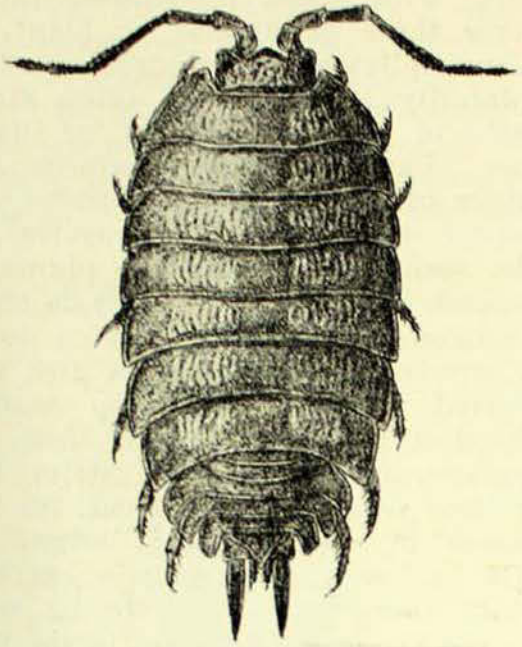


Porcellio laevis.
After Sars, × 4.

of life has wrought a remarkable change in this function. Air is brought directly into contact with the blood circulation. In one of the two commonest local forms later to be briefly described, a white spot will be seen on each outside flap (exopodite) of the first (front) two pairs of special appendages called pleopods on the underside of the body. These appendages are, of course, quite separate from the walking legs and should be examined for detail with the aid of a pocket lens. On special microscopic examination it is found that the white spots are tufts of fine branching tubes spreading into the interior of the exopodite from a slit-like opening on the outer edge. These systems of tubes have been developed by an in-pushing of the integument, and their linings have thus become a continuation of the external skin, although delicate by comparison. In the live slater they are filled with air, and they serve to aerate the blood circulating in the interior of the appendage.

The peculiar air-tubes present in the abdominal appendages (pleopods) of slaters give rise to some interesting questions regarding classification of the ringed and jointed-footed creatures (Arthropoda) as a whole. The six-legged insects, most of the spiders and many of their close relatives (ticks and mites), the centipedes and millipedes, and the isolated worm-like form *Peripatus*, all breathe air through systems of fine tubes which penetrate throughout the body, bringing the air into direct touch with the tissues. Commonly known as "tracheae", these tubes develop, as in the slaters, through ingrowths of the outer layer of the embryo or larva, and are lined by a delicate continuation of the outside skin. Some eminent zoological authorities have held the view that such peculiar breathing organs must indicate for the animals that possess them descent in evolution from a common ancestor. Accordingly it has been proposed to separate the insects (Insecta), spiders and allies (Arachnida), centipedes and millipedes (Myriopoda), and *Peripatus* as a group to be known as the Tracheata. On the excluded side would be the Crustacea ("Insects of the Sea") and some other ringed and jointed-footed creatures (Arthropoda) which have no tracheae.

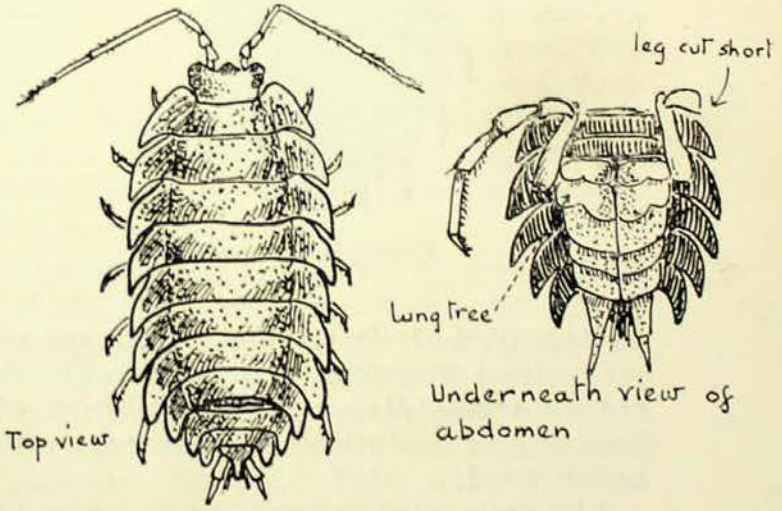


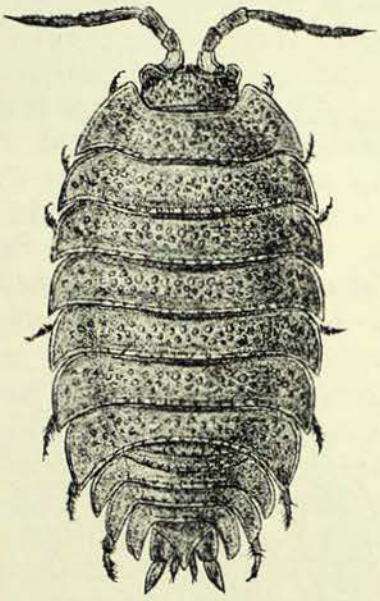
Diagram showing exact location of breathing organs.

As against the action of the separatist, however, the air-tubes of the slaters and their terrestrial allies have to be taken into account. These are precisely like tracheae in structure and function, differing only in that they are confined to the appendages, and do not penetrate deeply into the body. In the slaters and their

kind we are dealing with a highly specialized section of the Crustacea, and should not assume that they have derived their air-tubes from any ancestral form which they had in common with the widely separated spider group, for example.

If air-tubes and tracheae, or either separately, then, have been developed independently in the two groups just cited, it would be quite sound to claim that the tracheae of the insects evolved independently of either.

The above single example out of many will illustrate to the reader the difficulty experienced by the student in attempting the reconstruction of the genealogy, or



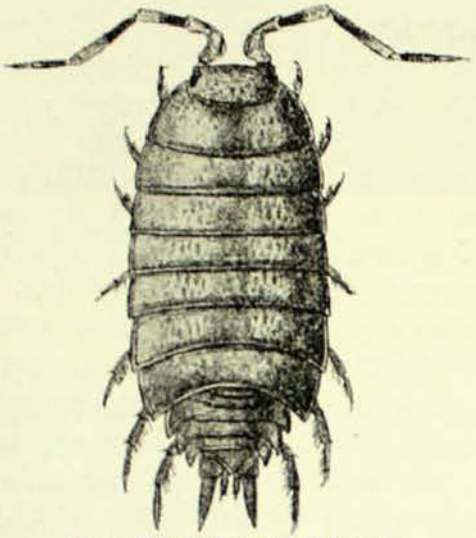
Porcellio scaber.
After Sars, × 5.

phylogeny, as it is technically known, of the animal kingdom. In this study, or aid to classification, the possibility of "convergent evolution" has constantly to be admitted.

Although slaters are very common animals, it is surprising how little has been published concerning their habits. It is generally accepted, however, that they eat decaying vegetable matter, and even devour insect eggs, dead insects and other animal remains. While in Europe this scavenging instinct may be a set-off against possible misdeeds, it definitely does not absolve the slaters from their pestilential habits in local gardens. In keeping with most introduced things, whether these be animal or plant, we find multiplication accelerated, and an adaptability to conditions often strong enough to oust indigenous or native forms. Fast breeding produces vast numbers of slaters in our gardens, and, in order that they may survive, the tender seedlings and delicate plants are consumed. A particular fancy is shown for ornamental staghorns, which do not long survive once the slaters give them concerted attention in damp weather. Perhaps it is fortunate that these tiny despoilers, in the main, restrict their attentions to suburban gardens, for their presence in a wider field might well create a serious economic problem. Luckily there is nothing to be feared from the presence of slaters in the house during wet weather. Nocturnal activity brings them from their hiding places, when they disperse over a wide area on foraging expeditions, and their aimless wanderings into residences more often than not end in slow starvation. Systematic attention to the task of eradication will keep these garden pests in check. Poisons provide the most effective means, but due care has to be exercised. The methods recommended are dusting soil with arsenical compounds, spraying food material or haunts with arsenate of lead, and placing thinly sliced potato, dusted with Paris green, in favoured haunts; thinly sliced potato alone will, at night, often attract a sufficient number of slaters to render effective the use of boiling water in their destruction. Further recommendations are the use of powdered borax sprinkled on the creatures in their haunts, and a bait made up of eight parts of powdered blood, or blood and bone, to one of Paris green. Some people occasionally allow their fowls a restricted freedom of the garden, for these are effective destroyers of slaters.

The two conspicuous forms of slater are known technically as *Porcellio laevis* and *P. scaber*. The former is distinguished readily by its smooth, slaty-grey back, often with wavy, pale markings on the

sides. On the other hand, *P. scaber* has its darker grey mottled back roughened with transverse rows of tubercles. A third, more fragile, narrower, and smaller species not uncommonly met with, is the species *Porcellionides pruniosus*, in which the back is very slightly roughened with granules. The life colour in this case is



Porcellionides pruniosus.
After Sars, × 6.

bluish-grey, tinged with a rusty bloom in the female, or various shades of reddish-brown.

In breeding the slaters lay eggs, which remain attached during incubation near the bases of the legs. When born the young are miniature replicas of their parents and remain for a time as a writhing, crowded, white brood on the underside of the mother. During growth the characteristic moulting (ecdysis) common to crustaceans is evident. The slaters, however, exhibit a peculiar method in casting their outer covering (exoskeleton). Instead of the whole being disposed of at one time, as in other Crustacea, that of the hinder half of the body is moulted first. It is only after two or three days, when the newly exposed covering has hardened, that the remaining half of the older outer covering is stripped away. As a result of the practice individual specimens are often encountered with the fore part of the body differing markedly in colour from the hind part.

Perhaps the one questionable virtue associated with slaters belongs to the time when they figured in old books on materia medica, and prompted cures through the stimulated imagination of trusting patients. It was claimed that when the slaters were dried and pulverized "they have a faint, disagreeable smell, and a somewhat pungent, sweetish, nauseous taste, and are highly celebrated in suppressions, in all kinds of obstructions of the bowels, in the jaundice, ague, weakness of sight, and a variety of other disorders". Modern scientific enlightenment has been responsible for discarding the above and other similar fantastic remedies from the pharmacopoeias.

Mr. Gilbert P. Whitley, ichthyologist, recently returned from a holiday trip to Western Australia. He flew from Perth to Carnarvon, where he made a collection of shells and other marine creatures. He visited the historic Dirk Hartog's Island, where many unusual shells were found.

From Carnarvon he flew to Port Hedland, where a further collection was made, thence to Broome. After a short stay at Darwin, Mr. Whitley returned to Sydney by flying boat, via Groote Eylandt and Townsville. The trip resulted in many new additions to the Museum's collections.

Mr. Harold O. Fletcher returned early in August from the Simpson Desert. He was second-in-command of an expedition, organized and led by Dr. C. T. Madigan, of the Adelaide University, and carried out palaeontological and biological work. The party consisted of nine members, and their means of transport over almost a thousand mile journey was a string of nineteen camels. This was the first occasion upon which the desert has been crossed, and a good deal of scientific work was accomplished.

The first part of the journey was from Charlotte Waters to the junction of the Todd and Hale Rivers in the north, thence east across the centre of the desert to the Queensland border. The Mulligan River was followed south to Birdsville. The second part of the journey was from Birdsville to Marree, via Lake Eyre.

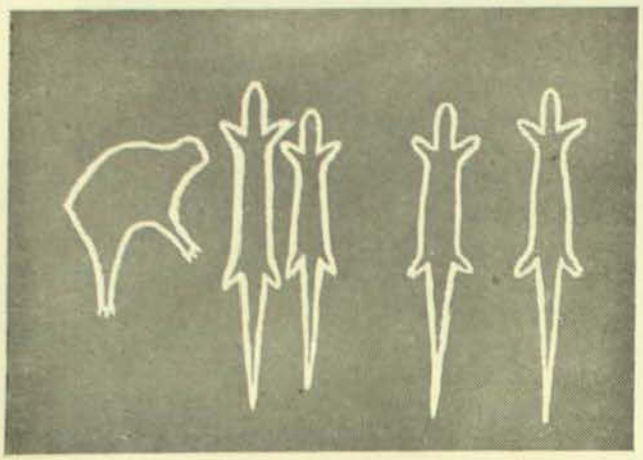
The Aboriginal Rock Paintings of New South Wales

By FREDERICK D. McCARTHY

NEW SOUTH WALES has a surprising number of groups of aboriginal rock paintings, the variety and interest of which are excelled only by those in the Kimberleys of Western Australia and the neighbouring region of north Australia. The paintings are found mostly in the rock-shelters so common in outcrops of sandstone, a rock widespread in the State, an excellent example of which is the well-known Hawkesbury sandstone in the Sydney district. The walls and ceilings of a number of the caves used as habitations by the aborigines are adorned with paintings, for the meaning and significance of art designs are known only to the initiated men, and sacred motifs may be placed in everyday places and on everyday objects without danger of exposing the secrets to the women and uninitiated. Where rock surfaces have been adorned by generations of native artists, there are to be seen superimposed layers of drawings, quite fresh series having been done over old and faded figures.

The majority of rock-shelters containing paintings are situated on the tops of high spurs and on the slopes of ridges, but many occur at the bases of cliffs, in valley bottoms, and on the shores of rivers and bays. Most of them, fortunately, are inaccessible even with our modern motor roads, and this is conducive to their preservation.

A fine series of men in war-like pose, the top series in red, the lower in white; two human feet in white outline, and two stencilled hands are also present. Gundabooka, N.S.W.
Photo.—H. R. Stevens.



Outline drawings in white of a native bear and four goannas. Parish of Tollagong, County Hunter, N.S.W.
After R. H. Mathews.

THE METHODS OF PAINTING.

Five methods, or techniques, of painting were employed by the aborigines in New South Wales, as follows:

(*a*) Simple outline and single line.

(*b*) The figure is infilled with lines, usually lengthwise, but occasionally criss-crossed.

(*c*) Silhouette, or a solid mass of one colour sometimes outlined with another.

(*d*) Stencil.

(*e*) Impression.

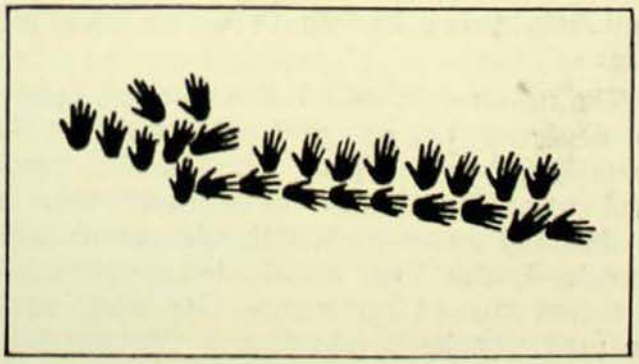
The existence of these various methods raises a problem for solution—do they represent progressive developments of the artists' knowledge, and if so, in what order were they invented or introduced? Unfortunately, our present inadequate investigations do not permit us to decide these points.

PIGMENTS.

The pigments used were charcoal (for black), red and yellow ochres of various shades, and white pipeclay. Outline drawings were made with a hard piece of any of these materials, and figures were shaded in the same manner. For silhouettes, stencils, and impressions, however, it was necessary to use the colouring matter as a paint, so the pigments were crushed up with a stone mortar and pestle, and mixed with water or the fat of the emu, goanna, marsupials or fish. In a silhouette the paint was applied with a brush made by fraying the end of a strip of bark or twig: line drawings were sometimes made in this way. On account of the sparse occurrences of the pigments, the colours used in various sites are generally those which are obtainable locally (charcoal, of course, was always at hand). For this reason, all of the drawings in some caves are in black only, or red, white, or yellow. In many series two, three, and four colours are to be seen. Yellow is the rarest ochre in New South Wales. The pigments were extensively bartered among the aborigines, and, as some of the deposits were sanctified in myth, the clay or ochre from them was eagerly sought after, and pieces travelled long distances because drawings made with pigment from a sacred deposit were imbued with a magical power derived from culture heroes and spiritual ancestors.

SUBJECTS.

The association of the subjects in any one site is influenced by several factors. One is location; for example, fish are commonly depicted in rock-shelters near rivers, lakes, and the sea because they formed an important item of food. Caves in which the natives lived contain a wide assortment of paintings of weapons, human figures, animals used for food, and other motifs, which may be done by one or several techniques; it is interesting to note that there are many sites in which stencils only are present. Sites which were used for ritual purposes may have large drawings of human beings which



Hand impressions in red. Parish of Wilpinjong, County Phillip, N.S.W.
After R. H. Mathews.

A large male figure, drawn in red outlined with white, eyes and girdle pendant in white; it is surrounded by sets of white lines and white stencils of boomerangs, hafted stone axes, and human hands. Bulga, N.S.W.

represent culture heroes and spiritual ancestors, associated with weapons and natural species; with the exception of a few sites it is, however, impossible to say whether a group of paintings formed a sacred site in the life of the aborigines because, as Spencer and Gillen pointed out, art designs are sacred only when in their proper context.

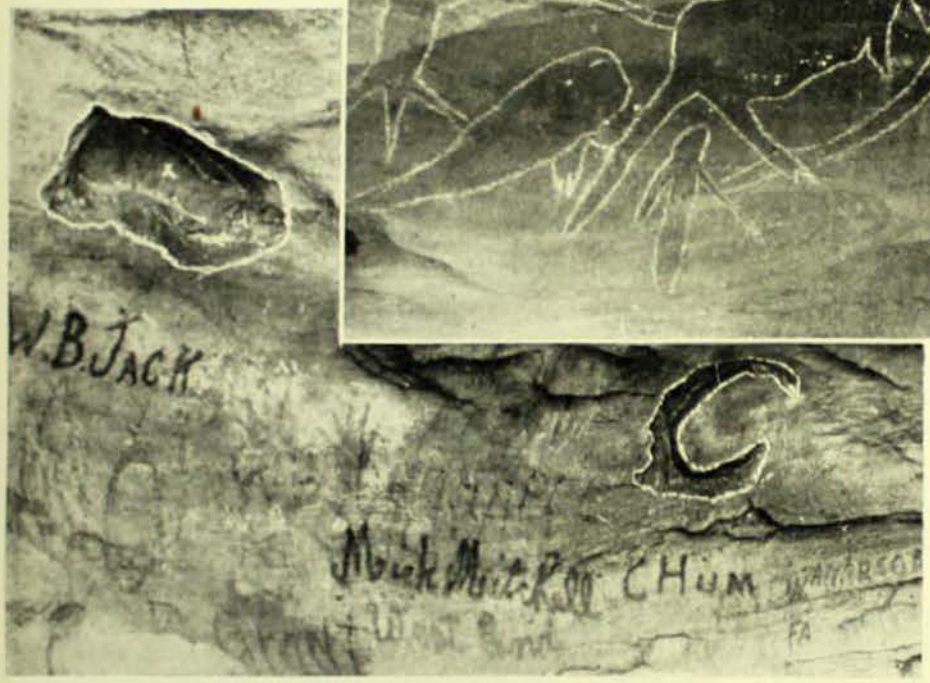
The choice of subject was limited by the techniques employed only in the stencilling and impression methods. In the Sydney district stencils and figures infilled with lines predominate, although silhouettes and line drawings are plentiful. In the interior of the State silhouettes are often associated with line mazes. Odd figures may often be seen in rock-shelters and on exposed rock faces, and the number of drawings in a series varies considerably, up to one hundred and fifty being known to occur in some sites.

The manner in which the human figure is depicted varies, and, although it is usually shown from the front, two stylizations of it may be defined. One is a dancing pose in which the arms are upraised, the legs are wide apart with the feet turned outwards, the neck may or may not be present, and the head is rounded or occasionally pointed; there may be too few or too many toes and fingers, the eyes are usually present, but the nose or mouth may be absent, and the ears are rarely shown. Male and female are often drawn side by side, but most of the anthropomorphs are males. In the female the breasts project laterally. The second stylization is a figure known as the "hocker", in which the arms are bent upwards, and legs downwards, in the middle; these figures may occur in a series, as at Tallong, but a maze is often the result, as in a cave at Howe's Valley. Perhaps the finest anthropomorph in any New South Wales site of paintings is that of a male in red and white at Bulga; he is just over nine feet high, and measures nearly seventeen feet from hand to hand. Ornaments are rarely shown in paintings of the human figure, although they are frequently present in engraved figures.

Mammals are represented by the kangaroo, wallaby, opossum, wombat, dingo, spiny ant-eater, native cat, phalanger, kangaroo-rat, rodents, and a few others; they are almost always drawn in profile. Of the birds the emu is quite common, other types rare, though a few ducks and a parrot are known. Among the reptiles, which are usually drawn from above, goannas predominate, and they must have been hunted assiduously to judge by the frequency with which

Top: A series of the "hocker" stylization of the human figure, drawn in black outlined with white. Howe's Valley, N.S.W.

Centre: A man (in the "lizard" stylization) stabbing one of two kangaroos with a spear; there are two fish or tadpoles below. Drawn in red outlined with white. Wollombi, N.S.W.



Left: A striking example of vandalism at Wollombi—one painting (x) has been removed, another is half cut out, and visitors' names are so thickly inscribed that few of the drawings can be made out.
Photos.—F. D. McCarthy.

they are painted. Snakes are generally shown stretched out, and there is one at Mootwingee twenty-eight feet long. The absence, or extreme rarity, of plants, insects, molluscs, and other invertebrates, which formed a considerable portion of the food of the aborigines, is rather striking.

In most of the groups a few weapons are shown, and their total comprises a wide range, including boomerangs, shields, clubs, and bundles of spears; baskets, nets, hafted and unhafted stone axes are also common. The types depicted are of those which are represented in our Museum collections of aboriginal material culture, and which were used by the aborigines at the time of the British occupation; this is a point of great importance when considering the age of the paintings, and confirms the view that they were made by the natives (and their predecessors) whom the white settlers met.

A "sun" motif is common in the Wollombi district; some examples have as many as thirty-eight rays, and where the half-figure occurs it probably repre-

sents the rising or setting sun. It is often drawn in white, and several are known in red.

The stencils are widespread, and form a most important feature of the rock paintings in eastern New South Wales. To make a stencil the object was placed upon the rock surface and liquid pigment was squirted from the mouth around its outline, thus making a negative impression of it. In this way human hands and feet, boomerangs, clubs, hafted and unhafted stone axes, and small fish were depicted, and in one instance a small human figure (probably a piece of bark was cut into shape for a ceremony and a stencil made of it) is shown. Hands to the number of over one hundred are quite common in rock-shelters. The stencil was made in white, red, or yellow on the plain rock, or the surface of the wall was coloured red or black beforehand; they were often made on a smoke-blackened wall. A well-preserved series of stencils is striking and attractive in its cave setting.

Impressions were made of the human hand, and occasionally of the foot; the pigment was smeared over the hand or foot, or it was dipped in the paint, and then placed on the rock surface so as to make an impression. Examples of this technique are comparatively rare, though they occur in several sites in eastern New South Wales.

Attempts by the aborigines to depict simple compositions in paint are few and far between. At Wollombi a fight is shown between two men drawn in red (now almost obliterated by vandalism), and a man is shown jabbing a spear into one of two hopping kangaroos drawn in red outlined with white. There are several sites in the interior of the State where picture-stories are present. In a large cave in western N. S. Wales are more than one hundred drawings, amongst them two men are shown fighting with boomerangs and shields, whilst a man is shown cutting a hole in a tree with a stone axe; there are several series of dancing men, and accompanying one set is a man beating the time with two sticks. These figures are painted variously red, white, and yellow on a smoke-blackened wall. A dancing scene in white on a black surface occurs in a cave on Coombie Station, Hillston district. Compositions are more numerous among the rock engravings of the Sydney district than among the rock paintings in the State.

ARTISTIC MERIT.

The artistic merit of the rock paintings in New South Wales is not of a very high standard. Although naturalism is the main inspiration, there is a lack of accurate detail, a poor appreciation of form, and an almost general stylization of the method of depicting each subject. There is no attempt to show body contours by shading, and any sense of perspective is entirely absent. The figures are stiff and formal, and some appear to have been drawn from a dead subject. They are not as vital as, and lack the technical excellence of, the masterly work of the Magdalenian cave artists of western Europe and Spain, and of the Bushmen of South Africa.

COMPARISON OF ROCK ENGRAVINGS AND PAINTINGS.

There is a striking difference between the rock paintings and engravings of eastern New South Wales and those of the area west of the Darling River. In the east the outline engravings especially are large and cover extensive surfaces of rock, but in the far west they are small intaglios of man, marsupials, emus, and reptiles, mixed with geometrical motifs; the paintings differ similarly, although not to so marked a degree. The difference is due to streams of culture infusions, which have penetrated the interior of Australia from the north-west and north-east, but which did not reach the south-eastern coast.

This comparison brings out several interesting points. Actually the rock engravings of the Sydney district are more skilfully drawn than are the paintings of eastern New South Wales, because the artists have introduced more life into their subjects, compositions are reason-

ably numerous, and the medium is a difficult one. The human figure is commonly depicted in both engravings and paintings, as are kangaroos and wallabies, emu and goannas, eels and weapons. Snakes are rare. In the paintings, however, the hand stencils form an outstanding feature with which there is nothing comparable in the engravings. As regards the engravings the lines of human footprints, a three-toed bird track like a convict's "broad-arrow", kangaroo and wallaby tracks, which lead from figure to figure in a group and from group to group have few complements in the paintings; I know of only two instances in New South Wales, in one of which a line of "broad-arrows" is painted in red, and the other one consists of a line of white dots.

The similarity of the general art style and of the subjects, however, indicates that the paintings and engravings were contemporaneous, and that the art traditions were passed on from generation to generation. The rock engravings at present in existence cannot be ancient, because the sandstone into which they are lightly cut weathers away within a few centuries; so far as the paintings are concerned, there is first-hand evidence to prove that some were done since the British came to Australia. That the arts of rock painting and engraving may be quite old in Australia is undeniable, but how old we cannot say.

Why is it that immediately aboriginal paintings are found there is a universal claim that they are ancient? This has happened in all parts of Australia since 1840, when Sir George Grey published imperfect records of paintings that he had discovered in Western Australia. This general belief has its explanation in the undoubted antiquity of the cave paintings in Europe and Spain; circumstances, however, differ in various countries, and in Australia rock painting flourished among the living tribes, and still flourishes in north-west Australia and in some remote parts of the interior. It is interesting to note that the stencilled hand, the "broad-arrow" track, and the "hocker" stylization of the human figure have world-wide distributions, and have apparently diffused into Australia. So, too, have some of the geometrical motifs of far western New South Wales, Central and South Australia.

SIGNIFICANCE.

The meaning and function of the rock paintings are similar to those of the engravings, but as this question was fully discussed in my previous article on the latter,* I will deal only briefly with it here. In New South Wales each of the clans in a tribe had a totem, and each tribe was divided into moieties which claimed the totems of their clans; each of the sexes had its totem to which no insult by the other sex was tolerated, and each individual had a personal totem which acted as his guardian spirit. Myths and legends tell the story of the creation of the members of the clan and their totems, and these form part of the instruction of initiates; some of the paintings were probably on initiation grounds. Again, in south-east Australia, culture heroes and spiritual ancestors figured prominently in the secret life of the tribes and in the myths and legends, and historical rites enacting their lives were performed. Rites were probably carried out in eastern New South Wales to increase the species painted or engraved at a sacred site.

Apart from their sacred significance and function, the paintings form an invaluable and irreplaceable record of the artistic talents of the aborigines, and to judge by the number of rock-shelters and caves containing paintings and evidence of long occupation, the natives had a keen appreciation of a "pretty fella", as they described paintings to Professor Elkin in the Kimberleys.

We have in New South Wales as many as one hundred or more groups of paintings (not considering the many isolated figures). Unfortunately, apart from a few investigators like the late R. H. Mathews and Mr. W. J. Enright, little

* AUSTR. MUS. MAG., vi, 12, 1936, pp. 401-9.

scientific attention has been given to them because of the lack of funds, with the result that adequate records of the majority of groups have not been published. Again, the vandal has been so busy that a number of splendid groups are now seriously defaced with visitors' names and drawings, while many paintings have been cut out of the cave walls. There is now an urgent need for everybody interested to do their utmost to protect and preserve these valuable and interesting relics. Local and shire councils should be pressed to erect steel wire grilles across all caves so that visitors may see the paintings but not damage or interfere with them. In other countries laws are in force which provide heavy penalties for such vandalism, and similar legislation is needed in Australia.

Early Theories of the Earth

By C. ANDERSON, M.A., D.Sc., C.M.Z.S.

FROM the earliest times when man began to give serious thought to possible modes of origin and subsequent history of our terrestrial home, many hypotheses and speculations, most of them without any substantial basis in ascertained or observed fact, have been given to the world. The scientific study of the earth, now called geology, was preceded by and evolved from cosmogony, just as chemistry was born in the crucible of the alchemist and astronomy was introduced by astrology. The cosmogonists, those bold spirits who refused to allow their slender equipment of knowledge to hamper their flights of imagination, vied with one another in propounding conflicting hypotheses to explain the mysteries of the universe and particularly they strove to present a plausible picture of the Earth's beginnings.

Even today many of the accepted conclusions of geological science are not susceptible of rigid proof, and there is room for difference of opinion both as to the facts and their interpretation. It is not surprising, therefore, that at an earlier period there was much diversity of opinion regarding the genesis of the universe, the birth of the Earth, the evolution of its oceans and continents, and the coming of the plants and animals which made it their home.

The earliest cosmogonies, those of the Babylonians, Egyptians, and Hindus, are scarcely separable from mythology and we need not dwell on them. The ancient philosophers of Greece and Rome, as we should expect, put forward various hypotheses in explanation of the cosmos, and one who takes the trouble to study their "systems" is at times surprised to find that, here and there, possibly by accident, some of the ideas set forth are not so very different from those held today. Thus the Pythagoreans accepted the principle of a perpetual and gradual revolution in the terrestrial system, such as that valleys have been excavated by running water and hills have been washed into the sea. Aristotle, one of the most learned men who ever lived, asserted that the distribution of sea and land is not enduring, that "it becomes sea in these parts where it was land and again it becomes land where it was sea". Strabo, the "squint-eyed", who was born some thirty or forty years before the commencement of the Christian era, was the author of a geography in seventeen books, which has come down to us almost com-

plete. He had travelled extensively and was apparently an acute observer in spite of the ocular peculiarity indicated by his family name; thus he had recognized that Vesuvius was a dormant volcano, and his sagacity was vindicated by its earliest known eruption in A.D. 79 which destroyed Pompeii and Herculaneum. The following statement by Strabo is worthy of quotation, for it shows that he had in a degree anticipated one of the guiding principles of modern geology:

> It is proper to derive our explanations from things which are obvious, and in some measure of daily occurrence, such as deluges, earthquakes, and volcanic eruptions, and sudden swellings of the land beneath the sea.

The fall of the Roman Empire in the fifth century A.D. was a severe blow to intellectual progress and active interest in natural phenomena. For centuries the Arabs alone of the nations kept alight the torch of culture and scientific enquiry. But though they contributed materially to the knowledge of mathematics, astronomy, medicine, and zoology, they took little interest in geological studies.

In the seventeenth and eighteenth centuries cosmogonists were very active and various works appeared bearing the description "A Theory of the Earth", or some variant of that ambitious title. Many of these works were written by theologians and the views expressed were strongly coloured by the religious beliefs of the authors. Thus it was necessary that the "Theories" should be consistent with the story of creation and the occurrence of a universal flood as described in Genesis. Although Robert Hooke, the English mathematician and physicist (1635-1703), one of the most brilliant and original thinkers of his own or any age, had as early as 1688 set forth the true mode of origin and significance of fossils, and given rational explanations of other natural phenomena, the "orthodox" view claimed all fossil forms to be relics of an earlier creation which had become interred in the earth's strata during the Deluge. The "Diluvialists", as they were called, formed a very powerful party and they were warmly supported by the Church.

Especially in Britain was there a strong inclination to make all "Theories of the Earth" conform strictly to the Mosaic account of creation, and the authors, earnest men all and many endowed with great powers of mind, were hampered in their disquisitions by their doctrinal beliefs. Through the generosity of Dr. John Tait, a former school and college companion, now Professor of Physiology in McGill University, Montreal, I possess a small library of geological works dating from the seventeenth to the early nineteenth centuries, and I have derived much pleasure and no little amusement from their perusal.

One of the most entertaining of these attempts "to build a ship with materials insufficient for the rowing pins of a boat", as Lord Bacon puts it, is Dr. Thomas Burnet's "Sacred Theory of the Earth", first published (in Latin) in 1680. The author, a learned divine, was born in Yorkshire about 1635, became Master of the Charterhouse and died there in 1715. He afterwards translated or recomposed the work in English, and more than one edition of the English version was printed. The work, which has considerable literary charm, had a great vogue in its day, and is said to have given great delight to Samuel Pepys, the famous diarist. Addison, too, seems to have fallen under the spell of the author, for an ode by the celebrated creator of Sir Roger de Coverley is appended to the English edition of the "Sacred Theory" and praises it lavishly. But it did not escape severe criticism, for J. Keill, of Balliol College, Oxford, in his examination of Dr. Burnet's Theory says:

> He begins his discourse with a saying of an old heathen, that philosophy is the greatest gift that ever God bestowed on man; but it is plain to any who will be at the pains to read his book that God has thought fit to bestow but little of that great gift upon him.

Burnet commences his theory with an account of Chaos, which he represents as a mixture of earth, water, and air floating in space. The heavier particles gravitated towards the centre, the lighter fluid particles followed, forming a deep ocean consisting of oily and watery particles,

from which a creamy upper layer arose and floated on the surface, just as cream separates in milk. The finest dust was the last to fall and this formed with the creamy layer a rich unctuous (blessed word) crust in which life originated. The lightest particles of all formed the atmosphere surrounding the whole. But this state of things did not long continue, for the heat of the sun produced cracks and fissures in the crust and these gradually extended to the great aqueous abyss. The waters rose, the surface was broken up and destroyed and a universal deluge took place. At length dry land again appeared, owing to a gradual subsidence of the waters, which retired into caverns previously existing in the nucleus or formed by the rupture of the crust. Vegetation again appeared and our present islands and continents were formed, while the sea still occupied in parts its original bed.

Such in brief is the Sacred Theory of the learned Burnet, who naïvely remarks that we cannot doubt these happenings. In a later work appearing in 1692 Burnet treated the Mosaic account of the fall of man as an allegory, for which heresy he was dismissed from his appointments at Court.

John Woodward, an assiduous collector of geological specimens, was born in Derbyshire in 1665 and educated as a physician. He bequeathed his collection and library to the University of Cambridge, where it is still treasured in the Woodwardian Museum. His "Essay towards a Natural History of the Earth and Terrestrial Bodies" was printed in London in 1695 and had a wide circulation. He was a matter-of-fact man, not a poet and philosopher like Burnet. In his work he describes his collection of fossils, minerals, and rock specimens and correctly surmised that fossils represented past faunas and floras. He supposed, however, that these remains had been carried to the position where we now find them by a universal flood, the Deluge of the Scriptures. He concluded that at the period of the Deluge the earth had acquired a new crust deposited from the waters of the flood, the heaviest, coarsest, and hardest bodies forming a nucleus covered by finer and lighter deposits. To explain the embedding of marine shells in the rocks he imagined that the principle of adhesion, which holds the particles of matter together, had been momentarily suspended, allowing the resulting pasty mass to be penetrated by shells.

About this time Leibniz, the great German philosopher and mathematician, published his "Protogaea". He supposed the earth to have been in a state of combustion for a lengthy period and to have gone out at length for want of fuel. A glassy crust was thus formed which gave rise to sand and gravel. Other kinds of earth were produced from sand and salt, and, as the globe cooled, the water, hitherto kept in a state of steam by the intense heat, became fluid and produced the ocean. Thus in Leibniz's view the earth was originally a radiant sun which became gradually converted into a dark planet.

Demaillet, a French philosopher, was of opinion that at one time the whole earth was covered with water in which all living things originated; even man had commenced his career as a fish and had gradually become transformed into a biped. As proof of this transformation he referred to mermaids, which had undergone half the process of conversion, but which in time would become perfect human beings.

William Whiston, mathematical divine (1667-1752), was born in Leicester and educated at Cambridge, where he distinguished himself greatly in mathematics, and where, in 1703, he succeeded Sir Isaac Newton as Lucasian Professor; in 1710 he was deprived of his professorship on account of his heterodoxy. William Thomas Brande, in a course of lectures delivered at the Royal Institution in 1816,* said: "Whiston, having blended the follies of Burnet, Woodward, and Leibniz, endeavours to conceal his imbecility under the lion's skin of

* Outlines of Geology, London, 1817.

mathematical calculation, and, taking many things for granted of which there is not the most distant probability, leaves us bewildered and perplexed; he is neither plausible nor amusing, and is best known as having called forth the libellous witticism of Swift." Yet his "New Theory of the Earth", first published in 1696, ran through six editions in a comparatively short time. My copy is the fifth edition, dated 1737, and has the title:

A New Theory of the Earth from its Original to the Consummation of all Things. Wherein the Creation of the World in Six Days, the Universal Deluge, and the General Conflagration, as laid down in the Holy Scriptures, are shewn to be perfectly agreeable to Reason and Philosophy. With a large Introduction concerning the genuine nature, style, and extent of the Mosaic History of the Creation. By William Whiston, M.A., sometime Professor of the Mathematicks in the University of Cambridge. London: Printed for John Whiston at Mr. Boyle's Head in Fleet-Street.

Whiston held that "the ancient Chaos, the Origin of our Earth, was the Atmosphere of a Comet". This view was probably inspired by the visit of the remarkable comet of 1680, which was still fresh in the memory of everyone when he began his cosmological studies. The Deluge, also, he attributes to the influence of another comet, "or more peculiarly the atmosphere and tail thereof", which brought about a vast fall of rain lasting for forty days. Simultaneously came "the breaking up of the fountains of the great abyss", due to the double tide occasioned by the near approach of this comet on November 18, 2349 B.C. Whiston is remarkably precise in his chronology, and submits a chronological canon setting forth the history of the earth from the creation to the year 1736, the sum total being 5,745 years and two months. This is wonderfully close figuring even for a professor of mathematics, and contrasts strongly with the two thousand million years now given as the approximate age of our globe.

According to Whiston the Garden of Eden was situated in the north-west of Assyria, though he confesses that the location of Paradise is a very obscure problem. But the book is full of curious notions, such as that the earth did not begin to rotate on its axis until after the Fall of Man, and that on leaving the Ark Noah settled in China, the inhabitants of which are his direct descendants.

Buffon, French naturalist (1707-1788), was inspired by a genuine love of knowledge and devoted his whole life to scientific studies. He was critical of the fantastic hypotheses which had been advanced by various authors, and remarked sarcastically that geologists must feel like the Roman augurs who could not meet each other without laughing.

Buffon's *Histoire Naturelle*, of which fifteen volumes appeared between 1749 and 1767, was designed to embody all the known facts of natural science and brought him an immense reputation. His first geological article, *Théorie de la Terre*, contained striking arguments against the views of the earth's origin put forth by Burnet, Woodward, Leibniz and Whiston, and he renounced the popular idea of a universal Deluge. He derived the earth and the planets from the impact of a great comet with the sun, and insisted upon long periods of time to allow for the slow processes of change on the earth and for the appearance of plant and animal life, though he had no adequate conception of the exceedingly slow progress of geological changes and of the evolution of life on the earth. He traces the history of the earth through seven epochs, beginning from its molten condition, which he surmised to have endured for 2,936 years; he determined this duration by experiments with balls of melted iron of different sizes, and therefore may be regarded as one of the earliest experimental geologists. In the second epoch the earth began to consolidate, and at the commencement of the third the primitive ocean formed and prepared the way for the development of life and the accumulation of marine sediments. The fourth epoch was marked by an increase of internal heat and the outbreak of volcanic eruptions. In the fifth epoch life was abundant in the polar

regions, which were inhabited by large animals such as elephants, mastodons rhinoceroses and others, though the equatorial regions were still too hot to be habitable. As the temperature decreased plants and animals began to migrate towards the Equator. Man appeared in the sixth epoch.

Although Buffon's work contains many absurdities and baseless speculations, it is a bold attempt to present the history of the earth in a rational manner, and he was one of the first to realize in some degree what is meant by historical geology.

Buffon's views were contrary to the tenets of religion, and at the behest of the Faculty of Divinity in Paris he published a recantation, which began:

> I declare that I had no intention to contradict the text of Scripture; that I believe most firmly all therein related about the Creation, both as to order of time and matter of fact; and I abandon everything in my book respecting the formation of the earth, and, generally, all which may be contrary to the narration of Moses.

The late E. F. Hallmann, B.Sc., joined the staff of the Australian Museum on June 9, 1909, as assistant in charge of the Lower Invertebrates. A graduate of the University of Sydney, he was specially proficient in the subjects of mathematics and zoology. Before his appointment to the Museum staff he was a teacher in the Department of Education, but he always maintained a keen interest in zoology.

At the Museum he undertook research on marine sponges, and acquired a considerable reputation as an authority on this difficult group. He produced several outstanding papers on them and prepared a valuable report on the sponges collected by the F.I.S. *Endeavour*.

He resigned from the service of the Trustees on February 28, 1912, to accept a Macleay Fellowship of the Linnean Society of New South Wales, and continued his researches, contributing several papers to the *Proceedings* of that society. He resigned his Fellowship in 1918 and again entered the Department of Education as a mathematical master, a position he held until his death.

Hallmann was a man of many interests and a delightful and entertaining companion. Up to the time of his death he was an Honorary Member of the Australian Museum staff and a constant and welcome visitor, always prepared to give any assistance on subjects of which he had special knowledge.

He leaves a widow and a family of six sons and two daughters to mourn his loss.

C.A.

* * * *

On June 16, the Honourable H. M. Hawkins, M.L.C., who had been an Elective Trustee since February, 1929, was accidentally killed.

He was appointed to the Legislative Council in 1932, joined the Cabinet as an Honorary Minister in that year, became Minister for Social Services in 1935, and had also acted as Minister for Labour and Industry and as Minister for Education.

He was a most versatile and accomplished man, and devoted himself wholeheartedly to the many activities in which he was engaged, whether business, politics, or church and social services. He had great organizing and administrative ability, and played a leading part in many charitable movements. His humane outlook and zeal for social betterment were conspicuous, and he was always ready to assist those in need of help.

He was highly esteemed by his colleagues on the Board of Trustees of the Australian Museum, where his wisdom and capacity for business were of the greatest service.

C.A.

Australian Insects. VI

Orthoptera: 1. The Cockroaches

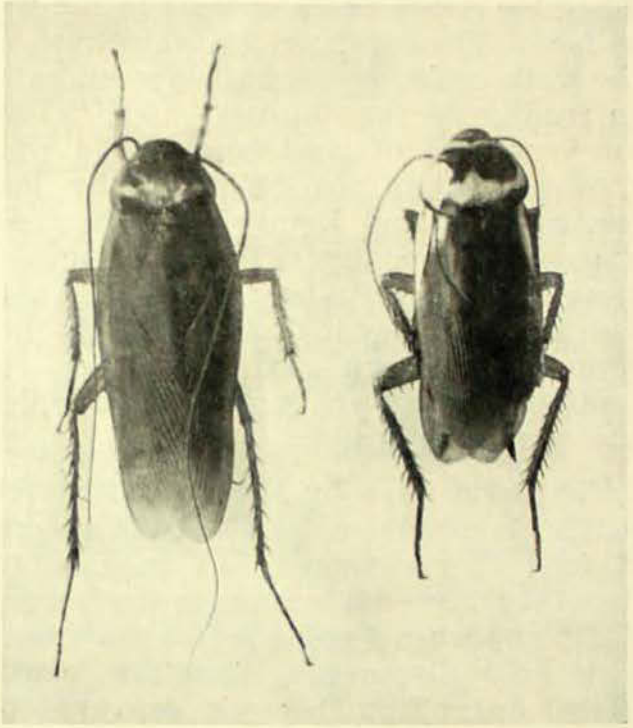
By KEITH C. McKEOWN

THE order Orthoptera, once the dumping-ground for a number of more or less distantly related insects, is now accepted as containing seven families, a number of other groups having been removed. Of these seven families, there are six which concern us here; the seventh, the Grylloblattidae, is at present known only from a few species occurring in North America and Japan. Those families occurring in Australia are the Blattidae (Cockroaches), the Mantidae (Mantids), the Phasmidae (Phasmids or Stick- and Leaf-insects), the Acridiidae (Short-horned Grasshoppers or Locusts), the Tettigoniidae (Long-horned Grasshoppers), and the Gryllidae (Crickets). Each of these groups is of sufficient importance to warrant individual consideration.

The essential features linking all members of the Orthoptera are briefly the possession of typical biting mouth-parts; the forewings elongate and narrow, modified into somewhat toughened tegmina or wing-covers; the hindwings membranous and fan-like, although wingless forms are common. Their metamorphosis throughout is incomplete.

THE BLATTIDAE—COCKROACHES.

These universally detested insects are better known to the general public by the forms immigrant from lands overseas than by their indigenous relatives, and the enquirer usually expresses surprise on learning that some three hundred species are known to be native to Australia. The explanation is, perhaps, not far to seek, for none of the native forms have acquired that unpleasant attachment for the company of man and become dwellers in his home, where the migrant insects have become, as it were, camp-followers and scavengers. The home of the Australian species of cockroaches is the bush, and it is but seldom that one is found within doors, and then its presence is usually accidental. The house-frequenting species, known as the Australian Cockroach (*Periplaneta australasiae*), is not a native, but probably came originally from Asia or Africa.



The American Cockroach (Periplaneta americana), left; the so-called Australian Cockroach (Periplaneta australasiae), right.

Since the introduced forms so force their presence upon our notice, it may be as well to give them priority. The four common domestic insects are the American Cockroach (*Periplaneta americana*), the so-called Australian Cockroach (*P. australasiae*), the German Cockroach (*Blattella germanica*), and the Oriental Cockroach (*Blatta orientalis*), all of them naturalized aliens.

"What is the secret of the success of the Common and the German Cockroach, not to speak of others, in countries, like

Britain, to which they are certainly not native?" asks Professor J. A. Thomson, writing about these cosmopolitan creatures. ". . . The success of the naturalized aliens depends on a variety of qualities. They are nocturnal in their operations; they run very quickly; they are able because of their much flattened bodies to get into almost inaccessible crevices; and in becoming domestic they have got away from their natural enemies. Another quality of great survival value is their wide range of appetite. As Mr. Frederick Laing says in his admirable British Museum pamphlet, 'The Cockroach' (1921): 'Nothing which is at all edible comes amiss to them in the way of food. The paper or the whitewash on the wall, books, boots, hair, are all eaten as readily as the daintiest dish.' They are very fond of good beer. In a well-known book on the cockroach by Professors Miall and Denny it is observed: 'Cucumber, too, they will eat, though it disagrees with them horribly.' They have been known to try ink and blacking; they devour their own cast-off clothes (or moults), their own empty egg-capsules, and their own dead!"

The harm done by the domestic cockroaches is not due so much to the amount of food they consume, but to the fact that they leave their excreta over everything, and when feeding soften their meal with fluid discharged from the mouth, which, apart from bacteria conveyed by this means to foodstuffs, gives it a characteristic and disgusting 'cockroachy' odour, which also persists in the places they frequent.

In the American Cockroach both sexes have well-developed wings, and can fly readily. This is the large species that usually flies in through the window on hot summer nights, and runs rapidly about over the walls and furniture on its long legs, taking advantage of every possible object which will afford it cover, and skilfully evading all efforts to effect its capture or destruction. It reaches a length of about an inch and a half, and is of a bright reddish-brown colour; the thorax is mottled and margined with a lighter tint.

The Australian 'Roach has similar habits, but is smaller, and may be distinguished readily from its near relative by the fact that the first thoracic segment is ringed with yellow, and the base

The little brown and yellow German Cockroach (Blattella germanica).
After British Museum.

of the wing-covers is streaked on the sides with similar colour. This species appears to be decreasing in numbers in this country, a disappearance which is sometimes attributed to replacement by the American species, but the real reason is obscure.

The little German Cockroach, perhaps the most numerous in our houses, appears to be something of a national outcast, since its country of origin is disputed, and no land will accept it as a national. Perhaps its home is Asia, and it seems definite that it is not Germany, where it is called the Russian Cockroach; but the Russians retaliate by calling it the Prussian Cockroach. Here in Australia there seems to be a growing belief, fostered by some of the firms specializing in 'pest destruction', that it is of but recent appearance in this country, that it is 'something special', since both sexes can fly, and that it cannot be destroyed by means used for the control of other species! All of these statements are incorrect. This really offensive little creature is less than half the size of the other species, and is dark yellow or light brown in colour, with the thorax marked

with two longitudinal dark brown stripes. It measures about half an inch in length, and has a slender form.

The fourth introduced species, the Oriental Cockroach, the 'Black-beetle' of England, appears to be increasing in Sydney. In this instance, the male is winged and the female wingless, save for small and useless flaps which represent these organs, giving one the impression that the insect is immature. Its maturity is, however, frequently apparent from the egg-capsule protruding from the end of its abdomen. In colour it is a rich, dark brown.

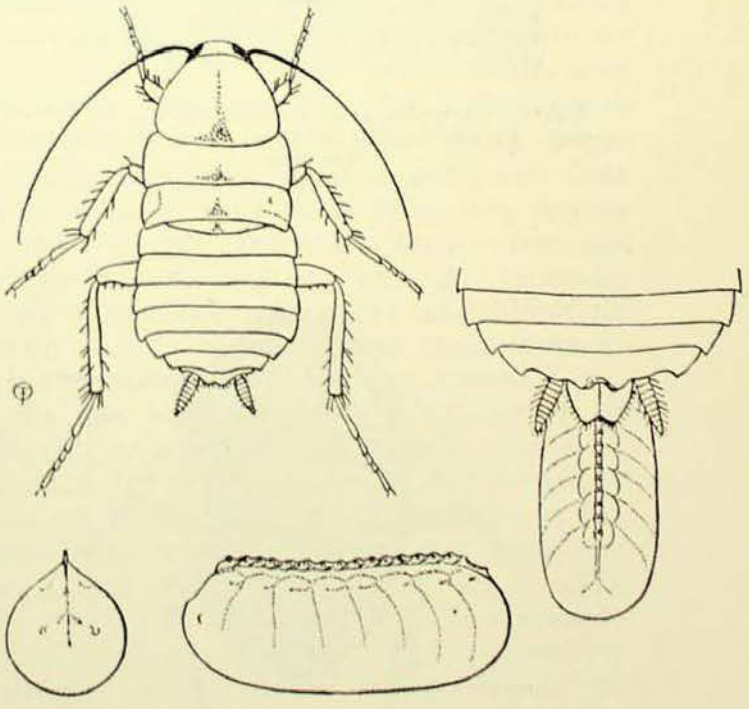
To turn now to questions of life-history. It will simplify matters to give a more or less generalized history which will be applicable to all species.

The eggs, which may number from about sixteen to forty, according to the species concerned, are enclosed in a horny egg-capsule with a keeled ridge along the upper surface. This capsule is carried about by the mother, protruding from the extremity of her abdomen, for a more or less indefinite period, but eventually she abandons it in some warm and sheltered situation among the dust, and leaves it to its own devices. The cockroach is not a devoted mother. Several of these egg-capsules may be deposited by the female in the course of her life.

When the larvae are ready to emerge, the capsule splits along the dorsal ridge, permitting the youngsters to emerge into the world with but little trouble. At first these babies are miniatures of their parents, but pale and transparent; they are quite capable of looking after themselves, and make haste to hide away in cracks and crevices. As they grow, the insects moult their skin, and, with about the sixth of these moults, become nymphs, possessing small wing-pads upon the thorax, the rudiments of their future wings. One final moult appears to be necessary before the insect is adult, but the total number of moults through which the cockroach passes, from birth to maturity, seems somewhat uncertain, and is, perhaps, influenced by scarcity or abundance of food and other factors. The development of some species appears to occupy several years, that of the German Cockroach about eight to twelve months. It sometimes happens that in the course of moulting, legs and antennae are injured or broken; this injury may be partially or almost wholly repaired by regeneration of the damaged appendages.

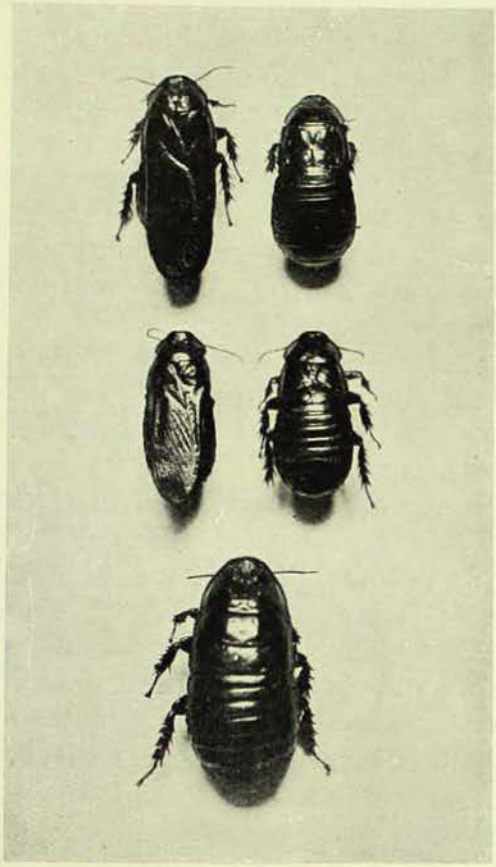
So far our attention has been mainly devoted to the introduced cockroaches to the exclusion of our native forms; this deficiency must be now, and in some degree, remedied, although here we are at once confronted by the fact that very little is known regarding their life-histories and habits. The ways of the native species appear to have been grossly neglected by our naturalists, although the few glimpses that are permitted us are full of interest and fascination.

The large reddish-brown cockroach (*Panesthia laevicollis*) is usually found in small colonies consisting of a mature male and female together with a number of young in small colonies hiding among the damp debris under fallen logs. When mature, these insects possess well-developed wings, but when captured are



Young cockroach: egg-capsule as carried by female, and view from end and side.
After British Museum.

usually found to have but small ragged stumps remaining. In the confined and rubbish-littered situations they frequent, the insects find these appendages a liability rather than an asset, an encumbrance rather than an aid, so they solicit the assistance of their comrades to gnaw them off close to the base! Such behaviour must be almost without precedent in the insect world. It is sometimes said that the cockroaches bite off their own wings, but, surely, this would prove a difficult feat, even for a cockroach.

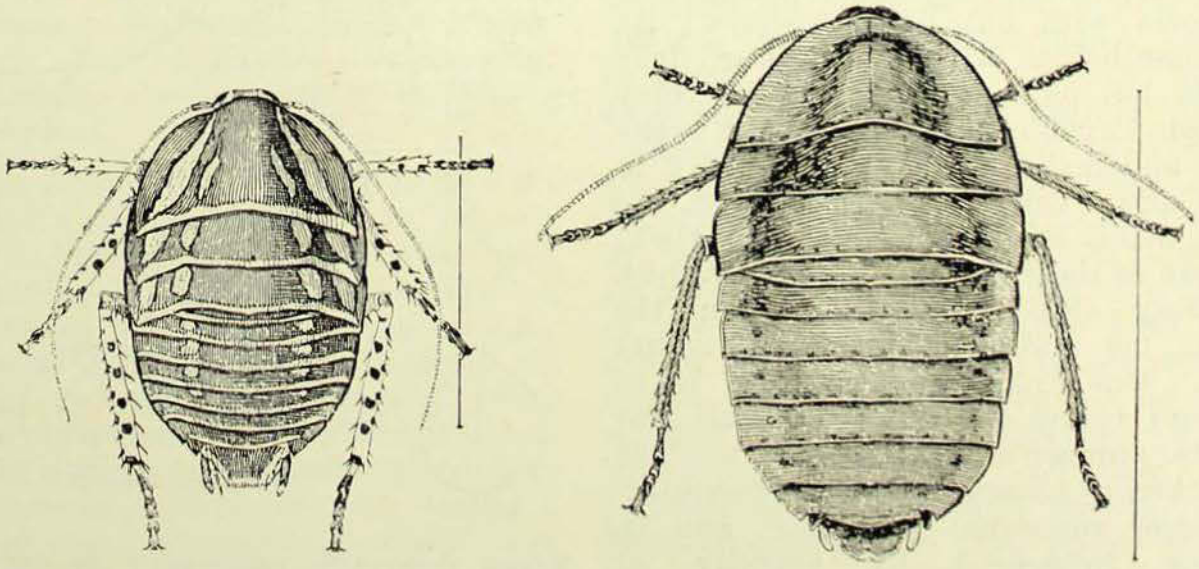


Native cockroaches: Panesthia laevicollis, top; P. australis, middle; and P. tryoni, bottom.

Photo.—A. Musgrave.

Another small cream and bronze cockroach, I believe as yet unnamed, inhabits the large nests of silk-matted leaves formed by a spider (*Amaurobius* sp.), and appears to dwell in amity with the legitimate occupiers, the spiders, together with ants, and a number of other species of spiders which avail themselves of the accommodation offering.

The most interesting of all our cockroaches is the solitary creature, *Macropanesthia rhinoceros*, a huge insect which may measure two inches and more in length. Its egg-capsule is elongate, and has been described as 'portmanteau-shaped'. Another giant of the tribe is *Geoscaphus giganteus*, measuring two and a half inches in length and one and a half across the body. Not far behind these in size is *Polyzosteria limbata*, an insect of a dull bronze-brown colour, with the outer edge of the dorsal plates margined with yellow. It is not uncommon in the vicinity of Sydney, especially in the sandy areas around Botany, where it may be seen resting in brazen indifference upon trees and fences. The females frequently bear large egg-capsules. Like a number of our



Bush Cockroaches. Polyzosteria mitchelli (left); Polyzosteria pubescens (right).

After W. W. Froggatt.

cockroaches, it has the habit of discharging an offensive fluid when disturbed. It appears to have been somewhat feared by the aborigines, who believed that blindness would ensue should the fluid come in contact with the eyes. Our present knowledge can neither confirm nor refute this belief. *Polyzosteria mitchelli* is a beautiful metallic green and yellow species, which measures under two and a half inches in length. It is quite the most beautiful of our cockroaches—surprisingly so in a group where one does not look for beauty. All these species are wingless in both sexes.

Among the smaller species is *Calolampra irrorata,* which lives under flaking bark on tree-trunks. The male is winged, the female wingless. Both sexes are greatly flattened, an adaptation to their mode of life, while the form of the female is reminiscent of a trilobite.

Heralds of the Spring

By J. R. KINGHORN, C.M.Z.S.

Birds, joyous birds of the wandering wing
Whence is it ye come with the flowers of the spring.
—HEMANS.

SPRINGTIME is here, and many thousands of bird visitors will be entering Australia from the north to spend the summer with us. They are the true migrants, and should not be confused with their less adventurous cousins the local migrants or nomads, which merely wander within a country, in a comparatively restricted area, following a well-defined food route.

Our visitors are famous travellers, having crossed and recrossed continents and oceans, flying many thousands of miles before reaching our shores. These little tourists may have commenced their flight from as far away as northern Siberia where birds such as snipe, tattlers, golden plovers, and a host of relatives find a safe breeding ground and home in which to rear their young around the great marshlands of the Asiatic continent. For it is the case that migratory birds breed in the coldest part of their habitat.

At the actual time of their departure the sun still had plenty of warmth in it, the icy winds had not commenced to blow, and there was a plentiful supply of food; in fact conditions seemed ideal for a longer sojourn, but Mother Nature is in charge of these matters, and the birds must leave when the urge drives them, they must leave for the warm southlands before being caught cold and foodless, they must travel along a route where there still is plenty of food to sustain them on their long and tiresome journey. Old and young congregate in enormous flocks, with much noise and apparent excitement, for the great adventure is upon them. They leave quite suddenly, and the countryside that was echoing with their cries one day is silent the next; there is a hush before the winter storms set in, but the birds in their flocks are well away and hurrying down the flyways towards their warmer winter homes.

To the young birds the adventure of migration is a new one, maybe they even consider it a pleasure trip, and certainly like all travel it is an education, but the older birds and the parents that know the route and all that it holds in store sense the trials and dangers to be encountered; this annual migration has become a routine, an adventure which cannot be avoided. In these northern breeding grounds there may be quite a cosmopolitan crowd of birds—snipe, golden

plover, and a host of relatives from all parts of the world—and the wonder is that when the flocks commence their journeys they unerringly sort themselves out into eastern, western and southern armies, and those that regularly fly down through Canada to South America make no hesitation about selecting the right direction, and those that go westward through India or northern Europe, or south to Australia, fly on with a determination to get through.

These brave little travellers are such strong fliers that many of them, perhaps wanderers, or even lost birds, are to be found scattered throughout the islands of the Pacific Ocean, as far afield as Ellice Islands, Fiji, and New Zealand. To reach these lands, distances up to eighteen hundred miles of ocean must be crossed without rest, and, as migrating birds do not fly at excessive speeds, they must have the stamina to remain on the wing for long periods of time, travelling by night as well as by day, and an instinctive sense of direction must guide them. I was reminded of these adventurous ocean crossings last year when coming through the Mediterranean Sea, as thousands of migrants passed overhead in flocks by day and night. Many of them, on sighting the steamer, would change direction and accompany us for hours at a time, some remaining for two days before turning northwards to Europe, and long before land was in sight. Some of the smaller birds rested their weary wings by alighting on the ship, sipping water or eating such food as was offered them by the passengers. Hewitt, in his poem *Passing Cape Verd*, makes mention of these migrants in the following expressive lines:

Far on the billowy ocean
A thousand leagues are we,
Yet here, sad hovering o'er our bark,
What is it that we see?
Dear old familiar swallow,
What gladness dost thou bring;
Here rest upon our flying sail
Thy weary wandering wing.

It is very evident that the wonders of migration are not appreciated or understood in Australia, where so many kinds of birds are with us all the year round. Perhaps it is because of this so few of us show any intelligent interest in bird life at all.

In England and Europe generally, and in the central and northern parts of the United States of America, even the man in the street appreciates the meaning of migration, and can tell of the departure or arrival of the birds. In these countries even the tiny wrens leave on the approach of winter for the warmer south, not returning again until springtime. It is this clockwork-like return of the birds in their thousands, their sudden appearance in the trees, shrubs and hedges, when the flowers are beginning to cover the countryside, and when the woods are filled with their songs, that contribute in no small measure to the beauty of an English spring. It is generally understood that the courageous travellers have completed a long and dangerous voyage, that they have covered thousands of miles, survived untold dangers, and lived through another great adventure.

Hundreds must have perished from the ravages of predaceous birds and animals, as well as from the effects of drought and storm, and even at their journey's end many perish by crashing into lighthouses in their bewilderment. It was Tennyson who wrote:

. . . The beacon's blaze allures
The bird of passage, till he madly strikes
Against it, and beats out his weary life.

To those tiny adventurers that survive it must surely be a very happy day when once again they settle down to rest in the calm and safety of their homeland, tired in body but still strong of heart. Is it any wonder that the springtime air is filled with the song of the birds, and that the peoples of the homeland look forward to the day when they can welcome 'The Heralds of the Spring'?

Australian Shells

Dog Whelks, Dove Shells, Ivory Shells and Small Whelks

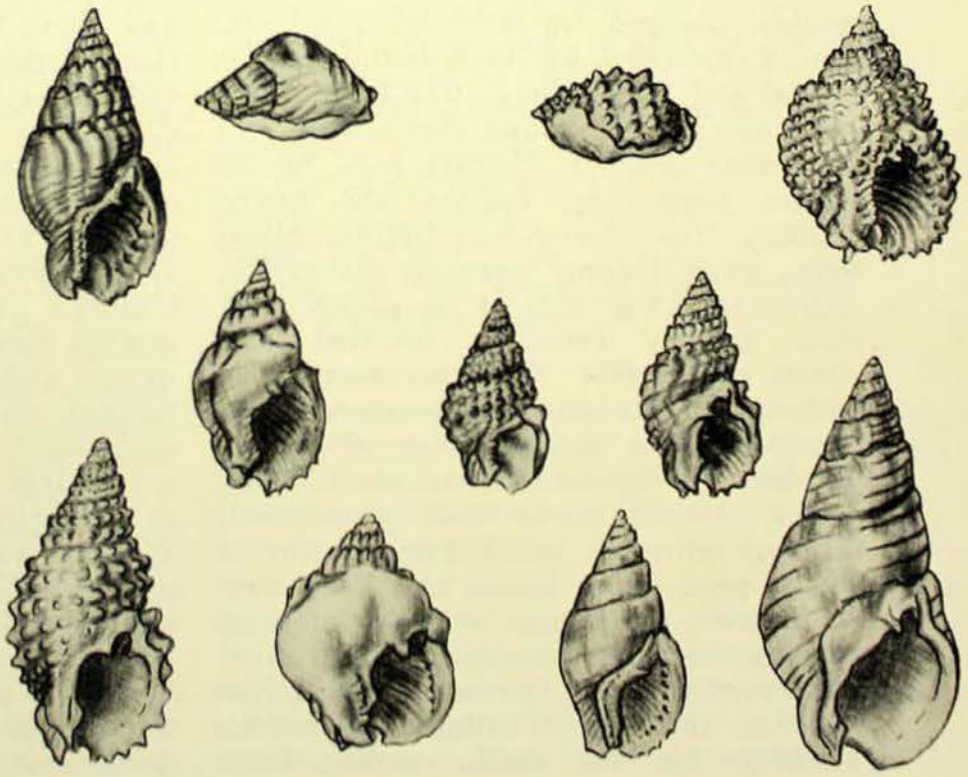
By JOYCE ALLAN

THE shells in these groups are to a large extent confined in their distribution to tropical Australia and islands of the South Pacific, some species even being found as far north as Japan. Though they are mainly small shells, their appearance is often striking on account of pretty colour markings or elaborate sculpture. For this reason they are favourites with shell collectors.

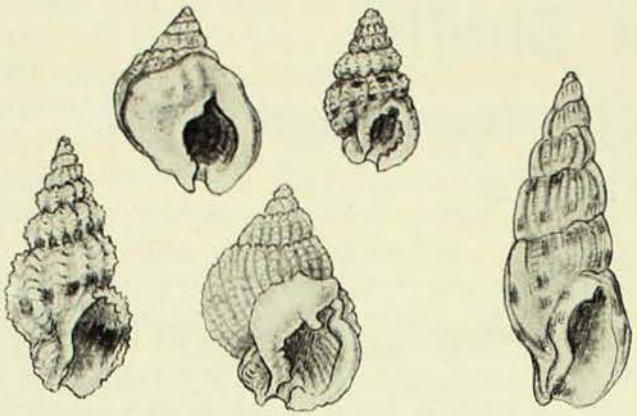
DOG WHELKS.

The family Nassariidae, or Dog Whelks, contains many tropical species, a number of which are common on the Great Barrier Reef of Australia. The species fall into several groups with ease, which makes their classification in most cases a simple matter—a very encouraging fact for young collectors.

Dog Whelks are regarded as scavengers of the shore, and, with other creatures of similar habits, keep it fresh and clean by removing decaying animal matter washed ashore. They are extremely active animals, as can be witnessed by watching one in a rock pool, and prey with great voracity on other shell-life. The animal's broad head enables it to glide along over the surface of the mud, leaving a track behind, and on its forked tail it carries a small operculum. The family was at one time thought to consist of more than five hundred different species of Dog Whelks, but over a series of years scientists have discovered that many of these are simply variations of better known forms, so that the number of true species is now reduced to round about two hundred.



Dog Whelks. Top row, from left to right, are Nassarius australis, Nassarius thersites, Nassarius graniferus and Niotha comtessei; in the middle row, Nassarius coronatus, Nassarius victorianus, and Nassarius acuticostatus; and in the bottom row are Nassarius papillosus, Nassarius arcularius, Nassarius dorsatus, and Nassarius glans.

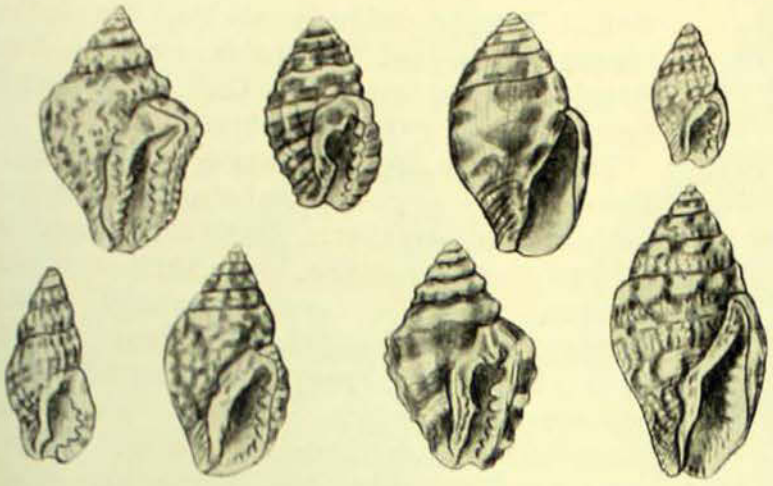


Dog Whelks. Top row, from left to right, Parcanassa jonasi, and Reticunassa paupera, and in the bottom row the three species are Phos scalaroides, Parcanassa albescens and Ratifusus bednalli.

The shells are all solid, though small, none reaching much more than two inches, the largest being *Nassa serta,* a reddish-brown shell which lives from New South Wales to islands of the South Pacific. Amongst the easily defined groups is one containing whitish papillose forms; the largest of these, *Nassarius papillosus,* is about one and a half inches high and has a brown patch on the back and pinky-brown upper whorls; *Nassarius graniferus,* three-quarters of an inch high, is heavily callused across the front; and a very beautiful, heavily sculptured species dredged in Sydney Harbour, *Niotha comtessei,* has been found also in Keppel Bay, Queensland. The two former are South Pacific island shells.

Another group is characterized by its species possessing, besides the heavy mouth callus, strong longitudinal plications, which become nodulose in varying degrees at the sutures of the shells. The most heavily callused, noduled and ribbed of these is *Nassarius arcularius,* with *Nassarius coronatus* its nearest ally, though it is a more slender, elongated and less heavily constructed shell. *Nassarius thersites* is a heavily callused, strongly plicated, small greyish species with a pronounced brown blotched hump on its back, which can be better seen by turning the shell sideways. These three species are found in Queensland, and, like most of the Dog Whelks, have brown markings on the shell, varying from definite revolving bands to scattered blotches, especially on the back of the shell and frequently inside the mouth. In dealing with those species possessing a callused mouth, a few small forms may be mentioned. Two species, *Parcanassa ellana* and *Parcanassa jonasi,* both of which extend throughout New South Wales and southern Australia generally, are very alike on first acquaintance; the former, whose earlier name was *burchardi,* does not exceed one-fourth inch in length, compared to the latter's size of half an inch. The third callused species, *Niotha albescens,* a South Pacific shell which is found also in New South Wales, can be immediately recognized by its finely cancellate appearance and its grey-brown spire, in direct contrast to the general creamy-fawn body colour; it is a little over half an inch high.

The remaining Dog Whelks dealt with in this article can be recognized without difficulty. *Nassarius dorsatus,* one of the few perfectly smooth species, is greyish coloured with indistinct brown patches, and a brown mouth and tip, and comes from Queensland and Western Australia; *Nassarius victorianus,* a Victorian shell, has bead-like longitudinal ribs and reddish-brown bands on a cream ground, and there is a number of closely allied forms which, however, show sufficient differentiation to enable them to be classed as separate species. Of these, only *Nassarius glans,* from Queensland and the South Pacific, is figured in the article. It is a large, smooth, tapering Dog Whelk, cream coloured, with tan blotches and fine tan revolving, equidistant lines on the whorls. Only the upper whorls of the spire have longitudinal ribbing, the sutures are deeply channelled, and the shell is about one and a half inches high. *Nassarius suturalis,* a Northern Territory, Queensland, and Western Australian form of this, is recognized by the nodules round the sutures; otherwise it is very similar to *glans*; a smaller South Pacific creamy species, *Nassarius sumalis,* has ribs running down the whorls from the nodules, *Nassarius spiratus,* a slender, pale shell, has a rose



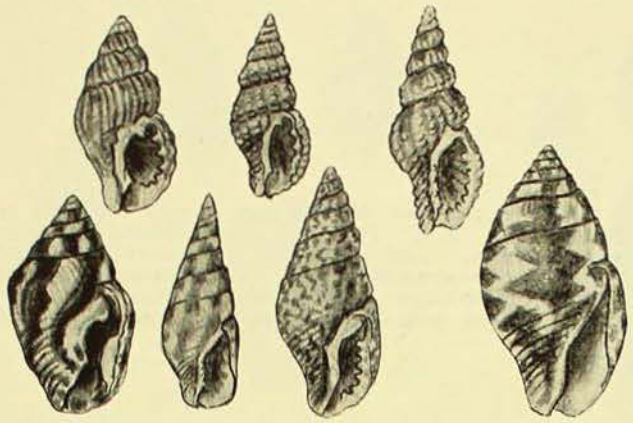
Dove Shells. In the top row, from left to right, are Pyrene versicolor, Engina lineata, and Pyrene tankervillei and Pyrene mundula. In the bottom row are Maculotriton digitalis, Pyrene tyleri, Engina mendicaria and Pyrene obscura.

to violet tip and longitudinal wavy brown bands, *Nassarius mucronatus* has the sutures compressed and not channelled as in the other forms of this group, and *Nassarius particeps* is the common New South Wales form of the typical *glans* type. *Nassarius particeps* can be seen in many rock pools around Sydney, where the very beautiful creamy animal, with its strongly contrasting black markings and its reddish operculum carried jauntily on its tail, rouses considerable interest as it moves briskly about at low tide, hunting for prey. Both *spiratus* and *mucronatus* are found in New South Wales, the latter also in Queensland, and I have seen it commonly at Lord Howe Island, the former extending into southern Australia. The remaining species figured are *Nassarius acuticostatus*, an inch-high South Pacific shell characterized by obliquely sloping, strong, longitudinal ribs; a Queensland and Papuan species, *Nassarius australis*, about the size of *Nassarius dorsatus*, dark brown coloured, with transverse white bands, and longitudinal, strong, but closely packed, ribs; and the small, very common eastern Australian shell, *Reticunassa paupera*, which is found in most rock pools and amongst most shell debris. A very minute species, less than one-quarter inch high, *Nassarius peritrema*, is dredged in about twenty-five fathoms off New South Wales; it is like a small *paupera*.

DOVE SHELLS.

These very pretty little shells are widely distributed throughout the seas of the world, both in cold and warm climates, but are more numerous in tropical regions. The family Pyrenidae to which they belong is very numerous in species, and the individuals are usually plentiful. It has been noticed that they appear to live almost a communal life; that is, when they are present in an area there will be numbers of them, and, on the other hand, they may be entirely absent. Dove Shells crawl about on sandy flats in shallow water, or live under stones, and may often be seen crawling over weeds when the tide goes out. They are particularly common at times round Sydney, and I noticed that they were similarly common at Lord Howe Island. The small shells, the largest of which barely reaches an inch, are often most strikingly coloured; the colours, however, are usually hidden in life by an epidermis. As with the previously family, the group shows considerable variation in individual species; but, nevertheless, the species fall into several definite groups, which simplifies identification.

The most striking of these groups is the one containing the shouldered species; that is, those with a shoulder-like structure on each whorl below the suture. Underneath the thin gold-coloured epidermis the patterning is generally very dark brown or black, whether it is the ground colour or arranged in bands, or in a mottled effect. One of the best examples, and certainly one of the commonest, is *Pyrene fulgurans*, a small species, about half an inch high, which is



In the top row, from left to right, are Pisania bednalli, Maculotriton bracteatus and Maculotriton unicolor, and in the bottom row are four Dove shells, Pyrene fulgurans, Pyrene menkeana, Pyrene semiconvexa and Pyrene undata.

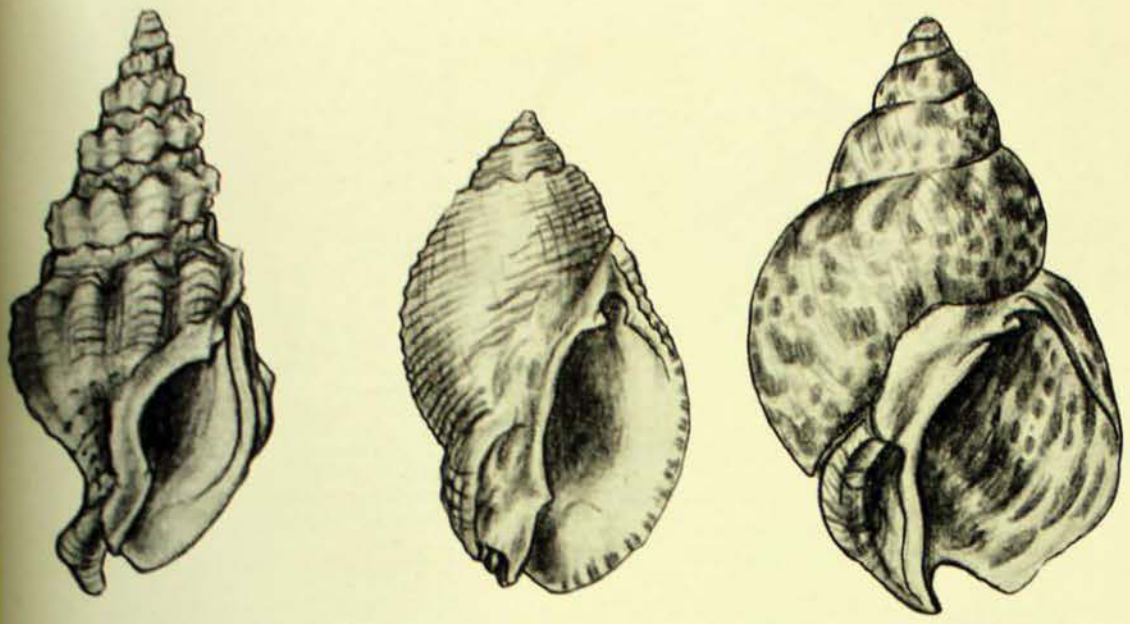
widely distributed through the South Pacific, reaching to tropical Australia; it has broad, white, wavy, longitudinal bands extending from the apex to the base of the shell, and a violet-tinged mouth. There is a closely allied species, *Pyrene punctata,* in which the white bands are replaced by small white or gold spots; this species reaches as far as Japan in its distribution. The commonest form of these shoulder Dove shells, however, is *Pyrene versicolor,* a very variable species in which the pattern markings consist of a mingling of wavy lines, bands and blotches of varying degrees. This occurs in the South Pacific, Japan, and tropical Australia, reaching to New South Wales.

The next group of Dove shells contains larger, more tapering forms, with the colouring more golden-brown, and resembling somewhat, though more pronounced, that on *versicolor.* The largest of these, *Pyrene obscura,* an inch high shell from north-west Australia, has one or more broad, white, interrupted, revolving bands on a golden-brown network background; while a slightly smaller South Pacific islands shell, *Pyrene tankervillei,* mostly has only conspicuous, descending, brown blotches on a white ground. Another species of this type is *Pyrene undata,* and in *Pyrene tyleri,* a smaller species still, the brownish colour generally forms a network on the white body colour. The last-named two are South Pacific islands shells, the latter reaching tropical Australia, even to New South Wales, and, on the other hand, extending its range to Japan.

Three more slender tapering species of Dove shells are the extremely common eastern and southern Australian species, *Pyrene semiconvexa,* a very narrow species, which is very common round Sydney, *Pyrene menkeana,* from South Australia, and a small, more squat shell, *Pseudamycla dermestoidea,* which is abundant in southern Australia. In the same family, Pyrenidae, is another group of shells, two species of which I have figured here, because they are common in the South Pacific. These are mainly conspicuous on account of revolving colour markings on the shells, either brownish-black on white or *vice versa.* The best known species is *Engina mendicaria,* a very solid little shell with broad white bands on a dark ground, which comes into Queensland; *Engina lineata,* on the other hand, is white encircled by several lead-black rather narrow lines, and is also longitudinally nodosely plicated; it too is recorded from Queensland. It must be remembered that the family Pyrenidae includes many species, a large number of which are found in Australia, and it is possible in an article of this size to mention only a few of these, the better known ones naturally being chosen. Once the collector is familiar with these, the identification of other forms becomes a simpler task.

IVORY SHELLS.

Ivory shells form a very small well-defined group of about a dozen species of shells whose characters are unmistakable. They are smooth and polished, exhibiting upon an ivory white surface spots and mottling of an orange-brown tinge. The species are separated from one another by the arrangement of their spotting and the presence or absence of a shoulder on the whorls of the shells. Ivory shells are natives of the tropical seas of the eastern hemisphere, several species occurring in Japan; and, although not yet recorded from Australia, a species, *Babylonia*



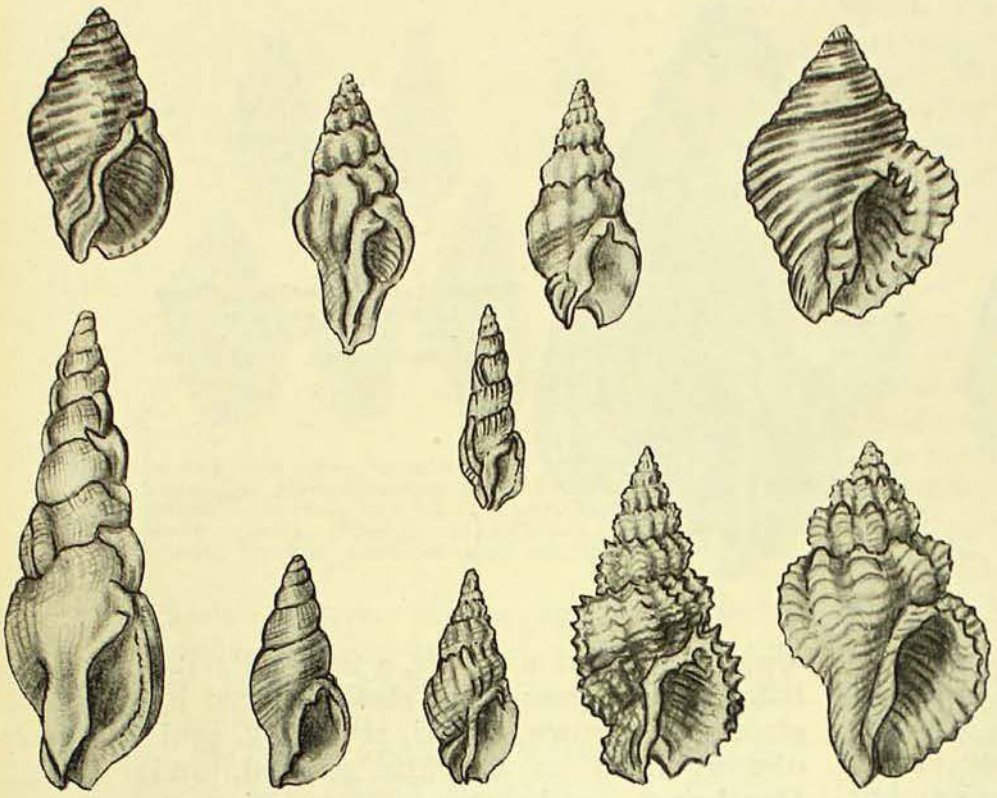
Three larger shells. From left to right these are Godfreyena torri, Nassa serta, and Babylonia zeylanica.

(*Eburna*) *zeylanica*, is figured here, as a specimen, with its locality, Cooktown, Queensland, queried, is in the Museum collection. In recent years other shells, thought not to occur in Australia, but which have been recorded from the Indo-Pacific, have been found living round the Great Barrier Reef, and it is possible that one or more species of Ivory shells will yet appear.

The Ivory shells belong to the family Buccinidae, which includes a number of shells that one might almost regard as misfits for other families. The most notable of these is the large dredged whelk, *Verconella maxima*, a Fusoid-Buccinoid shell about eight inches long, which is often brought up by trawlers working on the continental shelf round New South Wales. For some time it was placed in the family with the typical Fusoid shells, but is now in the Buccinidae. Similarly, the very pretty salmon-pink shell, *Godfreyena torri*, a rare treasure dredged in the Great Australian Bight, was at first regarded as a gigantic member of the family Nassariidae, but is now relegated to the Buccinidae. This species, incidentally, is about two and a half inches high, and is figured here.

SMALL WHELKS.

Other species of the family are two heavy, solid forms, a little over an inch high, *Cantharus undosus*, a South Pacific islands and Queensland shell, marked by strong, red-brown, raised, revolving, equidistant lines on a white ground, and *Cantharus erythrostoma* from Western Australia, which has strong longitudinal ribbing. Both these are covered in life with an epidermis which is noticeable on parts of the shells long after the animal has vacated them. The genus *Cominella* is represented here by two species—*Cominella filicea*, a common Sydney shell, and *Cominella alveolata*, a species extending from New South Wales into southern Australia, both about an inch high; the genus *Phos* by *Phos senticosus*, a tropical Australian and South Pacific shell, which is also found in Japan, and a smaller species, *Phos scalaroides*, from Western Australia; and the genus *Josepha* by the species *tasmanica*, a southern Australian shell. Other species figured here and placed in the family Buccinidae, are *Pisania bednalli*, a small southern Australian shell, and *Pisania reticulata*, another name for *Fusus mestayerae*, which comes from Tasmania and Victoria; an elongated white Queensland shell with varices on the whorls, *Caducifer antiquatus*, and three species of the genus *Maculotriton*, one a Queensland, New South Wales, and South Pacific shell, *Maculotriton bracteatus*, another New



Small Whelks. In the upper row are Cominella alveolata, Nodopelagia brazieri, Cominella filicea, and Cantharus undosus; in the middle row is Caducifer antiquata; and in the bottom row are Obex brazieri, Josepha tasmanica, Pisania reticulata, Phos senticosus, and Cantharus erythrostoma.

South Wales species, *Maculotriton unicolor,* and the third from Queensland, *Maculotriton digitalis.*

In concluding this article, a few strays whose position as regards family classification is doubtful are mentioned. A notable one of these is a southern Australian and southern Queensland shell, *Nodopelagia brazieri,* which is at present placed in the Buccinidae; the position of the others is uncertain. Readers may remember that in dealing with the Whelks (AUSTR. MUS. MAG., Vol. vi, No. 7, p. 234) I mentioned the doubtful family classification of a species of New South Wales shell, *Obex brazieri.* Though some authors include it in the family of whelks, others place it near the Buccinidae; so I have figured it again in this article. A smaller form of this, about an inch long, *Ratifusus schoutanicus,* comes from southern Australia and New South Wales, and *Ratifusus bednalli* is a Victorian-Tasmanian species of the same genus. It is to the collector's advantage to have the correct scientific names of the species in his collection, with, of course, their authentic localities; but the family classification, especially of doubtful groups, can be left until he is more familiar with the study of conchology. A study of anatomical structure often leads to the transference of a species from one family to another.

At the August meeting of the Board of Trustees of the Australian Museum, Mr. Frank B. Spencer was elected a Trustee.

Mr. Spencer, Managing Director and Deputy Chairman of Nestlé and Anglo-Swiss Condensed Milk Company (Australasia) Limited, occupies a leading position in the commercial community, and is greatly interested in matters of educational value.