The AUSTRALIAN MUSEUM MAGAZINE

VOL. XIII, NO. 1. Price—TWO SHILLINGS.

Cabbage Tree Island, off Port Stephens, N.S.W., is dedicated as the John Gould Faunal Reserve. It is the only known breeding place in N.S.W. of the White-winged, or Gould, Petrel. (See Article on Page 9.)

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THE AUSTRALIAN MUSEUM

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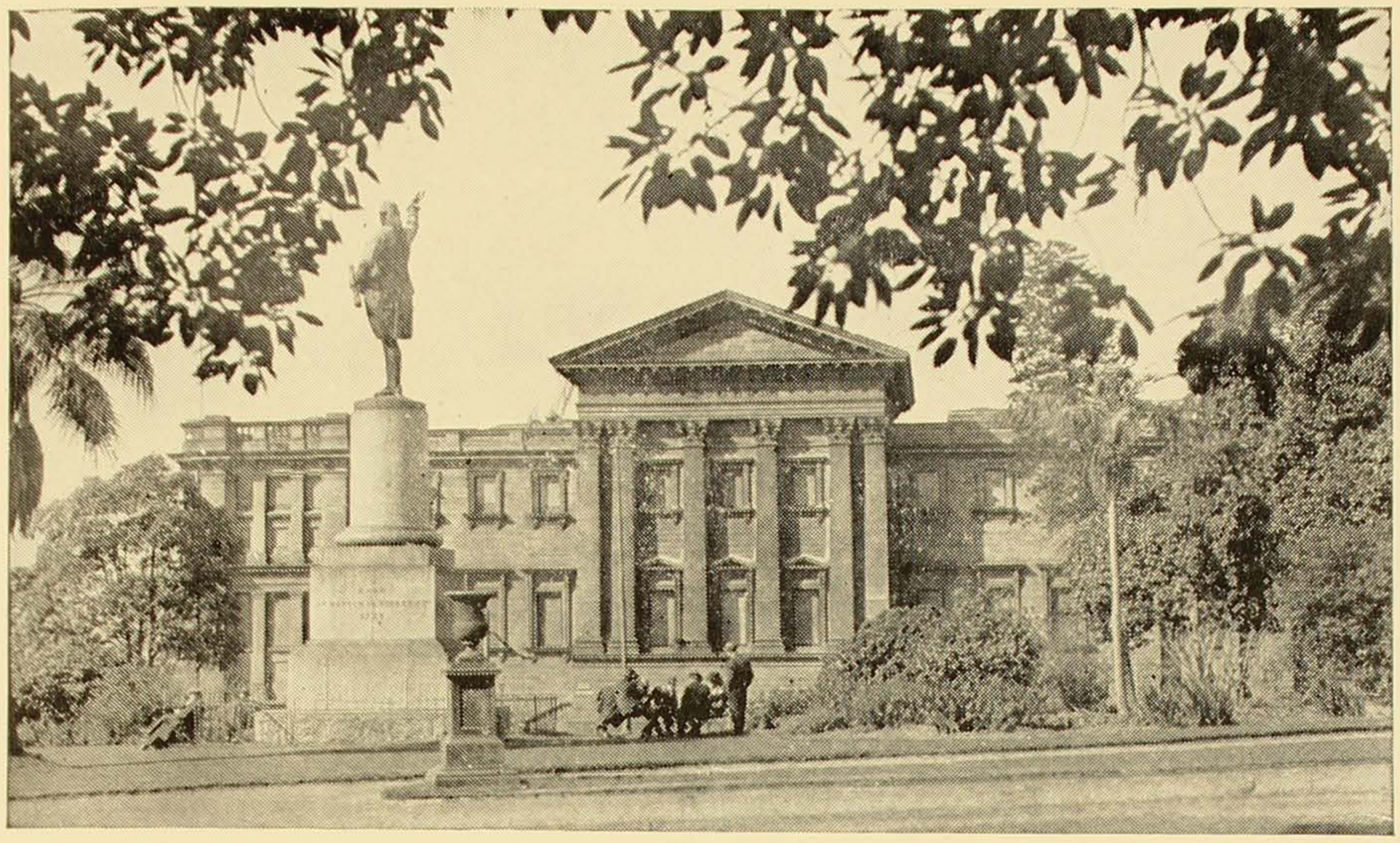


THE AUSTRALIAN MUSEUM MAGAZINE

OUR FRONT COVER: Allen A. Strom, author of the article "Fauna Preservation Faces A Crucial Period" (Page 9), took this photo of Cabbage Tree Island, N.S.W., one of six faunal reserves which the N.S.W. Fauna Protection Panel has had established for the protection of wild life.

VOLUME XIII, NUMBER 1 MARCH 15, 1959

THE AUSTRALIAN MUSEUM MAGAZINE

Published Quarterly by the Australian Museum - - College Street, Sydney

Editor: J. W. Evans, Sc.D. Annual Subscription, Posted, 9/-

VOL. XIII, NO. 1 MARCH 15, 1959

OBSERVATIONS ON THE BEHAVIOUR OF SEA URCHINS

By A. N. SINCLAIR, B.V.Sc., M.R.C.V.S.

Of the Underwater Research Group of N.S.W.

MANY of the habits of sea urchins were observed by the writer during day and night diving in the waters around Sydney with members of the Underwater Research Group of N.S.W. An aqualung and a waterproof torch were used.

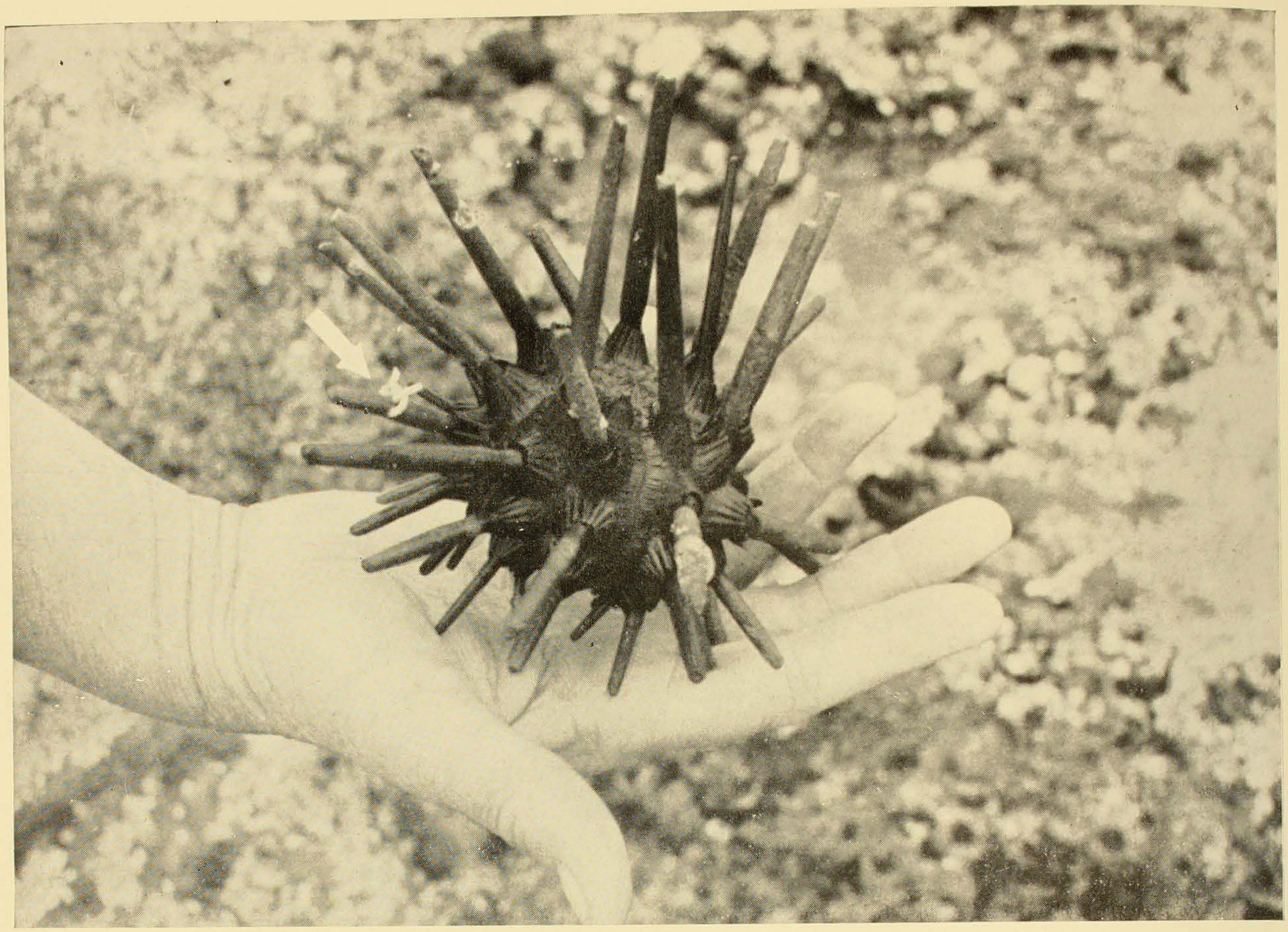
When diving in daylight one is impressed by the numbers of the large, rough-spined sea urchin *Centrostephanus rodgersii*. Many of these are seen "at home" in hollows carved in the sandstone rocks. These hollows may be deep enough to contain the whole urchin, but are never as deep, comparatively, as the sharply-etched hollows carved by the smaller urchins, *Heliocidaris erythrogramma*, described later in the article. Other urchins lie in crevices or under ledges, and occasionally are seen out on rock surfaces, but not moving. During daylight most of these urchins appear to be motionless, with the spines sticking out at right angles to the body surface in a typical "hedgehog", or defence, position.

After darkness sets in the picture rapidly changes, and the urchins become active. Within an hour or two of sunset, numbers of *Centrostephanus* are seen "out walking" on the rocks, but they don't seem to favour "walking" on the sand to any extent. The spines at such times are generally arranged in groups or "cones". If a torch is shone on the urchin for a short time no reaction to the light can be observed, but if the urchin is touched it immediately assumes the "hedgehog" position seen in daylight.

Homing By Urchins

Observing the urchins away from their holes at night posed the question whether they returned to the same holes they occupied during the day. This led to an amusing series of failures to fasten identification marks to *Centrostephanus rodgersii*. A nylon fishing line, carrying a plastic tag, was wrapped firmly around the body and tied securely, but the next day it was found on the sea floor with the knots still intact. Presumably the urchin does this "Houdini" act by moving the spines at steep angles until the irritant line is sloughed off.

After several weeks of failure to mark them with nylon line, despite a most complicated series of knots, brass picture wire was wrapped around the body of the urchin and hitched around several spines, only to meet with the same cavalier treatment. The most useful method found to date has been to



To enable this Slate Pencil Urchin's movements to be followed, a plastic-covered wire marker (arrowed) has been inserted in a fine hole drilled through one of its spines.

Photo.—Howard Hughes.

stick a small square of coloured rubber from a balloon on the tip of a spine. This will remain in position for at least 48 hours, and has done so for as long as a week.

Results of marking specimens of *C. rodgersii* in Clovelly Bay, Sydney, have shown that the urchins move up to three or four feet from their rock holes within two hours of sunset and return to their own holes by the next morning, though often each is lying turned round from its original position. One urchin was observed to go seven feet from its hole by 10 p.m. Apparently it kept on going, as it was nowhere to be seen next day and its rock hole was empty.

On any dive during daylight it is common to see vacant rock holes, which, by the absence of weed growth, appear to have been recently vacated. Usually, however, these holes are again occupied within a week, but our tagging techniques have been inadequate to reveal whether the occupants are the original ones or newcomers.

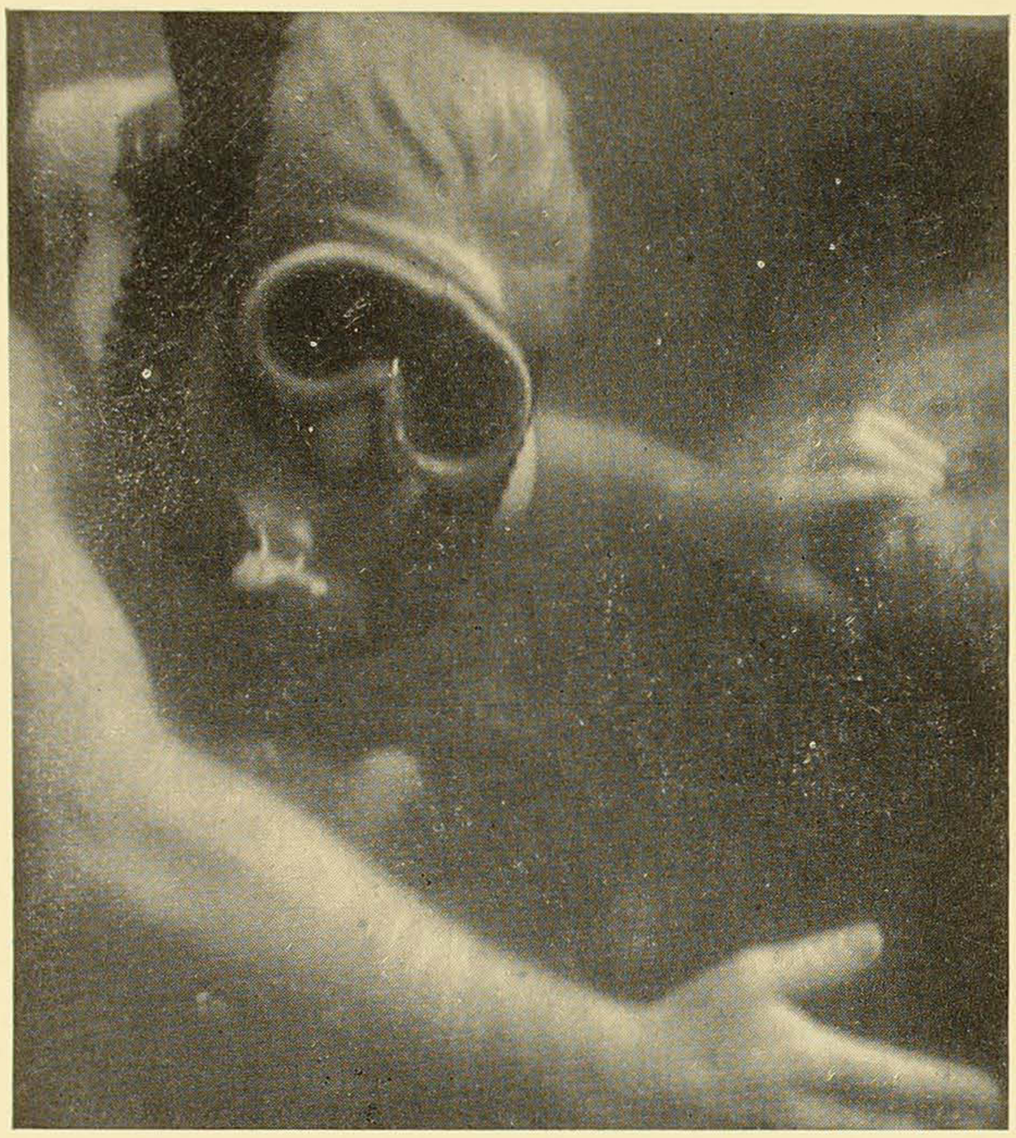
Phyllacanthus parvispinus, or the Slate Pencil Urchin, is also an adept at escaping from festoons of nylon line or brass wire, presumably by moving the spines. Also, it is suspected that this urchin has an additional means of escape, as brass wire has been seen almost cut through and with large dints in its surface.

Slate Pencil Urchins

Identification of individuals of this urchin has, however, proved a simple affair, as a fine hole can be drilled through one of the spines and into it a suitable marker, such as plastic-covered wire or brass wire, can be inserted. Two urchins marked in this way at Christmas time still carried their marks in mid-July.

Unlike most of the finer-spined urchins, the Slate Pencil Urchin does not seem to live in holes, preferring crevices between rocks. In more than 200 sightings of these urchins only one has ever been seen in a spherical

rock hole. Most are in crevices during daylight, and are so securely wedged in that they can only be moved by breaking spines—though if the crevice has a sandy bottom the sand can be dug away with a knife. Other haunts of the Slate Pencil Urchin are on the floor of "forests" of weed or kelp. It also burrows into crevices behind clumps of mussels. At Fairlight, Sydney, these urchins have been seen so deeply buried behind banks of mussels that only the tips of a few spines were visible.

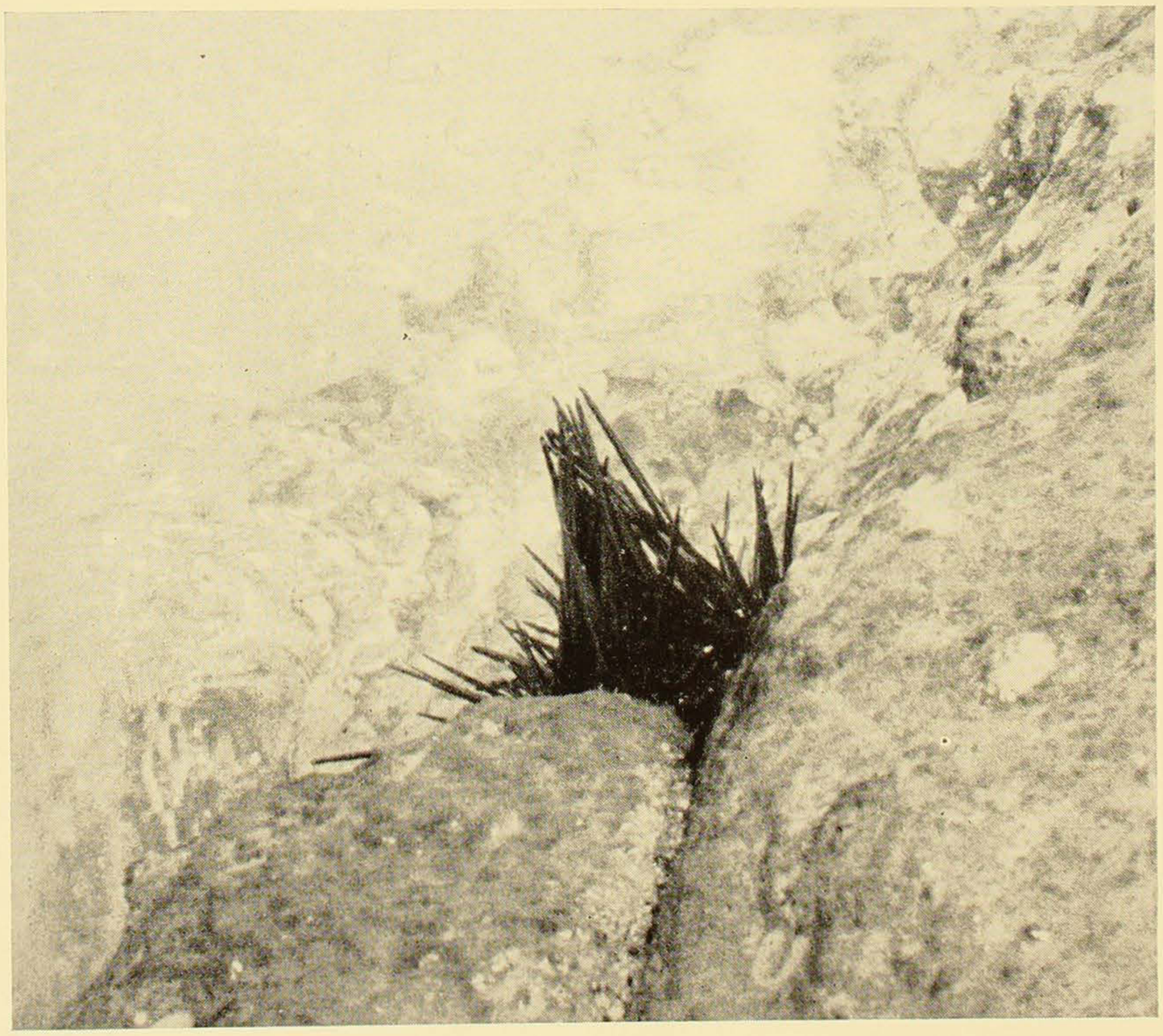


Above: The author examining sea urchins at a rock ledge 15 feet under water in Clovelly Bay, Sydney.

Photo.—G. Evelyn

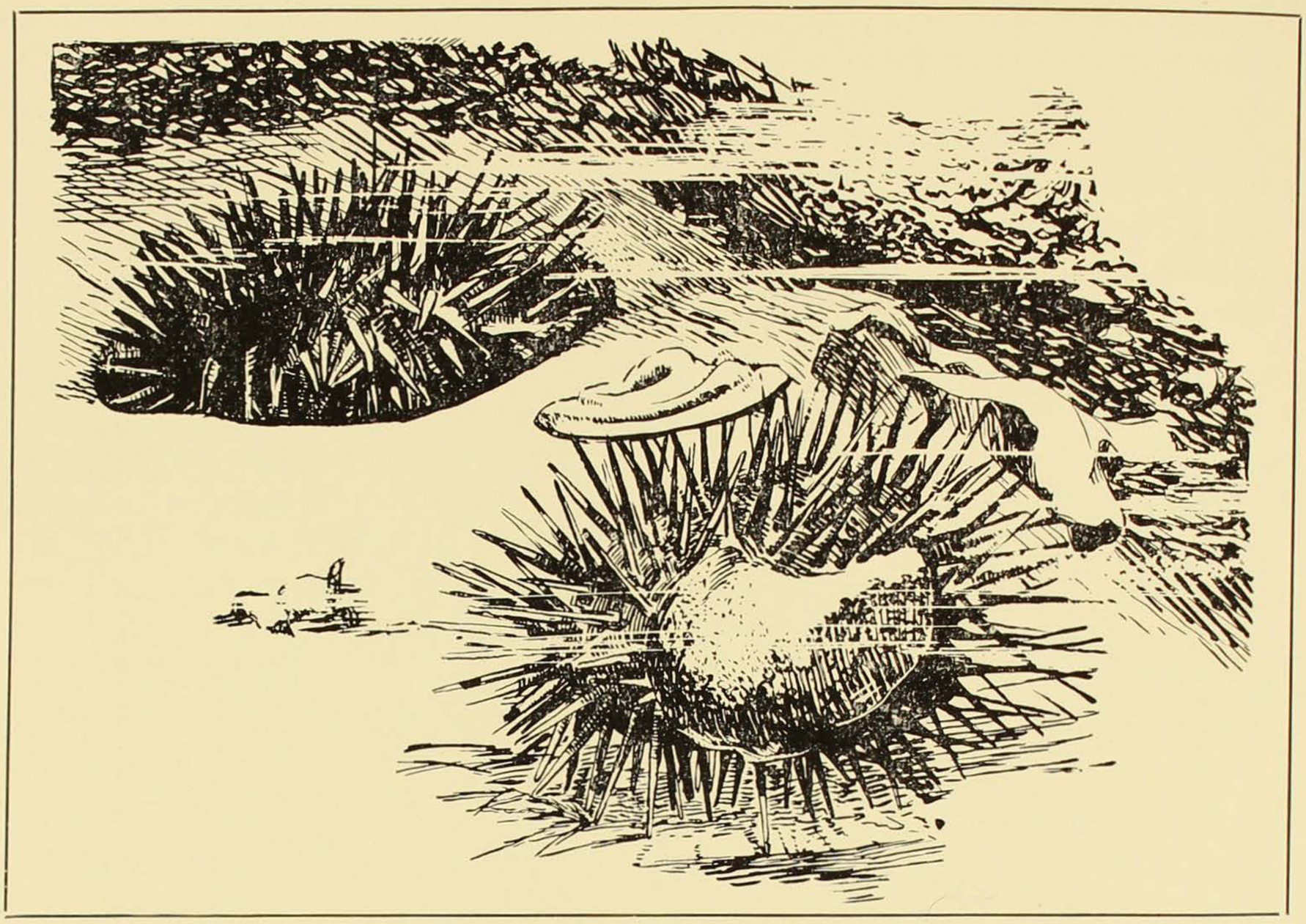
Dull, rainy days seem the best for seeing these Slate Pencil urchins. On a bright sunny morning at Obelisk Bay (west), Sydney, not one was seen, yet in dull weather, in the afternoon of the same day, more than 30 were seen in the area. Like *C. rodgersii*, these urchins appear to prefer deeper water and are more numerous as one approaches Sydney Harbour floor in 20 to 30 feet of water. Our deepest recorded observation is of four Slate Pencil Urchins on the sandy floor of the Harbour, between the heads, at a depth of 80 feet. Occasionally juvenile Slate Pencil Urchins are seen—usually in about 15 feet of water.

Although each Slate Pencil Urchin does not have its own particular rock hole, it does return to a particular locality. One marked specimen stayed under a small ledge, apparently without straying, for four months, but has not been seen during the last two months. Another identified urchin alternates between weeks of quiescence and periods of "going walkabout". It has moved as much as eight feet overnight and may



Right: The sea urchin *Centrostephanus rodgersii* arranges the long spines on its upper surface into a cone formation when it moves across rocks at night. Its spines are in the normal, or "hedgehog", position in daytime, when, as far as can be ascertained, it doesn't move about.

Photo.—Howard Hughes.



Above: The Common Sea Urchin (*Heliocidaris erythrogramma*) in a hollow in a rock which it has made by shuffling its spines. *Below:* An urchin of the same species carrying shells and seaweed debris as a protection against light.

F. J. Beeman del.

disappear for weeks, only to return again to what is apparently its favourite crevice about 12 feet down.

The Slate Pencil Urchins go out "walking" at night, and have been seen "attacking" whelks bigger than themselves. The "speed record" for this species is one foot in 20 minutes. Some have been seen with barnacles growing on their spines, but it is not known whether they can shed spines in that condition. Such action is suspected, however, as they are often seen with one or two spines covered with a sort of red "velvet" similar to that covering the body, whereas normal spines are greyish-brown.

The Common Sea Urchins

The commonest urchin at shallow levels within about six feet of the surface is *Heliocidaris erythrogramma.* It is the dominant species, and practically the only urchin present in this intertidal zone. It lives in crevices and holes in the rock, which can be almost "honeycombed". It appears to "dig" holes much deeper in relation to its size than any other species. This urchin appears in many colours—greens, reds, browns and purples, a new one being revealed at almost every dive. The spines are smooth and relatively short, and their shapes provided us with much interesting speculation until it was noticed that needle points and blunt points could exist in the same animal.

One of the most interesting combinations of spine shape and colour in this urchin is in the blue or mauve specimens. To date, the writer has yet to observe an all-blue urchin with any but needle-pointed spines. However, half-blue or blue-tipped spines may be either blunt or sharp-pointed.

The wandering or homing habits of *Heliocidaris erythrogramma* have not been observed, but if the urchin is detached from a rock and allowed to fall through the water it quickly assumes a "cone" arrangement of the spines similar to that observed in *C. rodgersii* while "walking". Also, occasional urchins show movement of the spines while in the rock holes.

H. erythrogramma has been observed 15 feet below low-water mark, but is usually in the shallower waters. Because of this, its homing instincts have not been studied as much as those of the deeper-living varieties

for, strange as it may seem, the shallower waters are more difficult for divers. This is because wave action is greater near the surface, and the diver is much more handicapped by inability to keep still. It is quite common, even on a still day, to be suddenly hurled many yards away from the object of contemplation—frequently with painful removal of areas of skin. The spikes of the urchin itself are a further hazard, and the results of too close a contact can only be removed by frequent applications of poultices to the affected parts. For these reasons, divers retreat to the comparative calm of deeper waters.

Another species of *Heliocidaris* is the larger *H. tuberculata,* with red-tipped spines. It has similar habits to *C. rodgersii*. The two are often seen in company, with the latter in large rock holes, under ledges or in crevices. Occasionally, *H. tuberculata* may be seen closer to the surface, in company with *H. erythrogramma*. When it is observed closely, waving, lemon-coloured tube-feet can be seen among the spines.

This species has yet to be seen "out walking" at night. However, it does move about to a limited extent, one having been observed to vary its position about six feet in a month. It is assumed that the movement takes place much later at night than the writer is prepared to be out diving.

This red urchin is usually a solitary animal as far as its own species is concerned, though on infrequent occasions up to 10 of them have been seen close together. There appeared to be more movement among them than normally at Clovelly, Sydney, in March, 1958, numerous pairs and trios being seen. However, the one under close observation remained alone, as it had been for the previous seven months. In mid-July, however, it succumbed to the general "wanderlust" and disappeared. *H. tuberculata* also appears to prefer deeper waters, usually being found from about 10 feet downwards.

Sheltering From Light

Tripneustes gratilla, a wanderer from tropic seas, apparently has the distinctive habit of being unconcerned with the need for shelter. It is usually found on walls of caves or right out in the open many yards from the nearest "shelter". It is a large-bodied urchin, with very short white spines tipped red or mauve. The rounded body has a plain darkish colour, or it may be all-white, with five darker major bands and five secondary bands. The latter type was the one most commonly observed. In this urchin the movement of spines appears to be on lines at right angles to these dark bands, and red tube-feet can often be seen so extended that the dark band is obscured.

Some of these urchins carry small pieces of shell or weed, presumably for sheltering from the light. This habit of attaching pieces of shell is not limited to this species however, as *H. erythrogramma* has also been observed doing it.

T. gratilla is usually seen at depths of 10 feet or more, and has only been sighted to date by our group in rocky areas in Sydney Harbour and at Fairy Bower, near Manly, Sydney.

Urchin Rolled Up In Kelp

A small spherical urchin, with smooth-pointed light-coloured spines and living mostly in weeds, is *Holopneustes pyctnotilus*. It is usually seen rolled up in a frond of kelp, apparently for protection. In such a position the urchin can literally eat itself out of house and home, for it eats the fronds on which it perches. As with the flies in the old song, the problem is to find where these urchins go in winter time, when most of the weed forests disappear, leaving only the brown stumps.

As can be appreciated from this article, most of the useful observations to be made by diving are of an ecological, rather than a systematic, nature, and it is because of this that an observation ledge has been carefully watched at frequent intervals during the past seven months. The ledge is at a depth of about 12 feet in Clovelly Bay, on the open coast near Sydney. It was, perhaps, not completely satisfactory for all types of observation, for no urchin had an individual "hole". For this reason, other observation points will be established after a 12-months' period has been completed. A further handicap to observation is that many local residents have developed a taste for eating sea urchins, and the colony now risks extinction.

In summer the colony comprised 20 *C. rodgersii,* one *H. tuberculata* and one *P.*

parvispinus. By early July the numbers of *C. rodgersii* had fallen to 14, but later in the month had been reduced to 10. This is in keeping with general observations on the scarcity of this species at this time. In June the marked Slate Pencil Urchin disappeared, and in mid-July the *H. tuberculata* also wandered off. An occasional visit by an unmarked Slate Pencil Urchin has been observed even as late as September.

After dark at this ledge the C. *rodgersii* go out "walking". Not all go out on any one occasion, and some go above the ledge and some below. Until identification is perfected we will not know whether individual urchins go out at constant intervals, nor even if some always go up and others down. Neither do we yet know anything about the distribution of the sexes in this colony.

About the feeding habits of *Phyllacanthus parvispinus* we know practically nothing. One urchin dissected at the Museum revealed *Galeolaria* tube worms in the gut. As this urchin has not yet been observed within six feet of the surface (up to 10 p.m.) we can only assume that it does considerable travelling later in the evening, for *Galeolaria* is attached to rocks in the shallows.

Noise Mystery

Another sea "mystery", possibly connected with the urchins, is that some divers (though not, as yet, the writer) consider that sea urchins are to some extent responsible for the crackling "static" noises so commonly heard when diving in the open sea and in Sydney Harbour on certain days. Don Linklater, of Bondi, Sydney, says that when he dived at dusk near Bondi, close to a large colony of urchins, the noise was extremely loud.

The only observations made personally by the author on this subject are that this noise is not heard in Clovelly Bay, which has a considerable population of urchins, but is heard when one swims only 10 yards or so out to sea. It might be argued that such observations are inconclusive. The effects of a confined space, like the bay, may distort the noise even if it were produced by the urchins. All these queries form a challenge to the underwater observer that makes each dive an adventurous voyage of discovery.

It is hoped that these notes will serve to illustrate our ignorance of the ecology of such sea inhabitants as the common sea urchins and point to a field of work within reach of the least venturesome divers, for much data can be gathered by using a diving mask and snorkel only. It is only by continued observations over the years that further light will be thrown on the life of these creatures.

New Wing to be Built at Museum

In the issue of this Magazine for September, 1958, mention was made of the "Hallstrom Theatre". On the occasion of the re-opening of the theatre after it had been closed for alterations, the Hon. R. J. Heffron, M.L.A., Deputy Premier and Minister for Education, announced that a contract had been let for the construction of the sub-basement and basement of a new wing for the Museum.

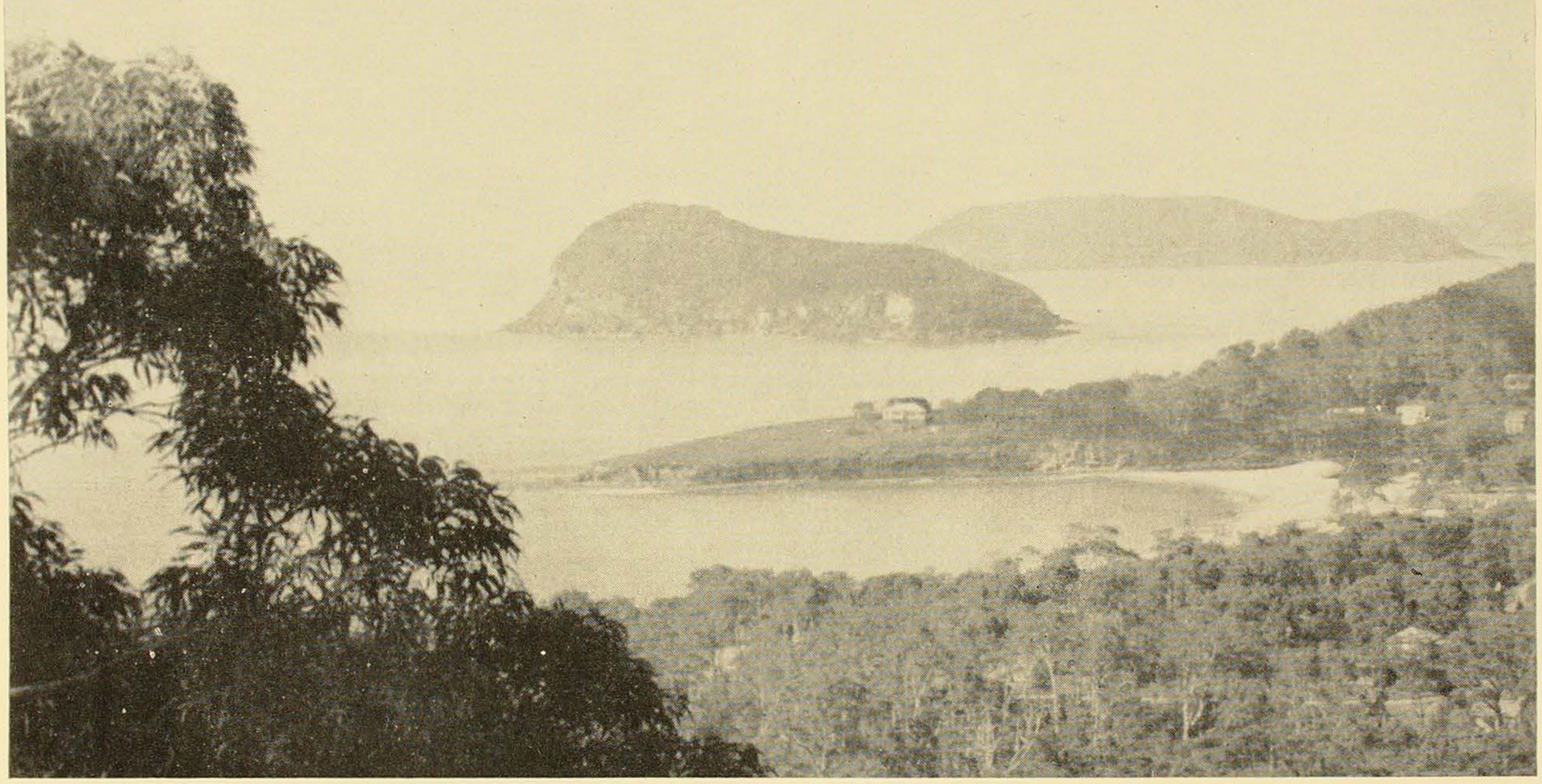
The two storeys, which will be in alignment with the William Street frontage of the Museum, will provide much needed laboratory and storage accommodation for the Museum and will relieve the serious overcrowding which has hampered the activities of the Museum for a very long time. How long will be apparent from the following statement that appeared in the Annual Reports of the Trustees for the years 1917, 1918 and 1919: "Every portion of the building is now occupied, either for exhibition, administration, bibliographical or storage purposes and as a result of this the affairs of the Institution are hampered and its activities in some respects brought to a standstill. No degree of re-arrangement can alter this state of affairs. The only relief possible is to considerably extend the building".

The last major addition to the Museum was the South Wing, which was completed in 1909. Although no new gallery space will be made available in the two storeys that are to be built, they will mean that it will be possible to re-open the New Guinea Gallery which has been used for some years past to store the Museum's valuable ethnological collection.

FAUNA PRESERVATION FACES A CRUCIAL PERIOD

By ALLEN A. STROM

Chief Guardian of Fauna, Chief Secretary's Department, N.S.W.



Lion Island Faunal Reserve (middle distance), at the entrance to Broken Bay, N.S.W., is one of the State's only two known breeding places of the Sooty Shearwater.

Photo.—Fred Hersey.

PROMPT action to obtain more land for faunal reserves in New South Wales is essential to prevent more and more forms of wildlife from becoming extinct. The next 10 years may well be the crucial period for wildlife preservation in this State.

Most of the community is interested in some fashion in our wildlife. A good nature story seldom fails to attract a large audience, many ordinary folk are almost experts on birds, plants, mammals and insects, and there are few who fail to respond to the brilliant flash of colour from a parrot or the symmetry and rhythm of a bounding kangaroo. But it is the failure to carry these interests through to an understanding of the fundamentals necessary for the preservation of wildlife that is the major obstacle to nature conservation.

In the natural environments that existed in this country when the white man arrived, the plants, the animals and the Aborigines had developed a delicate equilibrium in which there were no beneficial and no harmful species—these were labels that the settlers brought with them. Often a species served as a food and was therefore "good" to the early settler; the "bad" animals were those that served no purpose, or ate the crops, or else suffered by the prejudice of the accuser. In either case, the net result was to reduce the number of animals.

But by far the most effective weapon against wildlife that the newcomer brought to his new home was the power to rapidly destroy natural conditions and to impose upon the countryside the features that he knew in another place. This assault upon a

primitive environment began just as soon as the members of the First Fleet in 1788 began to lay out the gardens behind Farm Cove, and it has gone on to this day.

Animals may react in two ways to the changes wrought by man. The majority must die with the vegetation because their association with it is a tight bond forged over countless years of adaptation. Some may escape to untouched areas, but even in these areas population pressures eventually become excessive, resulting in death to the animals. On the other hand, a considerable number of species learn to live with man, benefiting from his crops, pastures and water supplies. In these new conditions natural population controls fail to act, and fecundity and adaptability throw the pendulum until, ironically, animal numbers become a menace to the economic use of the soil and we accuse the animal of being in "pest proportions".

Fauna Protection Act's Value

Man's mastery over nature has consisted largely of destruction instead of sound management, with little reference to the rights of the community.

The community will get what it is prepared to accept, and if the people of New South Wales want to see a continuously mounting list of extinct species they will continue to accept half-measures in wildlife management.

Yet the mechanism for protecting wildlife is available, for this State has legislation that some authorities have welcomed as the best in Australia. This is the Fauna Protection Act, which provides, inter alia, for control of habitat in the form of faunal reserves—areas which are dedicated for the purpose of conserving the breeding places of native fauna and in which the general public may enjoy natural surroundings and native wildlife.

Provided action comes quickly, a well-distributed system of faunal reserves could ensure the retention of samples of most of the naturally occurring environments in this State. But two factors are essential: Speed in locating available areas and sympathetic understanding from the authorities responsible for making the reserves things of reality. Such steps require vision and conviction.

Large faunal reserves should be complete ecological units, or the combination of two or more such units, but there is also a pressing need to hold small areas of cover, particularly where intensive clearing has led to almost complete removal of trees and vegetation. These small areas would be for faunal reserves of a special kind—wildlife refuges or fly-ways.

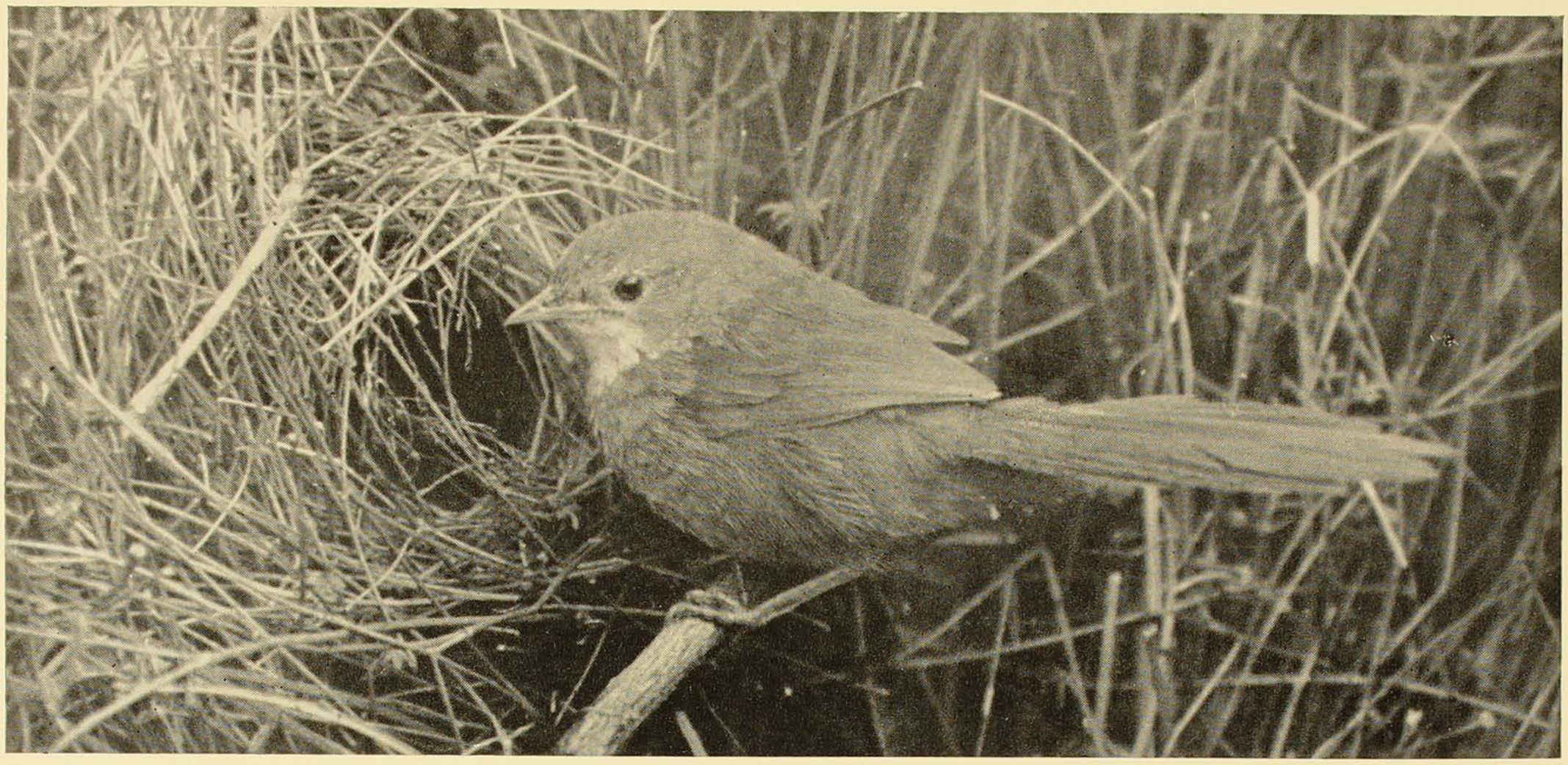
To have the land reserved and saved from alienation or development is the crucial need, and the reservation procedure must be pursued at full speed, even though the resulting reserves will be held in "cold store" for the time being. Securing environments unaffected by urban development is so urgent, because of the acceleration of development, that little should be allowed to interfere with the process. Admittedly, reserves need supervision and management, but to allow precious natural conditions to be destroyed because funds are not available for staffing is surely begging the question. While we argue about whether staff or reserves come first, the few remaining untouched lands may slip through our fingers.

The Kangaroo Problem

In the nine years since its establishment, the N.S.W. Fauna Protection Panel has been successful in securing the establishment of only six faunal reserves, of which there are two approaching significant size—Barren Grounds (about 4,000 acres) and Nadgee (28,000 acres). However, the Fauna Protection Panel and its first chairman, the late Mr. F. J. Griffiths, did not lack ideas or interest. Several recommendations failed to receive the concurrence of the Minister for Lands for a variety of reasons.

If it had been possible to establish a large reserve for the red kangaroo in the west, the problem of competition between sheep and kangaroos might have been averted. A similar problem with native fauna in South Africa and the United States appears to have been solved in this way.

It does seem inevitable that ultimately, if the community wishes to retain the kangaroo, the man-on-the-land will have to learn



The rare Eastern Bristle Bird, so called because of prominent bristles at the base of its beak, breeds in the Barren Grounds Faunal Reserve, N.S.W. Thought for about 40 years to be extinct, this bird was rediscovered a few years ago.

Photo.—Norman Chaffer.

to live with the animal. This means that faunal and rural authorities will, as at present, be continuously concerned with the problem of protection—sometimes for the kangaroo and sometimes for the landholder.

Present N.S.W. Fauna Reserves

The first faunal reserve was dedicated on September 17, 1954. It is known as the John Gould Faunal Reserve, as it covers the only known breeding place of the white-winged or Gould petrel. It is an island, Cabbage Tree Island, off Port Stephens.

Boorganna Faunal Reserve is on the Comboyne Plateau, about 200 miles north of Sydney. It comprises about 800 acres of brush country, and is 2,000 feet above sea-level. The district is rich in fauna, including some of our rarest and most valuable species. There are brush turkeys, lyre birds and fruit pigeons, while platypus are found in the creeks. An unfortunate factor is that the reserve is on one side of Mumford's Creek only, the other side being alienated. This induces rapid deterioration of environment, particularly in a brush forest in a narrow gorge, where incidental factors, such as maintenance of the humid atmosphere and close species associations, are essential. While Boorganna will serve a most valuable purpose, it cannot be said to give an adequate sampling of the rain forest environment.

The Barren Grounds Faunal Reserve is on plateau land about 2,000 feet above sea level, west of Kiama and just above Jamberoo. Nearly 4,000 acres in extent, it is mostly swampy heathland, where Christmas Bells, swamp sprengelia and bottlebrush make a beautiful showing. The swamps act as a water supply regulator for streams which belong to the Kangaroo River system, and so are of importance to the farmlands in the valley. The heathland is rich in bird life, and at least two fairly rare species, the ground parrot and the eastern bristle bird, are known to breed in this reserve.

Lion Island Faunal Reserve is on the picturesque island, discovered by Governor Phillip in March, 1788, at the entrance to Broken Bay. It is one of the only two known breeding places in New South Wales of the sooty shearwater, and the nearest breeding place to Sydney of the wedge-tailed shearwater. The purpose of this reserve is to care for these species and other bird life.

Gurumbi Faunal Reserve lies between St. George's Basin and the Nowra-Jervis Bay road. It is about 375 acres in extent, and has a fine hanging swamp, a good creek and open forest. Marsupial and bird life are abundant.

The Nadgee Faunal Reserve is in the south-eastern corner of the State, and has an area of about 28,000 acres. Its appreciable size makes it a worthwhile factor in fauna protection. It is also well protected, having the Merrika River as its northern boundary, the seaboard on the east, a State forest on the west and the Victorian border on the south. Co-operation with the Victorian authorities will be necessary to obtain, eventually, a large reservation over the swampy lands just south of the border.

A variety of habitats occur in this reserve, which is well watered and protected from destruction by members of the public. The natural boundaries make the area ideal for a faunal reserve, as the animals there can't destroy crops and pastures on agricultural properties. There are heathland, forests, rivers and lagoons. The reserve is particularly rich in bird life, lyre birds and bell-birds being numerous. It may well be the greatest stronghold in New South Wales of the ground parrot.

Public Apathy

So the story stands in New South Wales. Perhaps the major limitation to expansion of the State's system of faunal reserves rests in the attitude of the community. Some of the community are oblivious of the needs; some know, but are apathetic or fatalistic, feeling that the effort to preserve is doomed to failure anyhow. A still more dangerous diversion comes from those who would short-circuit the drive for retention of habitat by accenting the value of aviaries, zoological gardens and botanical gardens as the only means of saving animals and plants from extinction. Faunal reserves will provide not only the means for conserving and regenerating these but will also become a venue for the inspiration of the people by the contemplation of natural beauty and wildlife. If adequate staffing could be made available for these reserves, their popularity would quickly enrich the life of our country and justify the necessary expenditure.

From many sources information has become available that some species supposed to be near extinction have appeared again in reasonable numbers because of the close protection given in New South Wales.

This has occurred where there still remains cover in the form of natural environment. The maintenance of such conditions is the purpose of the faunal reserves.

Mr. Donald Francois, American zoologist and Fulbright scholar, who is temporarily attached to the research staff of the Australian Museum, Sydney, shows two specimens of *Euastacus serratus*, the largest freshwater crayfish found in the immediate vicinity of Sydney. The crayfish on the left weighs $2\frac{1}{4}$ lb. The one on the right is "in berry" (carrying eggs, which can be clearly seen). Mr. Francois is making an investigation of New South Wales freshwater crayfish.

Photo.—Howard Hughes.

Thryptomene (foreground) spills over a path in a garden of Australian native plants at the home of Mr. R. Savage, Heidelberg, Victoria.

Photo.—H. T. Reeves.

THE CULTIVATION OF AUSTRALIAN NATIVE PLANTS

By THISTLE Y. HARRIS

Lecturer in Biological Science at the Sydney Teachers' College, secretary of the Wild Life Preservation Society, vice-president of the Sydney branch of the Society for Growing Australian Plants and author of books on natural science

AUSTRALIA'S native flowering plants, many of them quite as attractive as well-known garden types, are at last being seriously considered by horticulturalists, and home gardeners will probably be growing them in much greater numbers soon.

Owing, no doubt, to the sophisticated taste of the early settlers, accustomed to the softer and well-tamed favourites from the older countries, Australian bush plants have been regarded, until comparatively recently, as well enough in the wild but quite unsuited to cultivation. Perhaps the very nature of the terrain where most of the wild-flowers flourish, with its poor soil and devastating winds, made the garden-lover feel that it was useless to try to tame such inveterate wildings.

Yet tamed they have been, and we may look forward with confidence to selecting from well-established nurseries many of the best of our Australian plants for home gardens.

There has been a general opinion, unsupported by fact, that Australian plants could not be pruned or shaped, would not tolerate either natural or artificial manures and could hardly ever be induced to succeed except in their natural environment. In addition, most early attempts at propagation were not highly successful.

Australian native plants are much commoner in gardens to-day, however. Some are grown among exotics in a mixed garden, but some gardens are devoted to them alone, and are landscaped to their

needs. New South Wales Christmas Bush (*Ceratopetalum gummiferum*), Bottlebrushes (*Callistemon* spp.), Geraldton Wax (*Chamelaucium uncinatum*), Mint Bushes (*Prostanthera* spp.), New South Wales Waratah (*Telopea speciosissima*) and a few other favourites have been common in our gardens for a long time. Now they are being joined by others, such as *Eriostemon myoporoides*, many species of Grevillea, *Leschenaultia biloba, Hakea dactyloides, Thryptome calycina,* some species of Boronia and many lesser-known ones.

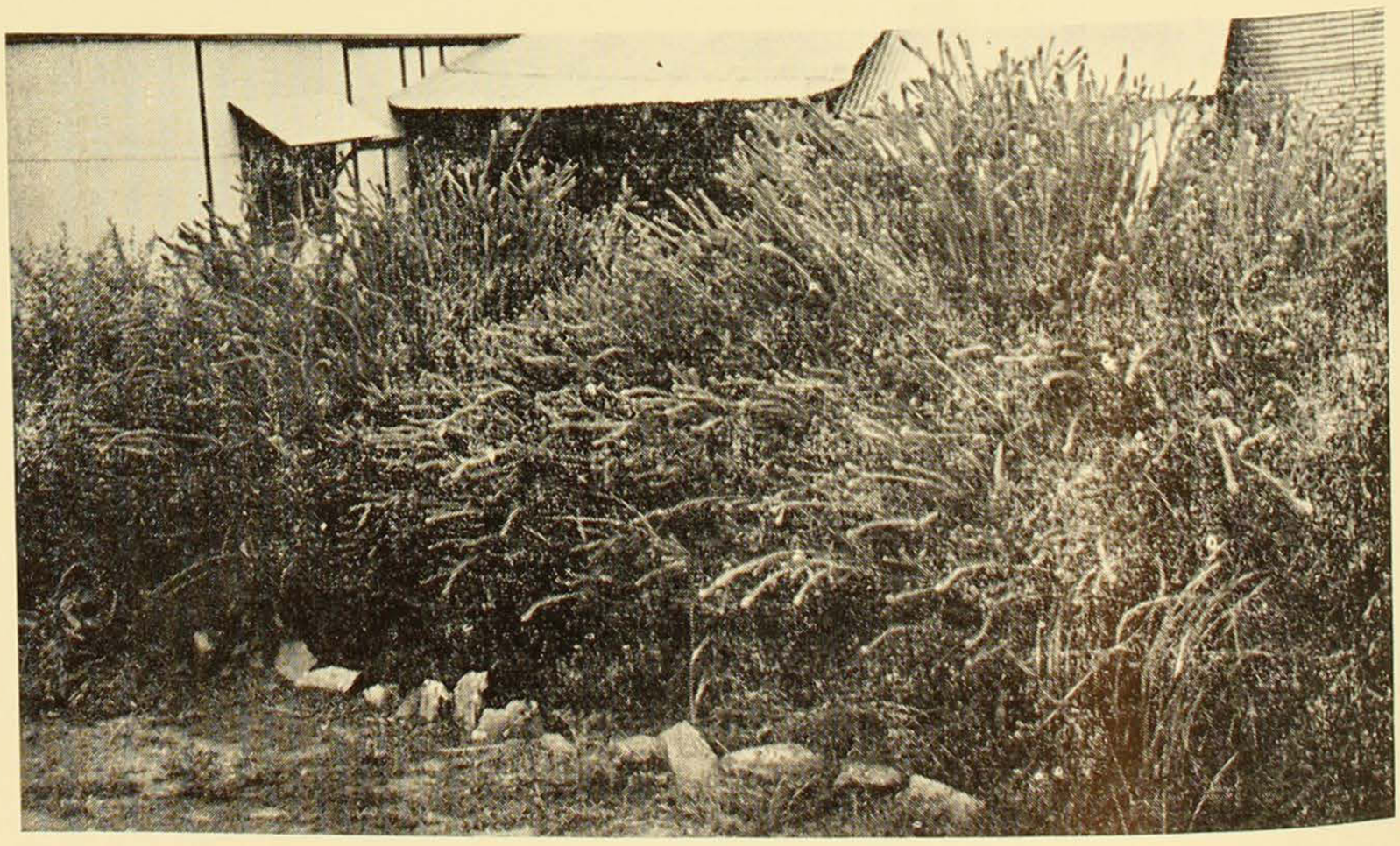
Remarkable Results

Where garden sites have been specially selected and laid out for natives the results can be remarkable. I have seen such gardens designed as a series of graded terraces on a sloping site, as formally planned garden beds on a flat site and as a set of geometrically arranged patterns, flanked with stones and approached by attractive curving paths, on an elevated area. Lithe branches spilling over the edges of carefully selected rock facades can give an air of gentle abandon, while an erect and highly floriferous shrub can supply dignity to an otherwise unexciting plot. And there is sufficient variety among our plants to provide a suitable subject for every situation.

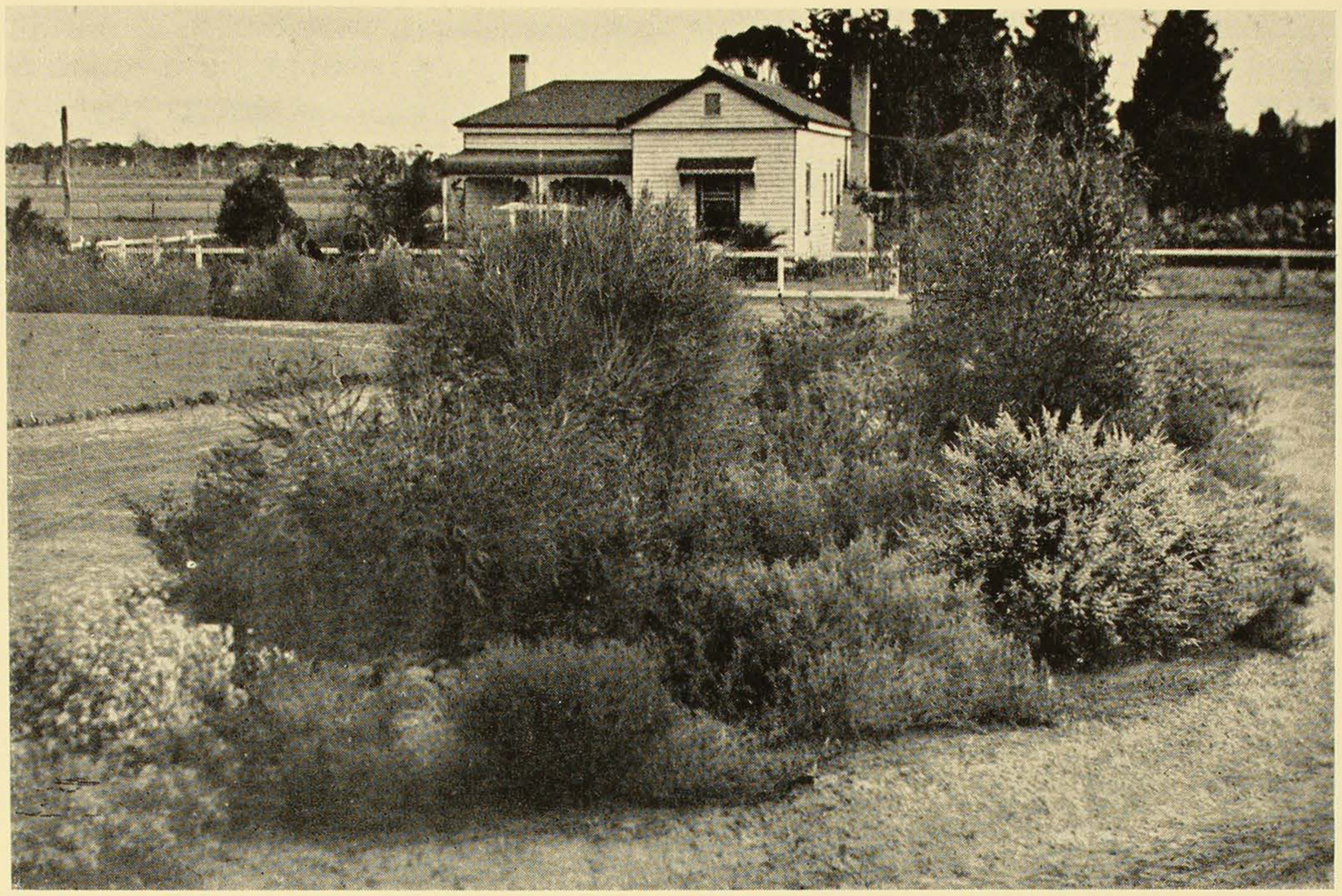
One of the factors contributing to this increased popularity of native plants is the recognition of their response to trimming and pruning. As a result, the sometimes unkempt look they have in the bush can be modified to a neater and more cultivated habit. Moreover, it is now certain that many natives, even those living normally in the most arid soils, respond to manuring, both artificial and natural, just as well as most exotic plants do.

Another factor is the recognition of variety of form within a species, a variety which can frequently be perpetuated through generations. By selection of more shapely, more floriferous and longer-flowering forms the popularity of Australian plants has increased enormously. Among such "finds" have been many double-flowering forms which have been propagated by cuttings. In cultivation in Sydney are bushes of a naturally occurring, double-flowering form of Sydney Boronia (*Boronia ledifolia*). This, in addition to being a shapely double form, has a flower half as large again as the normal one. In Victoria are several double-flowering Boronias, including *Boronia muelleri, Boronia megastigma* and *Boronia coerulea.*

Besides these there are many variants from the normal forms of plants—variants more desirable as garden subjects. A larger-flowered, richer-coloured form of *Leptospermum rotundifolium* (the Round-leaf Teatree), with a crown in the centre, is regarded by growers as one of the outstanding plants for next season. It may well be, for the common bush form is attractive enough. A suckering form of *Leschenaultia grandiflora* is highly prized because its suckers make the chances of losing the plant slight.



This Western Australian native, *Calothamnus villosus,* is grown as an informal hedge at G. W. Althofer's nursery at Dripstone, N.S.W.



A garden of Australian native shrubs makes an attractive approach to H. Lindner's home near Horsham, Victoria.

Photo.—H. T. Reeves.

In addition to these selected forms, both natural and cultivated hybrids are attracting the attention of growers. Some in the bush are catching the eye of the trained observer, and the introduction of a variety of species of the same genera into gardens has produced interesting hybrids, many of which are proving novel and beautiful garden shrubs.

These include the Leptospermums (Tea-tree). A wide selection of beautiful hybrids among them is on the market. Many are crosses of Australian and New Zealand forms, such as, for example, Lambeth's Leptospermum, x. Leptospermum, Red Damask var. Two tall Australian species, *Leptospermum rotundifolium* and *Leptospermum citratum,* have produced dwarf forms which may prove useful additions to the garden.

Eriostemon spicatus has been successfully crossed with *Eriostemon myoporoides,* and many Boronias and Prostantheras have been hybridised. *Hibiscus heterophyllus,* x *Hibiscus hueglii* has given a batch of seedlings with a wide variety in leaf form at W. Cane's nursery at Maffra, Victoria.

Perhaps the most interesting of the hybrids are to be found among the Grevilleas, or Spider Flowers. In W. Hodge's garden near Buchan, Victoria, the local *Grevillea victoriae* has hybridised with the New South Wales *Grevillea juniperina,* giving a variety of interesting hybrids of which three, Poorinda Queen, Poorinda Leane and Poorinda Constance, are now on the market from Cane's nursery. Other hybrids in the same garden have been obtained from *G. lavandulacea* x. *G. rosmarinifolia, G. oleoides* x. *G. punicea, G. bauerliana* x. *G. rosmarinifolia, G. chryophaea* x. *G. victoriae* x. *G. rosmarinifolia, G. fascicularis* x. *G. rosmarinifolia.* By careful selection one can often obtain a hybrid combining the best features of both parents. Hybrids Poorinda Queen and Leane, for instance, are both very floriferous, with a unique apricot-coloured flower and remarkably long flowering seasons. Constance is equally good, with rich red flowers.

Formula For Propagation

Melaleucas are also promising as hybrids for the garden. *Melaleuca fulgens* x. *Melaleuca steedmanii* (Payne's hybrid) combines the long-flowering quality of the latter with the highly floriferous character of the former.

The achievements so far in the field of hybridisation among native plants are arousing great interest among both amateur and professional growers. The possibilities of such new forms have excited the imagination of many of them, and they forsee—probably quite correctly—a vast number of new and more spectacular Australian plants.

As well as greater success in the field of cultivation, nurserymen are succeeding beyond their wildest hopes with propagation. With patience and skill, some of them have reduced the art of propagation from cuttings to a simple formula which can result in one hundred per cent. success.

This formula is: (1) Suitable temperature, (2) correct use of hormones at the correct strength, (3) correct potting medium, (4) constant humidity, (5) suitable type of wood in the cutting.

By systematic experiment W. Cane, of Maffra, Victoria, has worked out the correct formula for some hundreds of Australian plants, and can produce new plants from cuttings in a remarkably short time and with almost one hundred per cent. success. Many species which had defied propagators are now being grown with ease.

Bright Future For Native Plants

So one can see a bright future for Australian plants in cultivation. Gardens solely, or even mainly, of native plants will probably always be for the enthusiast only, because so many beautiful exotics have won their way into the affections of most gardeners. Many home gardeners, however, will soon be growing a considerable number of cultivated plants of Australian origin. It will not be long before the nurseries are handling Grevilleas, Boronias, Eriostemons and a host of other Australian plants in as great numbers as they are handling Daphne, Hibiscus and Gardenia to-day.

In addition, a rosy future for Australian natives on the world market can be foreseen. A few have established themselves already. Soon there should be hundreds. Small wonder, indeed, from a country which can produce a range of plants from alpine heaths to *Rhododendron lochae*.

To the conservationist, this state of affairs holds great promise. Inevitably, with increase of population, much of our bushland must go. If people become more interested in the cultivation of our plants they will also become more concerned about the plants' future in their natural growing areas. So we may expect many recruits in the cause of conservation from the ranks of the growers of Australian plants.

Book Review

AUSTRALIA'S ABORIGINES: THEIR LIFE AND CULTURE. By F. D. McCarthy, Dip.Anthrop. (Syd.). Colorgravure Publications, Melbourne. 1957, first limited edition, 200 pp., numerous illustrations, bibliography, index. £5 5s. 0d.

In making such a beautiful example of the printer's art available to students of Aboriginal life and culture at a moderate price, the publishers and printers, The Griffin Press, Adelaide, are to be congratulated. They also deserve praise for selecting Mr. F. D. McCarthy, the Curator of Anthropology at the Australian Museum, Sydney, to write such a book. He has produced a work which will hold its place for many years as the best general description of Australian aboriginal life and culture available to the layman.

In the words of the author, "It is intended to fill a gap in the literature of Australia and . . . contains chapters on the origin, physical characteristics, economic life, technology, social life, religion, magic and art of the Aborigines". In addition, it deals with the historical background of their culture.

The book is particularly valuable in its consideration of origins and in its description of native technology, as the author is the acknowledged authority on the archaeology and material culture of the Aborigines. The picture he has built up of how the Australian native has adjusted himself to his environment has the hallmark of reality because his knowledge of the human oecological situation is based on many years of close personal contact with, and study of, the native. Perhaps the most difficult chapter to write was the one dealing with the control of social life. It is hard, in a cultural situation such as aboriginal Australia, to state all of the exceptions to the rules which govern such matters as marriage, kinship terminology, inheritance, the exercise of authority and the settlement of disputes.

The chapter on art and decoration is very good, and is lavishly illustrated with coloured reproductions of aboriginal art objects. The whole book sets a standard for illustration which future publishers may attempt to emulate but almost certainly will fail to surpass. The author should be proud of the way his publishers have presented his work, and owners of copies of the book will thank both for a job well done.

—F. L. S. Bell.

The Huntsman Spider — Its Habits and Life History

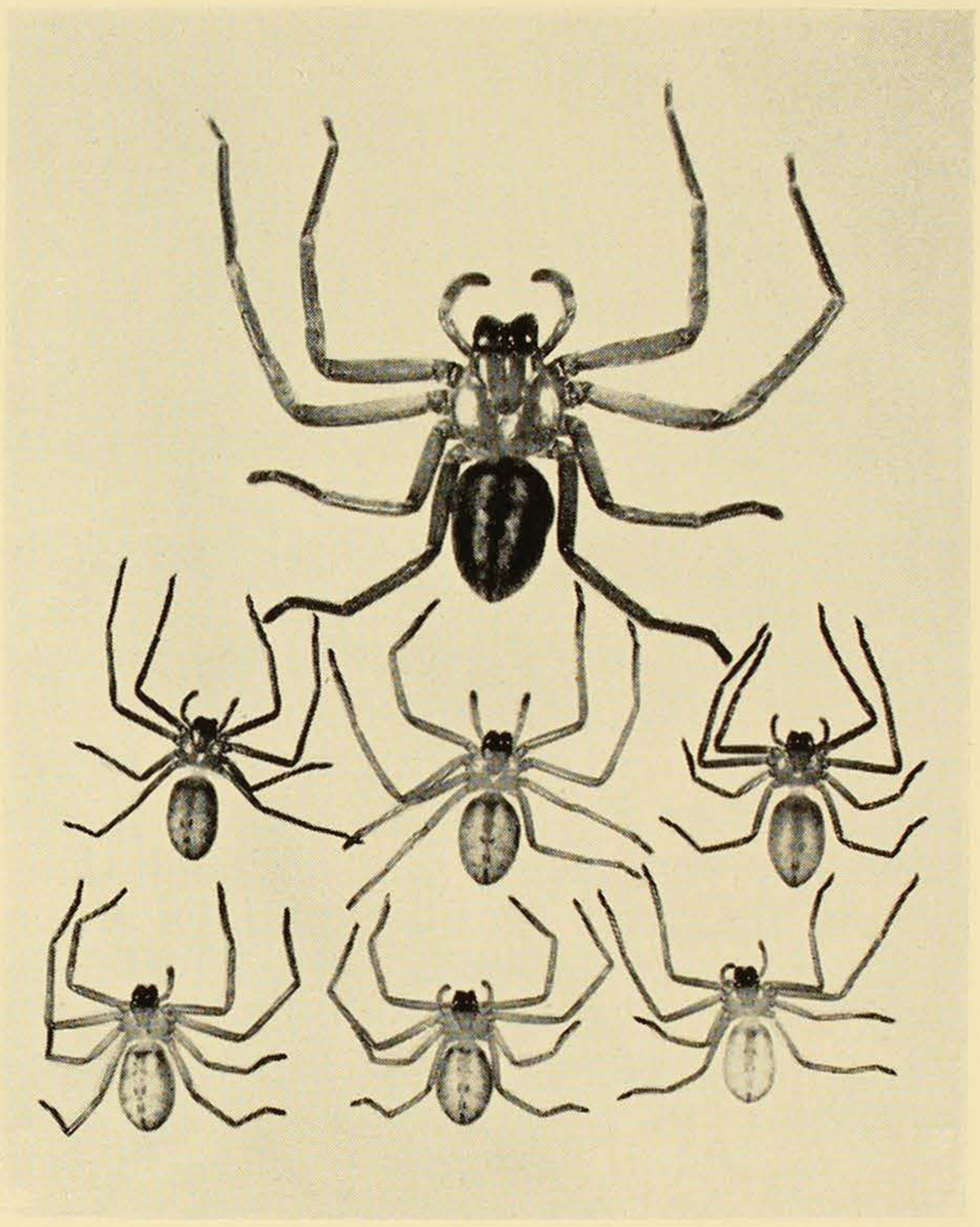
By V. V. HICKMAN

Ralston Professor of Biology, University of Tasmania

FEW spiders are more familiar than the large huntsman spider, *Delena cancerides* (Walckenaer), which often enters our houses. It is usually called a "tarantula".

This name, however, is not at all appropriate, and may be quite misleading. It strictly belongs to a small ground-dwelling wolf spider found in southern Europe, but has also been given to certain large hairy American spiders, close relatives of the Australian trap-door and funnel-web species. To make matters more confusing, some of the whip scorpions of India are also called tarantulas. In this article the huntsman spider will be referred to by its generic name, *Delena*.

The first recorded specimen of *Delena* was collected by the French naturalist, F. Péron, when he visited Tasmania with Baudin's expedition in January, 1802. It was probably one of the first spiders, if not the first, to be sent from Australia to Europe, and was described by Baron Walckenaer in 1805.



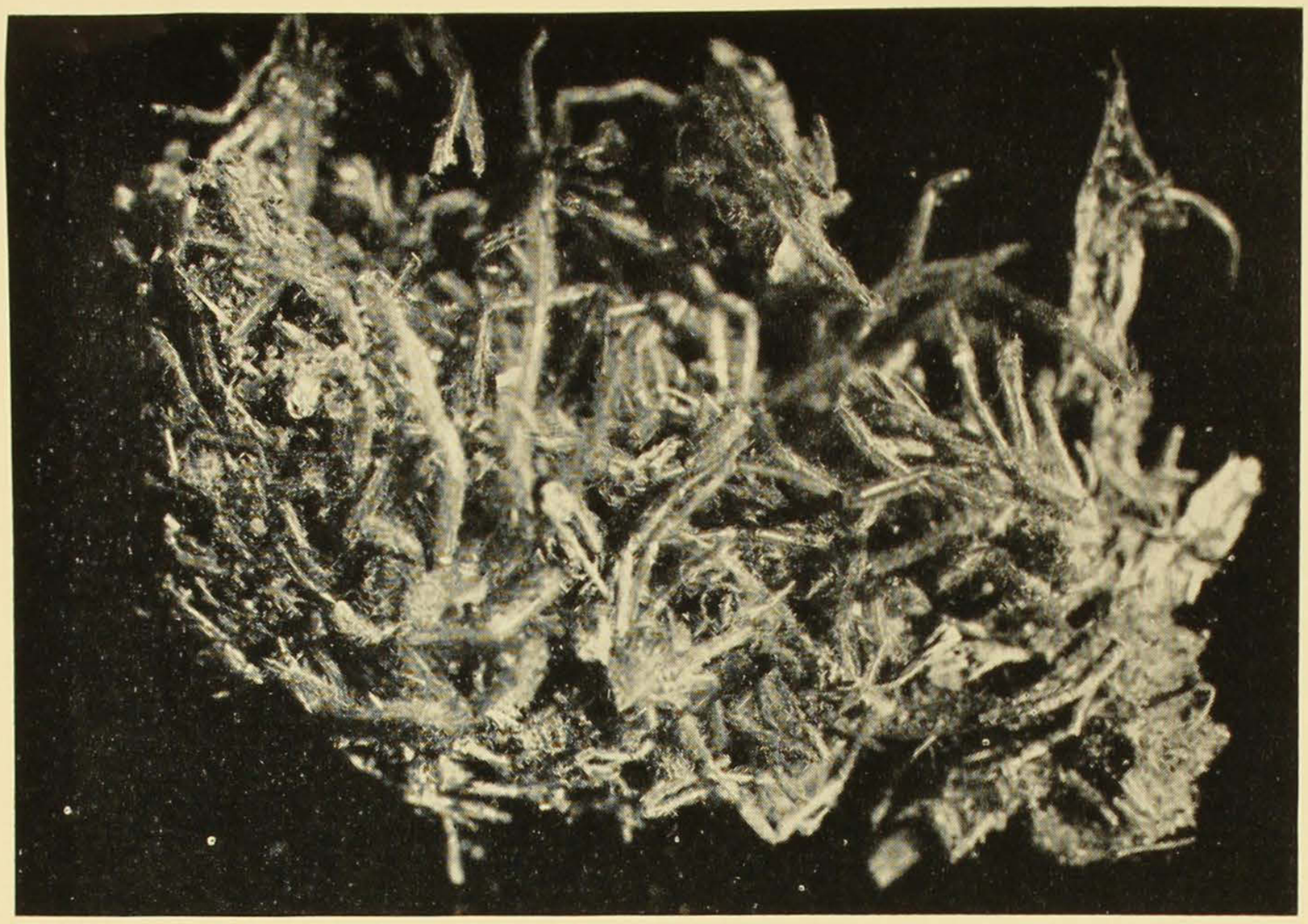
Family party: A female huntsman spider (*Delena cancerides*), usually called a "tarantula", with six half-grown young.

Photo.—Author.

The Huntsman's Nest

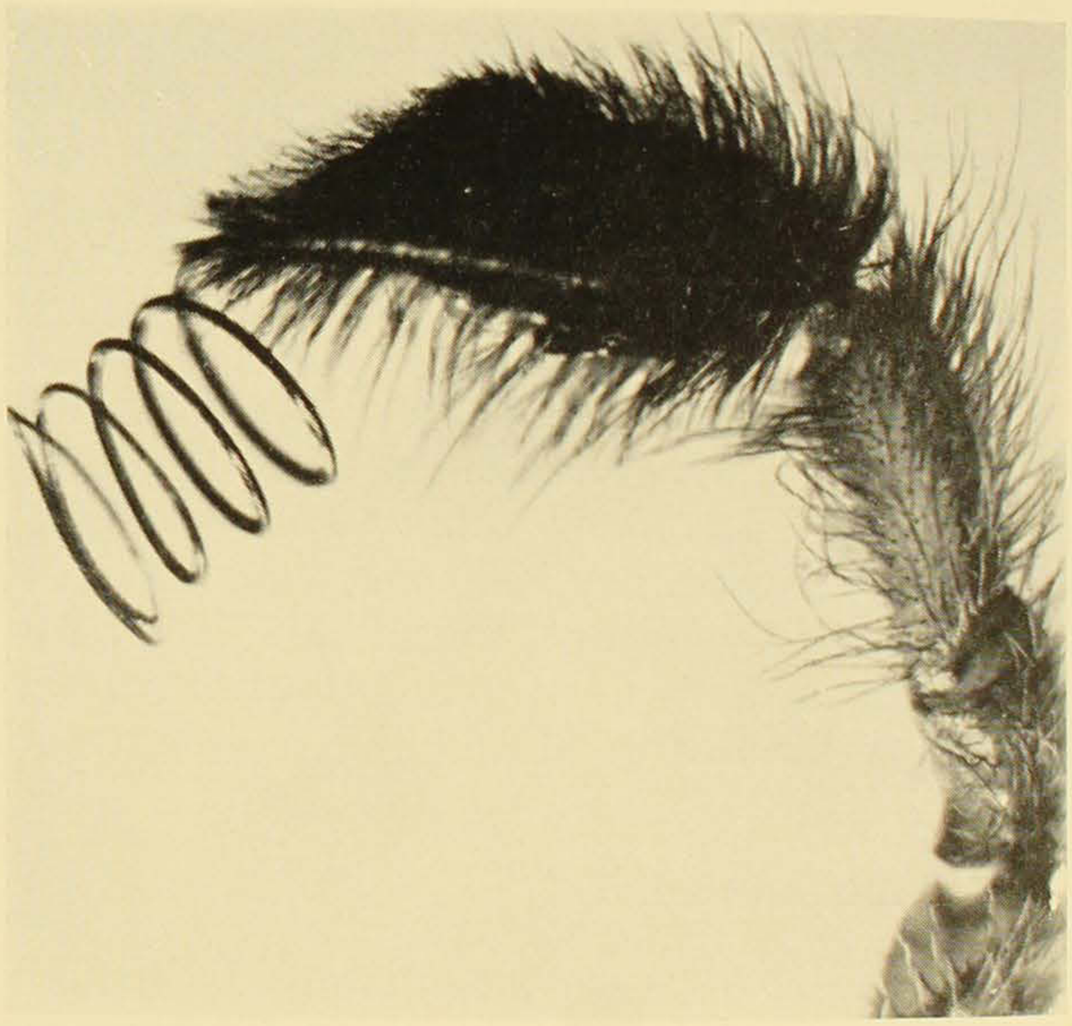
This spider is widely distributed throughout Australia. The two sexes resemble each other in general appearance, but the male has relatively longer legs and a smaller body than has the female. The adult male is also readily distinguished from the female by the club-shaped form of the palps (short appendages immediately in front of the first pair of legs). In Tasmania specimens of *Delena* found near sea-level generally have a less pronounced pattern of dark markings on the back than do specimens found at higher altitudes on the mountains and central plateau.

Delena's flat body and legs, capable of movement sideways, make it well adapted for living under the loose bark of trees or beneath the roofing tiles of houses. In dry localities *Delena* sometimes makes its nest in narrow crevices between stones on the ground. Although it does not build a web, it spins coarse brownish threads round the margin of its retreat, leaving only a small entrance hole. If the nest is under loose bark on a tree, any chinks or cracks in the bark are covered with threads of coarse silk. Some retreats appear to be used for only a short time, but others are occupied for a year or longer. It is not unusual to dislodge a piece of loose bark on a eucalypt and find a nest occupied by a large number of almost fully grown spiders, apparently belonging to the one brood.



Left: A mass of cast skins, mingled with the remains of partly-eaten insects, which formed a thick deposit at the bottom of a long-occupied *Delena* nest.

Photo.—Author.



Below: This long spiral organ is part of the male *Delena's* reproductive system. It is situated near the end of a palp.

Photo.—Author.

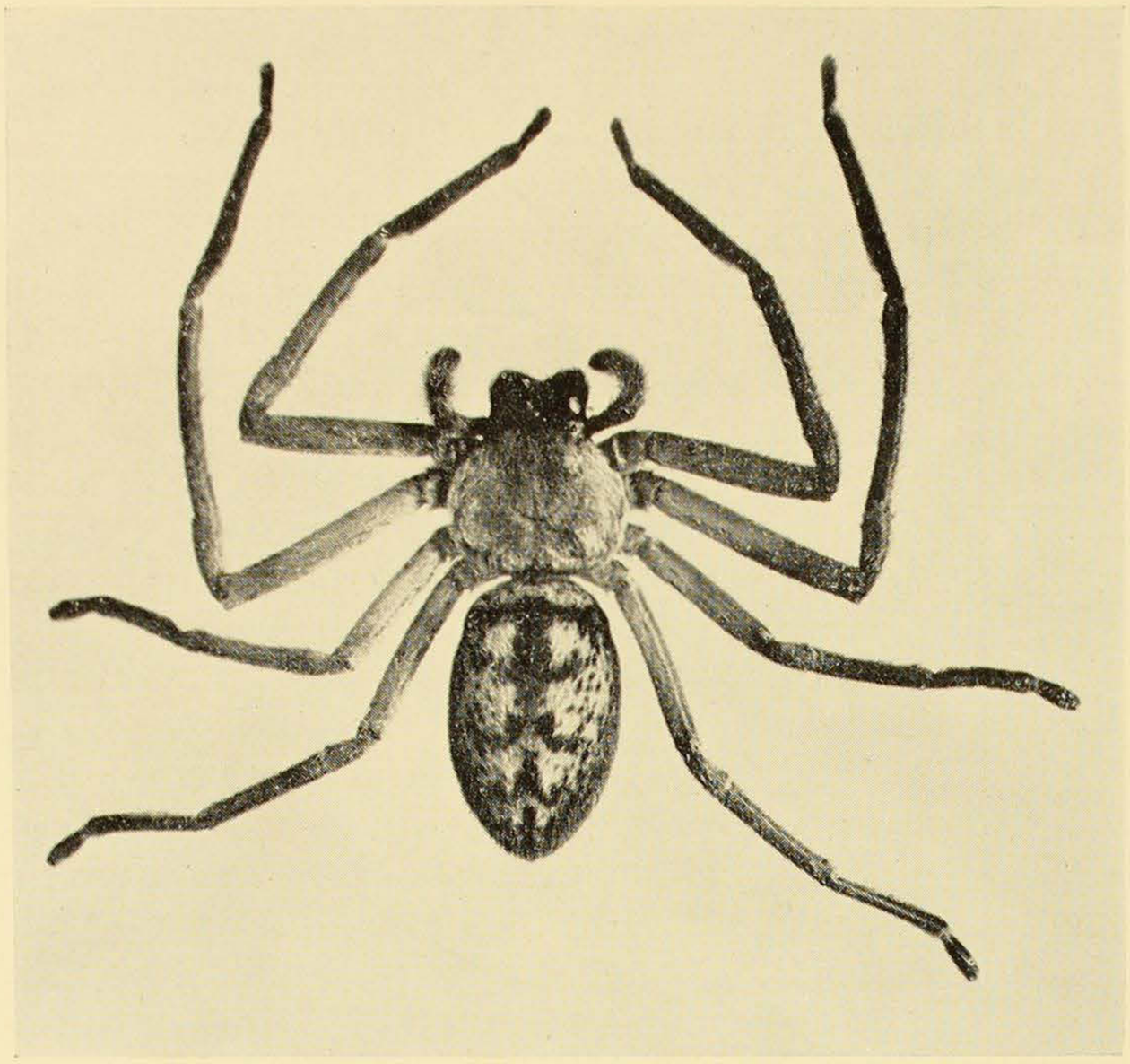
In the case of many other species of spiders dispersal of the young takes place soon after they have emerged from the egg-case, but with *Delena* the members of a brood frequently remain together for several months before dispersal. As the young ones grow they periodically cast off their skins. In nests that have been occupied for a long time these discarded skins, mingled with the remains of partly-eaten insects, form a deposit several inches thick at the bottom of the nest.

Courtship And Mating

Soon after becoming fully-grown, the male spins a small sperm web, which is very delicate and consists of a few fine crossed threads. On this web he deposits a droplet of seminal fluid. This is then drawn up into a long, coiled, tubular organ near the tip of his club-shaped palps. After this process of sperm induction, as it is called, the male lives a wandering existence in search of a female. Having found one, he announces his approach by tapping, with his abdomen, the surface on which she is resting. The taps are loud enough to be heard by the human ear at a distance of three or four feet.

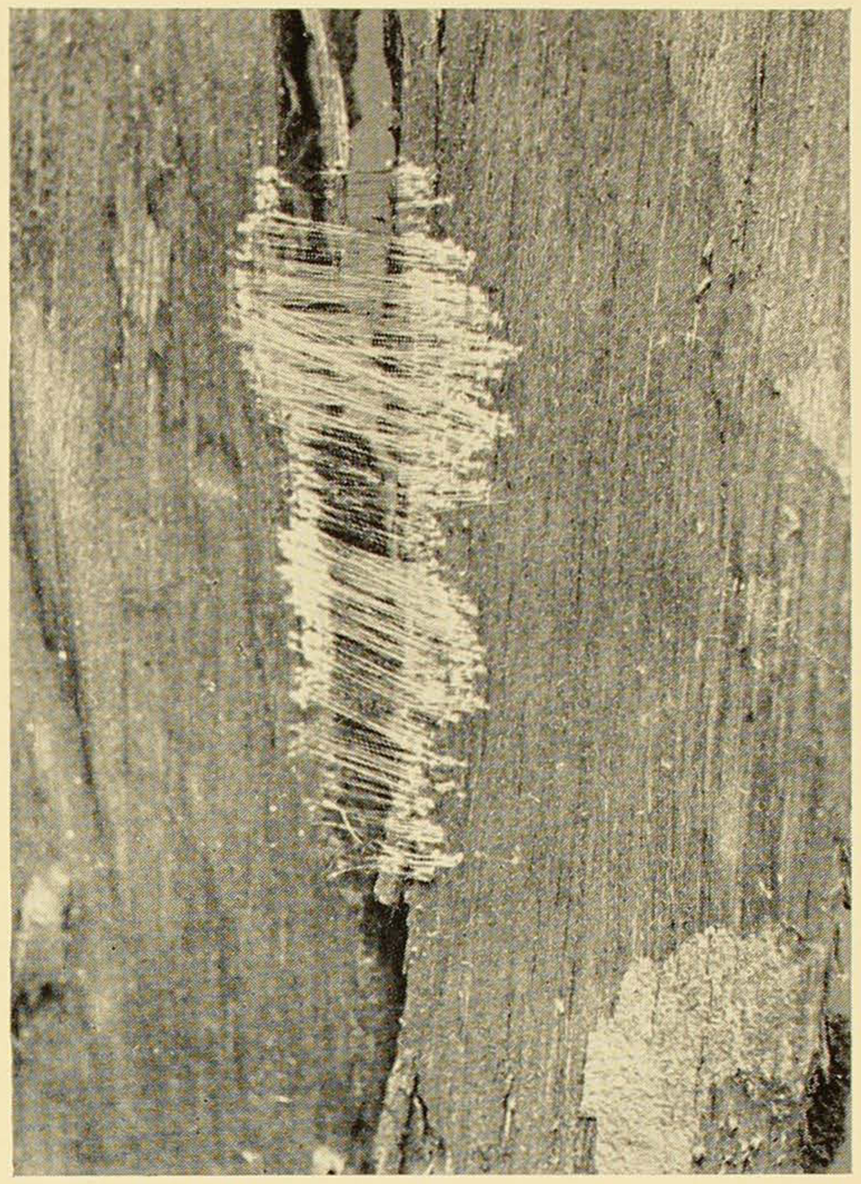
If the female is in a receptive mood she remains quiescent and the male approaches more closely, climbing over her and continuing the tapping movements. In most spiders vision is very poor but the tactile sense strongly developed, and it is probable that the behaviour of the male ensures that he is recognized by the female, The courtship may last for half an hour. Finally, when mating occurs the droplet of seminal fluid contained in the coiled palpal organ of the male is transferred to the reproductive system of the female, where it is stored in a pair of receptacles until required for fertilizing the eggs. Mating may occupy from two to three hours.

Egg-laying takes place during spring and summer, the eggs being enclosed in a white silken case. In Tasmania the first egg-cases are usually found towards the end of



This photo of an adult female *Delena*, clearly showing the well-defined markings, will help the layman in identifying the spider.

Photo.—Author.



Threads spun by *Delena* to close a crack in loose bark under which it has made its nest.

Photo.—Author.

October. As a rule, only one egg-case is made during the year, but if food is plentiful there may be two.

In constructing the egg-case the spider spins a sheet of silk in the nest and lays the eggs on it. A second sheet is spun over them, thus enclosing them in a more-or-less lens-shaped case, which measures from 26 to 43 mm. in diameter—about the size of a penny. When the eggs are being deposited they are covered with a clear fluid, which causes them temporarily to adhere to one another and to the surface on which they are being laid. However, the fluid soon evaporates, leaving the eggs covered with a white powdery bloom and no longer adhering together.

Each egg measures about 2.5 mm. in diameter and weighs about 8 mg. The number of eggs counted in twelve different egg-cases varied from 86 to 243 per case. The spider takes two to three hours to lay its eggs and complete the case. After that the mother guards it until the young have emerged. She then sometimes eats it.

The time the eggs take to hatch varies according to the temperature. Eggs laid in the early spring hatch in about 30 days, but those laid in mid-summer hatch in a shorter time. The newly-hatched spiderlings, very delicate and unable to feed, remain in the egg-case for another three or four weeks before emerging. While thus enclosed in their silken nursery, they shed their skins, or moult, three times. Shortly after the third moult they tear a hole in the egg-case and emerge. During the period between hatching and emergence, the mother frequently loosens the upper sheet of the egg-case by pulling it with her fangs, thus providing more space for the young.

Hatching Of The Eggs

On emergence, the young spiderlings do not immediately disperse, but remain clustered together in a dense mass on or near the egg case. Two to three weeks after emerging they undergo a fourth moult, and it is not until this has taken place that they attempt to feed. At first they share the mother's food, scrambling all over the prey she is eating and running off with any

morsels they can seize. The mother does not appear to resent this rapacious behaviour of her progeny. However, if the spiderlings become too persistent in crawling round her mouth parts, so that they themselves are in danger of being eaten, she gently pushes them away with her palps or front legs. It is not long before the young ones are able to catch small insects for themselves.

The members of a brood may remain together in the same nest until almost fully grown. Their rate of growth depends on temperature, availability of food, competition with one another and other factors. From hatching to the time full growth is attained *Delena* undergoes ten to twelve moults. During moulting the old skin splits along each side of, and behind, the carapace, or shield covering the front half of the body. The spider is then able to work the old skin off by a process of expanding and contracting its body and legs. Under normal conditions the blood pressure of a spider is about equal to that of a human being. However, when the spider is about to moult, the pressure nearly doubles. It is this increase in pressure that causes the old skin to split.

In a brood of *Delena* raised together in the same vivarium it was found that the time taken to reach full growth varied from 387 to 1,197 days. Males reached maturity before females. Contrary to expectations, the members of the brood lived together without any marked internecine strife. Out of 95 young ones 85 reached maturity. However, as each one became adult it was removed from the vivarium in order to avoid the inevitable conflicts associated with sexual maturity.

DO YOU KNOW THE ANSWER?

Q.: Is the well-known returning boomerang of Australian aboriginal tribes unique, and was it used throughout Australia?

A.: The returning boomerang is quite unknown in any other part of the world. Its use was confined to the Aborigines of eastern and western Australia. The missile was apparently evolved from an earlier non-returning boomerang, which often swerves in flight. It was used, far more so than now, in tournaments and for diverting flocks of birds into nets set between trees.

By comparison, the non-returning boomerangs are far heavier, and have a very shallow curve in relation to their length. They are true hunting and fighting weapons, which were commonly used to kill kangaroos and other mammals, birds, reptiles and fish, and could cause serious injuries in warfare.

Notes and News

Death of Mr. H. B. Mathews

Mr. H. B. Mathews, who resigned last December from the Presidency of the Board of Trustees of the Australian Museum, died on January 21.

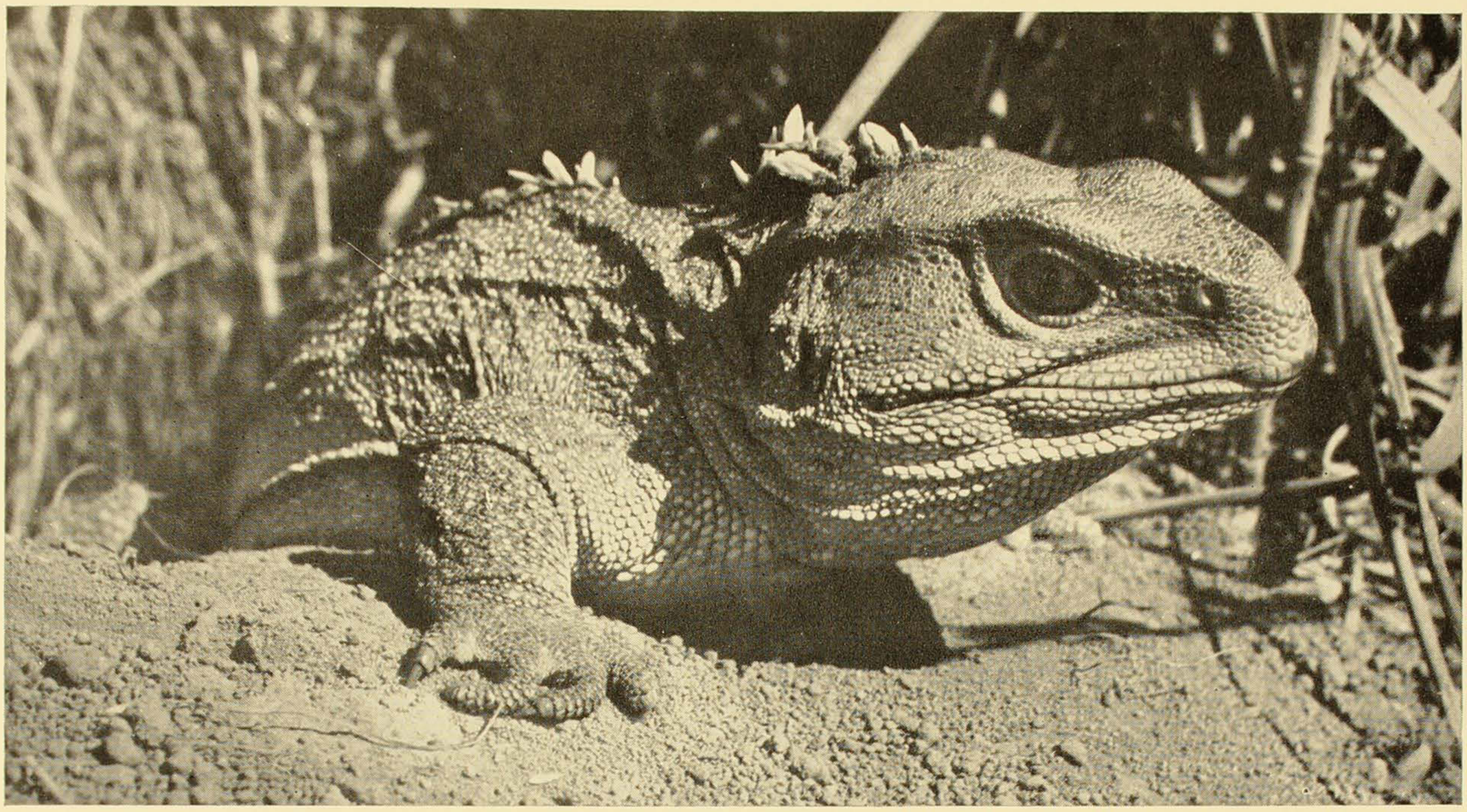
Mr. Mathews had been associated with the Museum since 1926, when, as Surveyor-General, he became an Official Trustee. In 1938 he was made an Executive Trustee, and in 1946 Crown Trustee. He was elected President in 1945, and acted in that capacity until the end of last year. He took a great interest in the Museum, which owes much to his kindly guidance for so many years. Mr. Mathews has been succeeded as President by Wallace C. Wurth, C.M.G., LL.B., who has been a trustee since 1946.

Study of Crania

Professor R. Ruggles-Gates, Emeritus Professor of Botany at the University of London, Research Professor in Biology at the University of Harvard and author of a well-known book, "Human Ancestry from the Genetical Point of View," recently examined the collection of Australian aboriginal crania in the Australian Museum, Sydney. He is particularly interested in the genetics of Aborigines crossed with white Australians, Chinese and other peoples in Australia.

Lantern Fishes

Dr. Rolf L. Bolin, Professor of Biology at Stanford University, California, and Assistant Director of Hopkins Marine Station, California, visited the Australian Museum, Sydney, from Hong Kong at the end of last year to examine its collection of Lantern Fishes (family Myctophidae), of which he is revising the world species.



The Tuatara (*Sphenodon punctatus*), here seen leaving its burrow, is the sole surviving member of a reptilian order otherwise known only from Mesozoic fossils. It has survived through a period of about 200 million years, and is found only on islands off the New Zealand coast. A distinctive feature of the tuatara is the spiny crest which runs along its back.

Photo.—W. H. Dawbin.

NEW ZEALAND, LAND OF UNIQUE ANIMALS

By N. G. STEPHENSON

Senior Lecturer in Zoology at the University of Sydney, and former Senior Lecturer in Zoology at Auckland University, N.Z.

AMONG the animals, birds and reptiles of New Zealand are some of the most remarkable creatures in the world, including the kiwi, the tuatara and the native frog.

What the native New Zealand land vertebrates lack in numbers of species they certainly make up for in their zoological distinctiveness. In addition to the uniqueness of some of its animals, the New Zealand vertebrate fauna provides an important example of the influence of man on a native fauna and a classic illustration, within comparatively short historic time, of the interaction between native and introduced species.

Although some 29 species of introduced mammals have taken quick advantage of the lack of competition and have been able to establish themselves in New Zealand in a wild state, mammals are conspicuously lacking from the native fauna.

It is generally conceded that the native fauna includes only two mammals—both bats. One, the long-tailed bat, is a species of the native genus *Chalinobus*, which also occurs in Australia, Tasmania, Norfolk Island and New Caledonia. The other is the sole species of a native genus, *Mystacops*. Whatever may be the history of *Chalinobus*, *Mystacops* can certainly be regarded as belonging to the original fauna of the country.

Prior to the arrival of man, then, there were no terrestrial mammals in New Zealand, a fact that had a profound influence on the extensive avifauna, which was thus freed from possible predators on land. Hence, flightless land birds were found in relative profusion, only to suffer an obvious fate with subsequent faunal changes. The spectacular Diornithiformes, or moas, the greatest land birds of historic times, were extinguished even before the arrival of Europeans. The arrival of Maoris in New Zealand in considerable numbers after about 1350 A.D. almost certainly contributed to their final extinction, for the Maoris hunted them as food.

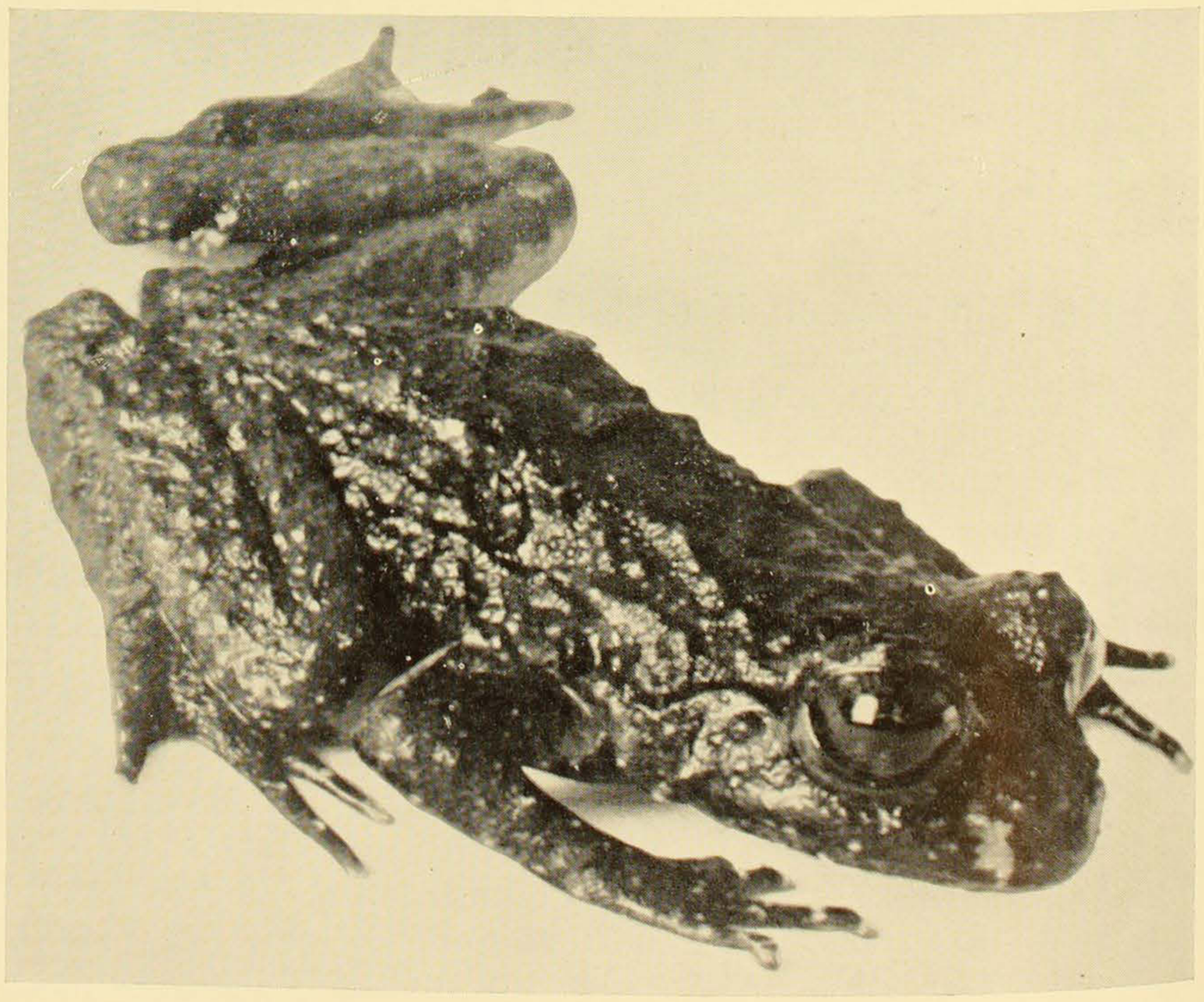
Rediscovery Of The Takahe

The white man and his introduced cats, dogs and pigs quickly took a heavy toll of the remaining land-bound birds. Some, like the takahe, have barely survived in restricted and isolated areas, but others, such as the secretive and nocturnal kiwis, appear to be holding their own against the ravages of advancing civilisation, largely because of their habits.

The circumstances leading to the re-discovery in 1948 of the takahe, *Notornis hochstetteri,* were most dramatic. In the nineteenth century, only four specimens had been captured—in 1849, 1851, 1879 and 1898. Subsequently, *Notornis hochstetteri* was presumed to be extinct, as already was the North Island species, *Notornis mantelli.*

In 1948, however, Dr. G. B. Orbell, after a planned search instigated by his noting footprints of an unknown bird, found a colony of these birds. They were surviving in a glacial valley at the eastern end of the Murchison Range, 2,200 feet above Lake Te Anau, in the South Island. Although the total number of adult birds in the Murchison and Kepler Ranges of the South Island fiordland has been estimated at probably more than 100, this flightless water hen of the family Gallinulidae has come very close to total extinction. Compared with other representatives of the same family, capable of flight, *Notornis* exhibits structural changes that find parallel in other flightless birds of New Zealand.

Moas and kiwis belong to a super-order of flightless, or ratite, birds (including also rheas, ostriches, emus and cassowaries), in which the breastbone lacks a keel and is raft-shaped. These birds have apparently evolved independently of one another. Hence, in New Zealand, moas have pursued a very different line of development from their geographical partners, the kiwis,



Leiopelma hochstetteri is a stream-dwelling species of the New Zealand Native Frog. From its eggs hatch froglets, not tadpoles. The froglets have tails which can be wagged, but gradually lose them while growing to adulthood. Study of the remarkable fauna mentioned in this article has contributed greatly to man's understanding of vertebrates generally.

though in their general characteristics these two groups resemble each other more closely than they do any other group of flightless birds.

The Moas form a single, well-defined natural group which, in the isolation of New Zealand, evolved into many species. In recent classifications, these species number 28, grouped in seven genera and two families. While the Moas were evolving into this multiplicity of species, certain structural changes were taking place. The wings were completely lost—a unique feature among birds—and the scapula and coracoid, which normally support avian wings, were reduced and fused into a single rod-like bone.

Bone Fragment Was Vital Clue

The first allusion in the literature to gigantic land birds in New Zealand is contained in a passage by J. S. Polack in "New Zealand" vol. I., 1838. Polack spent two years between 1834 and 1837 in the East Cape district of the North Island, and his actual discovery cannot have been later than 1837.

A more dramatic announcement came from Professor Richard Owen in London after the shaft of a femur of the species now known as *Diornis ingens* was collected by Mr. J. W. Harris in the Poverty Bay district between 1831 and 1837. Mr. Harris took the piece of bone to Sydney in February, 1837, and gave it to Dr. J. Rule, who in turn took it to England and showed it to Professor Owen.

Owen then made his famous pronouncement: ". . . . so far as my skill in interpreting an osseous fragment may be credited, I am willing to risk the reputation for it on the statement that there has existed, if there does not now exist, in New Zealand, a struthious bird nearly, if not quite, equal in size to the ostrich."

Owen's osseous fragment has been followed by vast quantities of skeletal remains from many New Zealand sources, and his brief paper of 1840 heads a voluminous literature on the extinct giant flightless birds of New Zealand—a literature of many hundred of contributions from several hundred authors.

The kiwis have survived, and at the moment their future does not seem at all precarious. Three species are recognised, though one, *Apteryx australis*, is usually regarded as consisting of three sub-species—*A.a. mantelli*, the North Island kiwi; *A.a. australis*, the South Island kiwi; and *A.a. lawryi*, the Stewart Island kiwi. Wings are rudimentary and a tail is completely lacking. Kiwis are further remarkable for their relatively enormous eggs, laid singly, in pairs or in threes.

Kiwis stand apart from all other living birds in that the nostrils are at the tip of the bill and not at its base. It appears that, in general, the sense of smell is of little importance to birds. There is poor development of turbinal bones in the nasal passages, which are usually relatively bare instead of being covered with a sensory epithelium, as in mammals. Birds therefore rely on visual clues to locate food. The primitive kiwi, however, is exceptional. It feeds chiefly at night and has poor vision, but a well-developed olfactory sense enables it to sniff out its food.

The Tuatara

Among reptiles, lizards are represented by geckos and scincs. Various other Lacertilian families represented in Australia, such as Pygopods, Agamids and Varanids, are entirely absent, as also are snakes.

On the other hand, the fauna includes the unique tuatara, *Sphenodon punctatus*, which is correctly described as a reptile and is not, strictly speaking, a lizard. The tuatara is the sole living member of the reptilian order Rhynchocephalia, and represents a group otherwise known only from Mesozoic fossils.

The Rhynchocephalians have obviously enjoyed a very long phylogenetic history, having had their beginnings at the advent of the Triassic period. Judging from the fossil record, these reptiles were never very numerous, yet one of them has survived in New Zealand with little apparent change through a period of about 200 million years.

To-day the tuatara is confined to the outlying islands of the New Zealand coast. It is often found on the steep slopes of rocky islets, frequently in shearwaters' and petrels' burrows, which it may even share with the owners.

The tuatara has a long developmental period, and eggs laid in November of one year do not hatch until midsummer of the following year. The young tuatara is armed with a caruncle to cut its way out at hatching time. This structure, found also among reptiles in chelonians and crocodiles, is on the upper surface of the snout, near its tip. It is a conical projection formed by a great development of the epitrichial layer of the epidermis.

This hatching mechanism differs fundamentally from that of lizards and snakes. In the latter, there is no caruncle, but the foremost teeth or tooth of the upper jaw may be much modified by being directed forward, formed precociously and enlarged. The result of this is that, by its projection forwards beyond the tip of the snout, a razor-sharp structure is available to pierce or slash not only the egg membrane but also the leathery shell.

Primitive Features

According to Mr. W. H. Dawbin, who has studied their growth rates, tuataras take about 30 years to reach maturity. Longevity is apparently a characteristic of these as well as other reptiles, and there are unconfirmed reports from Maoris on this point. Young tuataras lack the distinctive crest of the adults.

The tuatara exhibits an impressive array of primitive features. It is the only living reptile with a complete skull of the diapsid type. It has vertebrae which exhibit a primary amphicoelous condition in that the centra are concave at both ends. It has abdominal ribs or gastralia in the body wall, as well as the true ribs of the endoskeleton attached to the vertebrae. Indeed, in many features of its anatomy, the tuatara stands apart as a primitive Amniote.

The New Zealand native frogs, too, are unique, and appear to have had a long and independent evolutionary history. They are particularly primitive as Anurans, and the species, of which three are at present recognised, are grouped in a single genus, *Leiopelma*.

Tail-wagging Frogs

In both its anatomy and life history, this genus has attracted much attention. For example, its vertebrae are of the primitive amphicoelous type and are more numerous than those of modern frogs. It has cardinal veins as well as a postcaval vein, a feature common in tailed Amphibians or Urodeles, but not in frogs. It has abdominal ribs or gastralia which are remnants of the extensive dermal armour so characteristic of fossil amphibians and reptiles. It even has two tail-wagging muscles, though as an Anuran it lacks a tail in the adult.

The development of *Leiopelma* is rather like that of Urodeles, whether aquatic or terrestrial. In this New Zealand frog, the eggs are large and unpigmented, and they undergo lengthy intra-capsular development either on land, under damp conditions or in water. From the egg hatches a tailed froglet, not a tadpole. This froglet, which may hatch under terrestrial conditions, gradually loses its tail and acquires the proportions of an adult. This direct development of *Leiopelma* stands in sharp contrast to the indirect development of most of the so-called "modern-type" frogs, which have a free-living, and often highly specialised, aquatic tadpole stage, leading, at metamorphosis, to the adult frog. It is also distinct from the mode of development of some frogs, which is only secondarily direct and involves the suppression of a tadpole stage.

The few creatures selected for discussion in this article are among the most outstanding representatives of the New Zealand vertebrate fauna, and studies on them alone have made a notable contribution to our understanding of vertebrates generally.

STENCILS OF THE ABORIGINES

By FREDERICK D. McCARTHY

ONE of the interesting phases of a Museum anthropologist's work is to record the cave paintings, rock engravings and other relics left by the Aborigines in various parts of the countryside.

Many of these, fortunately, are in national parks, reserves and other places not endangered by suburban, industrial and general building development, and their recording can be done at a convenient opportunity. However, all trace of some relics, particularly groups of rock engravings, has been obliterated by Sydney's suburban expansion without the Museum or any other authority having the opportunity to record them.

A case of this kind was brought to notice recently by Mr. R. Doyle, who informed the Australian Museum, Sydney, that a rock-shelter containing aboriginal paintings in the Burragorang Valley would soon be engulfed by water as the storage level of the Warragamba Dam rose to its full depth. The Museum had known for many years of this small rock-shelter, but as it contained stencils only, and many bigger series are known elsewhere, no special attention had been paid to it.

A visit was recently made to the rock-shelter, during which the Museum's artist, John Beeman, made a scale diagram of the

Hands and boomerangs stencilled by Aborigines on a wall of a rock-shelter in the Burragorang Valley, N.S.W. The boomerangs are seen faintly at lower right. At top left are initials carved by tourists.

Photo.—Howard Hughes.

stencils, and its photographer, Howard Hughes, took, as a permanent record, an interesting set of pictures of the site and its setting.

Pigments Blown From Mouth

On the back wall of this shelter are a dozen or so human hands and a vertical set of four boomerangs, in white. The Aborigines made these stencils by placing a hand on the rock surface and blowing liquid pigment around it from the mouth so that an outline of the hand remained on the wall. When the pigment is examined it is seen to be spotted on the wall, increasing in density as it gets nearer the hand. Fish, lizards, human feet, tomahawks, clubs and a few other objects were stencilled in this manner by the Aborigines.

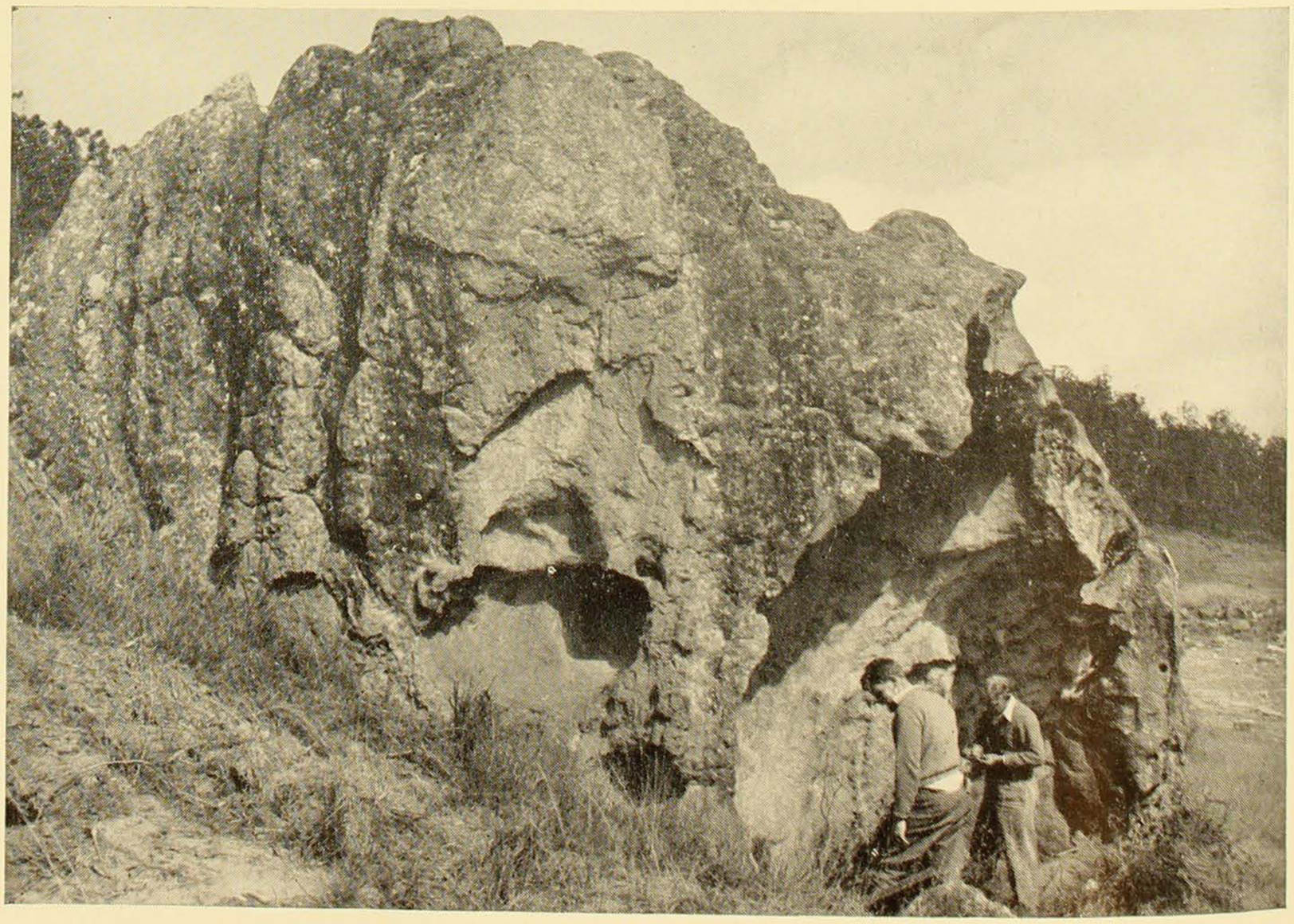
In the Sydney–Hawkesbury district, New South Wales, a census made some years ago revealed 911 white, 300 red, 17 yellow and four black hand stencils within 75 miles of Sydney, but more have been found since. White was thus the favoured colour for stencils, but among human and animal subjects in cave drawings in the area black and red (in that order) were preferred to white. Yellow is comparatively rare.

It is often claimed that a more permanent medium than water was mixed with the pigment to cause it to last so well, but this is improbable. Animal fat would be too viscous to spray from the mouth or blow from a piece of bark. Orchid juice was used as a fixative in Arnhem Land, but it was painted on a sheet of bark or a wooden object, not mixed with the pigment. The fact that the water pigment eventually stains the sandstone surface may have caused the belief that a more permanent medium than water was mixed with the pigment.

Some people claim that they have seen the impression of a stencil on a surface from which a layer of rock has fallen. The explanation of this is that the natives actually put stencils on such surfaces. These stencils faded to an almost indiscernible state in the course of time, and are thus erroneously thought to have penetrated the rock itself.

Stencils In Friezes

In the Sydney–Hawkesbury area rock-shelters of all sizes display from one to more than 100 hand stencils. In some caves they form an attractive frieze 20 or 30 feet long on the wall. There is considerable variety among them. The hands of children of all ages and of men and women are represented, the left hand most commonly. The two top sections of a varying number of fingers, from one to five, are turned down, and occasionally the whole five fingers are



The rock shelter in which the Aboriginal stencils were found. It is on the Warragamba Dam site and will soon be engulfed by water, so an artist and photographer from the Australian Museum made a permanent record of the stencils by drawing and photographing them. The Aborigines made hand stencils by placing their hands on a wall and blowing liquid pigment around them from their mouths.

Photo.—Howard Hughes.

turned into the palm to portray a closed fist. On the New South Wales coast the girls and women had one or two sections of the little finger amputated, and this custom is illustrated in some of the stencils. Stencils often include the forearm as far as the elbow. In some examples the ends of two forearms, just above the wrists, are joined together to represent a pair of hands, and occasionally a pair of hands is shown side by side with the thumbs touching each other. There are several fine examples of a circle enclosing a stencilled hand.

Although most of the stencils are scattered haphazardly over cave walls, and often in rocks and crevices, they are sometimes arranged in rows or groups. White stencils were often made on the smoke-blackened walls of caves in which natives lived, and sometimes on a reddened surface. The red hands often occur on the natural walls of shelters not used for occupation by the Aborigines, but some are to be seen on the blackened walls, together with white and yellow stencils.

These stencils are in all stages of preservation—from those so faint that they can barely be seen, to others in an almost perfect state—thus indicating that stencilling was practised for a long period. In well protected and dry shelters they will evidently last some thousands of years. In Spain stencils of the Aurignacian art of 20,000 to 30,000 years ago are still visible. They were painted on limestone cave walls, together with impressed hands (made by pressing a hand, covered with paint, on a wall). Impressed hands are commonly associated with stencils in Australia.

Stencils A Mystery

The meaning and significance of the Aborigines' stencils have always been somewhat of a mystery, and natives questioned in the early days of settlement in eastern Australia couldn't give a satisfactory explanation of them. The reason for the natives' ignorance about the work of their own people is only just becoming apparent. Studies, begun by the author, of superimpositions of cave drawings in eastern New South Wales indicate that they belong to the earliest phase of cave art, which was followed by red, white or white-and-black, and black periods, in that order. Thus, according to this study, the stencils were probably not made by Aborigines living during white settlement, but by their ancestors many centuries ago. For this reason, the tribes living at the time of the foundation of the settlement at Port Jackson had no idea of their meaning—they belonged to the Dreamtime spirit world of long ago. The general opinion about these hand stencils is that they represent individuals. In south-western Arnhem Land they are painted in caves during mourning ceremonies.

For further reference F. D. McCarthy's "Australian Aboriginal Rock Art" and the "Australian Museum Handbook" may be consulted.

Naturalists' Society's 58th Anniversary

The Naturalists' Society of New South Wales celebrated its 58th year last August.

The society has done important work in supporting fauna and flora protection and in cataloguing the flora and fauna of the County of Cumberland, in which Sydney is situated. It holds regular meetings, gives illustrated lectures, displays exhibits and conducts field excursions. Its meetings are at the Salvation Army Headquarters, Sydney, on the first Tuesday evening of every month, except January.

The society has published "The Australian Naturalist" as its official journal since 1906.

It traces its origin back to 1888, when the Natural History Association of New South Wales was formed. The first president of this association was Dr. George Bennett, F.Z.S., who made important early studies of the platypus.

The society amalgamated with the Flora Society in 1912, and, later, with the Wattle League. Its president is Mrs. P. Messmer.

Past presidents have included W. W. Froggatt, C. Hedley, T. Steel, W. J. Rainbow, E. S. Edwards, F. W. Carpenter, Dr. I. N. Mackerras, A. E. Watson, D. G. Stead, N. S. Barnett, S. T. Turner, F. J. Ludowici, Agnes A. Brewster, Constance N. Le Plastrier and E. H. Zeck.

The society states that its membership is steady, but that it would welcome more members in the 18 to 35 years age-group.

"CRABS' EYES" WERE A MEDIAEVAL "CURE-ALL"

By FRANK McNEILL

THE many people who find strange-looking, button-like objects in inland creek beds are usually astonished when they learn that their finds come from the stomachs of freshwater crayfish, sometimes called yabbies.

These stomach stones, traditionally known as "Crabs' Eyes", were much better known in the Middle Ages than they are to-day. In those times they were among the weird ingredients in the apothecaries' *materia medica*, and were accepted as a good remedy for all manner of ailments.

Over the centuries, however, knowledge of them has largely been forgotten. That is why the museum zoologist of to-day is so often called on to explain the mystery of these objects, which are found in stock dams as well as creek beds—and even in the nests of blue cranes, which feed on the crayfish. The inquirers rarely have a clue as to the nature of their finds.

The stones are known technically as gastroliths. While they are of fairly general occurrence in crustaceans, those from freshwater crayfish have always been the best known. In Europe during the last century they received some critical examination and study and, except perhaps for the exact time of their occurrence, the findings there apply generally to crayfish in Australia.

Coral-like Structures

When in the body of a crayfish, the stones, a pair of lens-shaped calcareous masses, are to be found centrally situated on each side of the stomach cavity, enclosed between the tough, horny lining of that cavity and the skin of the stomach wall. The sides turned towards the stomach cavity are smooth and flattened, or concave, while the opposite sides are convex. In the Australian crayfish the convex surfaces of the stones are smooth when fully developed, but in European species these surfaces are rough, with irregular prominences somewhat like the structure of some solid types of coral.

Crayfish's Gastric Mill

The gastroliths are actually a rich reservoir of ingredients for the hardening of the exoskeleton (outside skeleton, or shell) of crayfish. They are found fully developed just prior to shell-casting (ecydysis), a process that all crustaceans must undergo at intervals during their increase in growth. At the time of shell-casting, the horny (chitinous) lining of the stomach is also cast off, and this causes the stones to be shed into the stomach cavity. There they ultimately become ground down and, in a dissolved state, are absorbed and transferred to the newly-formed and hardening exoskeleton. Unless they are normally developed and re-absorbed, shell-casting is not healthily effected and the crayfish will die. The grinding-down is done by a gastric mill which all crayfish and lobsters have—a horny (chitinous) stomach lining thickened in places to form a system of levers connected with three strong teeth set in the narrow opening between the two chambers of the stomach.

Gastroliths are not mere concretions. They are produced in the superficial skin layers, and have a definite construction pattern. A vertical section shows that they are composed of thin, superimposed layers, of which the inner are parallel with the flat or concave basal surface, while the outer become gradually concentric to conform with the curve of the opposite surface. Moreover, the basal layers are less calcified than the outer curved ones, which are particularly dense and hard. In fact, in their composition the gastroliths are very similar to other hard parts of the exoskeleton of crayfish.

These stomach stones (gastroliths), also known as "crabs' eyes", came from eastern Australian crayfish, except the spherical one (bottom left), which was from a crab. They range in diameter from three-tenths to six-tenths of an inch. The layered nature of gastrolith formation is seen in the specimen at top-left. The rough surface of the small gastrolith near the centre shows that it is in an early stage of development.

Photo.—Howard Hughes.

A European authority who made an analysis of crayfish gastroliths found that they were made up of the following components: Animal matter soluble in water, 11.43 per cent.; animal matter insoluble in water (probably chitin), 4.33; phosphate of lime, 18.60; carbonate of lime, 63.16; soda reckoned as carbonate, 1.41. The analysis showed that the proportion of mineral to animal matter, and of phosphate to carbonate of lime, was greater in the gastroliths than in the exoskeleton in general.

The lobsters of North Atlantic waters are other large crustaceans in which well-developed gastroliths, similar in shape to those of crayfish, are produced. These stones have also been known since early times, and were used by the apothecaries.

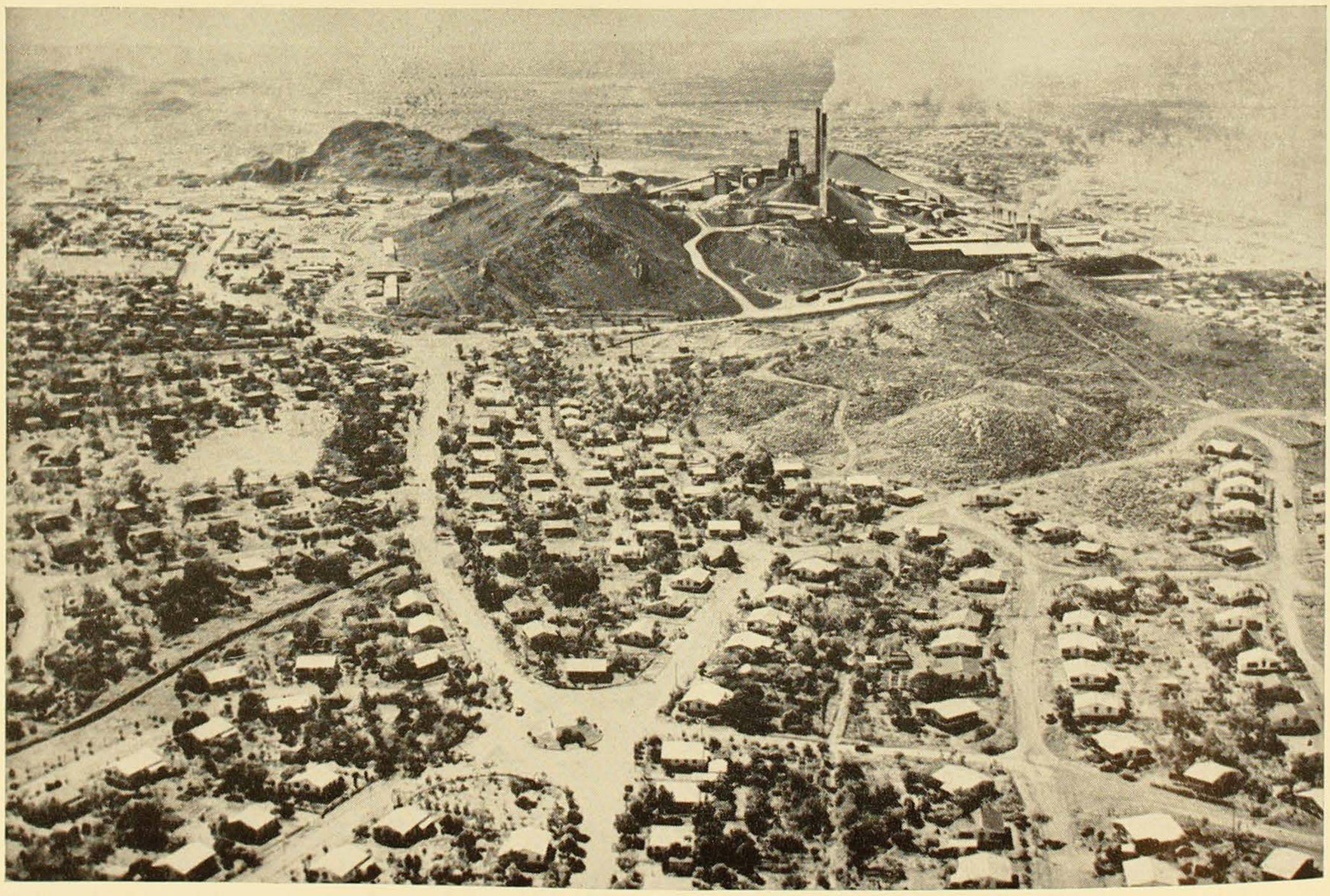
The alternative popular name, "Crabs' Eyes", indicates that the stones were also once well known, and sought, in the bodies of true crabs. Although true crabs undoubtedly produce them in a varying degree of prominence and shape, little notice has been taken of this in modern times. One old record refers to the conspicuous presence of the stones in the large, scavenging West Indies land crabs (*Gecarcinus*), which are stated to develop as many as four in a single individual, and seldom less than two.

The Mineral Wealth of North-West Queensland

By R. O. CHALMERS

THE vast open spaces of Central Queensland make a great impact on a traveller journeying along the route from the New South Wales border through Cunnamulla, Charleville, Longreach and Winton.

After leaving McKinlay, rugged ranges, first appearing in the distance and then gradually drawing nearer as one approaches Cloncurry, afford a change from the vast sweep of well-grassed alluvial black soil plains broken only by an occasional distant view of low flat-topped mesas to the west, many of them the home of the Queensland opal. The rugged ranges mark the outcrop of part of the Cloncurry shield, consisting of rocks of Pre-Cambrian age. There are several areas of these very ancient rocks in Australia and most are notable in that they contain mineral deposits of great economic importance. Such localities include practically all important mineral fields in Western Australia, the Radium Hill uranium mineralization in South Australia, the great silver-lead-zinc deposits of Broken Hill and virtually all mineral deposits of the Northern Territory, including the Rum Jungle uranium field.



The ridge of Mount Isa dominates this picture. Shafts for hauling ore, men and supplies are on the valley floor immediately to the left of the ridge. The biggest smoking chimney is the copper smelter. On the flat to the right of this chimney are a power station and copper-smelter buildings. Left of the ridge, in the foreground, is part of the residential "mineside" area; in the distance (right) lies the "townside" district.

Photo.—Sydney Morning Herald.

The Cloncurry gold and mineral field is no exception to the rule. It is an area of some 200 miles from north to south and 100 miles from east to west, and is exceedingly highly mineralized. The three main towns in the area are Mount Isa, Cloncurry and Mary Kathleen.

Deposits of copper minerals were first found in 1867 near the present site of Cloncurry, which lies some 200 miles south of the Gulf of Carpentaria. This was only seven years after Burke, on his rapid dash to the Gulf, had gazed on this fertile expanse from the nearby Selwyn Ranges and named it after Lady Cloncurry in his far-off native country, Ireland.

While over 500 copper mines have been worked at various times (most of them concentrated in a wide north-south belt in the eastern portion of the area) they have not contributed more than about a tenth of Australia's total output of copper. The picture has changed in recent years with the entry of Mount Isa into the field as the major copper producer in Australia.

Mt. Isa's Discovery

Mount Isa is one of the world's great mines and, as always, there is an interesting history connected with the discovery and development of an ore body of this magnitude. Mount Isa lies some 1,000 miles in an airline north-west of Brisbane. It is situated in the western portion of the Cloncurry field, where mineralization is not nearly as widespread as in the eastern section. Prospecting was therefore never carried out so intensively in this western region. The area, of course, had been known since the 'seventies when pioneers of the cattle industry, such as Alexander Kennedy, had run their herds many times on and around the site of the present mine. The outcrop of the ore body was discovered relatively late in Australia's mining history. At the end of 1922 or the beginning of 1923, John Campbell Miles, a prospector, set out from Richmond, Queensland, with some horses he was taking to the Territory for sale. The account in the next paragraph differs from others but is taken from an interview with Miles himself, now aged 74, when he re-visited Mount Isa after an absence of thirty years[1].

Miles eventually reached Duchess in January, 1923, after some sickness due to heat, flies and inadequate diet. There, with a choice of three routes to the Territory, he elected to follow the Leichhardt River, presumably making for Camooweal. At one spot where he decided to pitch camp on the river he tethered his horses and began exploring a nearby long, rugged ridge of reddish-brown siliceous rock. He discovered the outcrop of the ore body and collected specimens. These, when sent to the assay office at Cloncurry, showed high percentages of lead and silver Incidentally, the veteran miner discounts the well known story that he named the ridge Mount Isa after his niece Isabelle.

Gazing to-day on this prosperous, bustling town of 12,000 people, the site of Queensland's biggest single industry, it is difficult to imagine the less prosperous earlier days. The natural setting is attractive. The town lies in a broad shallow valley between parallel ranges of rugged hills. There is an abundant water supply, and trees and brilliantly flowering bougainvilleas and poinsettias abound in the many attractive home gardens, especially in the mineside section of the town.

Mount Isa has been a major producer of lead for sixteen years between 1931 and the present. Total production of metallic lead up to the end of 1956 was approximately 864,000 tons. Mount Isa is also a major producer of zinc and copper. The zinc is closely associated with the lead and they are mined together as is done at Broken Hill and other major Australian lead-silver-zinc mines. After separation, the lead minerals are smelted at Mount Isa to produce metallic lead but the zinc concentrates are sent abroad for smelting. The entirely separate copper-ore body, although right alongside the lead-zinc body, occurs only at depth and does not appear within 800 ft. of the surface. It was discovered as early as 1930, when a surface drilling programme was in operation to prove the downward continuation of the ore bodies already known, but was not worked until 1942 when silver-lead-zinc ore was being mined at 875 ft. The workings

[1] Mimag (Mount Isa Mines House Magazine), x (10), October, 1957.

could then be driven through into the copper ore body.

From then until 1946 only copper was mined, as a wartime measure, using makeshift equipment gathered from idle mines elsewhere in the Cloncurry field. Production of lead and zinc was resumed and in 1953, with the completion of a new copper smelter, Mount Isa once more entered the field of copper production and immediately became Australia's chief producer. Some 26,000 tons of copper were produced in 1956.

An account of the principal primary sulphide minerals at Mount Isa, together with the geological history and the mode of deposition of the ore minerals, has been given previously in this magazine (T. Hodge-Smith, vii, 6, 1940). Suffice to say, the primary sulphide minerals, galena (lead sulphide), sphalerite (zinc sulphide) and chalcopyrite (copper iron sulphide) are found replacing favourable beds in a thick series of banded, shaly sediments which have been steeply tilted and in part highly folded by earth movements.

As is the case in all major Australian lead mines the silver is contained in the galena. For many years the ore has been mined entirely by underground methods. The maximum depth of the mine is now 2,350 ft. In the early 'thirties surface oxidized ores, consisting mainly of lead carbonate, were worked in seven open cuts known as "glory holes". These gradually coalesced to form one very large pit some hundreds of feet deep which can still be seen at the north end of the mine. Unlike Broken Hill, however, where the same primary minerals are mined, spectacular, well crystallized museum specimens from the upper oxidized zone of the lode are scarce. Some beautiful crystallized specimens of cerussite (lead carbonate) and pyromorphite (lead chlorophosphate), a generous gift from Mount Isa Mines Ltd., were brought back in 1934 by H. O. Fletcher, who had passed through Mount Isa on a Museum field trip. These are very rare and the Australian Museum is fortunate to have such fine specimens. The writer visited the oxidized zone, in a copper ore body belonging to the Black Rock group, where for the first time specimens of cuprite (copper oxide), malachite (copper carbonate) and chrysocolla (copper silicate) were collected for the Museum. Mr. G. R. Fisher, Chairman of Directors of Mount Isa Mines, presented a very fine specimen of native copper from this oxidized zone. At the end of 1957 an open cut was begun to work the oxidized copper minerals.

Some few miles to the south of Mount Isa there is an entirely different type of mineralization. In the Mica Creek area, pegmatite dykes have intruded the sediments which seem to be a schistose variety of the shaly rocks in Mount Isa itself. The pegmatite dykes, consisting of coarse masses of feldspar, muscovite and quartz have invaded the schistose rocks along their planes of foliation. Crystals of yellowish-green opaque beryl, sometimes weighing several pounds, occur in pegmatites and small-scale mining of this beryl is carried on because this mineral is a source of metallic beryllium, one of the important metals of the atomic age. A number of very fine tourmaline crystals lying loose in the soil were also collected from this area.

Mary Kathleen

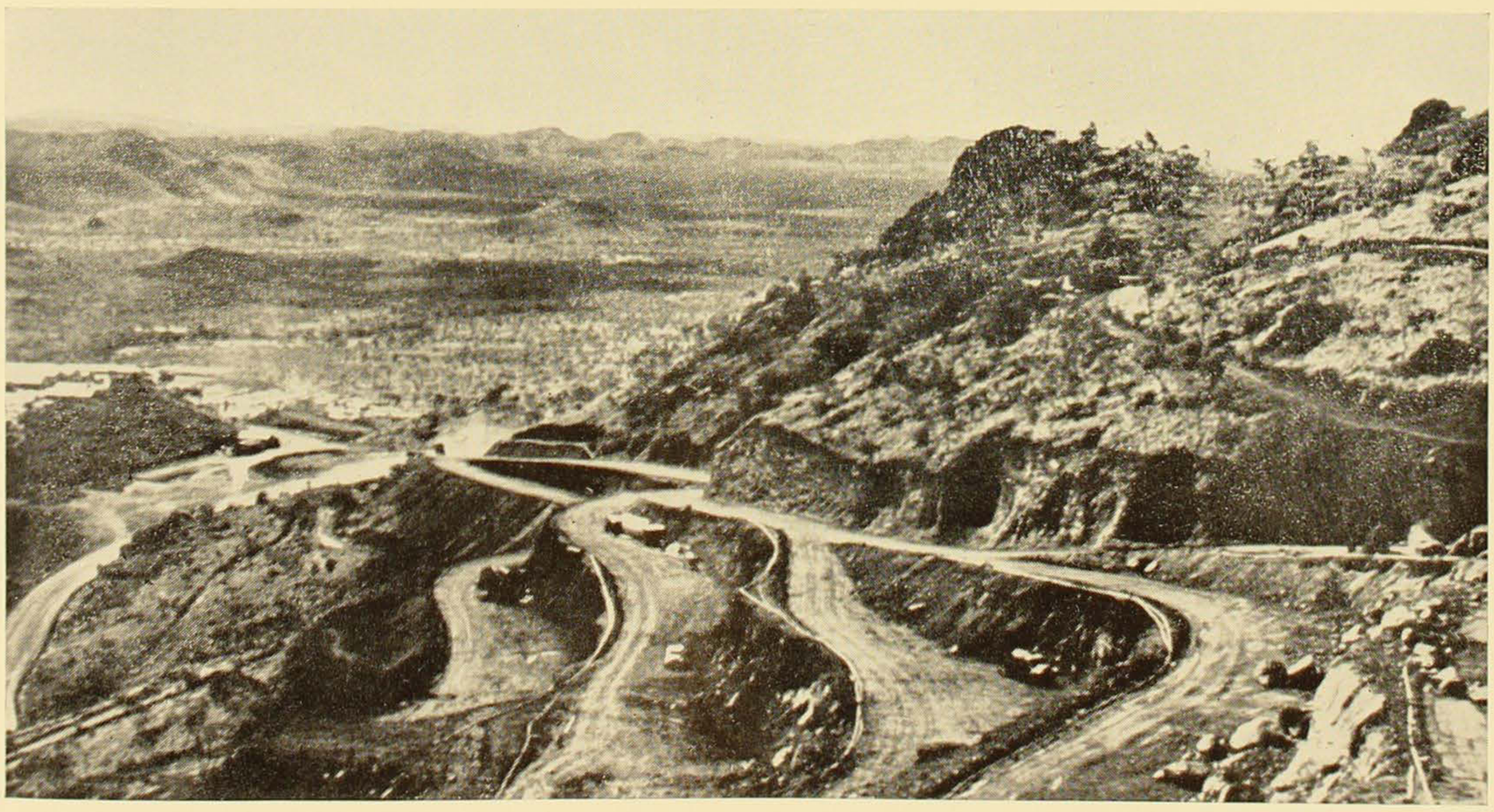
Mention of the atomic age brings us to the most recent mineral discoveries in the Cloncurry mineral field. In the early part of this century, discoveries of uranium minerals had been made at the South Australian localities of Radium Hill and Mount Painter, but except that minute amounts of radium could be extracted from it, uranium remained a chemical curiosity until the discovery that the uranium atom could be spilt, with the release of vast amounts of energy.

Radium Hill became an important mine, and in 1949, Rum Jungle, in the Northern Territory, was discovered and within a few years was an important producer of uranium ore. Both these uranium deposits were located in Pre-Cambrian shield areas, as indeed is practically every major uranium mine in the world. The Cloncurry field, being a similar Pre-Cambrian shield area, was by analogy regarded as a likely source of uranium and intensive prospecting was carried out throughout the area, particularly in the vicinity of Mount Isa, the largest centre of the district, where many local residents had often occupied their week-ends by

prospecting the surrounding district. It wasn't very much trouble to add a Geiger counter and an extra modicum of hope to their modest equipment and the first fruit of the search was the discovery on 14th March, 1954, of uranium mineralization at a locality some 25 miles north of Mount Isa, popularly known as the "Glowing Hills". This name was derived from some fanciful but quite erroneous tale that due to the uranium content these hills glowed in the dark. The search then became very intensive and, to summarize the position, by the end of 1955, when interest in prospecting for new deposits had practically ceased, thirty-seven localities of uranium mineralization of some significance had been found. Of these one is in the process of being developed as a major mine. This is Mary Kathleen, situated a few miles to the south of the Mount Isa-Cloncurry road, almost exactly half-way between the two towns.

The progress that has been made on this major mining venture, is most impressive. The ore body is on the side of a steep rugged hill and is worked by open cut methods Several benches have been cut at various levels in the side of the hill and the uranium ore is taken by large trucks down to level ground. There the ore will be treated mainly by chemical means and the final product will be uranium oxide which will be sent overseas for the manufacture of uranium metal.

The chief uranium mineral present in the ore body is uraninite, an oxide of uranium. It occurs in quite a unique fashion, hitherto unrecorded in any other part of the world. It is intimately mixed in the form of tiny grains, with two other minerals. One of these is a rather rare mineral, allanite, which is a silicate of calcium, iron and aluminium, containing the rare earth metal cerium. The other is an entirely new mineral, a silicate mineral containing cerium as a major constituent and also an appreciable proportion of boron. It has been named "stillwellite" after Dr. Frank Stillwell, of Melbourne, an eminent Australian mineralogist. Needless to say, it is a notable event in the world of mineralogy when a new mineral is discovered, but especially is this so when it occurs in large quantities as one of the main constituents of an ore body of major importance. The uraninite-allanite mixture is massive, black, and so fine-grained that the individual minerals cannot be distinguished with the naked eye. The uraninite-stillwellite mixture is likewise very fine-grained; it is liver-brown with a somewhat greasy lustre.



Roads lead up a steep hillside to the various bench-levels of the Mary Kathleen Mine, from which uranium ore is extracted by open-cut methods. Mine buildings are on the valley floor, seen in the middle distance.

Photo.—Author.

These mixtures of uraninite and other minerals are closely associated with a fine-grained, dark, hard, heavy rock composed largely of garnet and diopside, two silicate minerals of no economic importance. This latter assemblage of minerals is difficult to distinguish from the uraninite-allanite-stillwellite mixtures, so radiometric surveying is done on the face of the ore body and the uranium minerals are marked out to facilitate their removal.

Obituary

William Alfred Rainbow, Librarian

IN the story of the Australian Museum, Sydney, there have been several cases of fathers, their sons, and even their grandsons, spending their lives in its service.

William Alfred Rainbow, who died at Blaxland, N.S.W., on November 17 last after 47 years' service with the Museum, was the son of the late William Joseph Rainbow, entomologist at the Museum from 1895 to 1919 and an authority on spiders.

The younger "Will" Rainbow (as he was known to his friends) was born at Marrickville, Sydney, in 1886, and was educated at Sydney Grammar School, He joined the staff of the Museum on June 7, 1904. After a period as assistant librarian, he was appointed librarian in 1917. He retired on June 1, 1951.

Books form the backbone of scientific knowledge, and the Museum's library is widely consulted by zoologists, geologists, mineralogists and other scientific workers. In systematic zoology, especially, an exact knowledge, not only of the contents of books, but of the dates and other particulars of their publication, is very important, and Mr. Rainbow's influence will long be apparent in the Museum's library because of the valuable bibliographical notes and cross-references he made.

Always helpful with advice on literature, Mr. Rainbow also had a fund of information and anecdotes about the early days.

He was author and part-author of several biographical and bibliographical papers, including a list of the Museum's publications (Etheridge & Rainbow, 1916); a bibliography of a former Director of the Museum, R. Etheridge (Records 15, 1926:5), and the life and work of another former Director, C. Anderson (Records 21, 1945:279). Mr. Rainbow wrote the following articles for "The Australian Museum Magazine": A Brief History of The Australian Museum (1, 1922:137); Charles Sturt (4, 1930:75), and A Notable Aboriginal—Douglas Grant (10, 1952:301).

Mr. Rainbow assisted in the editing of "The Australian Museum Magazine" for 30 years after its inception in 1921, and of the Museum's Records and Memoirs. Many authors have acknowledged the help he gave them with their books and monographs. Memorial notices of George Bennett, an early medical man and zoologist, and of E. C. Andrews, an eminent geologist, owe much to Mr. Rainbow's careful preparation. Musgrave's "Bibliography of Australian Entomology," Troughton's "Furred Animals of Australia" and other standard works acknowledge his assistance, and the present writer also remembers him with gratitude.

The Museum's trustees engaged Mr. Rainbow to write a history of the Museum, but physical infirmities prevented him from completing this work.

Mr. Rainbow took a keen interest in civic affairs, and was instrumental in re-organising the Holroyd, N.S.W., Council, of which he was an alderman and had served a term as Mayor.—G.P.W.