

The
AUSTRALIAN
MUSEUM
MAGAZINE

EDITED BY C. ANDERSON, M.A., D.Sc.



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A diver rigged ready for descent. In the background are purling luggers anchored under one of the islands of Torres Strait.

[Photo.—*Captain Frank Hurley.*]



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Editor: C. ANDERSON, M.A., D.Sc.

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VOL. II., No. 1.

JANUARY, 1924

Editorial

Children and Museums.

THE children of to-day are the adult citizens of to-morrow, and it is the duty of grown-ups to insure as far as possible that they shall be good citizens. In this work museums can co-operate with other educational agencies, particularly in the direction of inculcating a feeling for nature and all its wonders.

It is with this object in view that the Trustees propose to inaugurate in the coming year a series of lectures for school children. Our ordinary lectures are held in the evening and young children are unable to attend, but the projected school lectures will be delivered in the day-time. They will be illustrated by specimens, by lantern slides, and, it is hoped, by suitable films. The Department of Education will be asked to co-operate in this enterprise, and no doubt nature-study teachers will have valuable suggestions to make as to the subjects most appropriate for lectures.

Many museums now have a children's room, containing exhibits specially selected to interest and instruct juveniles, and installed in cases adapted to the stature of its patrons. At present we have no room suitable for this purpose, but it is intended that when the much-needed extension of the buildings is under consideration, provision will be made for a comfortable well lighted hall of moderate dimensions which can be devoted to the interests of child visitors.

The Children's Museum, Brooklyn, N.Y., established in 1899, is perhaps the best equipped and oldest institution of its kind in the world; it is well staffed, has its own library and lecture room, a tree club, a wood-craft league and a children's museum league; it arranges programmes for scouts and organizes children's parties and field trips. With our limited resources we cannot aspire to such flights, but we earnestly desire to do what lies within our power to interest the little ones, to instruct them and to make them into missionaries.

Notes and News.

Major-General Sir Charles Rosenthal, K.C.B., C.M.G., D.S.O., V.D., M.L.A., was elected a Trustee of the Australian Museum at the October meeting of the Board. The new trustee, who is an architect by profession, had a distinguished record in the late war. He commanded the 3rd Field Artillery, 1st Australian Division, during the Gallipoli Campaign, and served later in Sinai, France, and Belgium, commanding the 2nd Australian Division at Hamel, Villers Bretonneux and other engagements, till the close of the war. Sir Charles was wounded seven times and eight times mentioned in despatches. He was awarded the Belgium Croix de Guerre, 1917, the French Croix de Guerre, 1918, and the French Legion of Honour, 1919.

Among the groups now under construction in the Museum is one representing a Papuan ravi. These large community houses were formerly used as fortresses, but now they are mainly club-houses, where the men gather to feast, smoke and generally have a good time. Most of the material used in this reconstruction was obtained by Captain Frank Hurley and Mr. Allan R. McCulloch, during their recent trip to New Guinea.

A habitat group in preparation will show a number of large fruit bats, the so-called flying foxes (*Pteropus policephalus*), collected in characteristic attitudes amongst the branches of a tree.

A commencement will shortly be made with the aboriginal group, the gift of Mr. Ernest Wunderlich, Trustee.

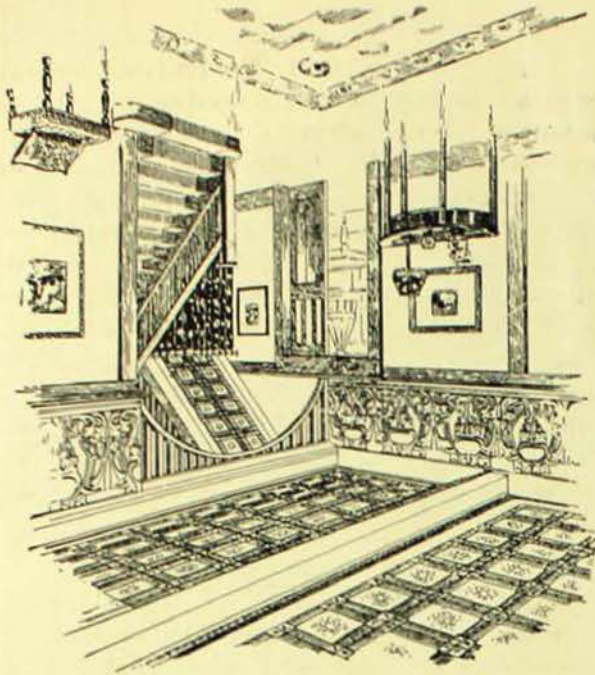
The retaining wall and embankment on the William Street frontage have now been completed, resulting in a marked improvement to the northern aspect of the Museum. We are greatly indebted to Mr. J. H. Maiden, Director of the Botanic Gardens, and his staff, for their advice and assistance in the matter of providing suitable shrubs and flowers for the area.

During October and November, several lectures, which were attended by large audiences, were delivered in the Museum. On October 24th, Mr. T. Hodge Smith lectured on "Sulphur; its Occurrence and Production." This address was illustrated by an instructive film, kindly lent by the American Trading Company of Australia. On November 8th, Mr. A. Musgrave delivered a lecture entitled "A Naturalist on the Nepean," illustrated by a fine series of coloured slides prepared by himself. An interesting lecture "Ten Months on the Kermadec Islands," was delivered by Mr. Tom Iredale, on 22nd November.

On October 10th, Mr. J. R. Kinghorn delivered a Museum extension lecture at Borenore, near Orange. The lecture was given under the auspices of the local agricultural bureau, which made all arrangements. The subject was "The Value of Birds to Man," and it will shortly be published in *The Agricultural Gazette of New South Wales*. The interest shown in the extension lecture scheme by country residents was clearly demonstrated on this occasion, the hall being overcrowded, many having travelled a considerable distance to attend.

Dr. F. Krenkow, of London, who specialises in Semitic languages, but is also a keen entomologist and interested in all branches of natural history, was in Sydney for a short time last year, and we were able to assist him slightly in his researches. Dr. Krenkow has made an abundant return, in presenting to our library Ganglbauer's four magnificent volumes on the beetles of Central Europe. In a communication to the Premier, Sir Timothy Coghlan, Agent-General for New South Wales writes: "It is understood that these works are not in the library of the Museum, and are practically unobtainable; they are presented to Dr. Anderson, and his staff, in recognition of much kindness he (Dr. Krenkow) received at their hands during his visit to Australia last year." Our grateful thanks are accorded to Dr. Krenkow for this valuable donation.

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Australian Pearl Fisheries.

BY CHARLES HEDLEY.

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IT would seem absurd to call a taste for pearls "old-fashioned," but wearing pearls was an ancient custom in the days of Greece and Egypt, when Phoenician traders bartered there the jewels brought from the coasts of Arabia and Ceylon.

cities of Mexico and Peru, the civilised Indians had amassed great stores of pearls, all of which were ruthlessly seized by the conquerors. Then, as now, the Gulf of California was the principal seat of the fishery, which was also prosecuted at Panama and Venezuela.



A stack of the giant or silver-lip pearl shell, cleaned, graded, and ready to be packed for export in the regulation case behind. The man exhibits two extra large specimens, that in his right hand being twelve inches in diameter.

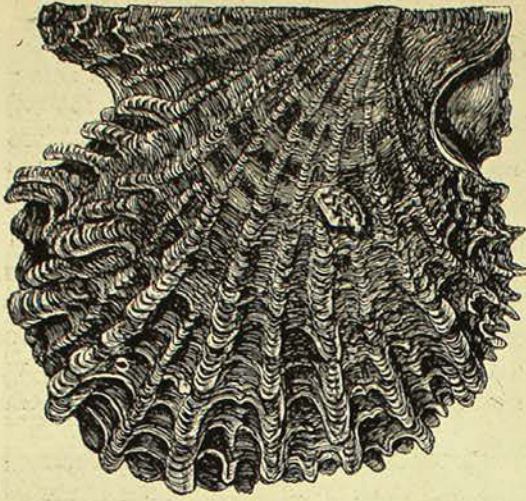
[Photo.—Captain Frank Hurley.]

Stories of beautiful pearls contained in the river mussels of the mountain brooks induced Julius Caesar to invade Britain. On his return to Rome, Caesar presented as a trophy to the temple of Venus a shield covered with British pearls.

Many centuries later it was the wealth of pearls to be obtained there that attracted the Spaniards to America. In the native

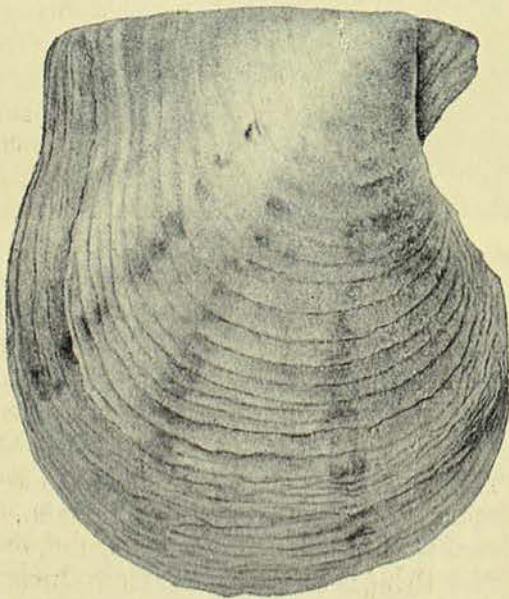
About the middle of the last century a third pearl fishery was discovered in the South Sea Islands, having its head quarters in Tahiti.

The fourth and last great pearl field to be found was that of Northern Australia. This covers a wider space than any other, extending for three thousand miles from Queensland through Torres Strait to Western Australia. It is also noteworthy for producing the largest



Pinctada margaritifera, the black-lip pearl shell.
[After J. E. Tennent.]

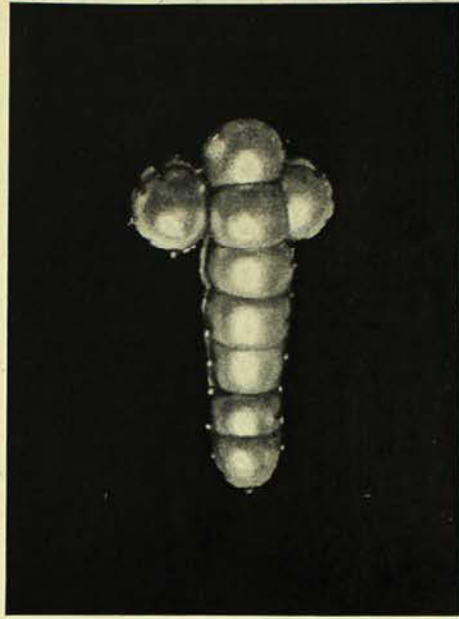
pearl shell, the Giant Pearl Shell, *Pinctada maxima*, a pair of which may reach as great a weight as 14 lbs., and a diameter of about a foot. Associated with this is the ordinary pearl shell, *Pinctada margaritifera*, locally called the "Black-lip," about 1½ lbs. in weight, and seven inches in diameter, varieties of which occur in the Asiatic, Polynesian, and American fishing grounds. A third kind is *Pinctada carchariarum*, the "Sharks Bay shell" of the trade. This is confined to Western Australia; it is a small shell, valuable only for the pearls it contains. The Sharks Bay shell is different in habits and appearance from the others. It grows in thick clusters and is gathered, not by diving, but with rakes and dredges. The animal is



Pinctada carchariarum, the Sharks-Bay pearl shell.
[After H. L. Jameson.]

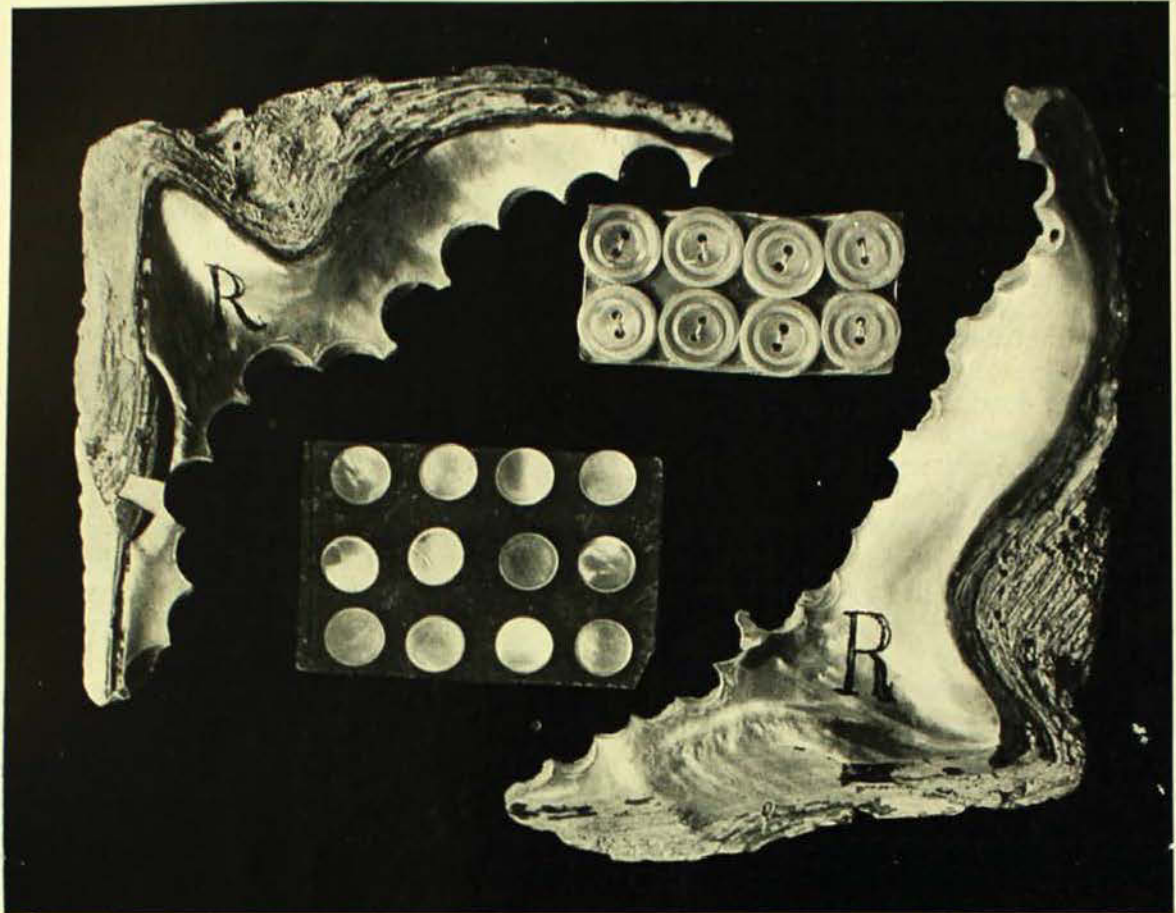
torn from the shell and thrown in masses into barrels to rot. After putrefaction has softened the mass, the pearls it contained are sieved out.

Several other kinds of small shells, of which no use is made, are known to the fisherman by the general name of "Bastard Pearl shell." Though commonly called "Pearl oysters," none of these shells are true oysters, they are more nearly related to the mussels.



The "Southern Cross" compound pearl.
[After W. Saville-Kent.]

When pearling was carried on at a distance from the beach, the men generally abstracted valuable pearls from the shell before it was brought ashore. Finding that the taking of pearls could not be controlled, the owners made a virtue of necessity and granted all pearls as perquisites to the men. Hardly a year passes without the discovery in Australian waters of a first class gem worth a thousand to three thousand pounds or even more. The celebrated "Southern Cross" pearl was found in 1883 off Baldwin, W.A. It takes the form of a Roman Cross; the shaft, one inch and a half in length, is composed of seven amalgamated pearls packed together like peas in a pod; the arms are an ill-balanced pair, one on either side of the last pearl but one of the shaft. The individual pearls are quite ordinary and the value of £10,000 placed on it by the owner was based on the interesting and unusual form of the aggregate. Probably the finest pearl ever found in Australian waters is a drop-shaped gem, the size of a sparrow's egg, weighing 100 grams, which



The butt end of the giant pearl shell left over by the factory. From such were sawn button blanks, of which a dozen small ones are shown. Such are polished, drilled and carded to form the finished article. The keel or butt end of the shell supplies handles for parasols and umbrellas.

[Photo.—Captain Frank Hurley.]

was taken in 1917 on the Western Australian coast. It was named the "Star of the West" and valued at £14,000.

The exquisite lustre of a pearl, its delicate play of soft colours depends upon the perfection of its surface. The eye naturally assumes that because the surface is so glossy it must be perfectly smooth, but on the contrary the lustre actually depends on that surface being broken. The nacre, that is the mother-o'-pearl stuff, whether lining the oyster or composing the pearl, is seen when highly magnified to be delicately rippled. The play of colours is caused by refraction, and reflection in different directions of light striking the ripples at various angles, and the lustre is also complicated by reflections from buried surfaces through transparent layers. An iridescence may be obtained from the impression in fine wax of a nacreous surface; this shows that the pearl itself has no more intrinsic colour than the raindrops of a rainbow. In each case the colours result from splitting compound light into its elements.

So the reason why pearls are easily dulled is that, when wear or acid destroy the microscopic ribbing, it ceases to refract light and the lustre disappears.

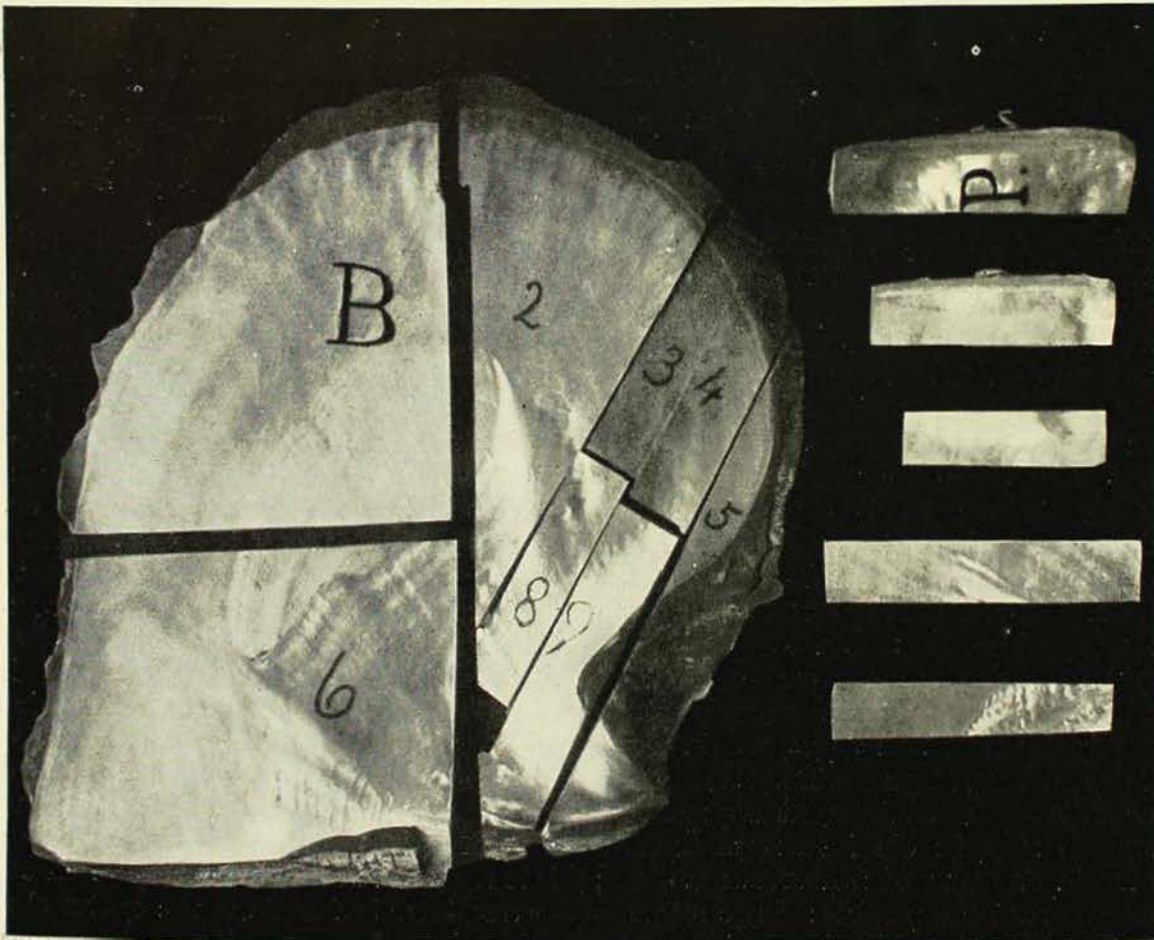
A question that has puzzled many wise heads is—How do pearls grow? Oriental poets replied that they grew from dew drops swallowed by the oyster, but that explanation has failed to satisfy modern science. In practice the shellers find that a healthy well-grown oyster rarely has a pearl, but that deformed crumpled shells are likely to possess them. This indicates that pearls are a consequence of ill-usage or disease. The inside of the pearl shell, except the border, is lined with mother-o'-pearl. Pressed against each sheet of nacre is a flap of skin called the mantle; this is edged with glandular cells secreting a slime that on exposure hardens into nacre. Should any grit, a grain of sand or a splinter broken from the oyster shell, be driven into the mantle it may be folded into a pocket lined with nacre-secreting cells. Lying in such a pouch the foreign substance

will be coated like a ball and adding coat to coat grow into a pearl. Parasites which have burrowed into the mantle may be smothered in nacreous slime and form a nucleus for successive wrappings of nacre. When pearls are sectioned the jaws or body of a minute tape worm or such parasite have been found embedded in the centre. Just as an onion bulb has one skin over another, so a pearl is composed of layer upon layer. Advantage of this is sometimes taken by jewellers, who strip a large pearl with a bad surface to obtain a smaller one underneath of better lustre and higher value.

The pearling industry is a double headed trade, on the one side pearls, on the other, shell. In Australia, the shell is the main line and the pearls are subsidiary. The shell is exported to be manufactured into knife handles, buttons, and such like mother-o'-pearl goods. Process of manufacture is shown by the accompanying illustrations photographed by Captain Frank Hurley from Mr. Hocking's museum at Thursday Island. One illustration shows a valve cut by the

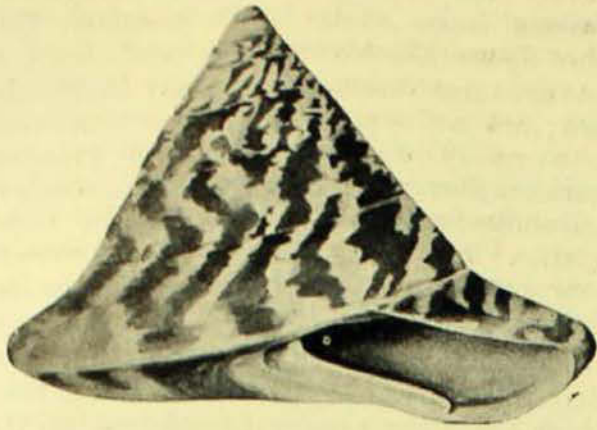
factory into slips, so as best to economise material intended for knife handles. The other figure illustrates the manufacture of the finest pearl buttons; here the blanks are sawn out by fine toothed revolving steel cylinders. The blanks are then ground, polished, pierced, and carded for the market.

A serious competitor in the button trade appeared in the fresh water mussel, *Quadrula ebena* from the Mississippi River. In the United States are many kinds of large and richly nacreous fresh water mussels, some of which produce a large harvest of handsome pearls. In 1892 the first American factory was set up in Iowa to utilise these shells, till then neglected, for buttons. The industry grew so rapidly that by 1912 as many as 6,400 people were employed in the business, and 48,000 tons of mussel shells were made into 25,200,000 gross of buttons. When material from the American freshwater mussel failed to satisfy the increased demand of the button manufacturers, a world-wide search was made for a fresh source of supply. About 1909 this was discovered in *Trochus*



A left or flat valve of the giant pearl shell, illustrating the first saw cuts made in the factory. "P" slips for making knife handles and dessert services.

[Photo.—Captain Frank Hurley]



Trochus niloticus, the button shell.

[Phyllis F. Clarke, del.]

niloticus, a pyramidal univalve shell about three inches high, painted with red stripes on a white ground and richly nacreous within. It lives on coral reefs of Northern Australia both on the surface and in depths of several feet, where it is gathered by diving. It is, or was, abundant on the whole of the pearling grounds. The fish is extracted either by cooking or by rotting out in the sand. In 1916, Queensland exported 950 tons, and in 1921 the export was 344 tons; as the supply diminished the price rose from £30 to £100 a ton. Japan is practically the only market for this. Probably the *Trochus* would be an excellent subject for cultivation and would be much easier to manage than the pearl oyster.

The first discovery of pearl-shell in Australia is said to have been made in 1861, by an American sailor called Tays, who was shortly afterwards drowned on the North West coast. The pioneer in Queensland was Captain Banner of the brig *Julia Percy* from Sydney. In 1868 he commenced operations on the Warrior Reefs on the north side of Torres Strait. Banner died soon after and was buried on Warrior Island, where an elaborate tombstone was erected to his memory by a grateful Sydney speculator whom he had enriched.

At first, the shell was gathered from the beach at low tide, and the natives, when they had exhausted this supply, waded and dived for it in deeper water. Later the shell was raised by diving from boats in two or three fathoms. The profits to the earliest collectors were enormous; prices were three or four hundred pounds a ton, and the shell, which had accumulated for ages, lay thick upon the bottom and was of the finest quality. Already in 1871 ten vessels engaged in Torres

Strait secured about two hundred tons, and twelve vessels in Western Australia took one hundred and eighty tons. In 1878 the Queensland fishery employed 700 people, producing 425 tons valued at £112,320.

The naked divers found their limit at from forty to fifty feet, but the shell was seen to go much deeper. From the Japanese the natives adopted the use of diving spectacles or close fitting goggles. About 1879 the diving dress, like that worn by the man in the frontispiece, was introduced into Torres Strait, where this modern method is distinguished as pump diving, as against skin diving. Above his ordinary clothes the diver puts on a waterproof overall one-piece suit, then a pair of huge boots each soled with a 25lb. weight. Thus clad, he takes his stand on a rope ladder hung overboard, while an attendant completes his toilet by strapping on his shoulders weights of 28lb. each, fastening the helmet to the collar of his dress, attaching the air pipe and finally screwing in the glass face of the helmet; then the signal "all right" is tapped on the glass. Away goes the diver holding on to a guide rope till he reaches bottom, when he jerks the rope to say "safe down." All the time that the diver is below, his particular attendant, the tender, holds the life line in his hand to receive and interpret the messages telegraphed by a prearranged system of pulls. Another man waits ready to execute the diver's orders immediately. Two men work the pump that sends down fresh air for the diver to breathe, while another has especial charge of the pipe that conveys it.

In the 'seventies the divers, who were then white men, commonly realised £500 a year, while the owners made fortunes, as new and rich fields were opened in deeper water. But even before 1880, the rate of remuneration failed to attract and retain white labour, and the pearling fleet was usually manned by Asiatics.

Diving is a very dangerous occupation, and, every year, men who are tempted by a rich patch of shell to exceed the limits of safety are killed or crippled by paralysis. Descent into the deepest parts of the pearling ground was forbidden by law. It would be supposed that the danger was in the descent, but on the contrary, it is the ascent, when performed too rapidly, that causes trouble. In the manufacture of soda water, gas is forced into water under pressure, and when

the bottle of soda water is opened, the gas escapes in bubbles and effervesces. Similarly, when the diver descends, he undergoes more and more pressure, which forces gas into his blood. As he ascends the gas is released, and too sudden a release induces violent effervescence. Should the blood bubble into the brain or spinal column, paralysis would ensue. The remedy against diver's paralysis, is to ascend very slowly, and by stages, from great depths.

The giant pearl shell is gathered not on the coral reefs but in passages between the islands, where it lies on mud or sand, often hidden in the sea grass. The best positions are where a brisk current of not less than three knots an hour sweeps over a space of perfectly level ground, ten to twenty fathoms deep. To prospect such a place for payable shell, the anchor is let down for a few feet, but still swinging clear of the ground. On this, a diver in his dress sits astride, and, as the vessel drifts with the tide, he watches the sea floor as it passes underneath. When he sees a patch of shell or a likely bed of weed that might hide it, the diver jumps off his perch and sets to work.

After the easily accessible grounds had been stripped, a new field, richer than any other, was discovered in 1881; this, which was later known as the "Old Ground," is an area of open water, stretching from Cape York towards New Guinea. Here was abundance of shell of the finest quality, though not rich in pearls. Methods of fishing were now re-organised to develop an area so distant from a land base. Frequent and wasteful trips ashore were saved by composing the fleets into parties of small luggers attendant on a larger schooner serving as depot and administrative centre. Such revived prosperity induced more boats to enter the trade with better means for diving and raising shell, but a consequence of so energetic a campaign was that the wealth even of the Old Ground soon became exhausted. About 1885, the harvest had seriously diminished, and several pearling masters with a number of vessels migrated to fresh fields in Western Australia. These adventurers afterwards suffered severely from a cyclone, and, hearing that the Torres Strait beds had made a partial recovery, they returned east in 1890. The riches of the 'seventies and early 'eighties, the good old days when seven hundred pair went to the ton, had gone for ever, but moderate profits

might still be made by close search and better management.

A dreadful disaster happened in March, 1899; while the pearling fleet were working on a newly discovered bed in Princess Charlotte Bay, a hurricane arose and dashed the whole fleet on the beach under Cape Melville. No fewer than fifty-four vessels were wrecked, and twelve white, 295 coloured men were drowned.

By 1905 over-fishing had further impoverished the Torres Strait field, and more than a hundred vessels were transferred to the Aru Islands in Dutch territory to seek fresh deposits. No large harvest has since been reaped in Torres Strait, and no new ground remains to be discovered, but cessation of work during the war has partially restored the beds. Fortunately, it happens that some rich beds of pearl shell remain near Darnley Island, inaccessible because of the great depth of water in which they lie, to provide a natural reserve for breeding. From this nursery, which lies to windward of the main fishery, spat will spread in time to restore the beds stripped bare by the shellers. Like the Alaskan sealers and the Canadian salmon fishers, the first Australian pearl-shellers acted wastefully and selfishly, without a thought of preserving the industry for future generations. An Act was passed in 1891, making it illegal to gather shell under a minimum of six inches diameter of the nacreous layer. But, because some shellers protested against this restriction, the diameter was in 1897 reduced to five inches. No other protection has been given to the industry.

The north west coast has the advantage over Queensland of offering a much wider area of pearling grounds, so that the shellers of the north west can find steady employment by working an area, leaving it fallow for a few years, and returning for another crop. When a bed has been picked over, it should have rest for at least three years to allow the shell to grow up again.

The price realised on the London market for shell has fluctuated greatly, so that a smaller catch one year might bring a larger return than a better catch another. Neither the maximum nor the minimum profits realised correspond exactly to the maximum or minimum of tonnage sold. The maximum amount of shell ever raised in Queensland was the take of 1897, when 1,233 tons were

marketed. After that date the output steadily declined, the annual produce from the peak of 1897 to the outbreak of war being expressed in tons, year by year, as follows:—1,061, 1,200, 1,212, 923, 910, 908, 778, 527, 444, 567, 424, 516, 571, 457, 462, 466. In 1921, Queensland exported only four tons, valued at £133.

The pioneers received far higher prices, £300 to £400 per ton, than their successors were ever paid. In 1884, the fishery paid £94,000, which diminished annually till 1888 when the return was only £45,000. An improvement then set in, and prices rose, till in 1899 the highest total value ever realised was when 1,200 tons of Queensland shell brought £130,105. The poorest return was represented by £79 per ton in 1894. After 1900, the prices made a substantial improvement, which was maintained for the rest of the decade. Taking 1912 as the last normal year the pearling industry of the whole of the Commonwealth, according to the Bureau of statistics, employed 4,291 men, who used boats and equipment valued at £250,574, and produced 2,102 tons of pearl shell,

It is now more than twenty years since Professor H. F. Osborn predicted that in Central Asia would be found the beginnings of many of the higher forms of life, including man. The American Museum of Natural History, of which Professor Osborn is now president, has for some years been carrying on explorations in that region, and the striking discoveries made have gone far to justify his bold prediction.

The third Asiatic expedition, under the leadership of Mr. Roy C. Andrews, has now completed its second year, and already a rich harvest of results has been gathered. Immense deposits of the bones of fossil vertebrates, comparable with those unearthed in the western states of America during years of intensive search, have been discovered and the forms are mainly types which can be regarded as ancestral to those found in other continents.

A copy of the *Far Eastern Times*, of September 28th, 1923, kindly forwarded by Mr. William Dixon, gives interesting details of the scientific results obtained. Speaking broadly, the expedition has proved that Central Asia was the original home of many animal types, and that a land bridge existed across Behring Strait until comparatively re-

valued at £530,298, and pearls worth £106,373.

In 1908, a Royal Commission was appointed by the Government of Queensland to consider if the beds could be worked without depletion of the industry, if the industry could be made regular and permanent, and finally, if it could be arranged to support a settled white population instead of nomadic aliens. The commission reported that the beds had certainly been exhausted by over-fishing, and that "in no other country in the world, outside the British Dominions, is any primary industry allowed to be monopolised by a race of aliens." It recommended that private property in pearl shell be vested in lessees, and that areas be leased to cultivators. But, antecedent to such re-organisation of the industry, this commission advocated the establishment in Torres Strait of a marine biological station, where the feeding, breeding, and complete life history of the pearl oyster might be thoroughly investigated by trained zoologists, so that when cultivation commenced, the cultivators could receive instruction how best to obtain a profit from their crop.

cent times, and served as a means whereby migration took place between Asia and America.

One of the most striking discoveries is that of a series of dinosaur eggs. These remarkable reptiles became extinct in Cretaceous times, but an astonishing amount of knowledge concerning them has been gleaned from their plentiful remains. From their structure, it was surmised that they were oviparous, and Mr. Andrews has been able to confirm this by the discovery of twenty-five petrified dinosaur eggs, one containing an embryo. The eggs, which are from six to nine inches long, were evidently laid in the sand in batches of five to nine, and left to be hatched by the heat of the sun.

Australian scientists are awaiting with interest the working out of the extensive collections obtained by the expedition, for it is possible that these may include remains of marsupials, ancestral to our own. If so, the hypothesis that Australian marsupials entered our continent from the north, across Malaysia, would be considerably strengthened.

The third Asiatic expedition is supported by the Jesup Fund, special gifts and contributions, the American Asiatic Association, and *Asia*.

A Visit to the Belubula Caves.

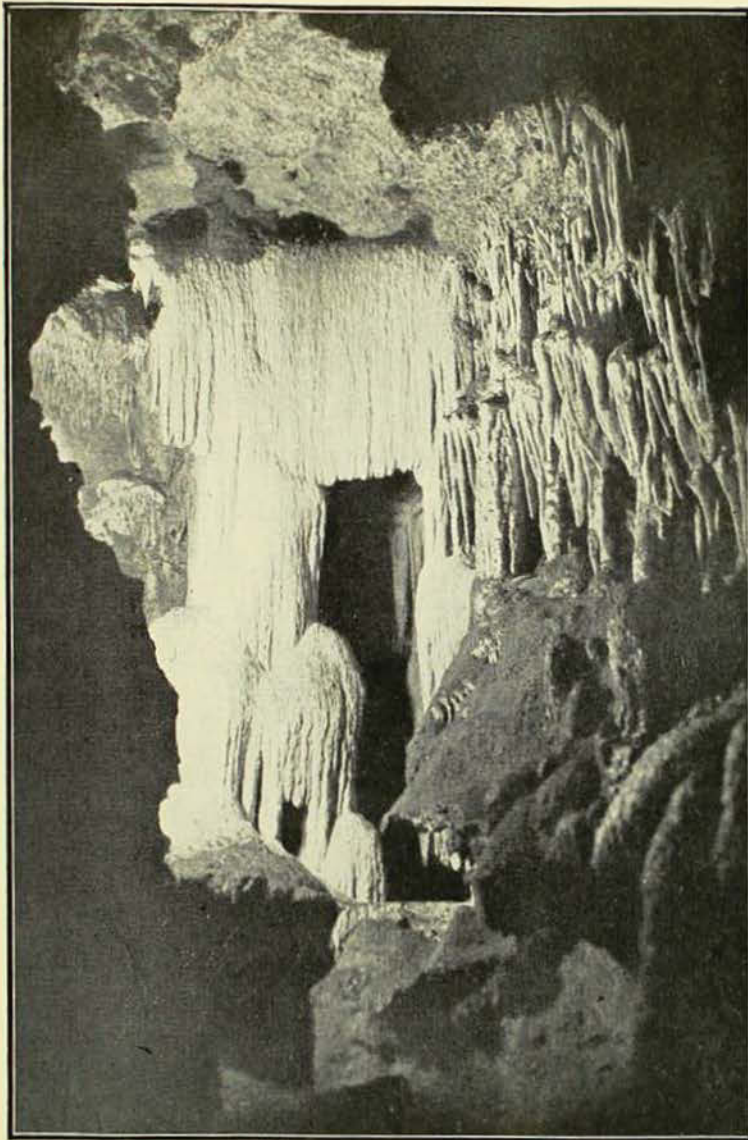
BY THE EDITOR.

IN the limestone belts of New South Wales caves are of common occurrence. Some of these, as the Jenolan, Wombeyan, Yarrangobilly, and Wellington caves, are well known and visited every year by thousands of people. But the Belubula caves are less accessible, and relatively few people, except those who live in the vicinity,

Belubula, that Mr. A. Musgrave, entomologist, and the writer recently visited the district.

The caves lie about fifteen miles west of Mandurama on the western railway line, and can best be reached from that town by driving ten miles along the road to Canowindra, then turning off to the right and following a very indifferent track leading to them. The country is very rugged in parts, steep-sided limestone knolls, covered with loose blocks of that rock, alternating with deep valleys, in which flows the Belubula river and its tributary creeks. The Belubula gets its name from an aboriginal word meaning "twisting snake," and the name is surely appropriate, for the river winds about in S curves, almost doubling on itself in places, so that, if one proceeds for any distance in a straight line, he will cross its bed two or three times. The river is in parts exceedingly picturesque, its banks fringed with stately river oaks (*Casuarina*) and spreading gums, with here a pebbly stretch and there a long deep pool, where lurks the Murray cod, and an occasional platypus has its home. It was a season of drought on the occasion of our visit, and numerous birds were congregated near the river and the waterholes, but of marsupials large or small we saw no trace.

The caves were discovered many years ago by a man named Rittmeister, who, when kangaroo hunting, rested near the spot one winter's morning and observed steam rising from a huge cleft in the limestone. Later, with some companions, he explored the caves, descending to a depth of nearly eight hundred feet at a distance



A "cascade" formed by deposition of carbonate of lime from solution; this may be described as a petrified waterfall.

[Photo.—A. Musgrave.]

have ever been in them. Caves usually have a distinctive fauna, pale creatures with poorly developed eyes or quite blind, and it was for the purpose of investigating the occurrence of insects, spiders, crustaceans, and other possible inhabitants of the less frequented caves at

of about a mile from the entrance, finding an interminable succession of passages and chambers. It was discovered subsequently that this was only one of a series of caves, which may possibly be connected underground, and no fewer than six entrances

have been found on different parts of the same hill.

Before proceeding to describe the caves we shall turn aside to explain how limestone caves and their characteristic structures are formed.

Limestone is composed of carbonate of lime, a substance which is readily soluble in water containing carbonic acid, which converts the carbonate of lime into soluble bicarbonate. Rain water contains a certain amount of carbonic acid, and this acid water slowly but surely eats away and tunnels the limestone rock, penetrating downwards along the joints and cracks. In the course of centuries and thousands of years this process removes an enormous amount of limestone, not only from the surface but underground as well, and it is therefore no wonder that extensive caves are of common occurrence in limestone areas in many parts of the world. Such regions are not merely honeycombed with caves, but great rivers will suddenly plunge into openings in their beds and flow deep underground in subterranean channels, to emerge again perhaps miles away, as

"Alph the sacred river ran
Through caverns measureless to man
Down to a sunless sea."

The Mammoth Cave of Kentucky has a system of underground lakes and rivers, a vast series of galleries and passages over two hundred miles in length, the whole extent of which has never been explored. Our caves are but pygmies compared with those of Kentucky, and the marvellous series of caverns in the huge limestone formation which extends through Carinthia, Carniola, Albania, and Greece.

The most characteristic feature of limestone caves is the stalactites or dripstones which hang from the roof; these are formed in the following manner. Surface water, acidulated by carbonic acid from the atmosphere and other acids from the soil traversed, penetrates through the overlying rock and reaches the roof of the cave. A drop of water containing some bicarbonate of lime in solution hangs on the roof long enough to enable some of the carbonic acid to escape by diffusion into the air of the cave. The drop is then no longer able to hold all its carbonate of lime in solution, and a thin pellicle of this substance forms over the surface of the drop. When the drop finally falls, a little ring of

carbonate of lime is left adhering to the roof; this is the commencement of a stalactite. Soon another drop gathers on the same spot, the process is repeated, and gradually the ring becomes a slender tube. The water trickles downwards over this tube, adding to its thickness and length, until a pendant, pointed cone, perhaps several feet in length, is formed. The rate at which a stalactite forms is exceedingly slow, for inscriptions seventy or eighty years old are seen covered by a very thin translucent coat. In the Adelsberg caves in Austria names scratched on the wall more than six hundred years ago are still perfectly legible. The falling drops still contain some dissolved carbonate of lime, and this is deposited on the floor, so that, in the course of ages, a column forms and grows upwards to meet the descending stalactite. On account of its mode of formation the ascending stalagmite, as it is called, is generally stouter than the stalactite, and its termination is blunt, not pointed. When the two meet they amalgamate and form a solid pillar, which helps to support the roof of the cavern.

Where the water oozes out fairly rapidly and trickles down an overhanging wall, a curtain or shawl-like formation is produced. Ordinarily stalactites, stalagmites, and shawl formations are white, and, as the whole deposit is crystalline, light is reflected from the myriad faces of small crystals, and the whole structure is a glittering mass of beauty. Where the water contains iron the deposited mineral is reddish, greenish, or banded in colour.

The formations known as "mysteries" have aroused much speculation as to their origin. They are unlike ordinary stalactites, for, instead of hanging straight down, they turn and twist in all directions, and cover the walls with a delicate tracery of interlacing twigs or moss-like structures. These mysteries usually occur on sloping or nearly vertical walls, and their peculiar forms are apparently due to capillarity. When a piece of blotting paper is dipped into an ink well the fluid will rise through its innumerable small pores, or capillary tubes, and, if for some reason a drop should emerge not at the point of the stalactite but on its side, growth may proceed in a horizontal or even an upward direction, the water rising by virtue of what is called capillary force. A twisted stalactite may thus result, and, as growth



A patch of "mystery" stalactites; their peculiar twisted form is probably due to capillary action.

[Photo.—A. Musgrave.

proceeds, it will assume the most fantastic shapes, sometimes resembling a ram's horn or even forming a complete ring. The Belubula caves exhibit a fine series of mysteries, rivalling those with which visitors to Jenolan are familiar.

The Belubula caves are still more or less in the same condition as when they were first discovered. There is no electric light, no stairways or handrails, and no official guide. The various members of the Hosie family, of Carlton Station nearby, are deserving of the greatest credit for their enthusiastic pioneering work in exploring these caves. They are ever ready to conduct appreciative visitors through the caves, and the Misses Judy and Eileen Hosie were of the greatest assistance to us. The courage, dexterity, and stamina displayed by these young ladies in this difficult and sometimes dangerous pastime was a constant source of admiration and encouragement to us. Only for the thought that what woman has done man may aspire to do, I fear that we should have hesitated to risk our limbs in some of the more difficult places.

He who wishes to explore these caves must provide himself with a supply of candles or an electric torch (and if the latter it must be warranted to behave properly), and prepare for a strenuous time underground, for the

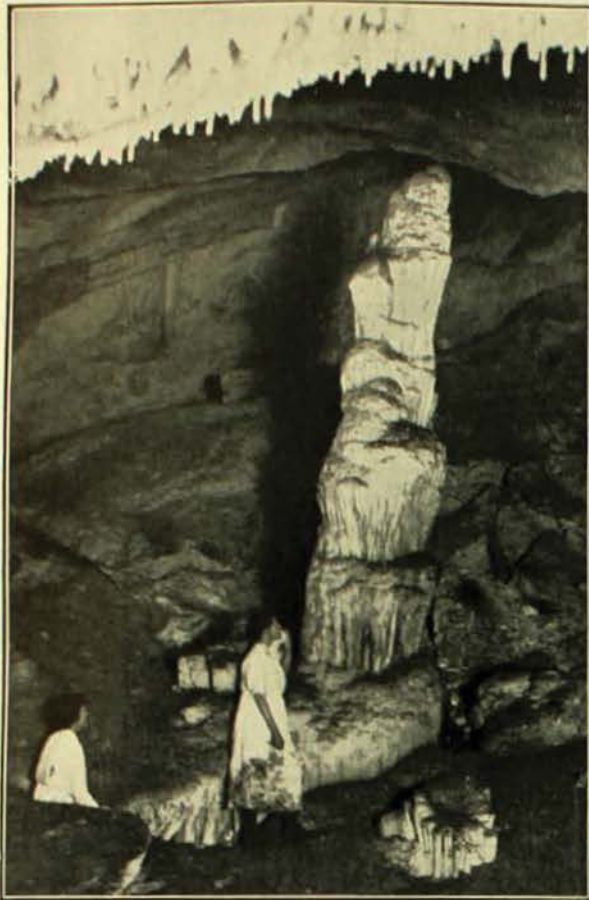
work before him might be described as a combination of mountain climbing and crawling along a drain pipe. And it is no ordinary drain pipe either, for above are dagger-like stalactites, ready to brain the incautious one if he raise his head at the wrong moment, and below are nasty sharp prominences that have to be treated with great respect.

The entrance to the largest and best known cave is situated on the northern slope of a limestone hill which looks down on an extensive river flat, and is marked by two large trees, a kurrajong and a gum, growing side by side. The gnarled roots of these have penetrated far down the entrance, and have perhaps determined its position. On our first visit we were alone, and, having stripped off all superfluous clothing, lighted our candles, and got ready our indispensable fishing line (for we were greenhorns and must needs provide a means of retracing our steps), we gingerly ventured into the almost vertical chimney. Then ensued a scramble over fallen blocks of limestone, along narrow passage ways, and down precipitous rocky faces. Now lowering ourselves by handholds on to the next ledge, and again slipping down an incline on our backs, we slowly descended into the bowels of the earth. For some distance the passage is very steep and narrow, but presently it opens out into a large, almost circular chamber with a high vaulted roof. The most conspicuous object here is a huge column, almost twenty feet high, usually called Lot's Wife, which reaches nearly to the roof. The floor of the chamber is covered with large irregular blocks which have fallen from the roof at



The entrance to the main cave, an almost vertical chimney.

[Photo.—A. Musgrave.



"Lot's Wife," a stalagmite nearly twenty feet high.

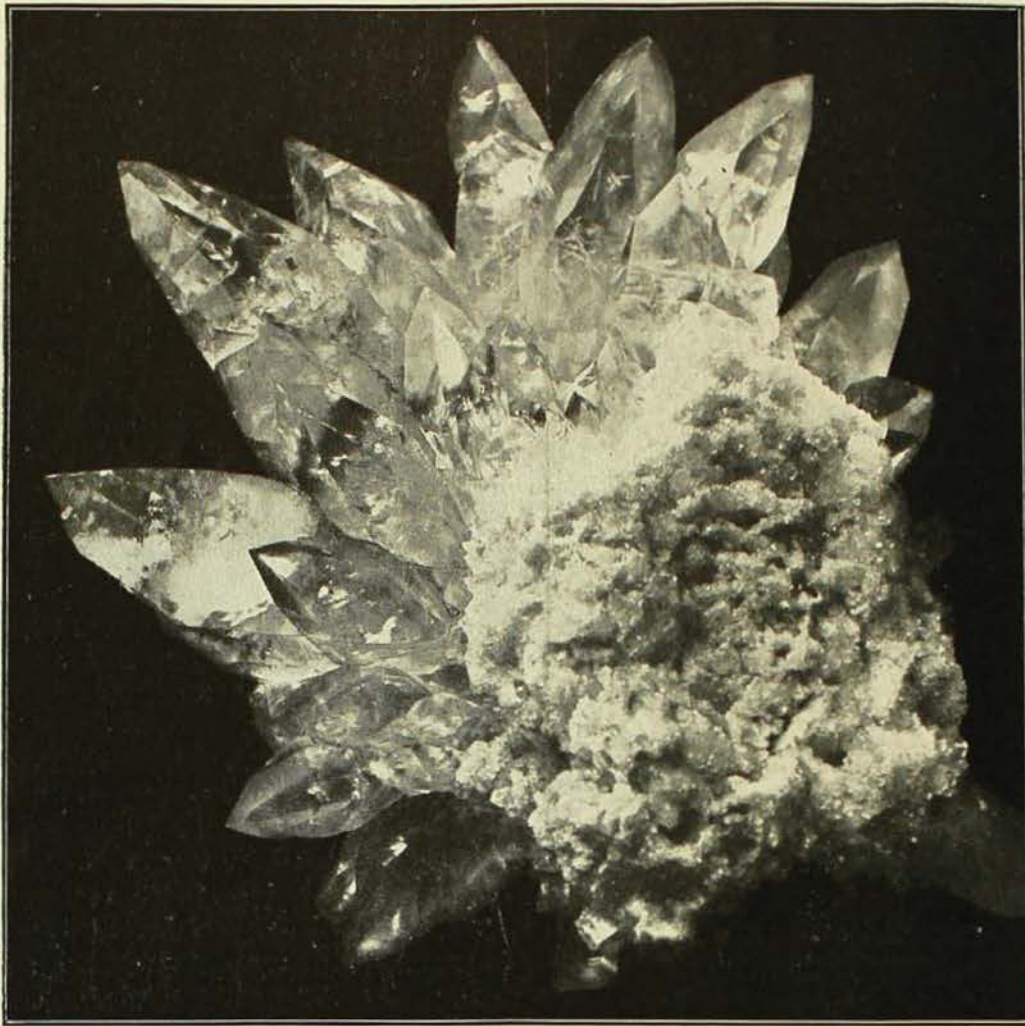
[Photo.—A. Musgrave.]

some time, and round towards the right from the entrance are some beautiful cascades, which, however, have suffered somewhat at the hands of marauding visitors. Passing round these we scrambled through a narrow passage and continued onwards and downwards, emerging every now and then into wider openings hung with glittering stalactites and bunches of small crystals, which, in the light of our candles, looked like clustering stars. But soon we reached the end of our line and must return. Blowing out our candles we rested for a time in the eerie darkness, listening to the constant drip, drip, of the water falling from the roof. Nearly everywhere the walls and floor are wet from the percolating water, and the floor is in parts covered with a layer of tenacious clay, which makes the going rather difficult and may even pull the soles off one's boots if they are not securely fastened. Then slowly and laboriously we struggled upwards and arrived at the surface tired, hot, and dishevelled. We unanimously resolved to call it a day, and dragged our weary bodies back to our camp, feeling that we wished never to see a cave again.

But after a good night's sleep our courage returned, and we were greatly cheered by the early arrival of the Misses Hosie. Under their expert guidance we were able to dispense with our fishing line, which was a great gain, for it is no easy matter to worm one's way along a tunnel not much wider than a rabbit burrow, carrying a candle, camera, tripod, flash-light apparatus, and other equipment, and at the same time paying out or taking in line. We could now make longer excursions underground, and were introduced to "fat man's misery," "the turn over," the "slippery dip," and other interesting features. And always we searched for fossil bones, or for living insects and crustaceans, but with only slight success. A few cockroaches, very fast on the run, some small spiders and beetles, and one crustacean made the sum total of our captures. Of fossil bones we saw no trace, though remains of extinct kangaroos and wombats have been found in the caves. An occasional bat could be heard fluttering round in the larger chambers, and the ubiquitous and iniquitous blowfly seemed to penetrate to the deepest recesses. But ever and anon we were charmed by the sight of snow-white stalactites, or beautiful fluted columns rising up from the floor, or again we would come upon a delightful crystal grotto, or a cascade looking like a petrified waterfall.

In one of the rooms, reached after traversing a number of galleries and corridors to a depth of approximately three hundred feet, for a distance of about eighteen chains is an overhanging ledge, draped with a curtain of stalactite growth and forming a shelf about ten feet above the floor. Here a fine crystal grotto was discovered some years ago by Mr. W. F. Hosie. When the ledge was broken into from above a lense-shaped opening, measuring about eight feet long, four feet wide and eighteen inches high, was revealed, the floor, roof and sides studded with beautiful groups and single crystals of transparent or translucent calcite. One of these groups was presented to the Museum by Miss Judy Hosie and its photograph is here reproduced.

Across the river from the main cave is another small nameless cavern, entered by a narrow opening in the face of an almost perpendicular cliff overhanging the river. Entrance is difficult for it is defended by a luxuriant growth of nettles, and the passage is both narrow and steep. The visitor must proceed warily, otherwise he may be pre-



A fine group of calcite crystals found in a grotto deep in the Belubula Caves.

[Photo.—G. C. Clutton.]

precipitated into a black gulf with serious results. A little way down we came to a small pool of pellucid water, overhung by, and reflecting, a number of fine large stalactites. This pool evidently waxes and wanes, for on the occasion of our visit the slopes surrounding it were coated with thin sheets of calcite left behind by the retreating waters of the wetter season.

The Bat Cave, unlike most, has a wide roomy entrance, but, alas, this soon contracts to a narrow winding passage, which must be traversed in a snake-like fashion, for it is not possible even to creep on hands and knees, except here and there where it opens out into fair-sized chambers. It is the home of numerous small bats, which seek refuge there by day and at dusk sally forth to harry the insects that fly by night. We were not fortunate to find any of the bats at home, though we saw a number flying round the entrance at sunset.

The Shepherd's Cave gets its name from a

tragic occurrence which happened about fifty years ago. The district was then uninhabited except by sheep and shepherds. One of the shepherds had about £1 in silver, which he was in the habit of counting, and the sight of so much wealth excited the cupidity of his mate, who killed the unfortunate capitalist, cut his body in halves, and dropped it through an opening in the roof of the cave, where it lay undiscovered for weeks. The murderer left the district, but, impelled by some morbid feeling, he returned and aroused suspicion by wandering round the scene of his crime. He was ultimately arrested, confessed, and paid the penalty.

The Belubula caves are well worth preserving, but already they show the trail of the vandal. Many of the stalactites and stalagmites have been broken and defaced, and careless visitors *will* write their paltry names on any smooth surface, and try the effect of a smoky candle on the white roof of a grotto. If their natural beauty is to be retained, and

the caves made accessible to the public, a caretaker and guide should be appointed, and a better road constructed over the last five miles or so, which must be traversed to reach them.

BIRDS.

Near our camp a small waterhole, overhung by a gum tree, was a favourite gathering place for numbers of birds, especially rosellas and diamond sparrows; their chattering was generally the earliest morning sound that greeted us. Along the river White-Winged Choughs (*Corcorax melanorhamphus*), handsome glossy birds, were fairly common, usually in small flocks of about a dozen.

We observed several of their mud nests securely built on horizontal branches of gums and river oaks. The Wedge-tailed Eagle (*Uroaetes audax*) was a familiar sight, sailing majestically high overhead or perching on a dead limb; once we surprised about half a dozen of these fine birds regaling themselves on a pile of skinned rabbits left behind by some careless rabbitier. The bulky untidy nests of this large eagle formed the most conspicuous object among the branches of the many dead trees, which, I am sorry to say, are now more common in the neighbourhood of the caves than living ones. Near the entrance to the Bat Cave a number of Fairy Martens (*Petrochelidon ariel*), had constructed their flask-shaped mud nests.

INSECTS.

As it was the end of summer, insects were comparatively rare, though some species were well represented. Log-rolling yielded several kinds of ground beetles, and we frequently came upon little heaps of their remains, forming a veritable insect necropolis; we concluded that these were probably the



Looking out from the entrance to the Shepherd's Cave towards the Belubula River.

[Photo.—A. Musgrave.]

victims of spiders; in the Bat Cave we discovered a new species of beetle. The nests of a large black ant, allied to our common Green Ant (*Ectatomma metallicum*) were conspicuous owing to the ant's habit of collecting the seed capsules of the White Box (*Eucalyptus albens*), and placing them on its nest. Many ants collect vegetable debris in this way so that the moisture so necessary for the development of the young may be conserved in the ground below. The paddocks everywhere were filled with the introduced plant known as the horehound, and upon its leaves the Painted Horehound Bug (*Agonoscelis rutila*), was found in great abundance. This red and black species, which measures half an inch in length, occurs in the Malay Archipelago, Papua, North Queensland and New South Wales; it is becoming more widely distributed over the southern parts of this State, as the horehound plant extends its range. In the quiet pools of the Belubula River, water bugs (*Micronecta*) abounded, and many of them, together with other aquatic insects, were captured with a scoop net.

Dr. H. A. Pilsbry, the distinguished conchologist of Philadelphia, U.S. America, who was a delegate to the Pan-Pacific Science Congress, spent some time at the Museum while in Australia, and, being a man of unbounded energy, he accomplished much work during his short stay. In a letter recently received by the editor, he says: "Having recovered from the scramble of my

last day in Sydney, I have time to take stock of Australian impressions. One of the most vivid of these impressions is the hospitality of Australia to us overseas delegates. I travel half round the world and find a Museum which offers me every facility I have in my own. I will never forget the kindness shown me by yourself and your able staff."

The Stick-Nest Building Rats of Australia.

BY ELLIS LE G. TROUGHTON.

WHEN one refers in lectures or articles to the land mammals of our continent, peoples' minds turn instinctively to the marsupials, for there appears to be a general impression that the Australian mammals consist of the pouched animals, the introduced domestic ones, a few bats and rodents, and the dingo, whose place of origin is still debated. Indeed, in nine cases out of ten, a lecturer or author will choose the marsupials for his subject when asked for a contribution on Australian mammals. In this article, I intend to bring other less widely known but intensely interesting sections of our indigenous mammals into the limelight of public interest and, I hope, regard.

When rats and mice are mentioned, to enlarge upon the above idea, city people at once think of the three introduced species, the long-tailed black or grey rat, the Norwegian brown or sewer rat, and the common house-mouse, and memories are conjured up of recent plague visitations. It may, therefore, be of interest to state that there are over fifty species of rats and mice native to Australia, Tasmania and the neighbouring islands. Of these, some are of much the same form as the introduced rats and distinguished only by their comparatively short tails, longer or more woolly fur, or their cranial or dental characters. Though potential plague-bearers, their cleanliness, timidity, and preference for the more or less uncultivated bush appears to nullify the danger. Specimens sent to the Museum for identification during recent rat and mouse invasions of country areas proved that it was the introduced species that were doing vast economic damage and not the indigenous ones, which have their long-established diet of seeds and nuts of native plants.

THE HOUSE-BUILDERS.

Among the most interesting of this half hundred native species of rats and mice, are, to my mind, the stick-nest building rats of the South Australian mainland (*Leporillus conditor*) and Nuyt's Archipelago (*Leporillus jonesi*), off the coast of that State. Specimens of such rats were first collected by Sturt on the Lower Darling in 1844, and

were subsequently described by Gould under the name of *Mus conditor*; the stick-nests made by this species were described by the explorers, Sturt and Mitchell, in the accounts of their respective expeditions. At the end of 1920, owing to the initiative of Professor F. Wood Jones of the University of Adelaide, a second species of stick-nest builder was discovered on Franklin Island, Nuyt's Archipelago, South Australia.

RABBIT-LIKE APPEARANCE.

Known as the "Native Rabbit" or "Rabbit-Rat," by the colonists of the long ago, these building rats are remarkable for their proportionately very long ears, which give them the appearance of small rabbits with rat-like tails; this likeness is heightened by a habit of sitting bunched up, which produces a compact fluffy appearance in life. The head and body of a large female captured by myself measured seven and three quarters, and the tail seven inches. The general colour of the back is a light yellowish-brown, grizzled with blackish-brown, the sides becoming greyish-buff; the fur of the under surface is slate-grey at the base, with buffy-white tips.

Unlike the two common introduced species of rats, the tail is shorter than the combined length of the head and body, and the fur is softer, thicker, and longer. Though of the same general shape, the hind feet are longer than those of ordinary rats, which doubtless assists them to balance firmly, while manipulating with their small but very capable hands the sticks used in building their fortified homes.

OOLDEA AND THE NULLARBOR PLAIN.

While on a collecting expedition in 1921, for the Trustees of the Australian Museum, Mr. J. H. Wright and myself were stationed at Ooldea and Fisher, on the Trans-Australian Railway in South Australia, and were afforded excellent opportunities for observing the nests and habits of these interesting rodents.

Ooldea is a small loop-line siding and watering depot, situated on the edge of the vast Nullarbor Plain, being set like a very dull gem of corrugated iron in a band of



The Stick-Nest rat as illustrated by Gould in Sturt's narrative of an Expedition into Central Australia. The nest, drawn from Sturt's description, is too regular, the artist evidently taking the author's "bee hive" simile too literally.

[After Gould.]

country reminiscent of Omar's "strip of herbage strown, that just divides the desert from the sown." On either side of this fringe of the plain, there is a remarkable contrast between the mallee and stunted scrub on the sand-waves eastward of Ooldea, and the flat monotonous landscape of the Nullarbor Plain, which the train enters immediately on the Perth side of Ooldea, traversing for about three hundred miles what is probably the longest stretch of straight track in the world.

During our stay of several weeks we made many excursions into the plain in search of birds and mammals of every description, being particularly interested in the building rats and the results of their skilled labour. There was a scarcity of nests close to the station, which was doubtless due to the aboriginals, who make a regular camp at Ooldea; food is often scarce and on the plain for several miles may be seen excavations where the natives have been digging out rabbits and bandicoots; the rats were doubtless eaten by the natives, who, according to observers, regard them as a delicacy; this would entail destruction of the nests, and account for their absence close in.

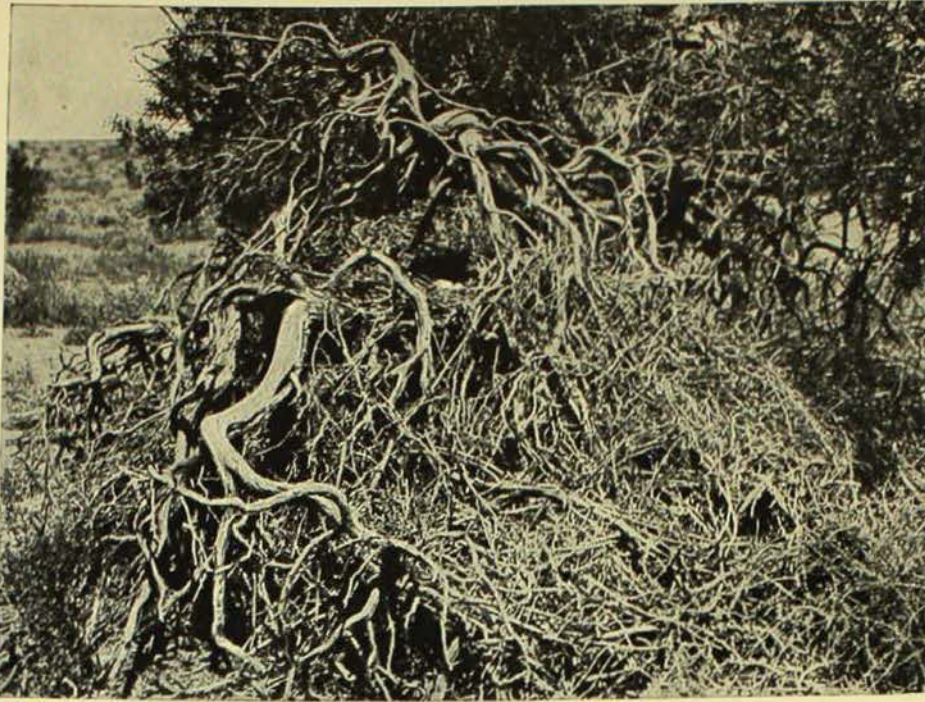
Scattered over the plain for about twelve miles westward of Ooldea, are slight depressions having the appearance of shallow

lake beds, where the soil is softer and the low monotonous blue bush gives place to thick rank grasses and clumps of stunted scrub. These "oases," "dongas," or "dongholes," as they are called, watered only in times of heavy rain, must seem a veritable haven of refuge to the animal life of the plains, which we found, to our relief, prone to congregate in them.

Many of the larger depressions or dongholes contained several of the rats' cone-like nests, ranging up to three feet in height, the sticks usually being closely interwoven with the trunk and limbs of a stunted bush, the whole forming a massive stronghold against strong winds, dingoes, and other enemies. Australia has no beavers, but our stick-nest building rat belongs to the same rodent order, and, if the shallow dongholes were filled with water, the rats' nests would look for all the world like those of the beaver; considering the relative size of the two creatures, our rats must spend at least as much energy in their building operations as do beavers, one of the rats' nests observed by us being at least three feet high, with a diameter of about five feet.

A DESERT ENTENTE.

On these arid plains, the struggle for existence and accommodation must be very



A typical stick-nest built by the native rodent, *Leporillus Conditor* Gould, with the eggs of a Striped Hawk in a depression on top. Note how the sticks are interlaced with the gnarled branches of the shrub.

[Photo.—E. le G. Troughton.]

keen, and in one of the larger dongholes we saw striking proof of this. One day, upon nearing a donghole, we saw a hawk rise suddenly from a low bush, which, on closer inspection, proved to be supporting a typical rat's nest at the summit of which there was a neat depression, housing three eggs of the Striped Brown Hawk (*Ieracidea berigora*). The association was truly a strange one, and it is difficult to imagine what pact or understanding brought about an *entente cordiale* between these apparently ill-assorted householders.

Bones littered within the rats' nests suggested a meat diet on their part, and anyway most rats are partial to birds' eggs. On the other hand, there are many records of the penchant of the Striped Hawk, for small rodents and marsupials, and one can reasonably suppose that this hawk, under ordinary circumstances, would be very partial to the rats as food. It has often been noted that the hawk in question occasionally uses the old nest of another hawk or a raven, but this utilisation of a mammal's nest must be as unique as the stick-nests of the rats themselves.

DREADED ENEMIES OF THE NIGHT.

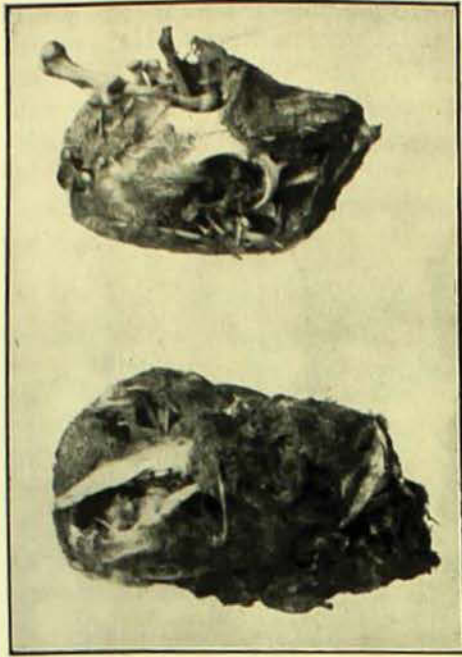
Whatever may be the explanation for the apparently mutual understanding between the hawks and rats of the one nest, no such

truce existed between the Delicate Owls (*Tyto alba delicatula*) and rats living on the Nullarbor Plain. The owls make their homes in the limestone caves or "blowholes" which honeycomb the plain; though the openings of these blowholes are sometimes too small to allow a man to enter, they usually open out into a fair-sized chamber, from which small crannies are given off; their name is derived from the surprisingly strong wind, often redolent of stagnant water and drying owl pellets, which blows up from the crannies and out through the openings above. According to popular re-



Looking down on Wright descending through a typical blowhole entrance. The limestone formation of the Nullarbor Plain is honeycombed with tunnels and occasional blowholes in which owls and hawks nest and rear their young.

[Photo.—E. le G. Troughton.]



Owl pellets containing skulls and bones of the Stick-nest Building Rat. Digestive action wraps the bones in fur, and this food waste is ejected from the owl's mouth. These castings were collected in a blowhole.

[Photo.—G. C. Clutton

port, the air is at times drawn strongly inward, the reversed direction of the draught being attributed to the action of the tides, some sixty miles away.

These owls must constitute an even more dreaded enemy than the dingoes, which traverse the plains at certain seasons but which would be unable to tear apart the strongly woven fortresses of the rats. One can picture the owls with soft, almost noiseless flight, swooping down out of the desert night and clutching up some hapless rat, busily engaged upon a foraging expedition or house repairs. Indeed, great numbers of native rats and mice must be consumed, as we found owls roosting in many of the blowholes, and collected a good many of their castings, the majority of which contained complete skulls of the stick-nest rat. Variety is lent to the menu by the smaller species of rodents, and marsupial mice, skulls of which were found in a number of the owl pellets examined.

A RAT HUNT.

The first donghole that we searched contained one large nest, which Wright proceeded to disturb, the writer waiting with gun poised. After several false alarms, caused

by rabbits rushing from the refuge, where they are seemingly quite at home, we caught our first glimpse of a living builder, moving very rapidly. The rabbit-like appearance of this rat was heightened by its method of running; we had ample opportunity to observe that this was quite rabbit-like and never hopping or jerboa-like. Having noted the rabbit warren to which the quarry had retreated, we burrowed after it with our hands and a small entrenching tool, the dust, heat, and high winds making the chase a truly strenuous one for all concerned. On our reaching the junction of two burrows, excitement became intense, and the rat, after several feints, sprang out with such velocity as to baffle its pursuers completely. This happened several times, but fortunately there is only a shallow layer of soft earth about two feet deep in the dongholes, with a hard stratum below which prevents the excavation of deep burrows, so that we eventually secured our largest specimen, crouching in a burrow with several rabbits.

Some of the large dongholes contained as many as six nests, and, though one regretted destroying the results of so much industry, time was precious, and the holders so unwilling to leave their forts that it became necessary to realise Mitchell's simile of the "signal fire used by the natives," by burning one of the nests to obtain a series of specimens. The rats, as they emerged, rose up firmly upon their strong hind feet and surveyed the surroundings before darting to a rabbit burrow.

THE FIRST DESCRIPTION OF THE ANIMAL AND ITS NEST.

After recording in his journal how his party had frequently observed piles of dry sticks and brushwood, and concluded that they were used for aboriginal signal fires, Major Mitchell continues: "Minute examination, however, soon convinced us of our error . . . the materials were not thrown promiscuously together, as would naturally have been the case had they been collected by the natives" for signal fires . . . "Our kangaroo-dogs also drew our attention . . . barking and scratching whenever we fell in with them . . . intimating that they expected to find something inside. At length, we broke several of them open, a work of no small difficulty from the solidity of the structure, and were not a

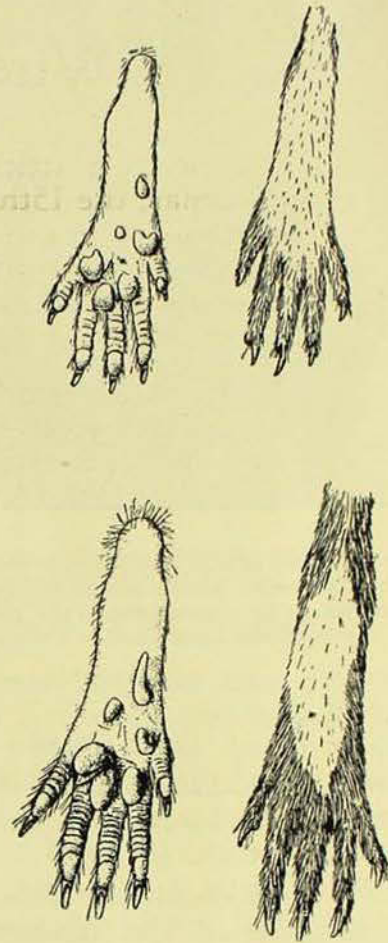
little surprised to find in the interior a small nest occupied by an animal something between a rabbit and a rat, which had constructed this formidable and massive stronghold to protect itself against the attacks of the native dog. For this purpose the little animal chooses some small bush or shrub, as a fixed *point d'appui*, to commence its operations; and by gradually working round this, and interlacing the materials of its fortalice, first of all with the growing branches of the centre bush, and afterwards with one another, gradually extends it to enormous dimensions . . . and enjoys the reward of its perseverance and ingenuity in subsequent security and repose. This little animal has ears exactly resembling those of a small rabbit, soft, downy wool, and short hind legs, and, but for the tail, might readily pass for a small rabbit."

One or more families may dwell in a nest, each family occupying a separate compartment, which is warmly lined with grass and connected with the others by passages.

VARIATION IN NEST STRUCTURE.

Sturt's description of nests observed in the same region as Mitchell's differs in stating that they were in the form of a compact cone, like a bee-hive, and they are so illustrated by Gould in Sturt's book. However, the discrepancies between the authors' descriptions of the nests are doubtless accounted for by the fact that the structures vary according to the conditions of terrain and available material. For example, twelve miles westward of Ooldea the dongholes gradually disappear, and the landscape at Fisher, about forty miles farther on, is very flat and fairly well covered with bushes which are only about knee-high. These bushes are too frail to support birds' nests of any dimension, nor do they supply adequate builders' material for the rats' self-contained flats, and so the residences of the latter change to low heaps of sticks placed over rabbit warrens. To offset the loss of the supporting bush, many of these loosely built nests have small stones placed on top of them by the ingenious little stick-layers, much as settlers place rocks or slabs on roofs to keep loose coverings down. These nests looked like deserted, flattened crows' nests, having none of the orderly shape of those nearer Ooldea, and we might have doubted

their being occupied had we not occasionally surprised a rat sunning itself on one of them. The rats were very alert, and the nests, placed at the junction of several rabbit



Above are the hind feet of the mainland Stick-nest Rat, which are more slender and without the heavy dark shading on the feet of the Franklin Island rat as shown below.

[J. R. Kinghorn and H. O. Fletcher, del.]

burrows, provided ample avenues for escape; the rats always disappeared before coming within range of our light gun, and to dig for them among the rambling burrows was impossible; they were also very wary of traps, and we congratulated ourselves upon having obtained a small collection from about Ooldea.

Professor Wood Jones' account of the Franklin Island rat shows that the nest structures vary considerably there also. He writes that sometimes an enormous amount of material is collected for the larger nests, which appear to lodge colonies. High up on a cliff he found such a nest, the foundation of which was probably the deserted home of a sea eagle, the rats having invaded it

from below. Upon the flat heights of the island, the nests are usually composed of dried herbage, and contain only a pair of individuals. The larger nests are complicated within, series of passages and chambers being made in the heap of collected *debris*; the smaller nests consist of an entrance run, central chamber, and exit run only. Upon the beaches, a wisp of wrack tucked between boulders, or some seaweed collected in clefts in the granite rocks suffices for a home. Like the mainland species, the island rats apparently never excavate burrows for themselves; in the islands, the Professor writes, the burrow of a penguin is almost always found beneath the rat's nest, into which the rat will readily retreat, as the mainland ones do into the rabbit burrows. He continues, "it is a remarkable fact that mutton birds, penguins, rats, bandicoots, and the black tiger snakes will all bolt into the same hole when alarmed."

CARRYING THE YOUNG.

Mr. A. S. Le Souef has noted the peculiar method adopted by the mainland house-building rat, for carrying its young, which cling firmly by their mouths to the teats of the parent; the young grow very fast, he writes, "and at two months are right side up, and upon their own feet," holding on to the teats and following every movement

of the mother. This extraordinary method of transporting the young has been adopted by several genera of Australian rats, the earliest observation being that of Sir George Grey during his governorship of South Australia, which was published by Gould in 1863; "a female (*Conilurus albipes*) had three young ones attached to its teats . . . they remained attached by their mouths, and grasped her body with their claws, thereby causing her to present the appearance of a marsupial minus the pouch." This method is also followed by the Australian rodents belonging to the genus *Uromys*.

RESTRICTION OF LIVING AREAS.

The mainland house-builder once had a very wide range, occurring on the Murray and Lower Darling Rivers, but as early as 1864 it was said to have become exceedingly rare. The fact that the aboriginals regarded them as a delicacy, and the advance of settlement with its disturbing stock has doubtless driven the species to the more inaccessible desert country. However, it is good to know that the vast Nullarbor Plain provides a haven where they may build in peace, save for an occasional collector and the owls. As the great east-west train roars its way across the immense plain it is doubtful if one passenger is aware of these quaint creatures, tucked away in the warm compartments of their ingenious dwellings, dreaming of the house repairs or foraging of the morrow.

Prize Essay Competition

Mr. George A. Taylor (Editor of *Building*) has generously presented five guineas to be awarded as a prize for the best essay by a pupil of a New South Wales school the subject being "A Visit to the Australian Museum." The competitors, who must be between the ages of twelve and sixteen on 1st March, 1924, may select any department, or may write a general account of the whole

institution, the essay to contain 1,500 to 2,000 words.

Competitors should hand their essays to their teacher, who will then select the three best written by pupils of their school and forward them to the Director of the Australian Museum, College Street, Sydney, on or before 1st March, 1923.

The successful essay will be published in THE AUSTRALIAN MUSEUM MAGAZINE.

Brigadier-General Reuter E. Roth, C.M.G., D.S.O., V.D., M.R.C.S., a former trustee, who has recently returned from a trip to Burma and the Netherland Indies, brought

back with him an interesting collection of weapons, ornaments and other ethnological objects. These with his usual generosity, he has presented to the Museum collection.

Living on a Volcano.

BY TOM IREDALE.

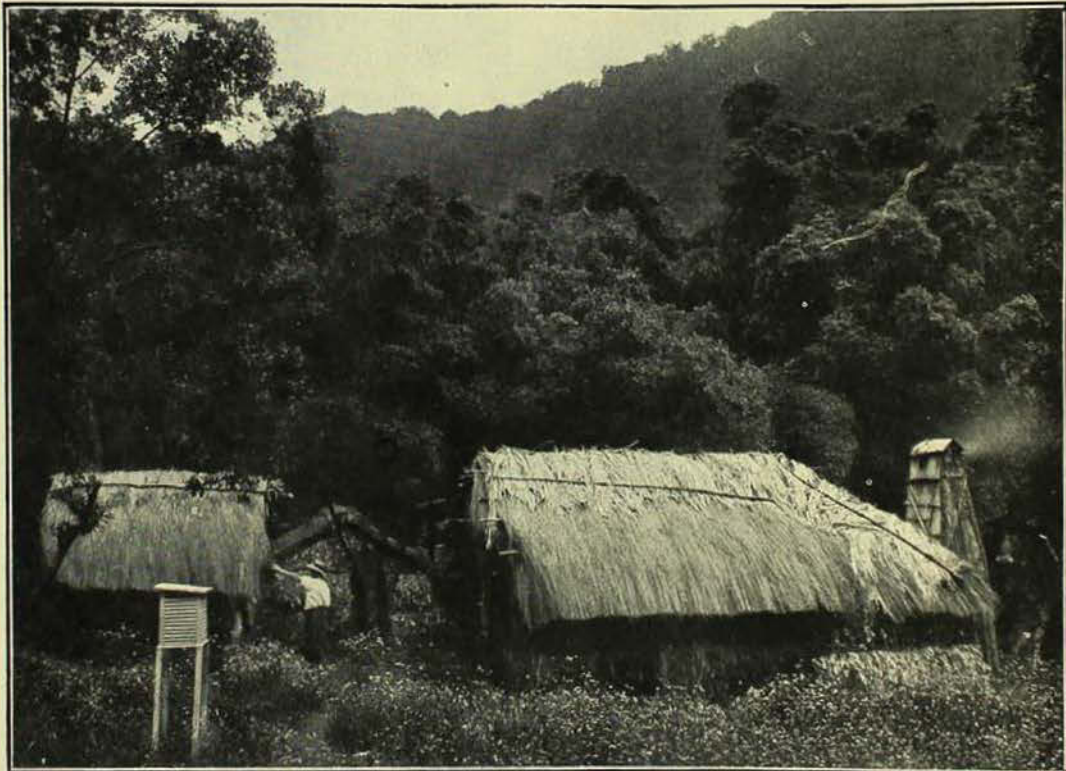
The photographs are by various members of the party, with the exception of the two bird studies which are by Mr. Roy Bell.

LIVING on the edge of a volcano is an expression suggesting danger, but only on account of the unreliable nature of the volcano. Its actions are not governed by laws we yet understand, and therefore, the expected happens when it is unexpected.

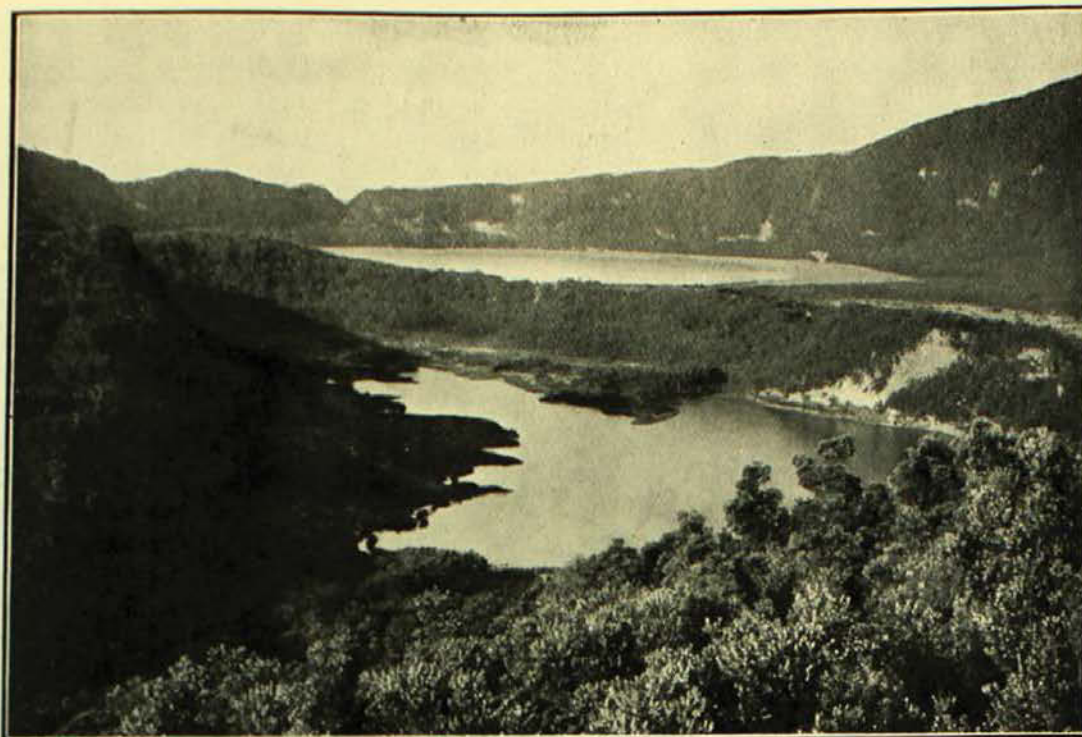
The Kermadec Group consists of a chain of volcanic islands lying some 400 miles north-east of New Zealand, the largest being Raoul Island, with an area of over 7,000 acres. This is simply a volcanic crater, at present technically dead, but not yet absolutely harmless. Life on it therefore, though comparatively uneventful, contains the vague chance of a sudden catastrophe. As recently as 1871 a small eruption took place, and there had been a bigger one about fifty years previously. It is not surprising, then, that the lingering fear of a possible volcanic outburst and the loneliness of the group

have discouraged settlement, and every attempt to establish a permanent colony on the islands, which are now uninhabited, has failed. Yet, it is a delightful place, with an equable climate and a rich volcanic soil. The disabilities after all, are comparatively few, and similar handicaps have been ignored in the case of other Pacific islands, such as Lord Howe and Niue.

There is no reliable landing place, but landings can always be made at some point or other. There is, of course, no regular steamer service in connection with the island, but the New Zealand Government steamer visits yearly, in case shipwrecked mariners have taken refuge there. At the time of my visit, the last settlers, a family named Bell, consisting of five persons, were making an attempt to exist. Our party brought the population up to ten, which was nearly a record for the island.



The party's camp on Denham Bay Flat.



Looking across the crater. In the foreground is seen the crater lake, so-called because of the eruptions emitted by it.

Our visit was timed to last twelve months, but, owing to the loss of a vessel, the steamer by which we left came two months earlier than usual, and therefore the time spent was only ten months. Our sojourn on the island was uneventful, but earth tremors kept warning us that we were really living on a volcano. Some of these were short and sharp, and these did the most damage. Others would last about a minute, but these did not alarm us much. The most irritating kind were repeaters, consisting of a series of thrills, at intervals of a few minutes, lasting perhaps for a quarter of an hour, and, of course, we did not know when they were going to stop, or whether they would develop into a real quake.

In the crater there was a cave which the settlers had termed the Oven Cave, because it was hot like an oven. We used to sleep in this cave sometimes, and, when lying on the floor, we could distinctly hear hot water boiling a few inches or feet down, but we never investigated the exact depth. About thirty yards distant was a hole only a foot deep, where the water could be seen boiling; we used to cook eggs in this hole, lowering them in a wire cage. A little further away was a rivulet which was always warm, and in which one could have a warm bath. A few stones were scattered by a slight tremor near this place when we were on this

island, and smoke came out of the hole; there were other active smokeholes on the island.

Though outside the hurricane region, big gales strike the island more or less regularly in the autumn each year, and we looked for one with interest. However, though we enjoyed (?) the anticipatory thrill, the hurricane did not touch the island. After events proved us to have been lucky, as, when we reached civilization again, we found that the hurricane had passed a few miles to the east and had been one of the severest known.

As noted above a few settlers were on the island, and the year after we left they met with an unexpected misfortune. Instead of a volcanic outburst or a hurricane, both of which they regarded as evils to be expected any time, a waterspout burst over the island. They had spent ten years cultivating a patch close to the landing place, and had planted nearly every known fruit and vegetable there. They had just laid in their year's stores, as the vessel had called shortly before the disaster overtook them. The whole of the cultivated portion and their stores were absolutely destroyed. Needless to say, after this disaster they left the island at the first opportunity.

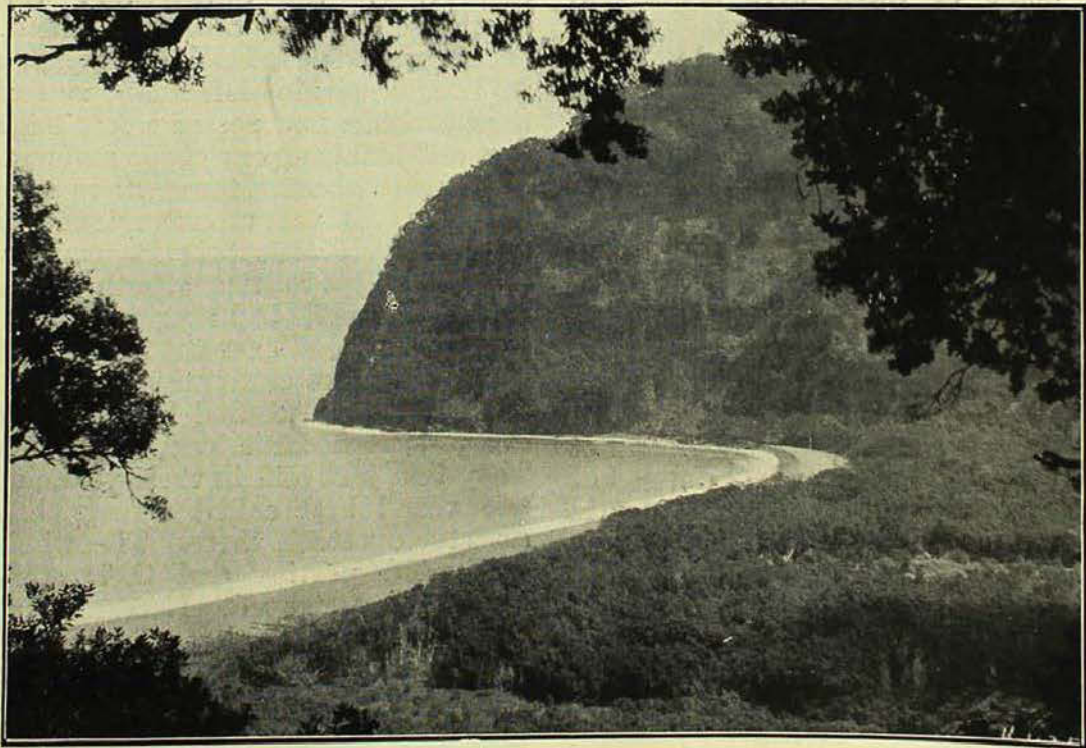
Having referred to the disadvantages, I may now mention the real delights of the place. There are no mosquitoes, there is no

excessive heat, there is no cold wind, there is a splendid rainfall, good soil, plenty of sunshine, and no neighbours. The maximum temperature recorded was 89 degrees, and minimum 59 degrees; the rainfall was 70 inches in the ten months, but there was rarely a wet day. For six months the prevailing wind was west, for six months east, consequently it was always calm on one side of the island or the other.

The crater which forms the island, has walls varying from 200 to 1,500 feet in height. There are two flats, one on the west side, and another on the north-east side. These are the habitable portions, but the floor of the crater could be cultivated were it easily accessible. The cliffs forming the rim of the crater are very steep on the outside, and almost as bad from the inside. On the western flat was a dry swamp near which wells have been sunk. These yielded fresh water, but, though the water is fresh, and the wells are about a quarter of a mile from the beach, the water rises and falls in the wells as the tide flows and ebbs.

I may now indicate the geological, botanical and zoological results in a general way. From a study of rock specimens, together with the notes taken on the island, it is now certain that the group has had a romantic geological history. The present crater is

the last of a series which has been formed by various outbursts during many ages. A few islets to the north-east belong to a long distant age, and appear to be the remains of one of the earlier craters, which, however, has been convulsed more than once since it was a crater like the present one. The western bay, where we lived, appears to be the eastern rim of another crater, probably of later date than the one now represented by the outlying islets, but still of much earlier date than the existing crater. In the middle of this bay is a rock, now covered by about four or five fathoms of water, which was above the water fifty years ago. Moreover, a hundred years ago an eruption was observed from a passing vessel, which, sailing up to Raoul Island, anchored in the bay behind an island, which was found to be hot and recently formed. Some of the rocks brought back were found to be of continental kinds, and therefore it has been concluded that an extensive land mass formerly existed here. At the present time, on account of the extraordinary vicissitudes the island has suffered, little life is present to suggest continental connection. Thus the botanical results would, if studied alone, negative any such conclusion, as the whole of the plant life is of insular character. The island is thickly covered with bush, pohutukava, the



North end of Denham Bay, where landing may be made under favourable conditions.



Effect of the "hurricane." These young trees were very supple and therefore better able to resist the elements than the older ones, yet even they had to yield.

well-known Christmas tree of New Zealand, a fine bush bearing crimson flowers, being the most noticeable plant. Magnificent tree ferns grow in the dampest portions, while stately palms are omnipresent on the high lands. The tangle of the pohutukava roots and the abundant growth of palms and ferns make travelling very difficult, much more so than can be appreciated from a verbal description. It was dangerous to leave the blazed track, and it was not easy to follow this at any speed.

The chief botanical discovery was concerned with the huge tree fern and the tale is worth telling. When the first survey of Raoul Island was made, the naturalist saw these tall trees, sixty feet high, noted their height and beauty, and then collected specimens of the fronds. The tree fern was duly named, but our party found that there are two distinct kinds, a tall and a short tree fern, and, while the naturalist had admired the tall one, he had collected his fronds from the more easily reached small tree.

As might be anticipated, there are no native mammals. The introduced goat is wild, but not common, while the Pacific rat, not the Norway Rat or the Black Rat of Europe is a pest, eating everything it can reach. As a consequence, stores have to be housed in rat-proof huts, that is, huts built well off



Tree Fern (*Cyathea kermadecensis*) about sixty feet high, the fronds being nearly twenty feet long.

the ground, the supports protected by smooth tin bands. Care has also to be taken that trees do not overhang these huts too closely, though obviously the huts must be built in the shade.

The bird life is interesting on account of the petrels breeding there. Petrels are seabirds, not unlike seagulls at first sight, but with very different habits. Petrels generally breed in holes in the ground, but the largest ones, Albatrosses and Mollyhawks, too big to get into holes, breed in the open, nearly always choosing isolated islands for this purpose. The Mutton Bird of Bass Strait was represented on the island by a bird with a longer tail, known to the settlers as the Black Burrower, so called on account of its breeding in holes. It arrives on the island to breed on the 14th October of each year. That was the experience of the settlers, and, sure enough, the birds turned up on that date during our year. No bird had been seen near the island on the 13th, and all the likely places where colonies had existed the preceding year were carefully examined and no traces were found. On the morning of the 15th several new scratchings were seen, and on the 16th a bird was actually handled. These birds are very bad tempered, quarrelsome, and ferocious, fighting with each other while burrows are being made, squealing and mewling all the time. When the young are about half grown, the parents leave the island and the young live on their fat while their flight feathers grow; when these are fully grown the young one is lean and hungry. Thus it never knows its parents, and has to battle for itself from infancy; apparently the young bird returns to its birthplace the following year to breed.

All over the island on the surface of the ground another kind of petrel breeds during the summer months, and this, the staple food of the settlers, is known as the Mutton Bird. It belongs to another family, and its habits are very different. The former flies very fast and low over the sea, comes in at night, flying right into the entrance of its burrow, landing with a crash, and makes a noise like a wild cat, is savage and dangerous to touch. This one does not fly so fast, flies high up, circling round the summit of the island towards sunset, but settling slowly, apparently afraid of hurting itself, and going round from six to sixty times before touching

the earth. It then lands somewhere near the spot and walks towards it, waddling like an old duck, and resting every two or three steps. It coos like a dove and is very gentle, never attempting to bite when picked up. These birds arrive very erratically, the first settling on the ground in August, others coming in a few at a time until the end of September. They make a nest of dead fern stalks, sometimes a quite pretentious structure, and having done this and sat on it for a while, about the beginning of October they all fly away again, leaving their nests to the wind and rain. In a fortnight or three weeks the birds return, single out their nests, patch them up a little, and then lay their eggs. When the young are hatched they are fed continually so that they become very fat, and then, as in the previous case, the old birds leave them, and the same process goes on.

This bird was our chief meat food, and the task of preserving them was an important matter. The birds are collected when they are nearly ready to fly, but before they have lost all their fat. They are then dressed, split, dried, salted, and packed in barrels; they are so fat that the pressure forms a layer of oil which protects them from decay. To be cooked, they must first be boiled to get rid of the salt, and then grilled; thus treated, they provide a palatable food.

Three other kinds of petrels frequented the group for breeding purposes, but they all bred in burrows and were not so numerous as the two mentioned. A matter of great interest should, however, be mentioned. While the Mutton Bird was breeding on the main island, all the summer, the islets to the north-east did not show any birds at all. When the birds had left the island, a large number of birds, apparently exactly the same kind, crowded on to the islets covering every available spot and breed. No one has yet been able to distinguish between these two kinds, known to the settlers as the Summer Mutton Bird and the Winter Mutton Bird, yet, not only do they breed at different times, but the breeding season seems to be longer in the case of the latter. While the islets are small, and the birds are very crowded none ever come across to the huge deserted main islands to breed. This is a puzzle we hoped to solve, but no solution could be found, nor could we provide any useful hypothesis. It is just possible that the

Winter Mutton Bird is the remnant of a colony that bred on the original island of which the islets are the only remains.

Other seabirds frequenting the group were well known world wide tropical forms as the Wideawake, Noddy, Gannet, Tropic Bird and White Tern. The last-named is a most beautiful bird, especially when seen against



Mutton Bird (*Pterodroma neglecta*) asleep.

the dark foliage of the tree tops it frequents ; it is snow white, and with elegant motion it glides about in the bright sunlight. Its habits are peculiar for a seabird, for it lives at sea and resorts to a tree to breed. It does not build a nest, but places its eggs in a knot-hole in a branch ; the egg, moreover, is almost globular, quite unlike any other sea bird's egg in shape. The young one is covered with black down, and, when half grown, is barred with rusty red, both stages contrasting with the adult.

Of land birds little need be said, as, owing to the frequent upheavals, no ancient forms have persisted, and at present only three comparatively recent settlers are living there.

As might be expected, insects of various kinds are very numerous, but all are recent forms, geologically speaking. A few large, handsome butterflies were seen, but these were obviously not at home.

Snails play quite an important part in indicating the ancient history of an island, for they do not like salt, as is known to every one. Consequently, large snails indicate permanent land, as they would be instantly killed by immersion, and they cannot

easily travel over the sea. Minute snails on the other hand can exist in crevices in logs and float from island to island. Thus, numbers of very large snails lived on Lord Howe Island before the rats killed them off, proving that this island had never been totally submerged. On the other hand, on the Kermadecs we found only very small snails such as might have travelled on driftwood ; these are mostly of northern origin, whence most drift reaches the island.

Whales are commonly seen in the vicinity of the island, and the earliest settlers camped here for the purpose of supplying whaling vessels with vegetables and water. The industry collapsed just about the time the Bells went there, and no whaling is done by anyone at present. Yet whaling is prosecuted at Norfolk Island, and it seems that the industry could be established on the Kermadecs.

The sea is full of sharks and other big fish, while good edible fish abound. Marine life is very abundant, as coral grows well, though there is no coral reef. The marine mollusca proved the most interesting of all the fauna, as the old types of marine molluscs had managed to survive the many disasters that destroyed the surface life, and one found a series of marine shells that exist on no other Pacific island yet investigated. It was anticipated that Lord Howe, Norfolk Island, and the Kermadecs would show similar forms, but that is not the case. The Kermadecs at present possess a unique sublittoral fauna of marine shells.



White Tern (*Gygis alba*) and its black nestling.

Crab Hunting on the North Coast.

By J. R. KINGHORN.

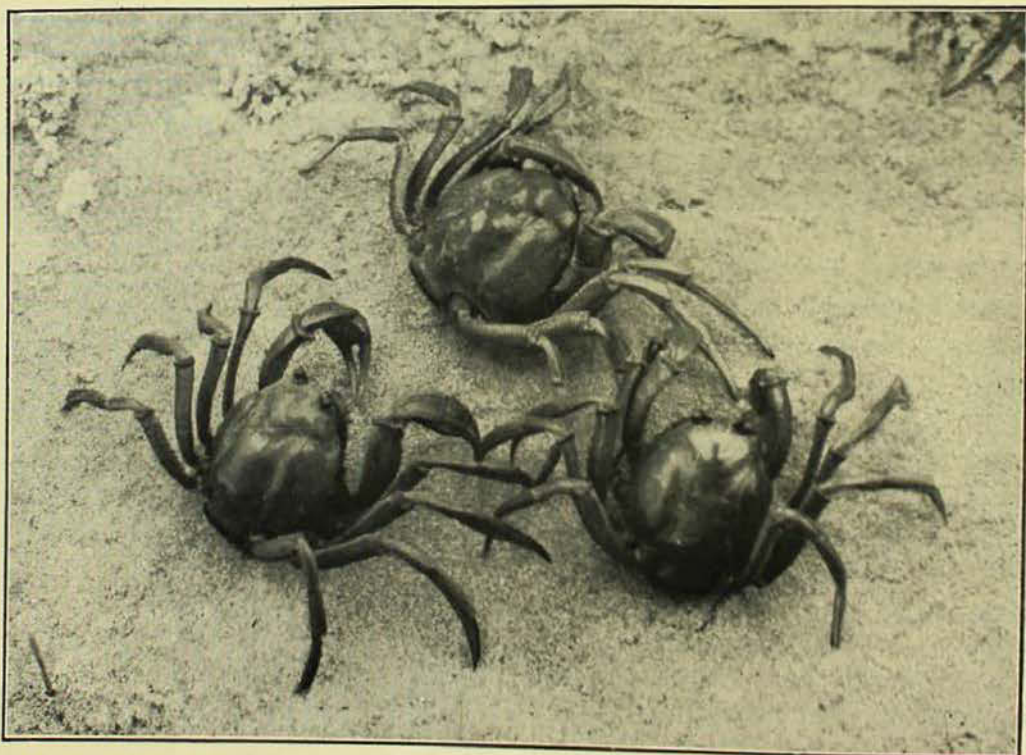
ANYONE who is interested in the animals of the sea shore and who wishes to explore new fields will enjoy a visit to South West Rocks, Trial Bay.

The coast here is peculiar in formation inasmuch as it resembles a giant fish hook which catches, and holds, some of our most valuable marine fauna. It is a great collecting ground, one which appears to be the southern limit of a considerable number of tropical species, and it is indeed a revelation to the naturalist. Here, then, in a charming locality, collecting may be done on the ocean beach, on the rocks, in the rock pools, in a tidal lagoon (South West Creek, an outlet for the river), on sand or mud flats or in a mangrove swamp, all within a few hundred yards of your home. For one trip during a low tide the equipment should consist of one 3 pint bottle of 5 per cent formalin (20 parts of water to one part formalin), one 3 pint bottle of 75 per cent spirits (4 parts absolute alcohol to one part water), a pocket-full of glass tubes, labels, pencil, cotton wool, butter muslin, thread, a small hand net, a spade, forceps, hand lens, and knife.

You proceed to one of the sand and mud flats, across which myriads of Soldier Crabs

(*Mycteris longicarpus*) swarm in vast armies, swaying here and there, hurrying and scurrying in all directions in their endeavour to get away from approaching man. They are in line one minute and in mass the next, they form fours and eights, companies and divisions, they walk and run over each other two, three, and four deep in their wild scramble, and the rush goes on until the soft watery sand is reached, when they all commence corkscrewing movements and quickly disappear below the surface.

The flat also abounds with a very small, peculiar, round-bodied crab known to some of us as the Sand Bubbler (*Scopimera inflata*), so named on account of the lines of spherical sand pellets which it makes while feeding, the lines starting from the mouth of its burrow and radiating outwards like the spokes of a wheel. This little fellow does not indulge in the same mad rush as the Soldier Crabs, but, having made up his mind that you are advancing in his direction, scampers quickly to his burrow, and lies hidden, very much on the alert, about six inches below the surface. Keeping your eye on the particular crab you wish to capture, place the spade about six inches from the



Soldier Crabs (*Mycteris longicarpus*) run about in vast armies when the tide is out.



The Fiddler Crabs (*Uca*) beat a hasty retreat to their mud burrows at your approach.

mouth of the burrow, at an angle of about 45 degrees, give a sudden hard thrust and a sliding iron door cuts off further retreat of the Bubbler. Raise the spade carefully, lifting sand, crab and all, and sort him out. The body of this species is large if it is the size of a pea, and, as it is the exact colour of its surroundings, is often very hard to see. When cornered in a burrow, the Bubbler often rolls itself up and may be cast aside as a lump of sand; but the foolish creature immediately unwinds and runs away, so that his 'possum act is not very convincing.

A little beyond this sand flat is a stretch of hard mud, mixed with sand. On your approach thousands of crabs wave their arms excitedly, they dance and signal to each other, and assume grotesque postures. A little green fellow with red tips to his nippers (*Sesarma erythroactyla*) sidles away to the edge of his burrow without loss of time, but he evidently does not know whether to go down or not for he dodges up and down several times before finally disappearing. Over yonder is another species, known to me as the Semaphore Crab (*Heloecius cordiformis*), a purple coloured fellow with two very long, angular, clumsy looking arms, and eyes at

the ends of long stalks. He stands and shows fight, backing or sidling away, or making a pretence of rushing forward. He bows and scrapes as if salaaming, while his arms wave wildly about, his nippers opening and shutting, as if itching to get at you. He is game enough as he stands high on the points of his legs—shall I say tips of his toes—and he performs a sort of cakewalk, which sometimes ends in a collecting bottle.

On some of the lower limbs of the mangroves on the outskirts of the swamp, you will find several other species of crabs, and by digging here and there in the mud more can easily be captured, for many kinds live within a very small area.

On leaving this part, you find a small streamlet; it is the last of the tide running into the creek from a large deep hole. Here, by using a net, you may capture an occasional swimming crab (*Portunus*). Drag the net through the grass weed near the bank and you will collect a wealth of life, such as small prawns and shrimps, young pipe-fish, and little weed crabs. A few hauls will reveal a host of tiny creatures whose presence was unsuspected.

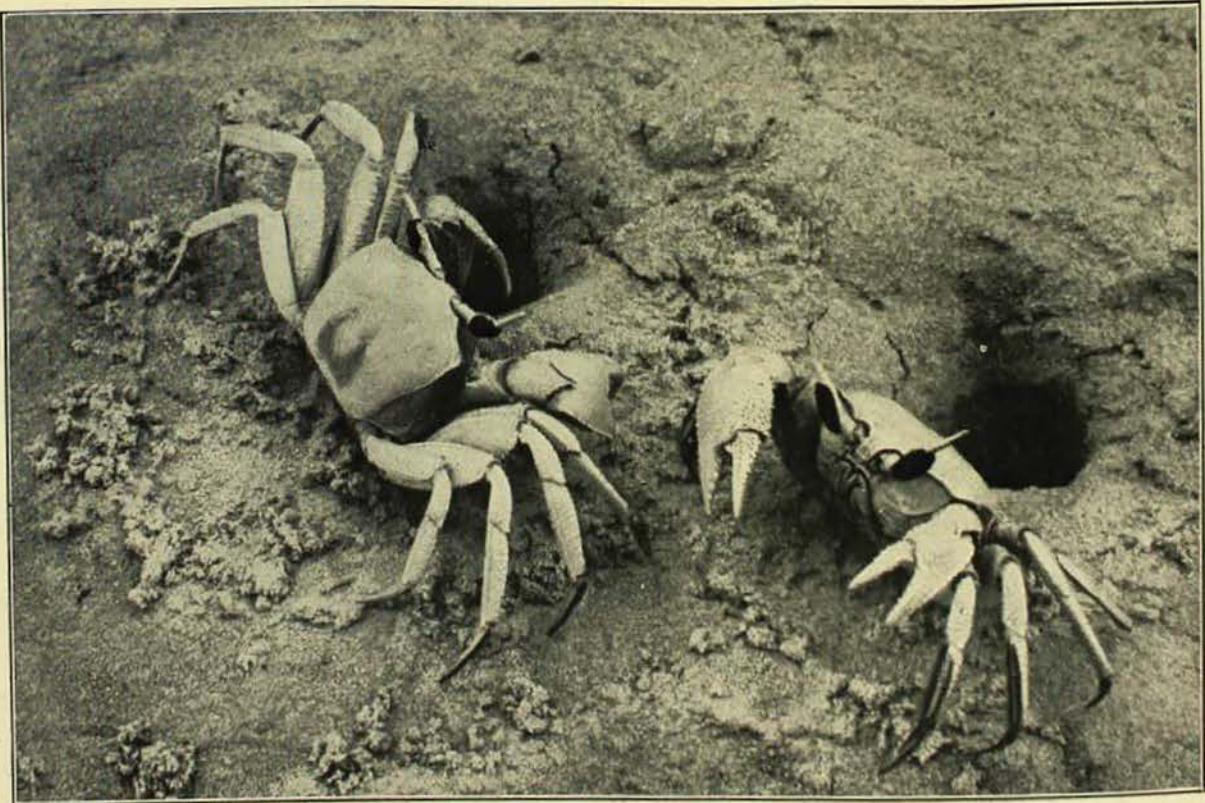
Across this stream is the softer mud,

with the water only a few inches under the surface. Everywhere crabs from the size of a match head to an inch or more across the body may be seen, and a peculiar click, click, clicking noise can be heard. What is it? You dig quickly in a burrow and turn up, besides the owners, which are our friends the mud crabs, a peculiar prawn, the Nipper Prawn (*Alpheus*). It has one very small almost useless nipper, and a very large lumpy-looking one, the two fingers of which form a sort of cup, and by bringing these together suddenly, snapping his fingers, as it were, he produces the peculiar clicking noise. Into the bottle with him and then dig again, dig wide and deep, allowing the water to fill the hole. There is a splash, in with the net quickly, bring up water, mud, and crabs in your haste, and you may be lucky enough to catch the maker of the splash, a small most beautifully coloured mud fish (*Cryptocentrus gobioides*). It is olive green, covered with many brilliant blue spots on the upper surface, while its sides are striped alternately with blue and crimson.

Presently you see a large red, or red and yellow chelipede, or nipper, apparently lying loose at the mouth of a burrow. You pick it up, and with it, out of the burrow comes

the owner, the Fiddler Crab (*Uca*), an extraordinary beast with one very small nipper with which it feeds, and another, larger than itself, which is used as a weapon. These crabs live in colonies, but evidently they are not very friendly with each other, for each one guards his burrow from intruders, pushes them out if they try to enter in their haste to get away from you, or drives them away if they approach its feeding ground; it is each one for himself. The females, however, have not the large fighting chelipede of the male, for theirs are both small ones.

Having finished with the mud flat, you cross the sand hill to the ocean beach, and there enjoy a few minutes chasing the White Sand Crab (*Ocypoda ceratophthalma*). It is an exceptionally fast runner and doubles and turns so quickly that it is very hard to capture. It is certainly great fun, but beware how you handle him, for he has a strong nipper, which he can use effectively. The large sand crabs nearly always make direct for the water when chased and wade well out; as the water recedes, they bury themselves in the sand with astonishing speed. If you want to witness a queer sight, hide behind a mound for a few minutes, and watch the spot where the crabs are submerged. After



The White Sand Crab (*Ocypoda ceratophthalma*) speeds across the ocean beach like foam before the wind, and he waits near his burrow to watch your movements.

a time, two long stalk eyes will stick up from the sand and wave about enquiringly, others will follow, and before long the owners themselves make their appearance, and start the return journey to the beach. If you move while the crab is just emerging from its hiding place, it will not bob down again but will jump up, run further into the surf, and disappear in the swirl of sand disturbed by the waves.

It is interesting to watch this crab feeding. With its nippers it scrapes up sand from each side and draws it in towards its mouth, rolls it about its jaws, and, after extracting the small crustaceans upon which it feeds, deposits the sand in a small ball, then takes one pace directly backwards and repeats the operation. The result is a track resembling vertebrae, from each side of which are diverging furrows corresponding to ribs.

Away to the east is a small inlet, "The Big Gap," a picturesque locality, famed for its beach worms (*Onuphus teres*). At low tide these may be seen everywhere, only their heads showing above the wet sand, giving the beach the appearance of a field of daisies. If, while on the beach, you screw your feet down into the sand in about a foot of water, you may disturb a small, very pretty, swimming crab; it is exceptionally quick, skimming through the water and again burying itself in the sand in a twinkling. This beautiful and much mottled little fellow was called by us the Marbled Crab (*Matuta*).

Most crabs are incapable of harming you if handled in the proper manner. To pick one up, first press it down with a stick, or with your fingers, then catch it by each side from above, your thumb and forefinger being near the base of the legs. The crab will wave its arms in frantic efforts to reach your fingers but only those with very long arms can manage to do so. The Fiddler, dangerous

as it appears to be, is the most easily handled, and the swimming crab one of the most difficult. It is as well when collecting in mud, to wash each specimen in clean water, otherwise, the mud will collect thickly in the bottle. Some of the larger crabs, in fact any with strong nippers, should not be put into bottles without first having their claws bound tightly to their bodies with a broad strip of butter muslin; otherwise, the collection will be sadly mutilated, and the bottle will contain many spare parts.

Having finished your day's work in the open, you will return to your quarters, sort out your catch, and label tubes and bottles. It must be remembered that a collection of any kind is worthless unless properly labelled with at least localities and the date collected. It is also desirable to keep a note-book in which to jot down information as to habits and peculiarities of specimens collected; this article is the result of such notes. It is well to number each specimen, or group of specimens, full particulars being entered in the note book under a corresponding number. If you do all this, you will have a collection which, even if of the most common objects, would be not only a credit to you, but a valuable addition to the collections of any museum.

Sea-shore collecting is perhaps the most fascinating of pastimes, and may be indulged in at low tide on almost any available beach, and, when one can find a locality such as South West Rocks, which is so rich in the rarer forms of life, it is not only fascinating and interesting to the casual collector, but of great value to naturalists. See what you can do on other parts of the coast, preferably some distance from Sydney, and send all you find to the Museum. A specimen may not appear to you to be of much value, but, even if it is not a new species, it may be a new record for the State.

The purpose of the Australian Forest League, just formed, is to link together societies and individuals interested in forestry, agriculture, and the study of nature in any of its forms, but particularly to create a "forest consciousness." Thoughtful Australians are concerned at the depletion of our forests and the inadequate efforts to preserve our trees, which are not only a delight to the

eye, but have an important and beneficial influence on climate and health.

The honorary secretary, Mr. F. T. Berman, Public School, Five Dock, will give all information to intending members. The annual subscription is half a crown.

We cordially wish this movement every success.

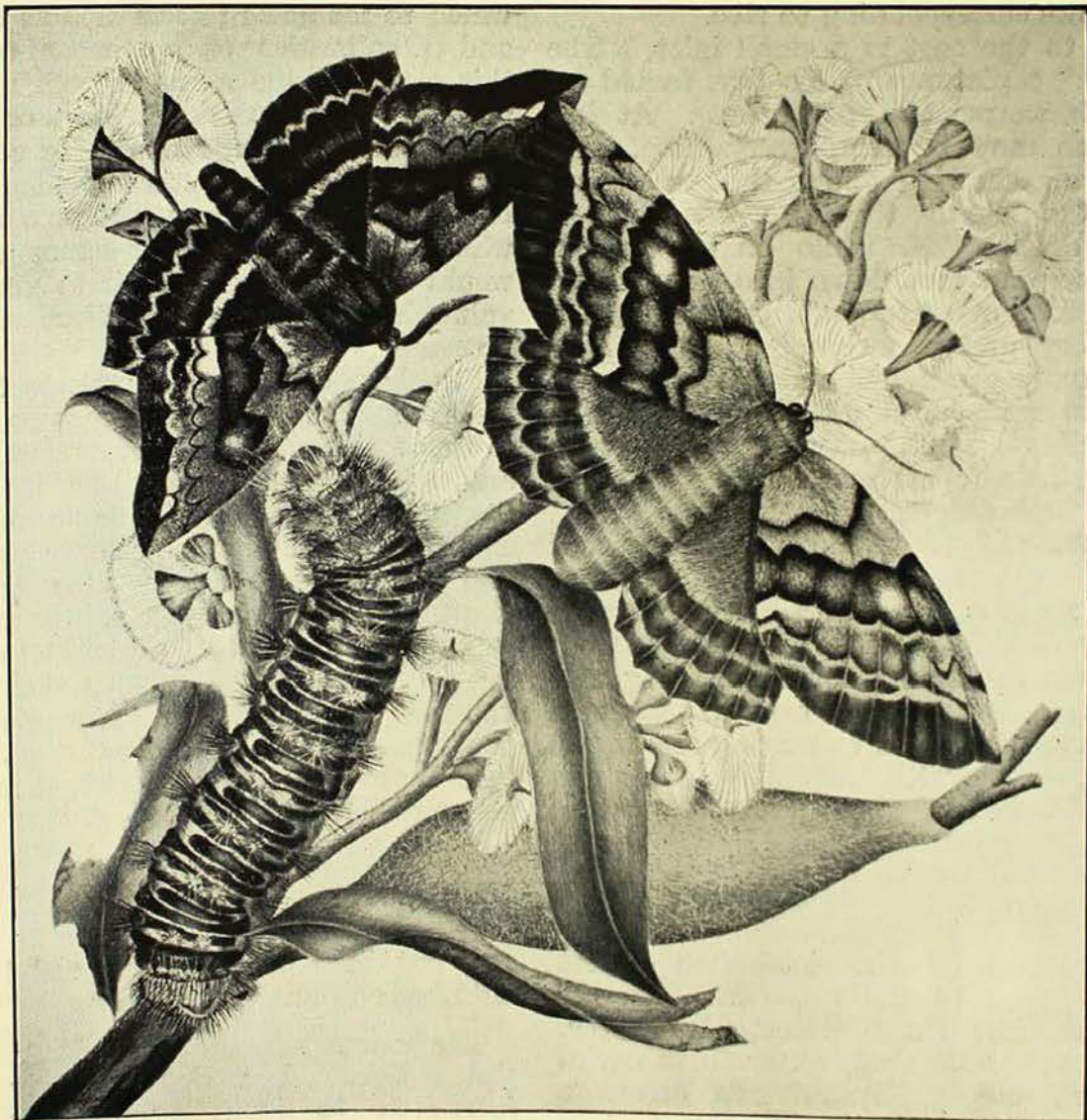
Some Caterpillars Injurious to Man.

BY ANTHONY MUSGRAVE.

THOUGH moths in the adult stage are perfectly harmless to man, nevertheless some species during their larval or caterpillar stage are armed with spine-like hairs which, if they enter the skin, set up a very severe irritation. Thus we learn of caterpillars in various parts of the world causing great discomfort to man through their poisonous hairs. In England and

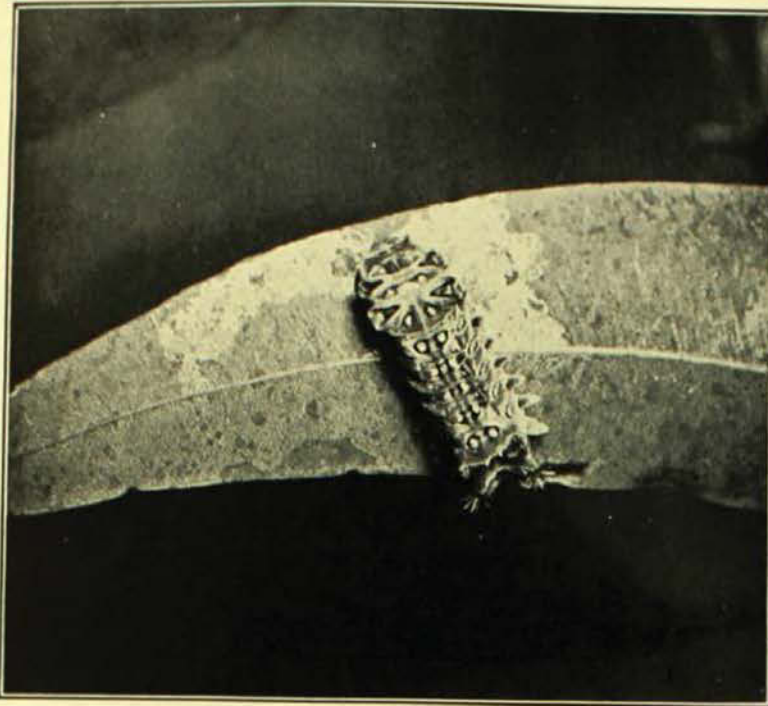
America the Brown-tail Moth (*Euproctis chrysorrhoea*) an insect destructive to shade trees, is in its caterpillar state covered with tiny barbed hairs. When the caterpillar moults, these hairs become scattered about by the wind, and on touching the skin set up a severe rash known as "brown tail rash."

In Australia we possess several species of these hairy caterpillars belonging to



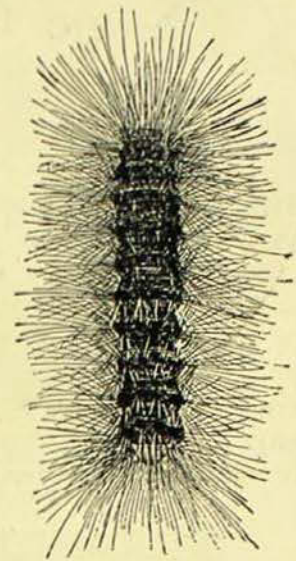
Chelepteryx collesi. The larvae (left) are dark brown with eight yellow spots on each segment of the body. The male may measure over six inches across the wings and the female (right) over seven.

[Helena Forde, del.]



Caterpillar of Cup Moth, showing erect spines towards end of body.

[Photo.—A. Musgrave.



Caterpillar of *Ochrogaster contraria*, whose spines may give rise to a painful rash.

[Agric. Gazette, N.S.W.

different families and those best known are here dealt with.

The caterpillar chiefly responsible for annoyance of this kind is *Euproctis edwardsi*, a member of the family Liparidae, the same family as that in which the Brown-tail moth is included. In the caterpillar state this moth feeds on the foliage of the mistletoe and eventually pupates in a cocoon under the bark of a tree. The cocoons are usually filled with the cast off spines of the caterpillar, and should these enter the skin, they cause a severe rash. An account of the injurious effects caused by the spines of this caterpillar is published in the Medical Journal of Australia for February 21st, 1920.

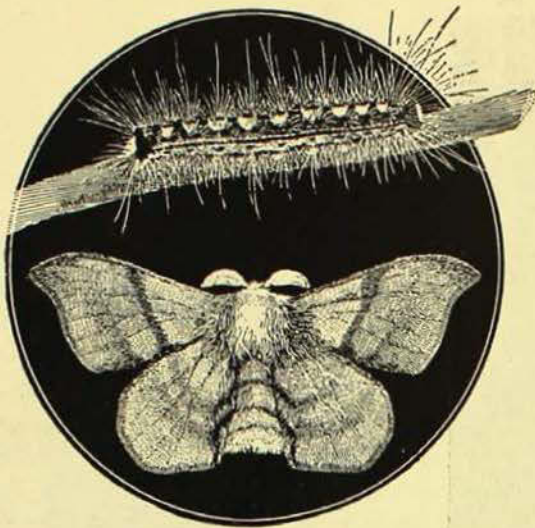
The larva of *Chelepteryx collesi*, one of our largest moths, is clothed with short stout hairs which serve to protect it not only during the caterpillar stage, but during the pupal stage as well, for the spines are forced out through the cocoon, and serve as an efficient means of protection to the pupa enclosed within. It was the unpleasant experience of the writer to let his hand come into contact with a cocoon of this species, with the result that one finger was literally befurred. Though many of the spines were completely removed with forceps, the majority broke

off, owing to their extreme brittleness, and remained in the skin, causing the finger to swell to twice its normal size.

Some of the larvae of the cup-moths (Limacodidae) are provided with little rosettes of spines, which, when the insect is touched, are spread out so that they enter the skin. They are brittle, and break off in the skin, causing severe pain. The larva of the Cup Moth (*Doratifera vulnerans*), a not uncommon insect on the eucalypts, is a noted delinquent in this respect. This slug-like caterpillar is green in colour, and flattened on the upper and lower surfaces, the under surface being broader than the upper. The little knobs bearing the spines are arranged in pairs near the head, and on the last two segments of the body. The spines are withdrawn when the insect is undisturbed, but are ready to be darted out at the slightest approach of danger.

The caterpillar eventually forms a hard, pear-shaped cocoon, attached by its broad end to a branch, and the narrow end is provided with a lid, which is removed when the insect finally emerges as an adult moth.

The hairy caterpillars of a moth, *Ochrogaster contraria*, a member of the family Notodontidae, have been shown by Mr-



The Hook Tip Moth, *Panacela lewinae*: the spines of this caterpillar have been responsible for the deaths of horses.

Agric. Gazette, N.S.W.

Froggatt¹ to be capable of setting up an irritation by means of their spines. These caterpillars feed chiefly on the foliage of the Weeping Myall (*Acacia pendula*), forming a "bag shelter" among the leaves. In this, they remain during the day, coming out at night to feed. From this habit, they are also known as Processional Caterpillars. As the Weeping Myall is regarded as a valuable

The collections secured by Surg.-Lieutenant W. E. J. Paradise, R.A.N., and referred to in the last number of THE AUSTRALIAN MUSEUM MAGAZINE, have been largely added to during a recent cruise of H.M.A.S. *Geranium* to the Gulf of Carpentaria. One of the most striking specimens procured is a large slab of rock in which are embedded the remains of a large extinct reptile belong to the order Ichthyosauria. This was originally discovered by some workmen during 1915, on a beach near Fanny Bay, Darwin, from where it was removed by Dr. H. I. Jensen, at that time Director of Mines, Northern Territory. Circumstances prevented him from forwarding it to Sydney, as he had intended, and he had to leave it in the Botanic Gardens at Darwin. Though unaware of its history, Dr. Paradise appreciated its value and tackled the problem of transporting the heavy rock so successfully that it is now safely stored in the Museum collection.

fodder plant for cattle and sheep during periods of drought, the bag shelters are destroyed whenever possible, but the task of cutting off the branches is not a pleasant one, for the bags are full of the cast hair of the caterpillars, which may give rise to a very painful rash.

The larvae of the Hook Tip Moth (*Panacela lewinae*), a member of the family *Bombycidae*, feed on the foliage of trees such as the stringy bark and wild apple, and, like the preceding species, spin a silken bag shelter.

According to Mr. Froggatt² the spines of these caterpillars have been responsible for the death of a number of horses which cropped the grass over which caterpillars were passing. Some of the insects were taken into the horses' mouths, the spines causing such a severe ulceration that they were unable to feed. People, who came in contact with the spines also suffered severely. The caterpillars do not pupate in the bag shelter, but spin a cocoon between the furrows of the bark of the tree on which they feed.

¹ See Froggatt, *Agricultural Gazette of New South Wales*, 1911, p. 443.

² See Froggatt, *Agricultural Gazette of New South Wales*, 1911, p. 446.

Lieut.-Commander H. T. Bennett, R.A.N., obtained some excellently preserved examples of ripple-marked quartzite on Vanderlin's Island and presented a specimen which is now on view in the Mineral Gallery. Ripples are formed on the soft sand of beaches by the action of tides. Ordinarily each tide effectively destroys those of its predecessor and produces new ones. Ripples may be formed under water, however, at any depth to which the agitation caused by wind on the surface may extend. If there is a plentiful supply of sediment to the water the ripples will become covered over and thus preserved. In this way a great number of layers, each with its surface ripple-marked, may be laid down one on top of the other.

At Vanderlin's Island this process, probably, was going on about 200 millions years ago, when the coal measures of the Newcastle district were being formed. The sand has since become consolidated into sandstone and further changed into quartzite, and is now elevated about 300 feet above sea level.