MARCH 15, 1956.

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The Yellow Robin at its nest. (See article, "Bird Life," Page 11).

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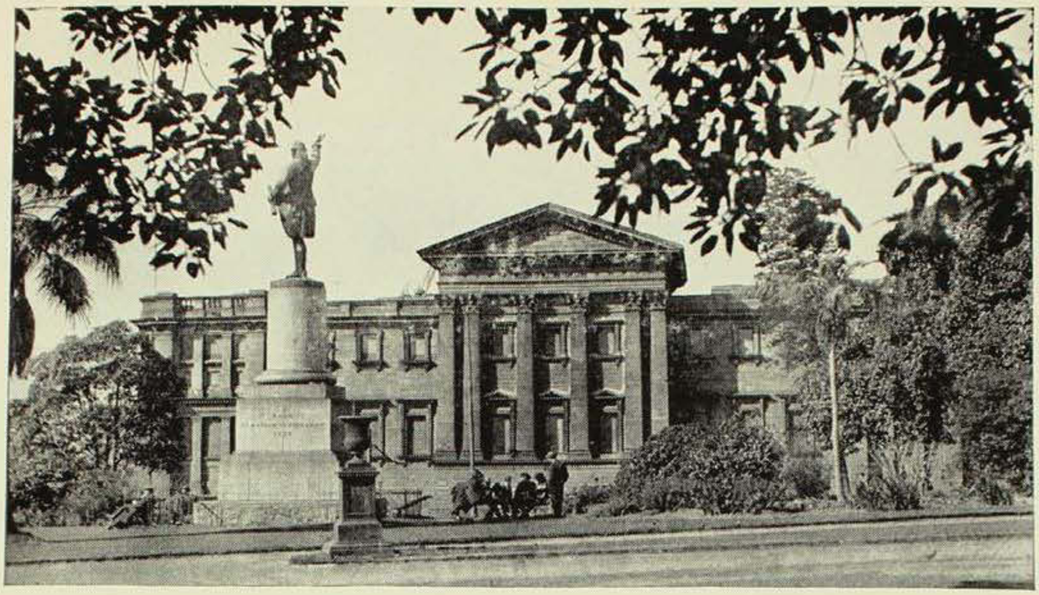
THE AUSTRALIAN MUSEUM

HYDE PARK, SYDNEY



THE AUSTRALIAN MUSEUM MAGAZINE

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

● OUR FRONT COVER.—Unlike the Northern Hemisphere, Australia has many different robins. The Yellow Robin of the gardens and coastal forests is by far the best known and most popular of them all.

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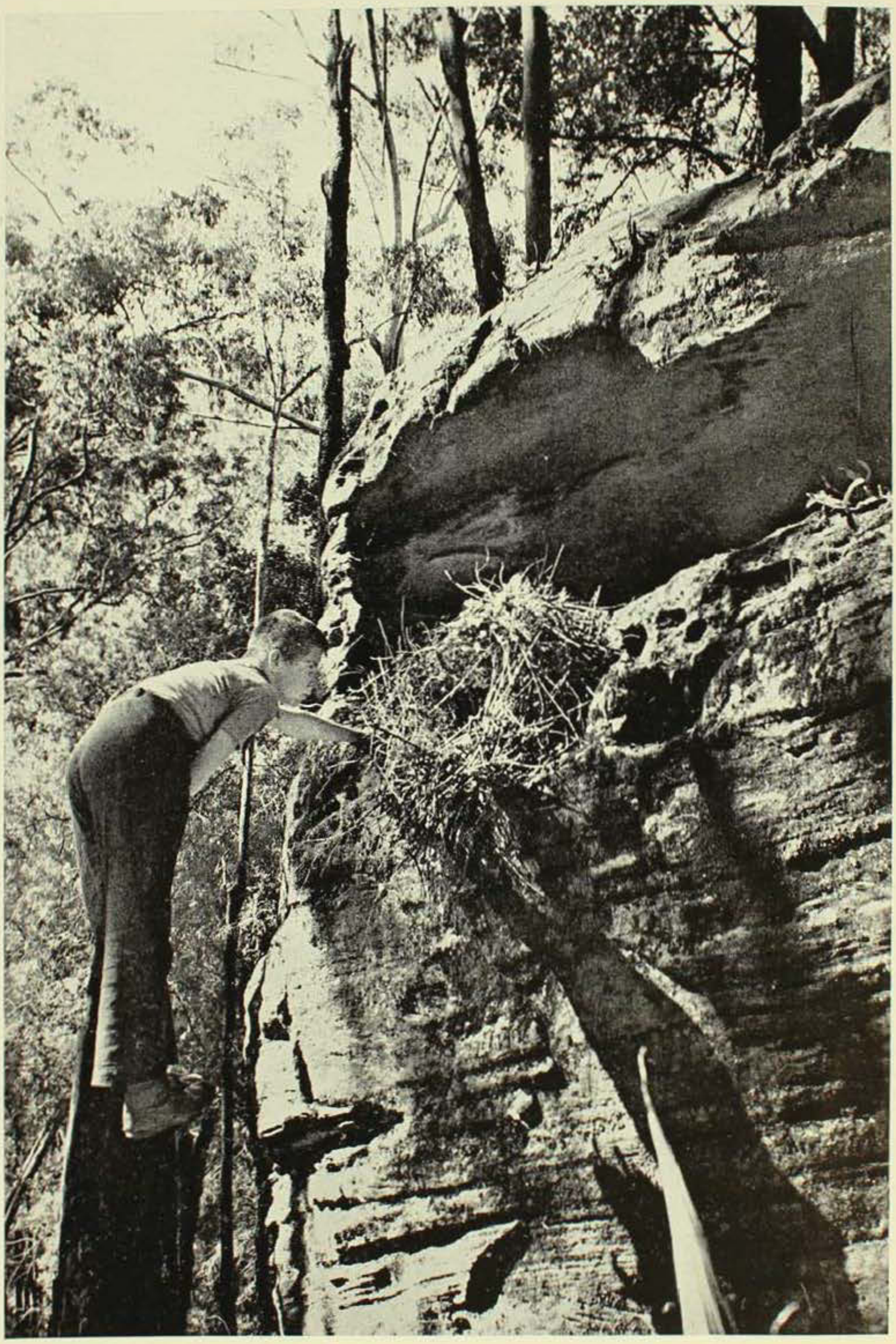

• The big, domed nest of the Lyrebird is in a position on the cliff face where no fox can attack the young bird. (See article on Page 11.)

THE AUSTRALIAN MUSEUM MAGAZINE

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Vol. XII, No. 1 MARCH 15, 1956.

Field Trip to North Western New South Wales

By R. O. CHALMERS

WHEN a Museum Trustee, Mr. G. Johnson, of the firm of Morley Johnson Ltd., generously offered finance for a Museum field trip the opportunity was eagerly seized by members of the scientific staff: they spend the greater part of their time within Museum walls and chances to extend their knowledge of the natural history of the State at first hand are keenly sought.

A route in the West Darling district was planned by R. O. Chalmers, F. D. McCarthy and H. O. Fletcher, embracing areas of mineralogical, anthropological and palaeontological interest. R. D. Mackay (preparator) was included as the fourth member of the party which left Sydney on 11th September, 1954, in two vehicles—one the Museum truck and the other a panel van kindly lent by the firm of Morley Johnson. Mr. O. le M. Knight, honorary correspondent of the Museum, came also in his own car with trailer, accompanied by Mr. D. Walker. The assistance given by these two friends of the Museum was invaluable. They provided practically all the camping equipment and bore the major burden of the camp duties. In addition they helped considerably with mineralogical and anthropological collecting.

On reaching Broken Hill our anthropologist and preparator left again almost immediately for Mootwingee, where Messrs. Knight and Walker had already gone direct by branching north-west from the main Wilcannia-Broken Hill road at Dolo Tank, and had set up a most comfortable and well-equipped camp. The chief work done here was the study and recording of the extensive gallery of pecked rock engravings, the search for fossils and the collecting of insects and reptiles. Unfortunately, no trace of fossils, excepting a few indeterminable worm tubes, was found and the question of the exact age of the Mootwingee rocks remains unanswered. This interesting area has been described before in these pages[1,2].

While work was proceeding at Mootwingee, the two other members of the party carried out mineralogical and palaeontological work in and around Broken Hill. Specimens were obtained from the recently discovered deposits of davidite (oxide of uranium, titanium and iron). Mr. Hore, of Broken Hill, guided us to a little known

[1] Barrett, C. This Magazine, iii, 12, 1927-9: 414.

[2] Chalmers, R. O. This Magazine, xi, 5, 1954: 156.

Members of the party camped near One Tree waterhole.

Photo.—R. D. Mackay.

and seldom visited locality on Huonville Station, where the rare gem mineral titanite (calcium titano-silicate) occurs. A visit was paid to Menindee, 70 miles away on the Darling, in particular to the site of a deep channel being excavated between Lakes Menindee and Pamamaroo by the Water Conservation and Irrigation Commission. Mr. Fred Carlson, engineer in charge of the project, led us straight to a spot in the excavation where, at a depth of 27 feet, shells and occasional vertebrate remains were found. The latter comprised fragmentary jawbones (without teeth) of a macropod, and a vertebra of a large fish. The shell remains have proved to be those of living species. Mr. Carlson has kindly promised to collect further specimens when excavations, now discontinued, start again, and it is hoped that the geological age of these deposits may be determined.

The party was re-united at Mootwingee and set out for Milparinka, rejoining the Broken Hill-Tibooburra road near Fowler's Gap. It was originally intended to return to Sydney from Milparinka, via Wanaaring, to provide an opportunity to examine aboriginal camp sites and workshops, and to collect artefacts. Meteoritic phenomena are reported at intervals from north-western New South Wales and it was hoped that information on the whereabouts of meteorites might be forthcoming. However a mechanical breakdown meant an enforced delay in the Milparinka-Tibooburra district. Our depot camp was near One Tree waterhole, 160 miles north of Broken Hill. This delay, and the floodwaters of the Bulloo and the Paroo having made the Wanaaring road impassable, necessitated a return to Sydney the way we had come, through Broken Hill. However good use was made of the time and much anthropological and zoological material was collected. All hands assisted the anthropologist but there were no volunteers to accompany the preparator in his very specialized job of catching live snakes.

The Western Division was experiencing one of the best seasons within living memory. The ground in many parts was carpeted with colourful wild flowers and rich pastures extended all the way through the normally low rainfall areas from west of the 15-inch rainfall line at Cobar right to the 8-inch rainfall line at Tibooburra, the most north-westerly town in New South Wales.

Our palaeontologist had visited Milparinka and Tibooburra some years ago and has described the normally arid nature of this region.[3] In that article he also described fossil localities from which lower Cretaceous molluscs and silicified wood were collected. These sites were revisited during the field trip.

Tektites (glassy meteorites) of wonderfully fresh appearance were presented to the Museum some years ago by Mr. V. C. W. Nicholls, owner of Pindara Station to the east of Tibooburra, where they had been found. It was not possible to visit this locality but inquiries were made from residents of the district and a close watch was kept by all members of the party while collecting aboriginal implements. This vigilance, unfortunately, was of no avail, indicating how rare tektites must be in this north-western corner of New South Wales.

[3] Fletcher, H. O. This Magazine, ix, 9, 1946-9: 315.

Exploring Between Tidemarks

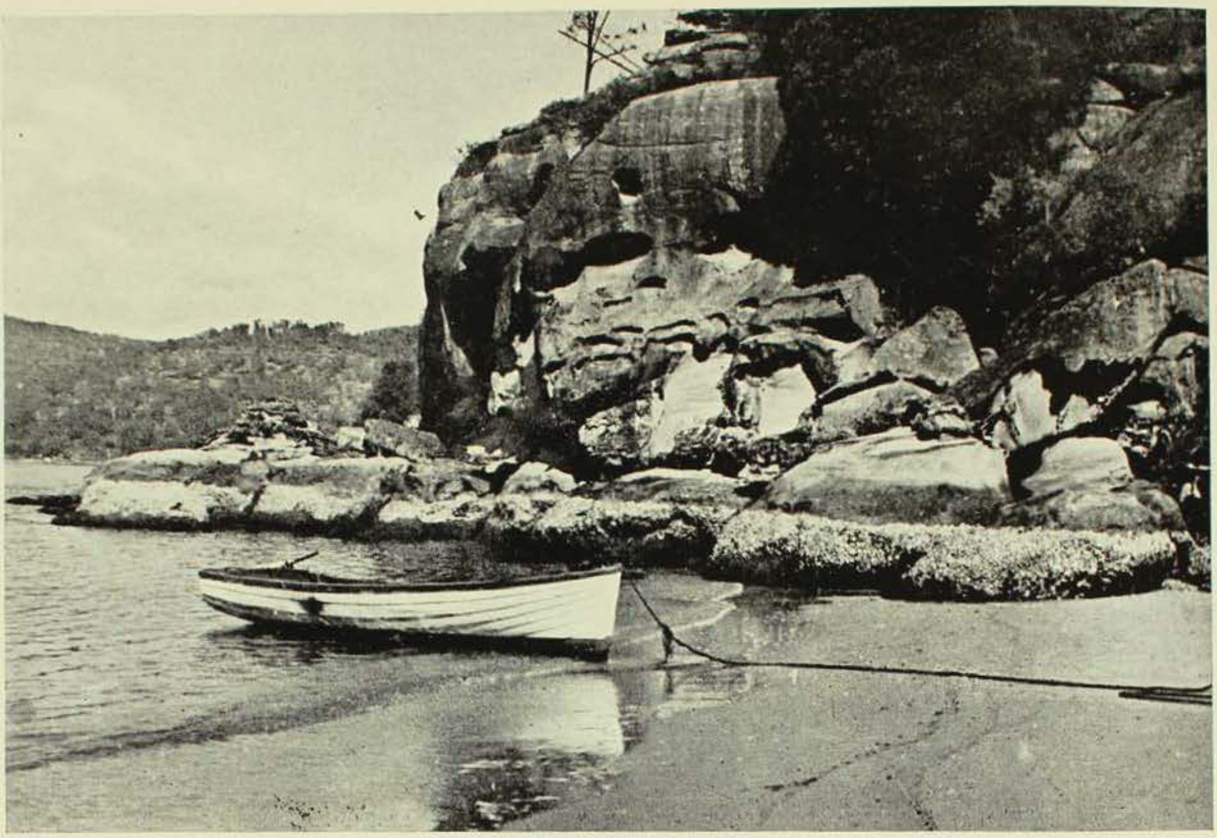
I. Zonation

By ELIZABETH C. POPE and PATRICIA M. McDONALD

NO experienced fisherman who wanted to gather cunjevoi ascidians for bait would dream of looking for them on the rocks or wharf piles except at low tide. He would know that this animal does not live at higher levels. By applying this knowledge our fisherman shows that he fully appreciates the fact that certain plants and animals occur at very definite and often clearly defined levels on the shore. In fact, he has observed one example of what is called the zonation of organisms between tidemarks.

Another clear case of horizontal zonation of a marine organism may be seen in the well-defined "frieze" of rock oysters growing in places like Middle Harbour (Port Jackson) or near the mouths of coastal inlets like Broken Bay. As may be seen in the first illustration the band of oysters, when viewed from some distance away, seems to grow up to a certain height on the rocks and above that level not a straggler appears. It is as though some giant hand had ruled a horizontal line and forbidden oysters to settle above it. However, when a closer approach is made to such a well-zoned area of rocks, the upper limit of the oyster band will be seen to show minor irregularities due to the altering conformations of the boulders and other local factors in the environment. It is thus obvious that the broad pattern of shore zoning is generally more easily appreciated from a distance.

This zoning of the rocky shore is not a local peculiarity but is found all over the world. It is a special instance of one of the great principles that determine the distribution of animals and plants—namely that organisms tend to be distributed in horizontal layers. A familiar example of this kind of distribution is the layering of the vegetation on a high mountain. As one climbs upwards, the trees become less dense, smaller and finally cease to exist. Above the "tree-line," the vegetation consists of grasses, mosses and lichens and if we go high enough, we reach the "snow-line," a point above which the snow lies



Zoning in a sheltered estuary: The regularity of the top of the light band of oysters is clearly seen above the darker band of mussels and seaweeds.

Photo.—E. C. Pope.

on the ground all the year and no plants are visible. Similarly the animals on the mountain, depending as they do on the plants for food, are zoned according to the vegetation available.

On local shores the pattern of zoning varies according to the amount of exposure to pounding surf. In sheltered waters a band of oysters may cover the rocks to the virtual exclusion of all other kinds of animals but on surf beaten shores the band of oysters is replaced by friezes of limy worm tubes and barnacles. In the following description we have chosen an area of exposed coast such as is to be found on many of the rocky headland reefs in New South Wales, *e.g.*, Harbord, Merewether or Ulladulla. For reasons of safety the zonation about to be described is not that of the most exposed and therefore dangerous points on the reefs but of areas which are somewhat sheltered from the full force of the waves—areas nevertheless lashed by white, foaming water.

When to Explore.

The duration of a low tide is limited, so it is best to start explorations while the tide is still falling. There are two high and two low tides in approximately every twenty-four hours. They vary in the height to which they rise and fall, as may be seen by reference to local tide charts. Every new and full moon there are periods of spring tides which are greater than average in their range (both up and down), followed a week or so later by neap tides which have smaller ranges than average. Thus it may be appreciated that the best times for shore exploration will be when the following combination of conditions occurs: A period of low spring tides, calm seas and an offshore wind. We will follow the water as it goes down and describe the zones from the top of the shore down to low water mark.

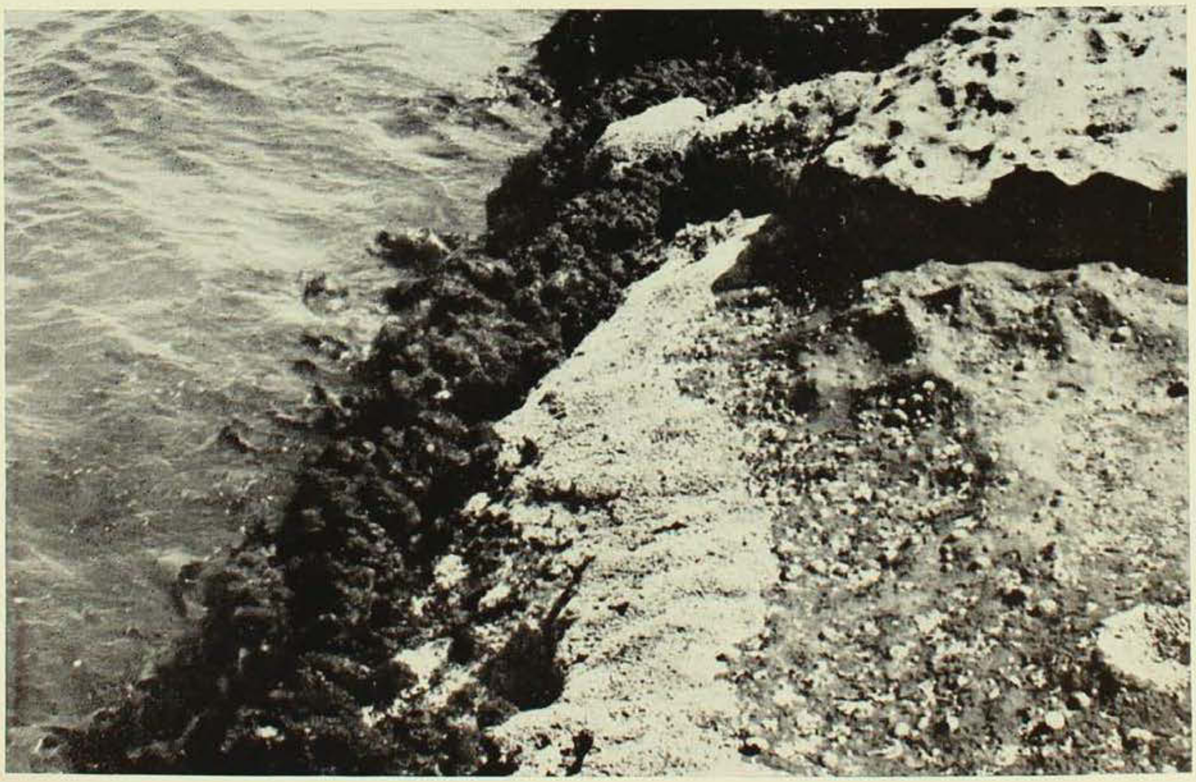
High Shore Area.

The highest areas of the shore rocks, although mostly only kept damp by flying spray, are populated by two small kinds of periwinkle snails—a nobby one, the noddywink (*Noddilittorina tuberculata*) and a smaller, smooth bluish one called *Melaraphe unifasciata*. They actually climb above the level reached by the high tides. No visible plants occur on these highest shore rocks in New South Wales. An occasional swift-moving crab (*Leptograpsus variegatus*), and a small limpet found on vertical rock faces are the only other common creatures to be seen and then only in favoured places.

Of the two periwinkles mentioned the noddiwink climbs to higher levels and is less abundant than the smaller *Melaraphe*. It has a tendency to hide in nooks and crannies and will not generally be found except where fine spray blows across the backshore rocks. *Melaraphe* often clusters together in depressions or shelters in cracks between the rocks. Young specimens of this periwinkle may also be found lower down on the rocks in the barnacle zone. They are in the process of migrating up the shore from the sea where they were hatched. The adult periwinkles, however, live almost exclusively on the high shore rocks.

ZONE INDICATORS.

In describing the zoning on the rocks it is customary to name a zone after one of the animals or plants which figure prominently at the particular level concerned. The best indicators of zones are those organisms which grow attached to the rocks or which move around only to a limited extent within the zone. Thus the highest area of the shore is named the periwinkle zone with *Melaraphe* as the indicator species. Below it lies a barnacle zone with up to seven different species of acorn barnacles growing in it. Next comes an area of rocks covered by a band of limy worm tubes—the *Galeolaria* worm zone. In the warmer months, however, the worm tubes may be partially obscured by an overgrowth of the green sea lettuce (*Ulva*). The zone below the *Galeolaria* one is the cunjevoi ascidian one which was referred to at the beginning of this account, while below this again is



Zoning on an exposed shore: Top of the kelp just visible in the water with the cunjevoi as a dark band between it and the white *Galeolaria* zone above. Barnacle zone only poorly developed here.

a zone of brown kelp. The organisms used as indicators, and for which the zones are named, are illustrated on page 9.

Each zone is not populated exclusively by the organism after which it is named but rather there is a varied group of inhabitants which prefers to live at each particular level on the rocks. The indicator is useful merely as a guide post to the zone and its associated animals. Not all species included in these associations are confined exactly to the same shore level. Some may range more widely than the indicator species while others occupy a narrower range.

Zones Between High and Low Water.

The periwinkle association has already been described. Only a few species of animals were noted, for not many organisms can adapt themselves to the rigorous conditions of the high shore rocks. As one explores at lower levels, one is struck by the increase both in the number and variety of the organisms found. This is very evident in the zone immediately below the periwinkle one—the barnacle zone. Most prolific is the little honeycomb barnacle (*Chamaesipho columna*). As many as 3,000 have been counted in a square foot and the rocks may even appear white owing to a coating of this particular barnacle.

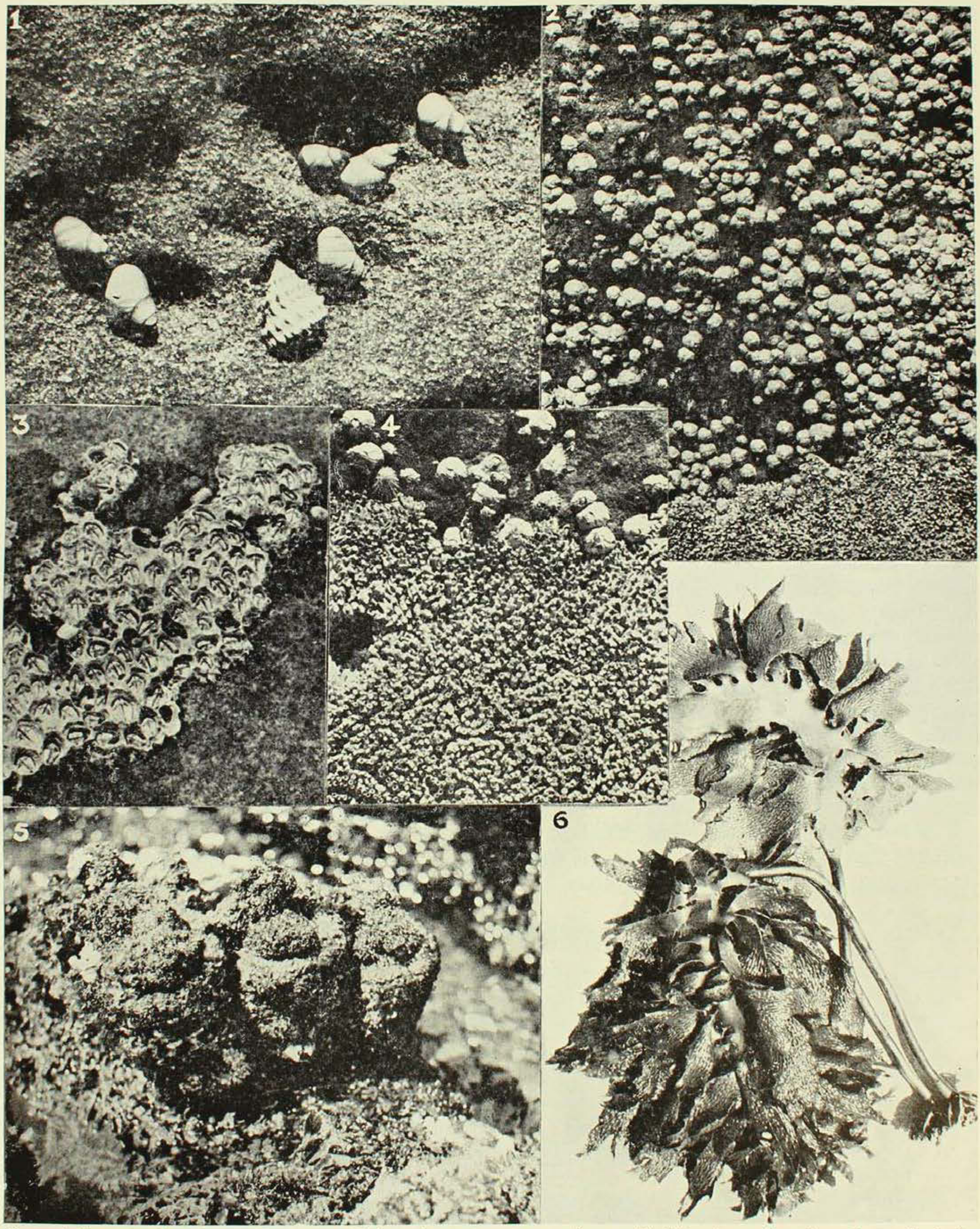
Other kinds of barnacle will be found where the surf actually breaks on the rocks. They revel in the "white water" and are known as surf barnacles; still other kinds prefer the shelter of crevices or the lower side of boulders. Besides the barnacles other types of animals may be numerous. Among these are the several kinds of small periwinkles—the black and white striped Austrocochleas, the plain black Melaneritas, the Mulberry shell (*Morula marginalba*) to mention only the more prominent sea snails. Here is also found the common limpet (*Cellana*) and the highest climber among the coat-of-mail shells (*Sypharochiton*). If there are cracks or pools full of water, three kinds of anemones may be seen—a red one, a green one and an olive one, speckled with white and brown. This last anemone often camouflages itself with specks of shell and sand grains. Some small crabs may be seen scuttling about at this shore level, while the very small five-armed seastar (*Patiriella exigua*) lives in many of the shallow pools.

Below the surf barnacles the *Galeolaria* worm zone begins. It is generally easily recognised because the rocks are covered by a dense white mass of inter-twined tubes each being about ⅛ of an inch bore and the whole tube about 1¼ inches long. The *Galeolaria* forms thick cauliflower-like masses in places slightly sheltered from the full force of the waves but it also occurs as isolated tubes scattered on the rocks in less favourable environments. The flesh of the worm is black in colour, as may be seen when a wavelet laps over the tubes. When the tides recedes the worm retreats into its tube pulling its door or operculum shut behind it, thus presenting an impenetrable front to the outside world.

The tiny spaces and passageways between the tubes provide ideal hide-outs for a whole host of small cryptic animals. Other worms of several types, small prawns and sea fleas, little gastropods of many kinds, a marine spider and a most peculiar stalked barnacle (*Ibla*) which often shows on the surface as black hairy patches among the general white colour. Sometimes a dense, short mat of coralline seaweed carpets the rocks at this level.

Next comes the cunjevoi zone. Cunjevoi is an aboriginal name for the ascidian known scientifically as *Pyura stolonifera*. Sometimes they are found growing separately, but ordinarily they are densely packed together to form a knobbly quilt over many square yards of rock. The individual animal has a cylindrical shape, about six inches high and two broad, its tough outer case is usually hidden by a thick growth of short seaweeds. At the top are two openings for the intake and outflow of seawater. At low tide, little jets of water squirt from these openings, thus accounting for this ascidian's other popular name of "sea squirt." If one cuts through the outer case with a sharp knife, it is found to be a beautiful mauve colour and to contain the red fleshy part of the

(*Continued on page* 10.)



Zone indicators: 1. Periwinkle zone—*Melaraphe unifasciata* and one *Nodilittorina tuberculata* (natural size); 2. Barnacle zone—mainly *Tetraclita rosea* with a few limpets (1/10 natural size); 3. Honeycomb barnacle—*Chamaesipho columna* (natural size); 4. *Galeolaria* worm tube zone, with transition to barnacle zone ($\frac{1}{4}$ natural size); 5. A few isolated cunjevoi ascidians (*Pyura stolonifera*) (1/5 natural size); 6. Dwarf kelp—*Ecklonia radiata* (greatly reduced).

animal. It is this latter part which is used for bait. Because of its popularity as a bait, the cunjevoi is often removed from the rocks and only scattered individuals may be found.

Lowest of the intertidal zones is covered by large brown seaweeds like the Dwarf Kelp (*Ecklonia*) or the two-foot high, familiar *Phyllospora*, which is frequently seen washed up on the beach after storms. This latter seaweed is beloved of small boys who delight to pop the gas-filled floats which are attached to its yellowish-green, strap-like branches. Round the bases of the *Phyllospora* grow most vividly coloured pink and mauve algae, some of which look like paint spilt on the rocks (they grow so close to it), and others looking like tufty little bushes. They feel hard to the touch owing to the deposition of lime in their tissues.

Zonation and its Causes.

It is interesting to guess at the causes underlying the zoned arrangement of shore organisms. It is generally held that the degree of exposure to desiccation is probably the most potent factor controlling shore zonation. Chief factors in the environment contributing to desiccation are winds, light, heat from the sun, and, of course, on the intertidal rocks, exposure to air at low tide, with the last named as the most important single factor.

The net result of this complicated local tidal rhythm is that certain of the highest areas of the shore rocks are only covered by sea water once or twice in a month (except for storms) and then not for long. The lowest areas are exposed to air just as occasionally and to all intents and purposes are virtually part of the subtidal or permanently wet part of the shore. Between these two grades of exposure lie places where conditions are intermediate between these extremes so that one can easily appreciate that each level of the shore has its own particular percentage value for exposure and the animals and plants which live at that level have to adapt themselves to it.

The higher a marine animal lives above low water mark the more it has to be able to withstand desiccation. Some kinds of organisms are not so well adapted to exposure and they occur on the lower parts of the rocks; others are almost terrestrial—they put up with so much exposure to air. Thus in their colonization of the tidal area plants and animals have through past ages migrated up from the permanently wet subtidal zone to occupy positions on the rocks in proportion to their adaptability and hardiness to withstand exposure and battering. This accounts for the arrangement into horizontal bands, for over the ages each species has become so adapted to occupy one particular shore level that it cannot now survive either above or below this zone.

Next issue: Adaptations of Seashore Animals.

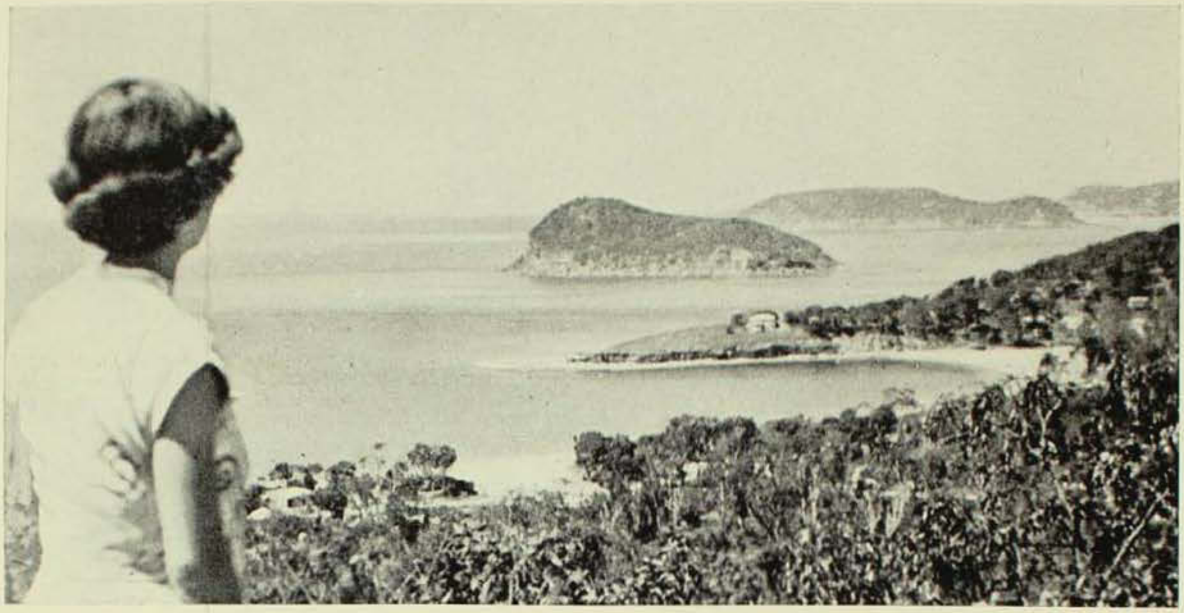
Interest in Marsupials.

Recent visits to the Australian Museum by two American research workers to study the comprehensive marsupial collections serve to emphasise the continued overseas interest in this group of animals.

Dr. Ernest Lundelius, a Fulbright scholar, examined a series of marsupial crania to compare them with sub-fossil specimens obtained by him in cave deposits in south Western Australia. During an examination of the material in company with the Mammalogist, two skulls of the small Broad-faced Rat-kangaroo of the south-west, apparently now extinct, were discovered among some unlocalised old collection crania.

The other American visitor, Dr. Frances A. Benedict (Zoology Department, University of California), also a Fulbright scholar, had been engaged in post-graduate research at Adelaide University and while there examined skins of the pouched animals in connection with her study of the microscopic structure of marsupial hair. A similar study of the hair structure in the flying mammals or bats had shown interesting signs of their relationship. Dr. Benedict's research may provide indications of the early ancestry and interrelationships of certain marsupial families.

The marsupial collections were also studied recently by Dr. B. J. Marlow (Wildlife Survey Section, C.S.I.R.O.) and Mr. Gordon Lyne (McMaster Animal Health Laboratory). Dr. Marlow was investigating the past and present ranges of marsupial species; Mr. Lyne studied marsupial pouch embryos.



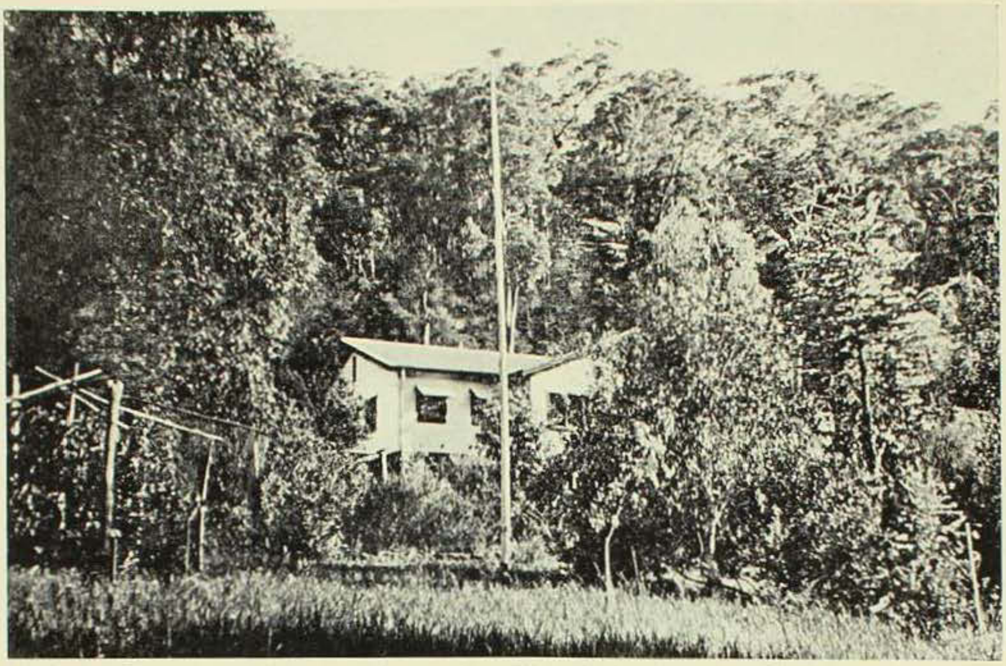
Bird Life of Warrah and the North Hawkesbury

By ALLEN KEAST

IT is doubtful if any stream on the coast compares with the Hawkesbury and tributaries for striking and diverse scenery. A good portion of its watershed lies in the Blue Mountains, a region of abundant waterfalls, cataracts, rocky gorges, luxuriant vegetation, and mist-shrouded valleys. Low down, rugged mountains give way to open parkland, rushing creek to clear reaches fringed by river oaks and gums. Then, for perhaps twenty miles, wide meadows and tilled fields, the centre of Sydney's dairying and vegetable industry, are accessories of the river. But it is in the tidal zone towards the mouth, where rugged sandstone cliffs, headlands and bluffs stand silhouetted against inlets and coves of vivid blue that the river finds its full personality. Here there is grandeur and colour, barren rock faces and rich hillsides of stately gums, plateaux covered with wildflowers, and gullies of cabbage tree palms. Animal life is rich and abundant down where river approaches sea.

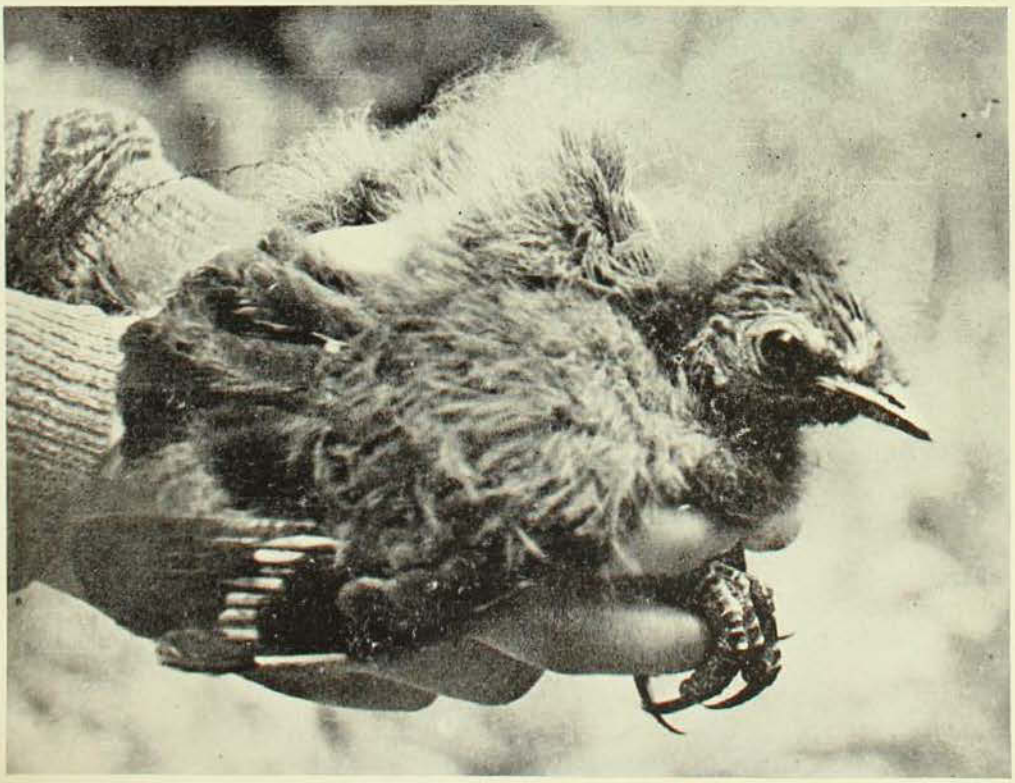
For several years it has been my good fortune to carry out field work in Warrah Sanctuary, on the north shore of the Hawkesbury between Pearl Beach and Patonga. It is here, in the valley behind Pearl Beach, that the University's field station, the Crommelin Biological Station, is situated. This property was given some years ago by Miss Minard Crommelin to encourage the study, by scientists and students alike, of the flora and fauna of the Hawkesbury. Today its fine buildings and library form a wonderful headquarters.

Illustration shows—The mouth of the Hawkesbury from a Warrah hillside. Pearl Beach is in the foreground and Lion Island in the middle distance. Barrenjoey and Palm Beach are behind the Island.



The library building of Crommelin Biological Station silhouetted against the hillside gums. The structure on the left protects experimental plants.

Warrah Sanctuary, the only national park on the north shore, contains some of the finest bushland on the lower river. Immediately beyond the park are other valuable areas, including the mangrove and waterside life of Patonga Creek, and the freshwater marsh behind Ocean Beach. Warrah has a full complement of interesting birds and mammals. Lyrebirds inhabit the sandstone gullies. Sea Eagles soar above the riverside cliffs and nest within the park. Small mammals, forest birds, reptiles and insects are abundant during the day. Night is characterised by



The half-grown Lyrebird chick from the nest on the cliff (see frontispiece). He is covered with long, warm down, and the powerful feet and long claws with which he will turn over debris on the forest floor, are well developed.

The hen Lyrebird, her tail twisted out of shape by long weeks of incubation, scratches amongst ferns and debris in search of insects for the lusty, growing chick.

the thumping of wallabies in the undergrowth, the chattering of possums in the treetops, and the calls of the Boobook Owl.

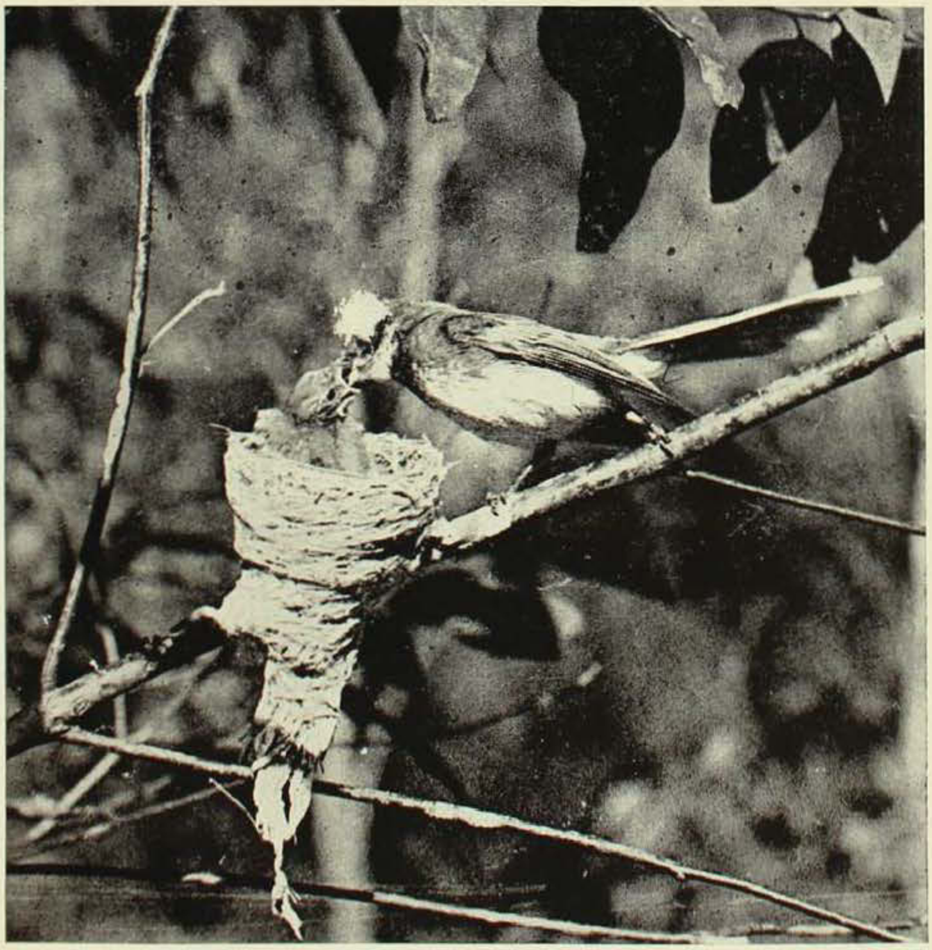
Spring arrives at Warrah in August when the barren plateau-top heathlands, soaked by the winter rains, come to life. This is the wildflower country. White heaths, pink boronias and Aeriostemons, yellow peas and bottlebrush, red Grevilleas and Callistemon form a many coloured mosaic. Abundant nectar brings the insects and birds. The latter are by far the most conspicuous inhabitants. Perhaps a dozen species inhabit the heathlands, mostly honeyeaters, and in August the air is filled with their nesting songs.

September is the month to start investigating the activities of the inhabitants of the gullies and forests below. Let us then work our way down the side of the cliff to where the waterfall sprays over the ferns. It is a bit of scramble for the undergrowth is dense and the rocks slippery. But the finding of a big cave rewards our efforts. We eagerly examine the myriad footprints in the powdered sand of the floor. One can trace the peregrinations of the tiny marsupial mice or discern a lizard's hurried dash to safety. And here is the "giant" print of a lyrebird which has recently been investigating cracks and fissures for spiders. A small brown bird suddenly appears around the boulders and scolds us. It is the Rock Warbler, the only bird restricted to the sandstone belt of the Sydney area and whose range is limited, it is believed, by the need for caves in which to hang a bulky nest. We thoroughly search the big cave and some of the boulders but fail to find its home. However, a fine clump of the little Tongued Dendrobium orchid appears where the sunbeams flicker on the rock surface.

The journey downstream is over moss-covered logs, broken rocks, and wide glistening platforms. The vegetation is dense here and the canopy above so thick that no sunlight penetrates to pattern the substratum. One's rubber soles, however, move noiselessly over the smooth rocks and logs—a great asset in the study of shy creatures. So it is that we approach within feet of a small band of Red-browed Finches splashing in a pool and do not disturb a Grey Thrush whose melodious songs make the undergrowth vibrate. We peer over a big boulder and surprise a goshawk. It crashes through the foliage in fright but never for a moment lets go of the rat trailing in its talons.

But is there not quite a disturbance in the undergrowth to our left? We pause and strive to see through the foliage. Seconds pass—then bursting into view comes Warrah's No. 1 citizen—a male lyrebird chattering to himself as his powerful feet send the fallen leaves and debris flying. He's getting earthworms and crustacea from the forest floor and as he moves across the clearing ahead one detects something truly regal in his carriage. But in an instant his bright eye catches sight of the crouching humans and he is off down the gulley with all the loss of dignity of a frightened hen. Spring is an anticlimax to the lyrebirds for their big domed nest was built in the middle of winter and by early August contained a chick with a voracious appetite. Does this interfere with the singing and dancing of father lyrebird? Not in the least, for the domestic chores are the exclusive province of the lady. It is a state of affairs sufficient to make the mere human male green with envy.

Perhaps a quarter of a mile below the waterfall the terrain levels out and the stream becomes a succession of sandy pools. The forest is more open now and gums and palms line the banks. A Yellow Robin flies past and clings to a vertical trunk; it knows that in this position its conspicuous yellow breast is out of sight and the intruders can be studied at leisure. A Grey Fantail comes dancing through the saplings, flaunting its fanlike tail and chattering excitedly. We almost walked into its half-completed nest without seeing it. Why does the fantail's nest have a "tail" to it? It's a point about which bird students have been arguing for years.



Grey Fantail at nest.

All photos in this article are by the author.

The Striated Thornbill clings to its nest.

There is a wealth of bird life down here in the valley: wrens, scrub-wrens, pardalotes, treecreepers, silvereyes, finches, shrike-tits, whistlers, cuckoos, and thornbills—perhaps a hundred species in all. Most of them breed in the park for there are nooks and crannies to suit all tastes—cliffs for the swallows, a giant gum with an all-encompassing view for the sea eagles, and leaves and hollow limbs, undergrowth and forest floor, to shelter the others. On this occasion we are lucky enough to see one of the finest nests to be seen in the park. The fussy little Striated Thornbills have hung their delicately-woven oval structure of red bark from the outer leaves of a low sapling—and it is in a well lit place for photography.

What is the future of the north shore of the Hawkesbury? This is uncertain but a plan being advocated by various public-minded bodies (including the Gosford Fauna Protection Society, Caloola Club, and Warrah Trust) calls for its dedication as a national park right back to the main northern highway at Moonee Creek. This area, which would have the seaside Warrah as its "anchor," includes the Kariong Peninsula and great tracts of country ideal for hiking trails and with unique river views. There is no denying the advantages of such a park as Sydney's population approaches the two million mark and Newcastle becomes an even greater industrial city. We wish these bodies success in their endeavours.

Returned from Abroad.

The Museum's Assistant Curator of Birds, Reptiles and Amphibians, Dr. Allen Keast, has returned from Harvard, where he took a Ph.D. degree with his thesis on bird speciation on the Australian continent.

Dr. Keast went abroad two years ago when awarded Harvard's Saltonstall Scholarship and a Fulbright Travel Grant from the U.S. Department of State. He visited many of the leading overseas museums and spent a considerable portion of his time in the Department of Birds at the American Museum of Natural History, New York, where the world's finest collection of Australian birds is housed. He also saw the Gould collection in the Philadelphia Academy of Sciences and studied the Arnhem Land material in Washington.

Apart from teaching at Harvard, Dr. Keast gave many lectures on Australia and was impressed by the keen interest shown in this continent. He cannot speak too highly of the kindness and helpfulness of the Americans he encountered.

Marsh Terns in Wheat Crops.

Visitors to the Museum last November included Messrs. John Hobbs and Edward LeSoeuf of Deniliquin. They told of thousands of Marsh Terns nesting in flooded wheat crops along the Murray. Although not rare, Marsh Terns are seldom discovered breeding in large numbers. One normally thinks of terns as birds of the sea that lay their eggs on islands—and without any semblance of a nest. This exceptional species breeds in marshes, however, constructing substantial platforms on top of rushes and water weeds. Last spring was an especially good one in the area and the bird life was remarkable both in diversity and numbers.

The Races of Man in Oceania

A Philippine Islands pygmy Negrito armed with a bow and arrow. One of a series of figures one-third natural size from the Races of Man in Oceania exhibit in the Australian Museum.

By FREDERICK D. McCARTHY

WITH the exception of Indonesia, where the antiquity of man has been traced back half a million or so years, Australia and the islands of Oceania were not inhabited by man in really ancient times. It was not, apparently, until the late Palaeolithic and early Mesolithic periods, between 20,000 to 10,000 years ago, that the first Pacific migrants reached Australia and New Guinea. Later, technical advances in Asian economic life (such as agriculture and the domestication of animals) which ensured man's supply of food, gave rise to an increase in population sufficient to force some groups of people further and further southward.

During the Neolithic period, which began about 7,000 years ago, emigrants in canoes were able to venture into the island world far from the mainland, into a world where culture progress, handicapped by comparative isolation, slowed to low gear and was secondary to securing a living and maintaining traditional customs. Today, practically all the inhabitable islands are occupied. The attention focussed upon Oceania by World War II has accentuated interest in its peoples and their future, its commercial possibilities and tourist capacities, while Australia, New Zealand, the Philippine Islands, and Indonesia have attained nationhood.

There are many thousands of islands in this vast Oceanic region. They range from tiny coral atolls and reefs a few feet above the wash of the sea, to mountainous and very beautiful islands in groups and chains, among which Borneo and New Guinea are the two biggest islands in the world, and Australia is an island continent. The climate varies from tropical in northern and central Oceania to temperate in the south, and the environment ranges from jungle-clad ranges and plains on the larger islands to barren and desolate islets. The peoples, their way of life, art, religion and social organisation vary widely in this world of islands, and anthropologists have not yet untangled the racial and cultural problems involved. An exhibit recently installed in the Australian Museum illustrates the principal races of man in this region, with a series of six figures each one-third natural size. The contrasts between these racial types is well demonstrated by these figures, particularly between the light and dark skinned peoples on the one hand, and the stature and physique of the various types on the other.

Semi-nomadic Hunters and Collectors.

The pygmy Negritos constitute an as yet unsolved problem to the anthropologist. Some authorities consider them to be a true race, one of the earliest to migrate from Asia to the Oceanic region. There they were formerly widespread but are now confined to the Malay Peninsula (Semang), Andaman Islands, Philippine Islands, New Guinea and possibly a few other islands. Other students believe them to be an environmental and physical variant of the Melanesians and not true pygmies at all.

The Negritos are primitive hunters and traders, small bands of whom live in remote inland jungle-covered mountain ranges, where they occupy caves and bough shelters. In the Malay Peninsula and Philippine Islands they hunt with poison-tipped spears, arrows and blow-pipe darts, but in the Andaman Islands and New Guinea they rely mainly upon the bow and arrow. They employ ingenious traps and snares for game, and collect plant foods. Negritos are ever ready to adopt new ideas, and some of them have learnt to cultivate crops, build villages, use pottery, stringed musical instruments and many other customs from neighbouring peoples, whose language they frequently adopt.

Opinion varies as to the racial origin of the Tasmanians (now extinct), from the claim that they reached the island by sea from southern Melanesia (New Caledonia) to the idea that they previously inhabited Australia, as an admixture of Negrito and Australian aboriginal stocks. It is generally believed that they crossed Bass Strait by a Pleistocene land bridge now covered by the sea. Some anthropologists relate them to the Ainu of Japan.

The Tasmanians lived a simple life. A few families in a horde or local group lived in caves or bough shelters, and each horde controlled its own territory. Their food was obtained by hunting, fishing and gathering plant foods. They wore skin-cloaks (in the winter), seed and shell ornaments, and used spears, clubs and stones as weapons. Their canoes were made of three long bundles of bark-strips tied together. Realistic paintings of animals on bark, simple incisions on spear shafts, and engravings of circles and other motifs on rocks, constituted their art. Little is known about their social organisation, religion and language.

The origin of the extinct Tasmanians has not yet been settled but they are generally considered to be of Negrito stock. Their main weapons were the spear thrown by hand, and clubs.

The Australian Aborigines, who form the Australoid race, came from south-east Asia, travelling on rafts or in bark canoes across the island stepping stones of Indonesia and New Guinea. Their physical

An Australian Aboriginal stalking game. The spear is thrown with a spear-thrower, a wooden implement which adds greater power and accuracy to the use of the spear.

characteristics survive among the Pre-Dravidians of India, Veddahs of Ceylon, Sakai of Malaya, and among the Indonesians and Melanesians, thus indicating a former widespread distribution. Wide variability exists in all their physical characters, particularly in height (from under 5 to over 6 feet with an average of 5 ft. 5½ in.) and facial features. Opinion is divided as to whether one physical type of extreme variability occupies the continent, or whether three sub-types exist, comprising a frizzly-haired Negrito stock (the Barrineans of north-east Queensland) which was replaced by two Australoid strains, a stout hairy bodied southern group (the Murrayans) and a dark sparsely-haired northern type (the Carpentarians), a theory somewhat convincingly advocated in recent years by Professor Birdsell. He identified the Barrineans as a Tasmanoid type surviving in the Atherton jungles.

The Aborigines of Australia are semi-nomadic hunters, fishermen and plant-food collectors who follow a way of life similar to that of the Tasmanians, but possess the spear-thrower, boomerang, basketry and other more advanced technical appliances. Local groups of a few families control their own portion of the tribal territory, and are governed by a council of elders. Social life is strictly regulated. Religion consists of totemism and beliefs in spiritual ancestors, with a wealth of myths and legends expressed in art and ceremonies.

GARDENERS AND FISHERMEN.

In New Guinea and the islands of the Western Pacific, live a negroid people known as the Melanesians. They consist of localized communities of extraordinarily wide variation due to racial admixture, isolation and environment. They are, in the main, of short stature. These peoples were originally classified as dark-skinned Papuans and light-brown Melanesians, but this division is a linguistic one not allied with physical types. Light-skinned Melanesians are found in eastern and central New Guinea and along its shores (and elsewhere), and dark-skinned groups live in western New Guinea, Bismarck Archipelago, Solomon Islands, New Hebrides, New Caledonia and Fiji. Past migrations are revealed by the presence of an Australoid strain in many parts of Melanesia (particularly in northern New Caledonia, New Britain, and the To people of New Ireland), and of a pygmy Negrito admixture in New Guinea. More recent intrusions of people into this region are proved by the occurrence of the Polynesian strain in Fiji, and of a Micronesian one in Ontong-Java and other islands.

Characteristic elements of the Neolithic culture of Melanesia are the simple cultivation of taro, yams, sweet potato, coconut and other fruit trees, the possession of pigs and dogs, the building of permanent villages, the making of polished stone adzes, pottery, bows and arrows, outrigger

A western Papuan native carrying a stone-headed club and wearing a bailer-shell pubic cover. The Papuans and Melanesians represent the Negroid race in the Pacific.

The sturdy build of the Polynesians is well shown in this figure of a Maori chief holding a greenstone mere, and wearing a flax skirt. One leg and his face are tattooed.

and plank canoes. The Melanesians (formerly cannibals and head-hunters) are governed by village councils and chiefs. Their religion consists of ancestor worship and hero-cults, with elaborate masked ceremonies. Secret societies exert an important influence in social and ritual life. As a people they are renowned for their artistic work in wood, shell and other materials, and for excellent carvings of human figures and animals.

Two racial strains, the Caucasoid and Mongoloid, are blended in the Polynesians into a tall and handsome people, and in some of the islands in this region an early Melanesian strain is present. Their economic life is similar to that of the Melanesians; in addition, pigs and dogs are domesticated. Notable examples of their Neolithic way of life are the building of permanent villages protected by or adjacent to fortresses (in some islands), the use of polished stone implements, and skilled work in wood, shell and other materials. Their massive carvings of gods and other works in stone are well done, as are the neat decorative designs on wood and on bark-cloth. They are expert navigators who use large dugout and plank canoes, and are clever fishermen.

The Polynesians are governed by chiefs and priests, but some islands were ruled by a royal family in former times. Their religion consists of a pantheon of gods, such as Tangaroa (sea), Tane (forests), Tu (war), and others presiding over different spheres of the people's life, of ancestor worship and of hero-cults such as that of Maui who fished up islands from the sea.

The Micronesians are not represented in our series of figures. A very mixed population, in which Melanesian, Indonesian and Mongoloid (the dominant one) racial strains are present, inhabits this northern chain of islands and atolls. Stature varies from short to very tall, head shape from broad to long, skin from light to dark-brown, and hair from straight to wavy and frizzy. The culture and way of life are similar to that of the Polynesians.

(*To be continued.*)

Collecting and Preserving Insects and Their Allies

By A. MUSGRAVE

(*Continued from page* 391, *December*, 1955.)

PRESERVING AND SETTING—*continued.*

Mould.—This is an ever-present problem in tropical countries, and, even in southern Australia, care should be taken to see that the bodies of the insects are dry before packing, or that they are not stored in a damp place. Insects found to be affected may be painted with a mixture consisting of a pinch of thymol in benzene. Trichlorphenol is a recent preventive of mould and is regarded as effective when placed in tins with freshly caught insects from New Guinea and other tropical localities with a high humidity. Collectors in the tropics would be well advised to employ one of the following mixtures suggested by British Museum authorities[1] for treating the inside of store-boxes:—

Corbet and Pendlebury's Mixture: The constituents, which are mixed as indicated, are powdered naphthaline (6 parts), chloroform (1 part), Beachwood creosote (1 part), petrol (4 parts). They should be mixed gradually as follows: 1½ parts of naphthaline to one part of chloroform, then add 1½ parts of naphthaline and 1 part of Beechwood creosote; stir well. Then add the remaining 3 parts of naphthaline and the petrol to increase the bulk. Stir the mixture thoroughly both before and while it is being used. As this mixture is of an inflammable nature due precautions must be observed, and it should be kept in an air-tight bottle.

British Museum Mixture: Flake naphthaline is added slowly to a quantity of chloroform till the latter is saturated. An equal bulk of creosote is then added and the mixture kept well stoppered.

[1] J. Smart, Instructions for Collectors, No. 4A. Insects.Brit.Mus. (Nat. Hist.), p. 141, 1940.

Both these mixtures are applied in the same way, and both dry up and leave a deposit of naphthaline and creosote in the box which prevents the development of moulds and the attacks of insect pests.

Store-boxes and Cabinets.—The set specimens are stored in store-boxes or cabinets. The former are the cheaper but require constant attention to see that insect pests are not destroying the specimens; the latter, on the other hand, usually have a cell around the inside of the drawers to hold naphthaline and so need only occasional supervision to see if the naphthaline requires replenishing.

Store-boxes are obtainable at dealers in natural history material. Entomological cabinets are sold by some, but not all, dealers and it may be necessary to have them built by a cabinetmaker to specifications. Some institutions favour steel cabinets with steel drawers, but others find that humidity is not absorbed by metal as by wooden drawers and the specimens decay. Some climates are more prone to humid conditions than others and some buildings housing collections are inclined to be damp and so foster mould in collections.

Greasy Specimens.—Many large-bodied moths are prone to become discoloured with grease which corrodes the pins and stains the paper in the cabinets. These insects, as soon as they are killed, should be treated by opening up the abdomen and removing the body contents. Powdered magnesia is then placed inside the body; about a fortnight later this is removed and replaced with enough cotton wool to fill the cavity in a normal manner. The insect can then be set. Greasy specimens may be dipped in petrol and then covered with powdered magnesia which, when dry, may be blown off.

Insect Pests.—Museum beetles (*Anthrenus*) and book lice (*Psocidae*) are the major pests in collections in colder climates, while in the tropics the tiny red Singapore Ant (*Monomorium*) is a serious problem. Powdered naphthaline or moth balls act as a deterrent, but paradichlorbenzene, though not so long-lasting, is more effective. Any pests found in the collection may be destroyed by means of bisulphide of carbon (*highly inflammable and explosive*) or carbon tetrachloride. Some authorities find that DDT powder is a good preventive against *Anthrenus* and mites.

Preserving Soft-bodied Specimens

Such soft-bodied insects as termites, book-lice, bird and animal lice, fleas, bat-parasites, and silverfish are usually killed and preserved direct in 75 per cent. alcohol or methylated spirit. The larval or caterpillar stages of moths and butterflies, the grubs of beetles, the larvae of wasps and flies may also be killed in the same preservative.

A preservative which has come to the fore in recent years is KAAD, and its allies KAA (1) and KAA (2). These are preservatives for Coleopterous larvae. The letters stand for kerosene, alcohol, acetic acid (glacial), dioxane. These formulae are given by Dr. P. B. Carne in the *Proceedings of the Linnean Society of N.S. Wales*, lxxvi (1-2), 31st May, 1951, p. 29. The first consists of kerosene 8 per cent.; 95 per cent. alcohol 70 per cent.; glacial acetic acid 14 per cent.; dioxane 8 per cent. The others will be found in Dr. Carne's paper, and are probably only of interest to entomologists engaged in special research work.

Centipedes, millipedes, scorpions, spiders, ticks and *mites*, many of which are found in situations similar to those in which insects occur may also be preserved in 75 per cent. alcohol or methylated spirit. These animals are more or less soft-bodied and their characters are lost when allowed to dry. O. Lundblad, an authority on water mites, recommends the following formula for preserving these small animals: glycerine 5 vols., water 4 vols., glacial acetic acid 1-½ vol.

All bottles or tubes containing spirit material should be labelled, the information being written in pencil on cartridge paper and placed in the bottle with the specimens. If the specimen is a parasite (flea, louse, tick or mite), the name of the host should appear on the label. Sometimes it may be desirable to collect the host for purposes of identification, in which case a register number may be attached to the host and the same number noted on the spirit label with the parasite; the particulars are then written up in an exercise book kept as a *field register*.

Packing Specimens.—Material to be sent to a museum should be carefully packed. Pinned specimens in store-boxes should be cross-pinned to prevent heavier insects from breaking loose and causing damage. Boxes containing pinned or unset specimens should be packed inside a wooden box or a stout cardboard carton, with an inch or more of packing (crumpled paper, wood wool or wadding) on all sides. Material in spirit tubes may be packed all around with cotton wool or crumpled paper, placed inside a box and then packed into another box as in the manner described for insects. Some collectors prefer to remove the corks and plug the tubes with wads of cotton wool soaked in alcohol and to place the tubes in large screw-topped jars. Cotton wool is put inside the jars to prevent the tubes moving and then the jars are placed with packing in stout wooden boxes and the lids screwed down. A single tube containing a specimen of a spider or other soft-bodied creature may be placed in a hollow made with a brace and bit in a small block of wood. Room should be left at either end for a pad of cotton wool and a piece of carboard should be tacked over the open end.

Addressing Packed Specimens.—If specimens are destined for the Australian Museum, they should be labelled: "Natural History Specimens Only. Fragile," and addressed to: *The Director, The Australian Museum, College Street, Sydney, New South Wales.* Small packages should have the address and stamps on an attached luggage tag to prevent damage to the package by the post office cancellation stamp.

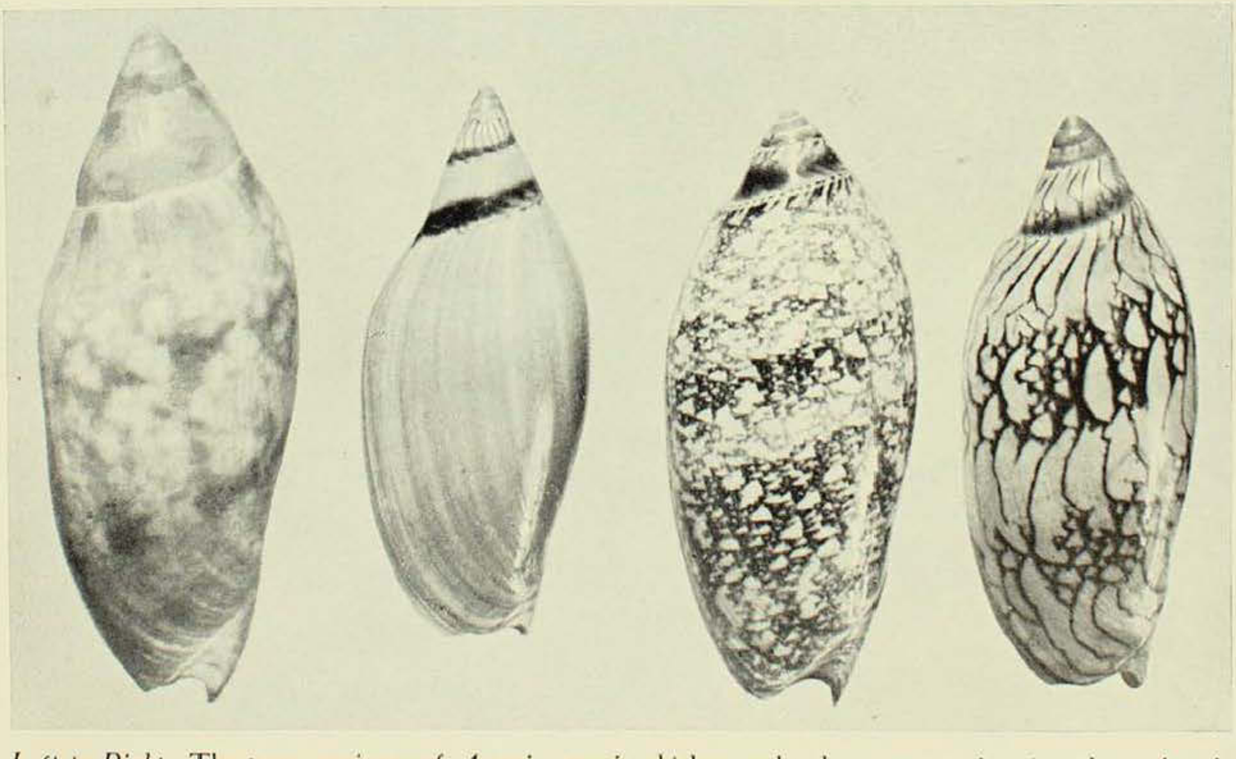
Collectors' Items
Volute Shells of the Genus *Amoria*

By DONALD F. McMICHAEL

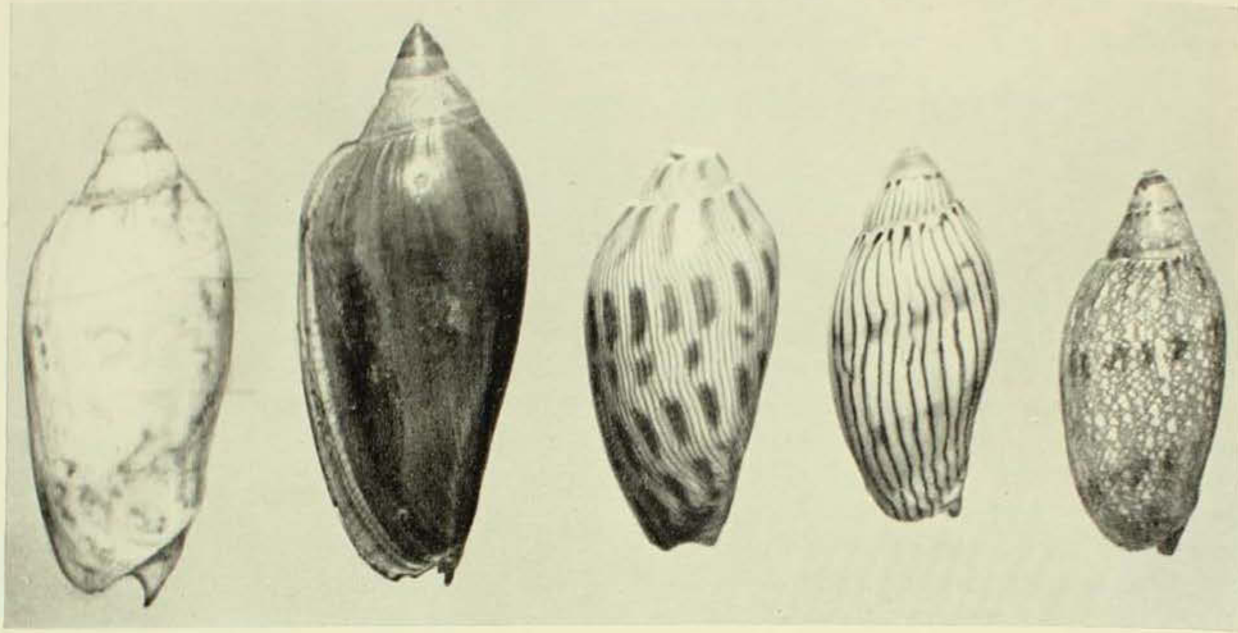
AMONG the various groups of sea shells a few stand out as the favourites of the many Australians who delight in building up personal collections of these lovely objects. To the scientist working in a museum the beauty of the shells with which he works is of little consequence, for he must be interested in them only as animal species, each the end product of a long and complicated evolution. To him, the interest of a particular group of shells lies not in appearance, but in the information which it provides as to the way in which evolution has come about, and some of the plainest and most unattractive shells have proved the most important in this regard.

None the less, even the scientist sometimes cannot help but admire the beauty of a particular group of shells, and at times these same shells may prove worthy of special study, and play their part in unravelling the story of the development of life. Such are the volute shells belonging to the genus *Amoria*, which have long been favourites of shell collectors. These shells are found only in Australian seas, and since they mostly live in the northern waters, they are not common. This adds to their value as collectors' items, and several of the species sell for over a pound for each specimen.

A few years ago, Dr. N. H. Ludbrook, of the South Australian Mines Department, found it necessary to study this genus in particular detail, since the shells occur as fossils in the Pliocene rocks of South Australia. As a result of her studies it has been found that wrong names had been applied to several of the species and some new names have been provided. Dr. Ludbrook was able to study the original specimens of most of the species described and so we can now name them with certainty.



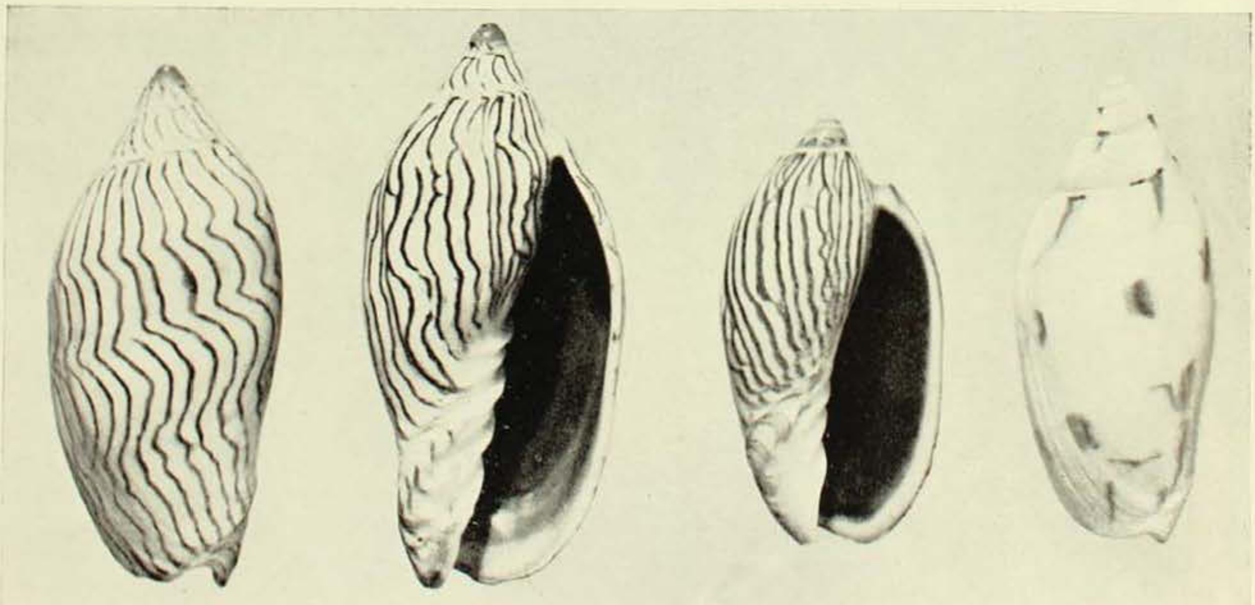
Left to Right: The type specimen of *Amoria grossi*, which may be the same as *Amoria volva*; *Amoria grayi*; *Amoria damoni*, and the related species, *Amoria keatsiana*.



Left to Right: *Amoria spenceriana*; *Amoria molleri*; *Amoria canaliculata*; *Amoria turneri* (the fine-lined "broderipi" variant); *Amoria praetexta*.

In order that amateur collectors will be able to correctly name their shells, photographs and brief descriptions of all the species are given here. It is hoped that any shell collectors who are in the northern part of Australia will keep a sharp lookout for these shells, as there is still much to learn about the habits and distribution of these lovely animals. The genus *Amoria* is characterised by a glossy shell with a small conical protoconch or embryonic shell. There are no knobs or spines on the shell, which is perfectly smooth. Shells range from about one to four inches in length. Little is known of their habits—such as feeding, egg laying—or life history. Some of the species are rather similar so, to make identification easy, the more distinctive species will be described first.

Amoria caroli is a small to medium-sized species from the coast of Queensland. It is fairly common and is easily distinguished



Left to Right: *Amoria macandrewi*; *Amoria elliotti*; *Amoria jamrachi* and *Amoria caroli*.

by its creamish-white shell, marked with three or four spiral bands of widely-spaced, reddish-brown patches.

Amoria canaliculata is a small to medium-sized species which is found very rarely on the Queensland coast. It received its name because the sutures or junctions between the whorls are quite deeply excavated. In colour pattern it somewhat resembles *A. caroli* but there are five spiral bands of orange-brown patches. These patches are narrower and more closely spaced and the shell is sometimes marked with fine, orange, longitudinal stripes.

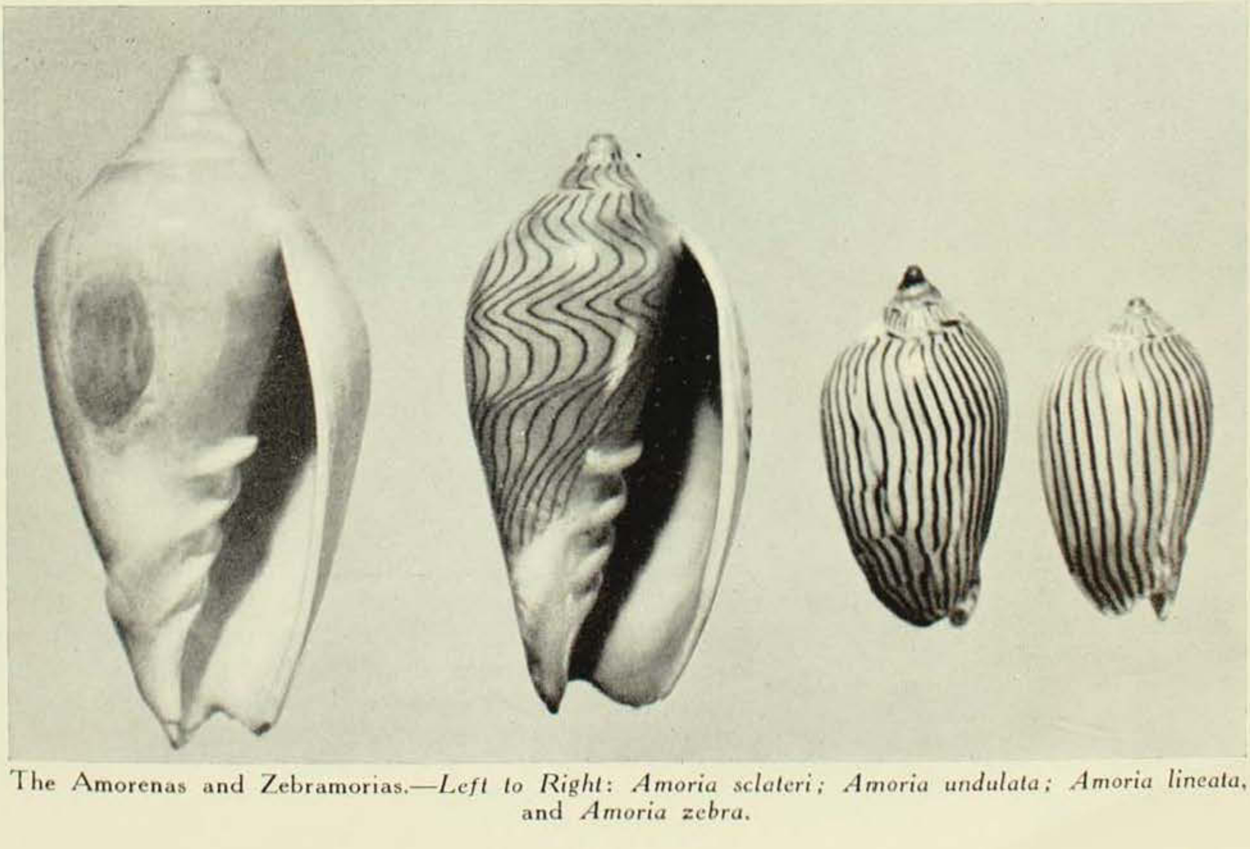
Gray's Amoria (*A. grayi*) was formerly known as *A. volva* and also *A. pallida*. It is a medium-large species from Western Australia and is easily distinguished by its tall slender form and uniform orange-grey colouration. Above the suture is a narrow band of dark-brown pigment.

The true *Amoria volva* is a rather rare, large, Queensland and North Australian species. It is creamy white, splashed with triangular patches of orange-brown. A shell from Caloundra, Queensland, may be the same species. This shell was named *Amoria grossi* and the type specimen is illustrated on page 23.

One of the most attractive north-west Australian species is *Amoria damoni*, which has also been called *Amoria reticulata*. It is a large species with a fairly short spire. The body whorl is finely marked with more or less triangular white flecks on a brown background, with three or four faint bands of brownish colour spiralling the shell. The suture is marked with orange-brown above and black below. This species seems to intergrade with the shell named *Amoria keatsiana*, formerly called *A. gatliffi*. The latter form has a taller spire and the colour pattern is different, the white patches forming very broad irregular triangles, with the brown background suppressed and showing only as irregular longitudinal lines between the white.

Amoria spenceriana is a smallish, white species from Queensland. It is apparently very rare and can be distinguished by its short spire and white shell, marked faintly with irregular brown splashes in a few spiral bands.

An uncommon species from deeper water of the coast of New South Wales is *Amoria molleri*. This is a medium-sized species, with the shell a characteristic bright orange colour on the back and



The Amorenas and Zebramorias.—*Left to Right*: *Amoria sclateri*; *Amoria undulata*; *Amoria lineata*, and *Amoria zebra*.

coated with white around the aperture. Near the lip on the outer edge some faint orange undulating lines show.

A small north-west Australian species is known as *Amoria praetexta,* which is somewhat similar to *A. damoni* in its colour pattern. It can be distinguished from the latter species by its small size, relatively high spire, and the fact that the white triangles are much smaller and more numerous, on a light brown background. The body whorl is also characteristically marked with two or three bands of dark spots

The remaining species of this genus fall into three groups. First there are four species of true Amorias which all have a similar colour pattern of narrow, brown, longitudinal lines on a creamy white shell. *Amoria elliotti* is a fairly large species from Western Australia with widely spaced, dark brown lines, which tend to run together. The sutures are quite smooth and the aperture is a little compressed. These characters enable its separation from *Amoria jamrachi,* which is smaller, with somewhat excavate sutures and the aperture expanded. The longitudinal lines of jamrachi do not coalesce as much as those of *A. elliotti. Amoria macandrewi* is again somewhat similar, but the longitudinal lines are more orange-brown, and always distinctly undulating.

The final species of this group is *Amoria turneri* which is a small species from Northern Australia. The longitudinal lines are sometimes fairly close together, sometimes well spaced and sometimes quite wiggly. The first of these three variants has been called *A. broderipi,* while the last has been called *A. newmanae* but these differences are not especially significant. Turner's amoria can be distinguished from the other lined species by a series of orange-brown spots below the suture, one spot being above most of the longitudinal lines.

The second group consists of two small, solid species from eastern Australia, which have very short spires and thickened shells. They have been separated as a subgenus, *Zebramoria,* because of their zebra-like patterning—longitudinal brown lines on a white background. The common New South Wales form, *A. zebra,* is smaller, with a shorter spire, which is smooth. The other form, *A. lineata,* occurs more commonly in Queensland and has a relatively taller spire which is slightly ridged below the embryonic whorls.

The third and final group of two species has been called the subgenus *Amorena,* and is distinguishable by the shape of the shell, which is broadened by a more or less distinct shoulder on the body whorl. The shells are of moderately large size and the commonest species, *A. undulata,* is orange to cream in colour, with fine brown undulating stripes all over the shell. It is found in the offshore waters of southern Australia from New South Wales to Western Australia. A deepwater form with a white spire has been called *A. moslemica* but it is not a distinct species. *Amoria sclateri,* a very rare species known only from Bass Strait, is creamy white all over though its aperture may be somewhat orange coloured. This species has also been known as *Amoria kingi.*

Shells.

The Shell Department recently acquired two specimens of the scarce *Conus rhododendron,* a South Pacific island shell much sought by collectors and not hitherto represented in the Museum collection.

Mr. A. W. B. Powell, Assistant Director and Conchologist of the Auckland Museum, New Zealand, twice visited the Shell Department for several days, studying the collections (principally Kermadec Island material) and literature.

Baroness Ravensdale, of London, paid a lengthy visit to the Department to discuss Australian shells, following her return from the Great Barrier Reef.

Chief Attendant Retires.

Mr. W. A. Medway, Chief Attendant at the Australian Museum for fourteen years, retired last November. He joined the staff of Museum attendants in 1922 and so, apart from absence on service in World War II, had served the Museum for thirty-three years. At a farewell gathering the staff of the whole Museum, through the Director, Dr. J. W. Evans, wished Mr. Medway every happiness and expressed their thanks for his assistance, always cheerfully given. A stainless tray and a water set were presented to Mr. Medway.

Sponge, Plant or Primitive Vertebrate?

A Fossil Organism of Unknown Affinities

By H. O. FLETCHER

LIVING in the coral reefs and deeper waters of lower and middle palaeozoic times were certain strange creatures which from time to time have been placed in widely diverse divisions of the animal kingdom.

Most palaeontologists today consider they are sponges of some sort as the shape and internal structure suggest affinities with the Class Porifera. It has been found impossible, however, to include them in any of the four main groups of the living and extinct sponges and they are therefore placed in a special category with suggested affinities with the Porifera.

The so-called "Sunflower Coral," *Receptaculites*, is one of these "mystery" organisms. It is known from rocks of Ordovician, Silurian and Devonian age in various parts of the world. In Australia, the Sunflower Coral has been found from various localities in Victoria, New South Wales and Queensland. Incomplete but well preserved specimens have been collected from the mudstones and limestones of Silurian age at Loyola and Wombat Creek in Gippsland, Victoria. In the Middle Devonian limestones of New South Wales they occur at Fernbrook (near Mudgee), at the Goodradigbee River and other localities near Yass. In Victoria they are found in rocks of the same age at Buchan and Bindi. *Receptaculites* has also been recorded from possibly Ordovician rocks at Belubula, in New South Wales, and from doubtful Upper Devonian strata at Mount Wyatt, Queensland.

Following their appearance in seas of the Ordovician geological period about 400 million years ago, these so-called sponges steadily flourished and increased in numbers and species. The group lived for approximately 150 million years before it became extinct and disappeared from the geological record.

The external appearance of the Sunflower Coral was variable and apparently assumed shapes ranging from cup-like to platter- and conical-like creatures with a central cavity and a large opening. Built up fragments and incomplete fossil remains also indicate a spherical or top-shaped appearance. Specimens grew to a width of slightly more than twelve inches. Complete fossil specimens of *Receptaculites* have not been found and so there is

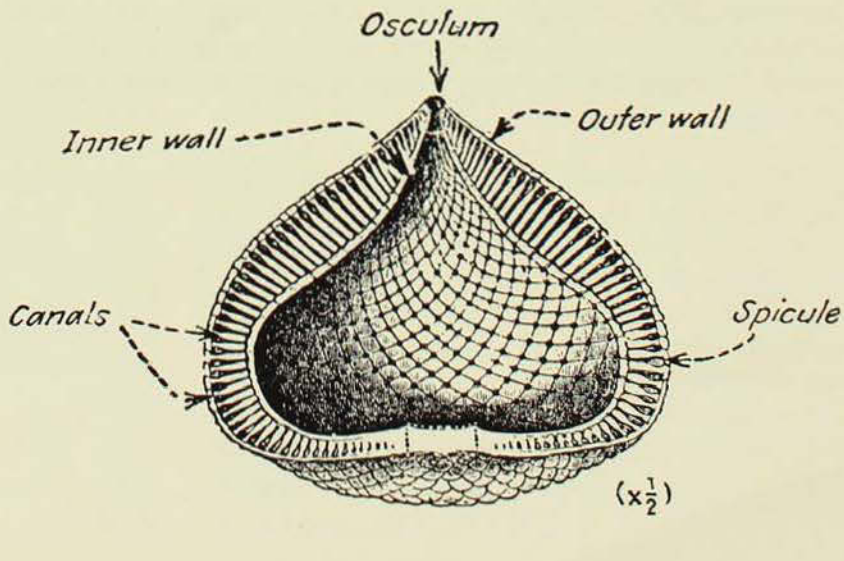
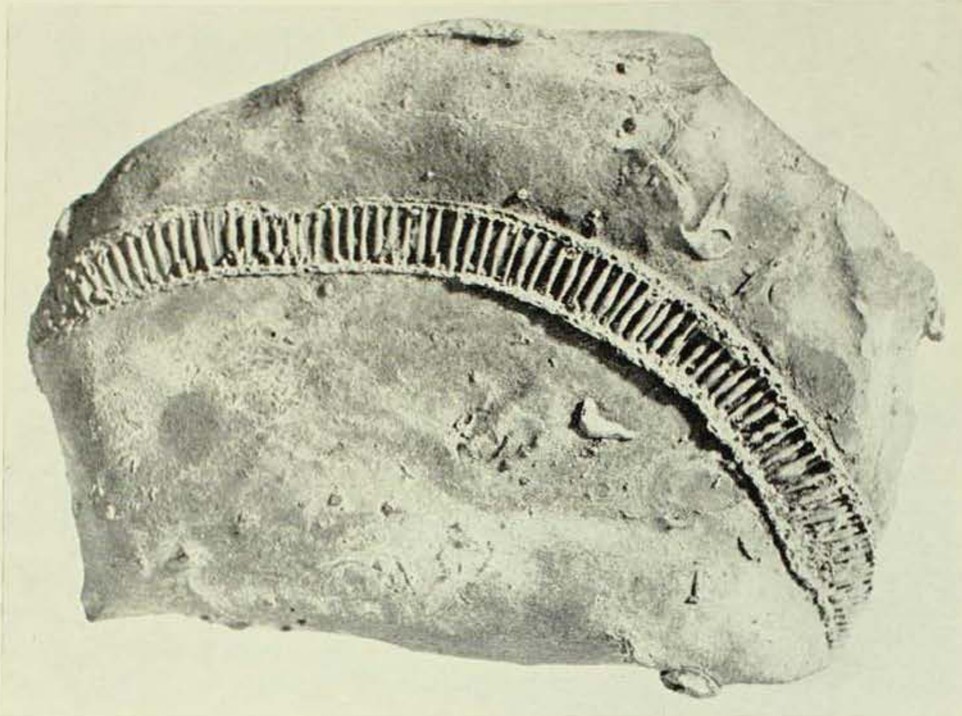


Diagram of *Receptaculites* showing the internal structure as it would appear in a vertical section of a perfect specimen.

After Billings, 1865.



A natural section of the wall of *Receptaculites australis* Salter, afterwards etched, showing the columns.

some doubt regarding their actual external appearance and shape. Most fossil and living sponges assume the shapes postulated for *Receptaculites* and it can be readily understood, even though some of the internal structures do not agree with the true sponges, why the group has been classified as having affinities with them. Unlike living sponges the Sunflower Coral was not attached in any way to the seafloor.

If these so-called sponges were living in our seas today they would cause little comment or interest from a casual observer when seen on a beach, washed up after heavy weather. They had little to recommend them in appearance or beauty and would be passed by as just another example of marine life.

The group however, has achieved fame in the world of fossils as one which has caused a great deal of controversy among scientists in all parts of the world and even today there is no unanimity of opinion regarding its correct position in the classification of the animal kingdom. The organisms show a complex and variable structure which has puzzled palaeontologists since the first specimen was described in 1827

In studying the life of the past, palaeontologists for the most part are restricted in their studies to the hard parts or the skeleton of the original animal. These are the only parts readily preserved and therefore to bring the fossils to life again, and study them as living creatures of a onetime fauna, it is necessary to interpret the relationships between the hard parts and the soft tissues long since disappeared. This may be done by careful study and comparisons with closely allied organisms which are still living.

A great deal has been written on the results of macroscopic and microscopic studies of the supposed general structure of the so-called sponge *Receptaculites*. The opinions of authors vary, however, to such an extent that any satisfactory conclusion regarding its original structure is most difficult.

In general it has been recorded that examples of the genus *Receptaculites* were variable in outer form but usually assumed a somewhat platter-shaped body which grew from a small inversely conical nucleus.

It will be seen from the illustrations that the body of *Receptaculites* is provided with a thick wall with an inner and outer layer joined by numerous columns (referred to by some authors as pillar-like spicules) arranged at right angles to the surface. In thin section the columns are shown to possess a central axial canal and are expanded at their extremities into rhomboidal summit plates. These fit into one another to form a mosaic-like outer layer.

When the surface plates are weathered away, or are viewed from the inside, the vertical columns or spicules give off four transverse or horizontal rays. At the inner extremities of the columns, where they abut upon the central cavity, they expand to form small horizontal plates which are traversed by horizontal canals. These plates are united together to form a continuous layer. It is considered that through these canals water which has filtered between the summit-plates is admitted to the central cavity.

It is interesting to note that in living sponges all are attached and exhibit a wide variety of form. The interior of any sponge is crowded with minute life and recently an investigation proved that a sponge about as large as a wash-tub contained 17,128 individual animals. These included small slender fish, about an inch long, which moved around in the sponge canals. No doubt in palaeozoic times the Sunflower Coral, with a somewhat similar sponge structure, was also invaded with the minute life of those days.

The first fossil remains of these strange unattached platter-shaped organisms were described by Defrance in 1827. The specimens were found in Devonian rocks in the neighbourhood of Chimay, Belgium, and were named *Receptaculites*, meaning a stone receptacle. The specimens were not well preserved and certain characters were imperfectly shown or entirely missing. Defrance considered that the regular arrangement of the rhomboidal plates of the outer surface was similar to the scales on the cone of a pine-tree. He was in doubt whether the specimens were marine organisms but finally concluded that they might belong to the order of Polyps, which in general includes creatures with a cylindrical body and a mouth at one extremity.

A few years later Goldfuss described and figured two fragments of the same species already described by Defrance. The places occupied by the connecting columns or pillars were vacant and Goldfuss compared the tubes to the canals in the siliceous sponges, referring his specimens to the genus *Coscinopora*.

In 1839, Murchison examined some specimens preserved in a shaly limestone from Silurian rocks at Ludlow in England. Not suspecting they had any relationships with *Receptaculites* he referred them to Mr. König, who expressed an opinion that they might belong to the Ascidiae, a group of primitive vertebrates commonly known as "Sea Squirts." This view was upheld by another author a few years later after examining further specimens of the Receptaculitidae, but Professor Phillips in 1841 regarded them as Cystideans, stemmed or stemless echinoderms with a globular test composed of many small plates which are arranged with or without any symmetry.

In the following years authors described many additional specimens of the Receptaculitidae and they were referred to still other animal groups including the Foraminifera, the corals and also to the sponges. A great deal has now been written on this group but there is still no certainty or unanimity of opinion.

A good deal of research has been carried out on *Receptaculites* found in the lower and middle palaeozoic rocks of Australia. From an examination of a large number of specimens it was decided that only one species, *Receptaculites australis* Salter is represented and these occur mainly in rocks of Silurian and Devonian age. It was found that there is considerable variation between certain specimens but these may be linked by other material showing regular gradations in characters. All the Australian specimens are fragmentary and it was impossible to add any definite information regarding the shape of these organisms. The specimens consist of portions which are curved or platter-shaped and others which indicate they originally belonged to oblong or cylindro-conical bodies. One specimen has a surface five inches long by three inches wide, with one of the sides curved almost at right angles. Others from the Yass district are circular and oval in section so that it would appear that possibly the platter-shaped specimens are definitely only fragmentary and are portions of a much larger body the exact shape of which is still unknown.

The Story of Galaxias

By GILBERT P. WHITLEY

ONE of the fishes observed by the French settlers in the Falkland Islands in 1764 may have been a *Galaxias*, but the account of it[1] is not detailed enough for us to be sure. So our story of *Galaxias* really begins on 18th April, 1773, with Captain Cook at Dusky Bay, New Zealand, when, in an inland lake, one of the naturalists noted, "a small species of fish (*esox*), without scales, resembling a little trout; its colour was brown, and mottled with yellowish spots in the shape of some ancient Asiatic characters."

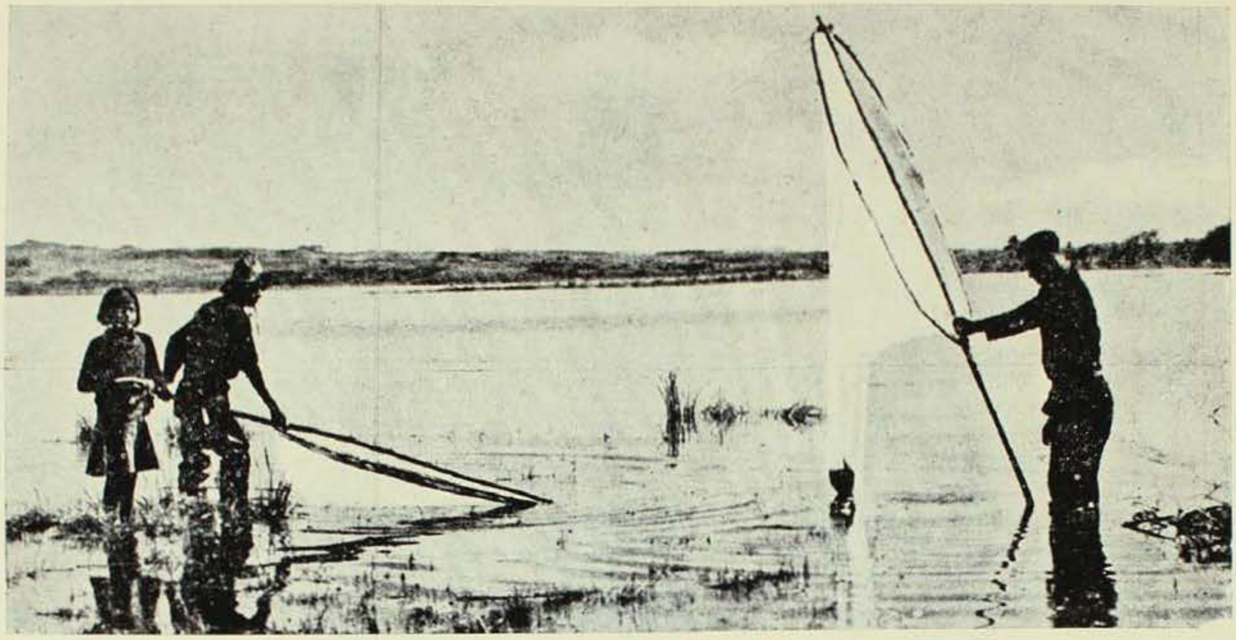
Esox is the scientific name of the pike and the species was named *argenteus* by Gmelin in 1789, but Cuvier invented for our fishes the generic name *Galaxias*, which means the Milky Way, or a galaxy of stars, probably because of their coloration. In 1802, Peron, another great French naturalist, found the beautifully coloured *Galaxias truttaceus* in Tasmania, and, much later, Darwin, aboard the *Beagle*, collected several more species. By the middle of our twentieth century, eighty-eight nominal species had been named, though the true number of species would be fewer (probably about fifty) because some were named twice or several times over. A list of these names and the countries from which each kind came is tabulated on page 34.

The general appearance of *Galaxias* may be gauged from the illustrations to this article. Many country folk confuse these small freshwater fishes with young trout, but a trout has scales and a little "fat-fin" (adipose dorsal) between the true dorsal fin and the tail, whereas *Galaxias* is without scales and lacks the fat fin; the small mouth and the teeth on jaws and palate are also characteristic of *Galaxias*, which is known in Australia as New Zealand Whitebait, Mountain or Native Trout, Jollytail and Eel Gudgeon.

The usual length of our species is from $2\frac{3}{4}$ to 7 inches, depending on age and species; the giants of the tribe in Australia are the mountain-loving *Galaxias coxii* ($8\frac{1}{2}$ in.) and *G. auratus* (9 2/3 in.). These are dwarfed by one New Zealand species, *G. argenteus*, which has been reported to grow to 23 inches in length. It is appropriate that this Giant Galaxias should hold pride of place since it was the one discovered by Cook's naturalist (Forster) in 1773. I have seen Forster's original manuscript account of it in the British Museum (Natural History); his was a dull green fish with yellow horseshoe-shaped "Asiatic" marks, the unpaired fins dark greyish, paired fins greenish, and belly yellow.

The Galaxiid fishes are of particular interest on account of their distribution: they are found in fresh water from sea-level to the tops of mountains, in rivers, lakes and tarns; some, like the Whitebait migrate to and from salt water but none of them seems to travel far out to sea; several kinds like to burrow in peat and soft clay. Study of the table of species shows that numerous kinds have been found in southern Queensland, New South Wales,

[1] A Voyage round the World . . . . by . . . . Bougainville. Translated from the French by J. R. Forster (Dublin, 1772), p. 70.



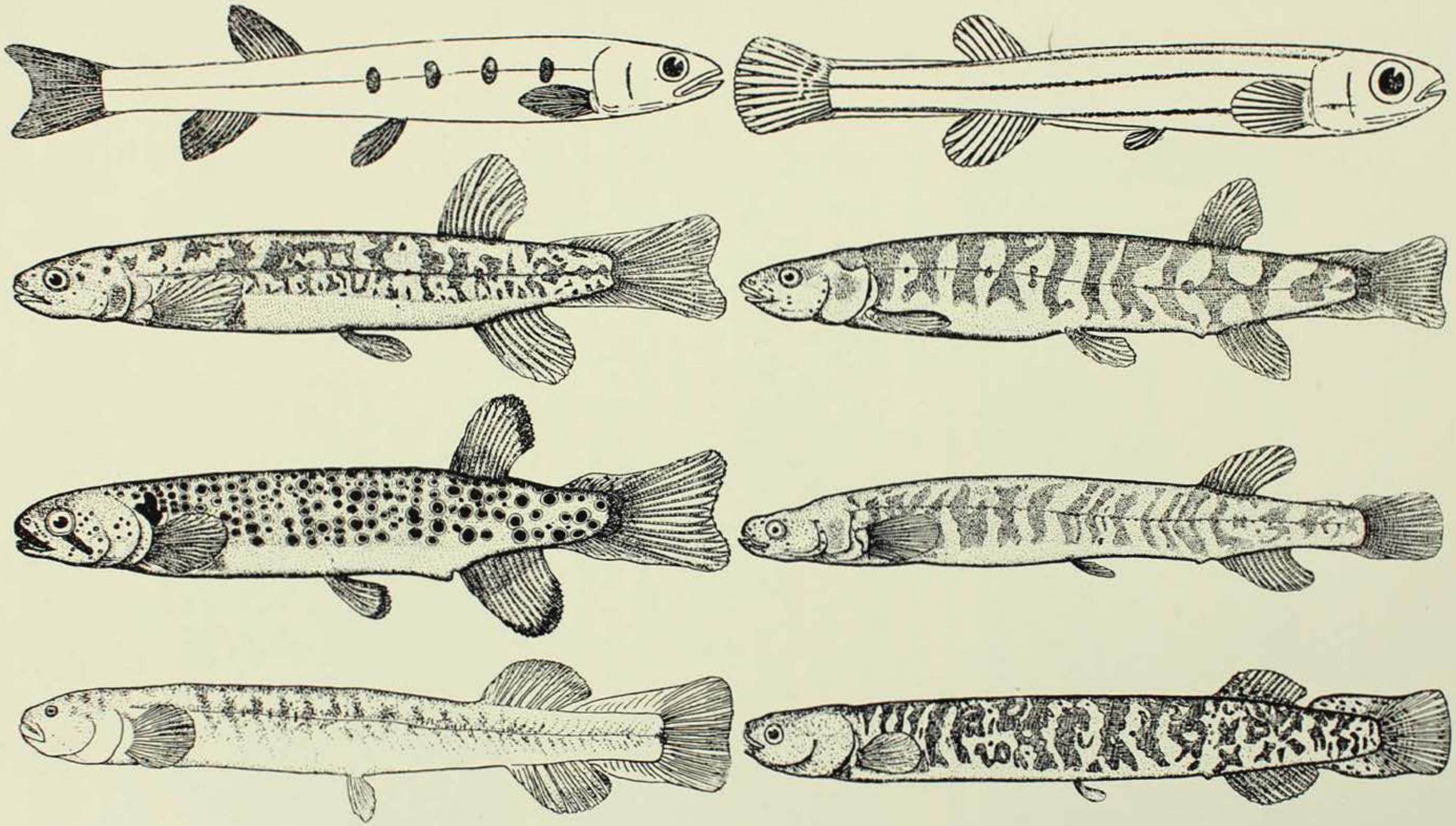
Maoris netting whitebait near Te Kohanga, New Zealand.
Weekly News (Auckland), *circa* 1937.

Victoria, Tasmania, South Australia, south-western Australia, North and South Islands of New Zealand, Lord Howe Island, the Aucklands, Campbells and Chatham Islands off New Zealand, Argentina, Patagonia and adjacent islands, Chile, Magellan Straits, Tierra del Fuego, the Falkland Islands and South Africa. An Indian and a New Caledonian species, though originally named *Galaxias indicus* and *neocaledonicus*, are nowadays separated from the genus, whose distribution can thus be encompassed by a huge circle, with the South Pole as its centre and with the circumference near the 30° S. lat. meridian; its southern limit may be taken as the 60° S. lat. meridian.

A handful of the tiny fish known as Whitebait, from the Waikato River, New Zealand.
Weekly News (Auckland), *circa* 1937.

This remarkable distribution for fishes which cannot stand sea water for long makes us wonder how the Galaxiidae originated and were dispersed—perhaps by means of land-links now vanished, or left behind as relics of some great Antarctic continent. Theodore Gill in 1893 reviewed some of the means of dissemination which had been suggested by various students: some of the fishes might have been encased in drifting icebergs and carried to more congenial waters; they might have survived a long sojourn in salt water which would be fatal to them nowadays; or they may have originated from similar species formerly oceanic but now extinct therein and restricted to fresh water, but he thought it highly improbable that all the forms common to such distant regions could have been so fantastically distributed.

Dollo, Regan, Hedley, Waite and other scientists have pondered the problem of the curious range of *Galaxias* and the modern view seems to favour a large Antarctic continent's existence in pre-Tertiary times. This has since regressed



A SELECTION OF AUSTRALIAN GALAXIIDAE.

1. *Galaxias fuscus*, from Victoria.

2. *Brachygalaxias pusillus*. Victoria.

3. *Galaxias johnstoni*. Tasmania.

4. *Galaxias parkeri*. Great Lake, Tasmania.

5. *Galaxias scopus*. Islands of Bass Strait.

6. *Galaxias upcheri*. S.E. Tasmania.

7. *Saxilaga cleaveri*. N.W. Tasmania.

8. *Saxilaga anguilliformis*. N.W. Tasmania.

Nos. 1-2, after Mack; 3-6, 8, after Scott; 7, original reconstruction.

leaving patches where *Galaxias* still lingers, or perhaps the land-masses have shifted their positions to some extent.

Certain other animals with distribution similar to that of *Galaxias* may be mentioned here. Earthworms such as *Acanthodrilus* "so thoroughly wedded to the soil and . . . so impatient of sea-water"; freshwater crustaceans having curious parasites known as *Temnocephala;* several kinds of plants and insects, and the Grayling (*Prototroctes*) of Australasia which is related to the South American fish, *Aplochiton*—these have evidently been left behind by the shrinking of the old Antarctic continent so that their modern range more or less coincides with that of the Galaxiid fishes. Such phenomena must have a common explanation. The Lampreys of the genus *Geotria* are very similar in Australia, New Zealand and South America. So are some of the purely marine fishes: barracouta, kelpfish, nototheniids and others, whilst ornithologists find the same similarity in petrels, gulls and cormorants from those regions. Certain shore shells and loricates or chitons are found in South America and Tasmania, as well as on Kerguelen and other isolated circum-Antarctic islands. *Galaxias* has not so far been found in these islands; if it ever existed in them *Galaxias* would have been exterminated by the Pleistocene glaciation.

It was not until 1936 that a fossil *Galaxias* was found, in Pliocene deposits of diatomaceous shale at Kaikorai stream, near Dunedin, New Zealand. When complete this fish would have been between 7½ and 8½ inches long, and probably lived in fresh water rather than salt, at a time when Dunedin's climate was warmer than it is now. Though this interesting fossil has been described and figured,[2] it has not yet been specifically named.

The New Zealand Whitebait of commerce consists of the young or larval specimens of several species of fish which ascend rivers in hordes towards the end of the year. The dominant species is a "Galaxias" known as *Austrocobitis attenuatus.* When the whitebait run, nets of all kinds are used by both whites and Maoris and the packed mass of succulent fish is either consumed on the spot, or canned for export. The Maoris used to catch these Galaxiidae in green flax nets, pile them on hot stones, cover them with mats and earth for about half an hour, but without the addition of any water. Thus prepared, if not for immediate use, they were firmly packed in tightly plaited baskets, in which they would keep for months. The quantity of whitebait taken varies considerably from year to year, being dependent on wet or dry seasons and many other factors; consequently prices vary too.

In 1932, a restriction was imposed on taking whitebait in New Zealand. The Maoris objected, claiming that they were immune from the regulations under the Treaty of Waitangi. "Consequently," quoth their spokesman, "no enactment nor regulation can override the Maori fishing rights, which enable Maoris to catch Whitebait in any manner . . . . . in any New Zealand water . . . For this we return thanks to the Father, Son, Holy Mother, the Holy Angels, the Faithful Angels, and their and our own mouthpiece, Piri Wiri Tua, for ever and evermore." Actually the restriction was on the taking of Whitebait for sale and in that respect was enforced on Maori and Pakeha alike; Maoris were able to take the fish for their own consumption.

Our story of *Galaxias* began in New Zealand in the eighteenth century. It is time to bring it to a conclusion. Is it "to be continued" and will there be a happy ending? Or will these unique little relics of an ancient age be replaced by introduced fishes, such as *Gambusia, Salmo, Tilapia,* and other horrors heaped on them by mankind?

The following list of the eighty-eight nominal species of *Galaxias* (in the broadest sense) gives a modern idea of the numerous kinds named and where each came from.

[2] Oliver, 1936, Trans.Roy.Soc.N.Zeal. 66: 284 & 286; and Stokell, 1945, *ibid.* 75: 134-136, pls. xi-xii.

abbreviatus Clarke—New Zealand.
affinis Regan—Tasmania.
alepidotus Bloch & Schn.—N.Z.
alpinus Jenyns—South America.
amaenus Castelnau—Victoria.
anguilliformis Scott (*Saxilaga*)—Tas.
argenteus Gmelin—N.Z.
atkinsoni Johnst.—Tas.
attenuatus Jenyns (*Austrocobitis*)—N.Z. (type). Recorded from Lord Howe I., S.E. Australia, Tas., S. America & Falkland Islands (many synonyms).*
auratus Johnst.—Tas.
bollansi Hutton—N.Z.
bongbong Macleay—New South Wales (type), Vic.
brevipinnis Gunther—N.Z. & subantarctic islands.
brocchus Richardson—Auckland Iss.
bullocki Regan (*Brachygalaxias*)—Chile.
burrowsius Phillipps (*Lixagasa*)—N.Z.
*campbelli** Sauvage—Campbell Iss.
capensis Steind.—South Africa.
castleae Whitley & Phillipps—N.Z.
charlottae Whit. & Phill.—N.Z.
cleaveri Scott (*Saxilaga*)—Tas.
coppingeri Gunth.—Magellan Strait.
coxii Macl.—N.S.W., Vic.; S. Australia?
*cylindricus** Cast.—Vic.
delfini Philippi—S. America.
*delicatulus** Cast.—Vic.
dissimilis Regan (*Paragalaxias*)—Tas.
dubius Gilchrist & Thompson—S. Africa.
fasciatus Gray—N.Z., Auckland & Chatham Iss.
findlayi Macl.—N.S.W.
forsteri Cuv. & Val.—N.Z.
fuscus Mack—Vic.
globiceps Eigenmann—S. America.
gracillimus Canest.—S. America.
grandis Haast—N.Z.
grandis Philippi (=*platei*)—S. America.
grandis Clarke (=*argenteus*)—N.Z.
hesperius Whitley—W. Australia.
huttoni Regan—N.Z.
indicus Day (not a true *Galaxias*)—Bengal & Madras.
johnstoni Scott—Tas.
kayi Ramsay & Ogilby—S. Australia.
koaro Phill.—N.Z.
kokopu Clarke—N.Z.
*krefftii** Gunth.—N.S.W.
lynx Hutton—N.Z.
maculatus Jenyns (=*variegatus*)—S. America & Falkland Is.
*minutus** Philippi—S. America.
*nebulosus** Macl.—N.S.Wales.
neocaledonicus Weber & Bft. (*Nesogalaxias*)—New Caledonia.
nigothoruk Lucas—Vic.
nigrostriatus Ship. (*Brachygalaxias*)—Western Australia.
*obtusus** Klunzinger—Vic.
occidentalis Ogilby—W. Australia.
ocellatus McCoy—Vic.
oconnori Ogil.—S. Queensland & N.S.W.
olidus Gunth.—? Queensland.
ornatus Cast.—Vic.
parkeri Scott—Tas.
paucispondylus Stokell—N.Z.
planiceps Macl.—N.S.W. & Vic.
platei Steind.—S. America.
postvectis Clarke—N.Z.
prognathus Stokell—N.Z.
*pseudoscriba** McCoy—Vic.
*punctatus** Gunth.—N.S.W.
punctifer Cast.—S. Africa.
punctulatus Philippi—S. America.
pusillus Mack (*Brachygalaxias*)—Vic.
reticulatus Rich.—Auckland Iss.
robinsoni Clarke—N.Z.
rostratus Klunz.—S. Australia.
schomburgkii Peters—S. Australia.
scopus Scott—Iss. of Bass Strait.
*scottii** Ogilby—N.S.W.
*scriba** Cuv. & Val.—N.S.W.
shannonensis Scott (=*Paragalaxias dissimilis*)—Tas.
smithii Regan—Falkland Islands.
titcombi Everm. & Kend.—Argentina.
truttaceus Cuv.—Tas. & Vic.
upcheri Scott—Tas.
variegatus Lesson—Falkland Iss. & S. America.
*versicolor** Cast.—Vic.
vulgaris Stokell—N.Z.
waitii Regan—N.S.W.
*waterhousii** Krefft—S. Australia.
weedoni Johnst.—Tas.
zebratus Cast. (*Agalaxis*)—S. Africa.

In New Zealand there is a related genus, *Neochanna*, with two species, *apoda* and *diversa*.

*Specific names marked with an asterisk in the above list have been regarded as synonyms of *attenuatus* by authors.

Polynesian and New Guinea Specimens Studied.

Major Donald S. Marshall, Research Anthropologist for Polynesia at the Peabody Museum, Massachusetts, examined Polynesian specimens in the Museum during a four-day visit to Sydney. Although not numerous in relation to the anthropological collection as a whole, the Polynesian specimens include some rare pieces, particularly among the Sir Joseph Banks and Captain Cook material; there are also some fine examples of Maori greenstone carvings and implements in the Sir William Dixon series. In the Mammology Department, Major Marshall made a study of a series of crania of Polynesian natives, in connection with researches into the origin and distribution of races of the south-west Pacific region.

On his way to spend a year in anthropological research in the eastern highlands of New Guinea, Dr. Carl A. Schmitz, from the Rautenstrauch-Joest Museum, Cologne, Germany, made a detailed study of the Museum's specimens of bark-cloth from New Guinea.