The AUSTRALIAN MUSEUM MAGAZINE

VOL. IX, No. 4. JANUARY–APRIL, 1947. Price—ONE SHILLING.

Hermit Crab.

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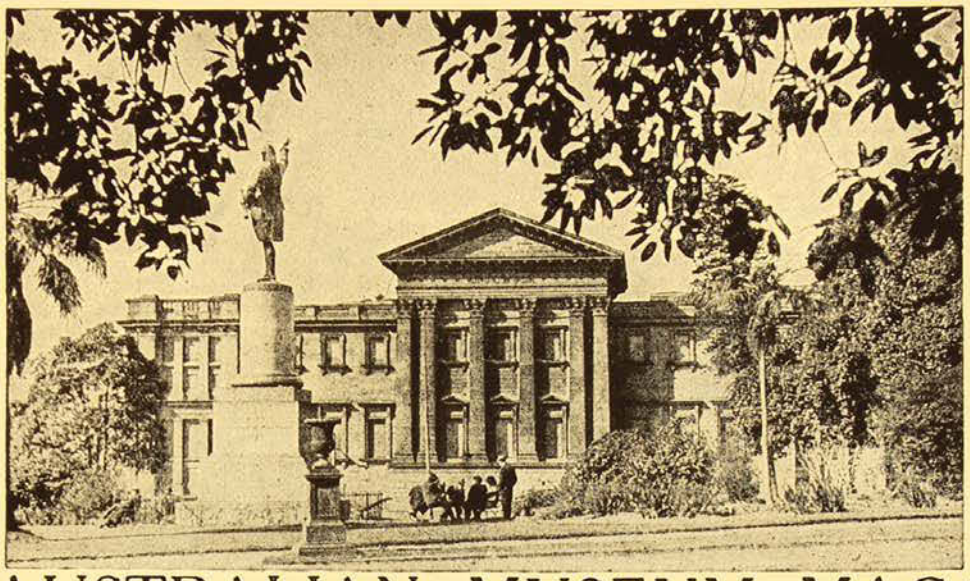

THE AUSTRALIAN MUSEUM MAGAZINE

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

● OUR FRONT COVER. Hermit Crabs, *Clibanarius strigimanus*, are often brought to the surface by the nets of the trawlers and when turned out on the deck they extend their limbs out of the shells and walk about. If startled, they instantly withdraw into their shells and, as Whitelegge picturesquely puts it, "their limbs rattle like old bones".

The inner surface of the hand and the movable finger carries several raised patches covered with regular corrugations and when these are rubbed together a stridulating noise is produced. However, some authorities believe that these strange structures may be used for other purposes than producing sound; they may be used for holding objects firmly between the hands or for locking the two front legs together when the crab retires to its shell, and so prevent an enemy from moving them up and down and getting behind their guard to the soft parts of the body behind.

The actual size of the specimen may be estimated from the fact that the shell is six and a half inches long. (See pages 129–132.)

Photo.—Howard Hughes.

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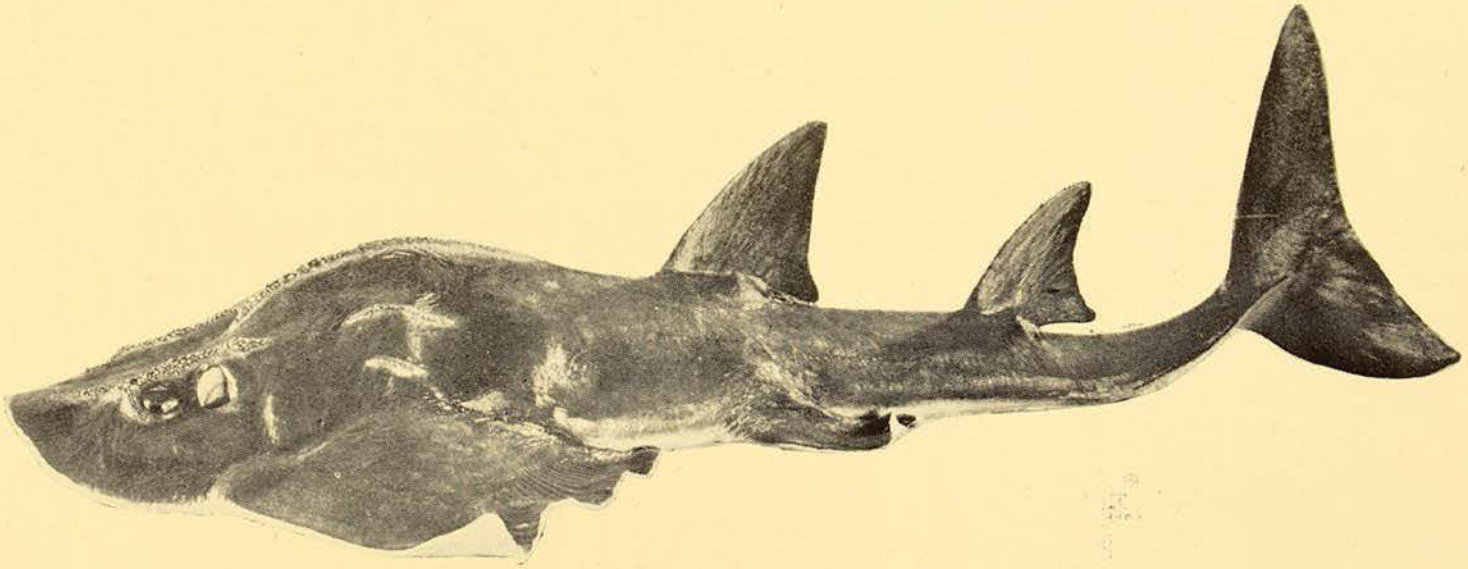

Rhina, the Shark Ray: the new exhibit in the Australian Museum Gallery. This animal, measuring 8½ feet in length by about 5½ feet in width and 1½ feet in depth, is the largest specimen known. In life it weighed 275 lb.

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Rhina, The Shark Ray

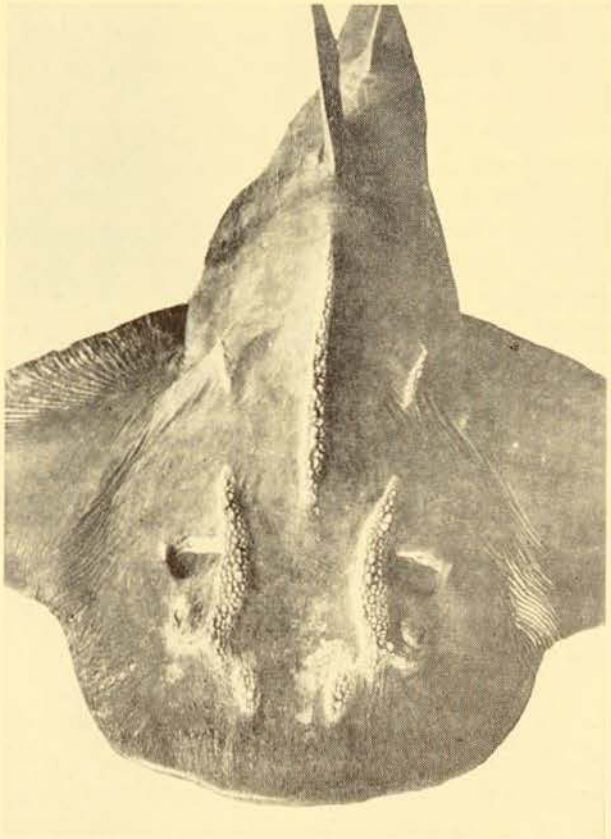
By GILBERT WHITLEY

IT is perhaps not generally known that the galleries of the Australian Museum contain some of the largest fishes* of their kind in any Museum. Here the public can see mounted monsters such as the Hammerhead Shark, Sawfish, Devil Ray, Queensland Groper, Marlin, Ocean Sunfish, and large sharks, such as any game angler might wish to catch. The latest addition to this giants' gallery is a fine coloured cast of *Rhina,* the Shark Ray. This animal, measuring 8½ feet in length by about 5½ feet in width and 1½ in depth, is the largest specimen known, and originally weighed 275 lb.

Mr. J. H. Williams, of Broadcasting Station 4MK, Mackay, Queensland, presented us with the specimen which was caught by Mr. Frank Walz in Mr. Charles Wells's fish trap at McEwan's Beach, Mackay, on 16th November, 1945, and frozen for transport to Sydney, through the good offices of Mr. Hugh Hope. Its arrival in excellent condition was particularly welcome because this Museum had no specimen of the species (indeed very few museums have good examples, the only ones I have seen being dried skins in Berlin and Brisbane years ago).

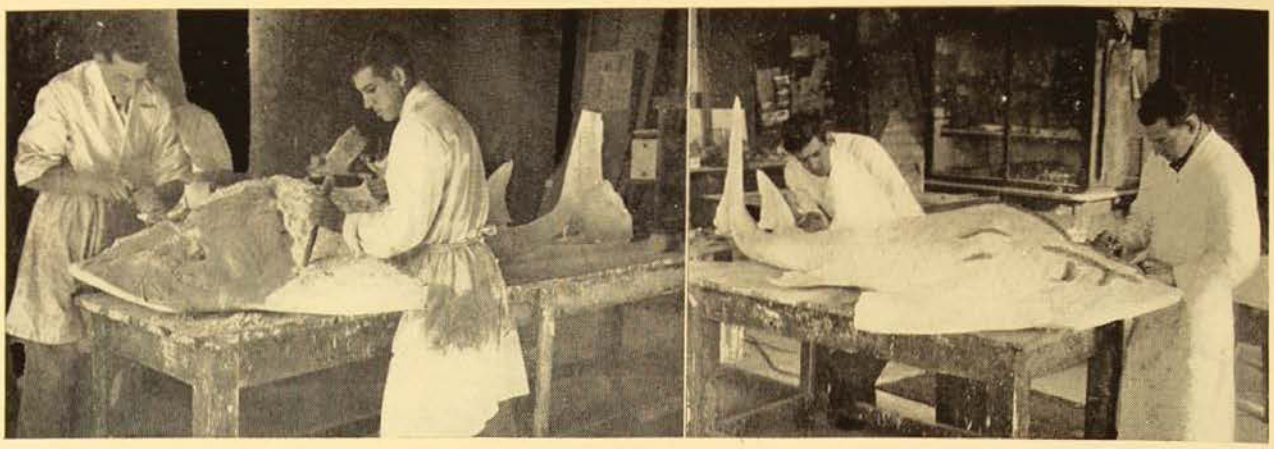
Description.

The odd appearance of the Shark Ray, with its rounded snout, broad "wings", ridges of hard tubercles on the head, and arched pads of teeth, attracted everyone's attention. The species is somewhat intermediate in structure between sharks and rays: the general form, with well developed tail and dorsal fins, is shark-like, especially in the hinder parts, but the wide pectoral fins and the gill-slits



Upper surface of head and body, seen from the front, showing rows of tubercles forming ridges.

* Using that term, against my inclination, in its widest sense to include sharks and rays.



Stages in the preparation of the cast.

below the head indicate a closer alliance with the rays, particularly the shovel-nose rays. The large opening behind each eye is the spiracle, used as an extra breathing aperture when the gills are lying on the sand.

The mouth is provided with more than seventy teeth across each jaw, but the teeth are blunt molars arranged in "pavements" which do not stretch evenly from side to side but are arched into a middle scroll with a smaller wave on each side in the lower jaw and these fit into corresponding scooped-out areas in the curled "pavement" of upper jaw teeth. Each tooth, moreover, has a finely rippled surface. Altogether the jaws form a most efficient apparatus for crushing the crustaceans or shellfish on which it is said to feed. The Shark Ray, despite its size, is evidently quite harmless to bathers.

The specimen was an adult female, several large eggs like ripe yellow apricots having been found inside it when it was cleaned before leaving Mackay. The species is said to be ovo-viviparous, that is, the eggs would develop internally and the young be born as miniatures of their parents. No embryos were found in this one, however, and practically nothing is known about the breeding and life history of the species.

The general colour of the cast is a leaden or dark sandy-grey with some very indistinct, light, oval spots, about the size of thumb-prints, on the dorsal fins and back. The eyes are dark brown with a small black pupil, and the rows of denticles on the head are pale horn-yellowish. The under surface of the animal and the inside of the spiracles are pale dull yellowish.

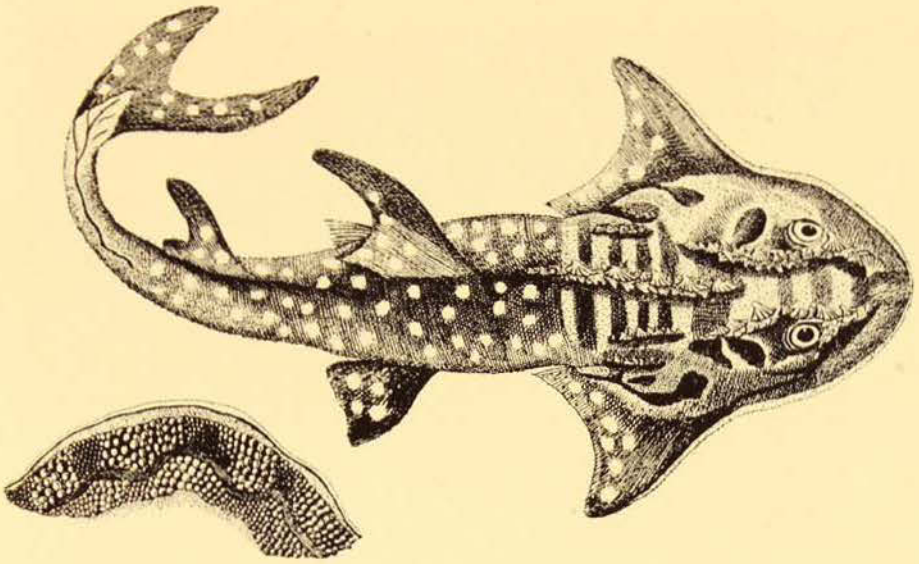
The Shark Ray is exhibited in a swimming attitude with the fins waving and the large tail fin, with its great upper and lower lobes, sweeping to one side.

Casting.

The preparation of the cast from the huge specimen involved a great deal of labour on the part of the Museum preparators. The colours of the fresh specimen were recorded for future reference by the artist, Mr. Gordon Binsted. Then the plaster mould was made and put aside to dry. The rows of tubercles or denticles on the head presented a problem in reconstruction but Mr. J. Kingsley, who was in charge of the casting, decided that they would be most successfully reproduced in plastic material.

Several kinds of plastics were experimented with to ensure accuracy in every detail without subsequent shrinking or curling and eventually an extremely satisfactory result was achieved. The plastic "denticles" were put in place in the mould and a plaster cast made of the whole animal, reinforced with girders and brackets of steel so disposed as to strengthen the body, support the exhibit, and also give bases for easy handling during transport from studio to gallery, which finally could be done by two or three men.

The plaster cast having dried, the artist painted it from his original colour sketches, and the whole was mounted on the sandy floor to complete what is now



The first illustration of a Shark Ray, by Bloch and Schneider, in 1801.

a lifelike exhibit, more lifelike, indeed, than the original specimen, which could not be preserved entire because of its bulk and the fact that it had deteriorated slightly on its long journey from Mackay.

History and Distribution.

The Shark Ray was first made known to science by the German authors, Bloch and Schneider, in their *Systema Ichthyologiae* published in 1801. They gave a Latin description and a very good figure of a small female from Coromandel, India, bestowing the scientific name *Rhina ancylostomus* which the species still bears. Probably theirs was one of the specimens labelled "Koromandel" which I saw in the Berlin Museum in 1937. Since that *Systema* appeared, the Shark Ray has been dealt with in a number of books and articles, an excellent list of which was provided by H. W. Fowler (Bulletin U.S. National Museum, 100, xiii, 1940, p. 299) so that we now know that this tropical marine species occurs in the Red Sea, Arabia, East Africa, the Seychelles, India, Ceylon, Penang, the East Indies, Cochin China, Philippines, China, Japan and down to tropical Australia.

It has been sometimes confused with the Angel Shark (*Squatina*) and has been called Mud Skate and Bow-Mouthed Angel Fish.

Some specimens have been described as having tortuous black lines in addition to the usual dull brownish coloration and whitish spots, but none has hitherto been reported to exceed about seven feet in length. A fine illustration of a male from Ceylon appeared in Hornaday's "American Natural History" published in 1904, but has been overlooked by later naturalists who can hardly be blamed for missing an illustration of an Oriental ray in a book devoted to a "knowledge of the higher animals of North America".

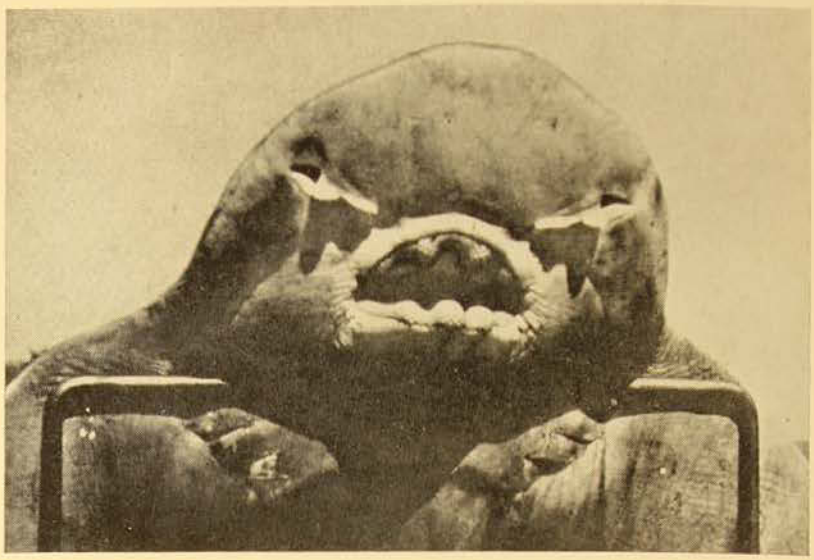
The Shark Ray is probably distributed around the Australian coasts from the north-west to Queensland but records of its occurrence here are sparse, generally not accompanied by any details as to date of capture, size, stomach-contents, etc., so that we are ignorant as to its habits and life-history. The Shark Ray has been noticed in our waters from Broome, north-western Australia, and the following parts of Queensland: Darnley Island, Dunk Island, Sarina, Mackay district (about five noted by Mr. Williams in the past eight years), Cleveland, Southport and Moreton Bay. It is apparently an inhabitant of inshore waters and probably lies inactive on the sandy bottom or moves slowly with the tides in search of food.

Affinities.

On first beholding the Shark Ray, an inexperienced observer might be pardoned for thinking that it was a hybrid between a Shark and a Ray.

When the First Fleeters saw the Shovelnose Rays of Botany Bay, for example, one of them wrote*

* William Bradley, MS. journal, October, 1788. Holostat copy in the Mitchell Library, Sydney, pp. 132-133.



Face of a north-western Australian Shark Ray, showing the large nostrils, the remarkable mouth, and the gill-slits underneath the head.

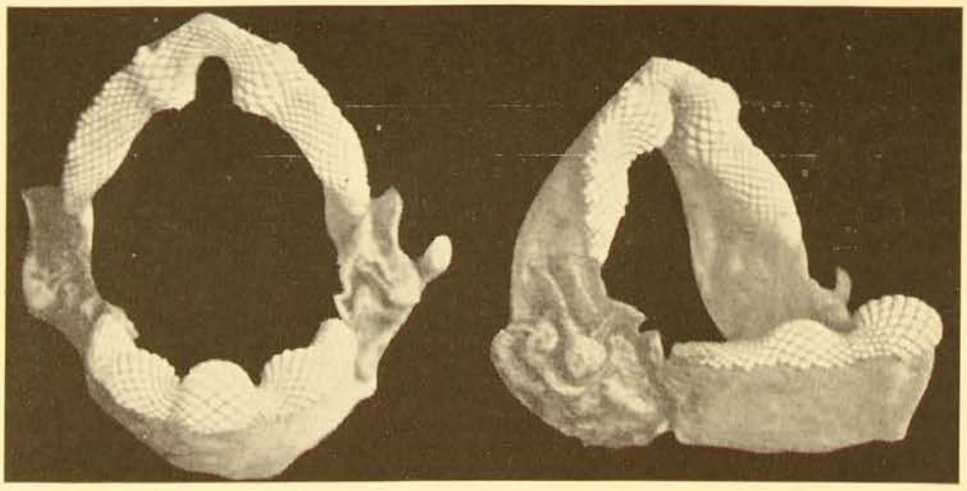
[Photo. anonymous.

"We met with several Fish that seem'd to partake of the shark, the upper part being that of the skate or other flat fish with the back fins & tail of the shark. This kind of mixt breed is also found among the Beasts and Birds, the Quadrupeds, the Dog excepted partake of the Kanguroo and Opossum, many having the false belly & hind legs & feet similar to those of the Kanguroo. The Birds frequently partake of the Parrot."

That the animals of Australia were of very mixed breeds was a popular opinion in the early colonial days, but such reasoning was based on false analogy. Hybrids in nature are very rare amongst fishes and I know of no cases whatever amongst sharks or rays.

No, the Shark Ray is true to its own particular type, and has probably been stable for millions of years. The affinities with Sharks and Rays could be elaborated at length but may be briefly touched on here. All normal sharks have gill-slits at the sides of the head and they generally have a spindle-shaped body. In the bottom-haunting wobbegongs (*Orectolobus*), however, the body has lost its streamlining and become rounded and paunchy. The Angel Shark or Monkfish (*Squatina*) has the pectoral fins much expanded on each side of the wobbegong-like body but the gill-slits are still on the side of the head; it is the most ray-like of the sharks and is somewhat similar in shape to the Upper Devonian fossil *Gemundina*.

In the Shark Ray and indeed all the rays (whether shovelnose, fiddlers, skates, stingarees or devil rays) the gill-slits are underneath the head, the body and pectoral fins are broad and flattened, not spindle-shaped, and the teeth are usually blunter than those of sharks.



Teeth and jaws of a Shark Ray from Cleveland, Queensland. Each tooth has a finely rippled surface.

The tail and dorsal fins of the Shark Ray and Shovelnoses are still remarkably shark-like but degeneration of the tail is very marked in the skates and it becomes a whip-like lash in stingarees and devil rays, the main function of swimming being performed by the sweeping pectoral fins of the latter. Indeed, the dreamy flapping motion of cow-nosed rays caused Dr. W. K. Gregory to call them "winged Sharks" which, in a way, they are.

One more curious point may be mentioned: the presence of the anal fin in most sharks and its absence in the rays. When present, the anal fin lies below the butt of the tail between the pair of ventral fins and the lower lobe of the tail-fin. In the bottom-living rays, the anal fin does not occur, but most sharks use it for swimming in the upper layers of water.

But, in certain sharks, known as the Dogfishes (Squalidæ), there is no anal fin either, which led me to express the idea that Dogfishes may be sharks which *have been rays,* long æons ago, and have since taken to swimming freely and become, as it were, streamlined sharks again. There are clues in their mouths and teeth, their blood vessels, and a ridge along their sides that also point in that direction.

Perhaps we shall never know the whole story of the evolution of the sharks and rays but at least *Rhina,* the Shark Ray, may stimulate thought and act as yet another reminder that we still have much to learn.

A Raft of Fish Eggs

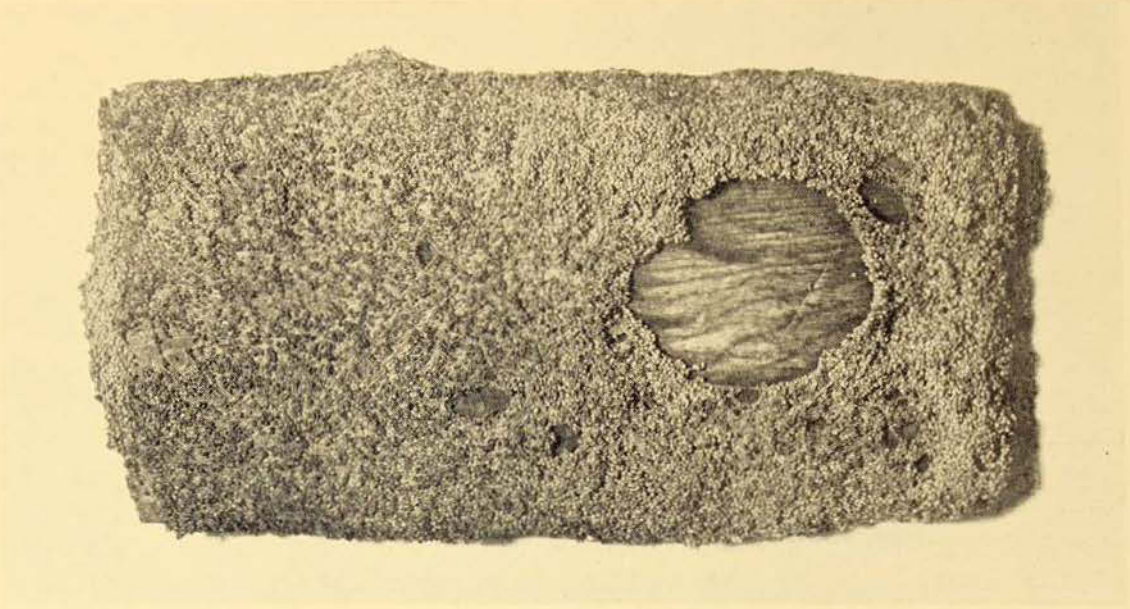
By G. P. WHITLEY.

So Eggy withal, that a man would have Sworn
He had just in the Pill'ry been taking a turn.
—E. Ward, *The Rambling Fuddle-Caps,* 1709.

A REMARKABLE mass of eggs, encircling a floating piece of wood, was washed up at Coff's Harbour, New South Wales, in 1945 and brought to the Museum through the offices of the *Daily Telegraph.* The wooden board was twelve inches long, six broad, and about three-quarters of an inch thick; the edges and most of the top and bottom were covered with tiny spherical eggs connected by skeins of a silk-like resilient substance, as if some animal had worked round and round the board, attaching its eggs as one might wind a ball of string or a bobbin, the eggs extruded along with the strings. The eggs were, of course, "dead" after the long trip to Sydney and microscopic examination revealed no developmental stages or identifiable yolk, and no animal had been found with the board to indicate their origin. However, it is reasonably certain that here we have the first recorded case in Australia of the so-called "nest" of a flying-fish. The eggs of garfishes, long toms, and flying-fishes have fine threads radiating from their surfaces, or at their poles, and these, at least in the case of flying fishes, adhere to—or rather drape around or tangle—floating objects.

In other oceans, similar clumps of eggs entangled in floating Sargasso weed have been illustrated by various authors and an excellent historical survey of such cases has been given by Dr. E. W. Gudger.[1] Three-quarters of a century ago, Professor Louis Agassiz thought that these egg-clumps were the work of Angler fishes, but Theodore Gill, a distinguished ichthyologist, showed in 1907 that the eggs were those of flying-fishes, a fact

[1] E. W. Gudger: *American Naturalist,* lxxi, 1937, pp. 363-381 and figs.



The "raft" of fish eggs from Coff's Harbour.

evidently known earlier by the simple sailor, Bullen, who wrote of them in his *Cruise of the Cachalot*. In more recent times, some of the eggs were kept in aquaria and the young flying-fishes were hatched and reared.[2]

The eggs and their cords are heavier than sea-water so, on their own, would sink, but by being wound around floating objects, they float in the more oxygenated, warmer and purer surface water. When the young flying-fishes have hatched, they evidently swim together in little schools. Several such groups of young *Cypsilurus melanocercus* were reported from Sydney Harbour in December, 1945, and February, 1946. That species is the best known of the Tasman Sea kinds and may well have been responsible for the peculiar "raft" of eggs. It grows to a length of eighteen inches, sharing with the Catalina Flying-fish of the United States, the honour of being the world's largest members of the flying-fish family.

[2] L. Mowbray: *Fauna Bermudensis*, i, 1931, p. 4, 2 plates; see also William Beebe, *Nonsuch*, 1932, p. 64, frontispiece and plates opp. pp. 77 and 81.

Native Commerce in Oceania*

By FREDERICK D. McCARTHY

ONE of the most vivid impressions that Malaya leaves upon the traveller is the ever-present sight of the natives disposing of the products of their gardens and crafts. Whether the tourist be on a stroll in one of the cities, or on a trip through the rural areas, the industrious Malays will be seen on all sides engaged in this all important aspect of their life.

You might ask why it is so important. One reason is that there is a constant demand from the cities and towns for rice and other foods grown in the neighbouring cultivation areas, mostly of terraced gardens. Secondly, the craftsmen have to dispose of their goods to obtain food and clothing for their families, whether they live in cities or villages. And so, from daylight till long after dark, the roads are lined with a motley stream of bare-footed brown men and women, among them whole families and even hamlet groups, taking their goods to market or bringing them home. Everywhere, too, the appalling density of population has created a grim struggle for existence amongst this prolific people.

In Celebes, transport is done by the men mainly with the aid of their small but tough ponies, which are recompensed for carrying heavy burdens with careful and sometimes affectionate attention; great value is placed upon them because of their intimate relationship to the existence of a family. Here the people are Mohammedans, as in Java, and each organized market is held every fifth day. As each of the larger villages has a market the people are able to attend such gatherings frequently if they so desire, trading being the livelihood of some families. The market-place is chiefly the business of the women, and from dawn one sees them, heavily laden, trudging to the rendezvous. Here their goods are displayed on mats and in baskets in orderly rows, and they enjoy every moment of the bargaining with their customers. They are neatly clad in brightly coloured silk blouses and long batik-patterned skirts, their hair is brushed and oiled, and they wear their finest ornaments.

* See also "The Story of Money", *Australian Museum Magazine*, V. 11, 1935, pp. 386-93.

(Photographs by the author.)

Section of a large market in Bali. The fruit is displayed in well made baskets which the women carry on their heads—this custom gives them a graceful carriage and poise throughout life.

A group of women selling fruit on the main street of Djokjakarta, Java. Note the shoulder sling for carrying the basket used by the woman walking along the footpath.

In Java there is an unbroken stream of natives passing each way along the roads and tracks leading to the markets. The men carry tremendous loads in the Chinese fashion, with two large baskets hanging from a pole slung across their shoulders. Though of small stature, their steel-like muscles stand out on their well-developed bodies, and they move at a jog-trot. Here, both sexes are always at work, because a large number of families gain their living as vendors in the markets or as pedlars. The men wear white cotton shorts, a shirt which is usually flapping wide open to cool their bodies, and a large straw hat. The women have a neater appearance, and throughout these islands their carriage is upright and graceful, due to their training from childhood to carry burdens on their head.

The goods on sale display an imposing array of native foods and crafts. There are so many varieties of fruits and vegetables that a selection of them must be difficult for a coolie with only a few cents to spend. The markets are permeated with the strong smell of the spiky durian, the taste of which, however, is delicious. The kinds of fruit and vegetables appear to be unlimited, and among them are mangoes, coconuts, pawpaws, bananas, taro, yams, nuts and berries. Another strong aroma comes from the many species of fish, particularly the small fry and prawns set out on large trays; fishing is an important industry along the coasts, river and lake shores, and the fishermen sell their catch immediately on landing to buyers who send it by fast runners to distant markets. In

A busy day for the men at a fruit and vegetable market in a village near Batavia, Java, where the baskets are carried on a shoulder-pole.

A pedlar of Makassar, Celebes, with cool drinks and syrups for sale.

the latter places, too, one sees clay pots of all shapes, beautifully formed and burnished, colourful baskets of all sizes, hand-woven cloths of exquisite workmanship and design, steel tools and gardening implements produced in the native forges.

Prior to World War II, throughout the Netherlands East Indies, the native markets were flooded with cheap goods of Japanese and European manufacture, mostly from the former country. As a result, native cloths, tools and ornaments were being rapidly replaced by foreign products, and many of the native craftsmen depended upon the tourists for their livelihood rather than upon their own people. Even in the country districts this transition was apparent, and the large range of European sweets, household goods, drapery and ornaments on sale was beginning to make the native markets more like an out-door chain store. As most Indonesians lived on from ten to twenty cents a day ruling prices were very low.

A large number of food vendors, with various delicacies of intriguing shapes and colours cooking on their little portable stands, are always present in the markets, and they have a steady stream of customers. In the cities, also, and along the highways, these travelling restaurants are numerous. Beside the roads are numerous stalls, often tended by girls and their mothers, all chewing areca nut and lime, and selling food to hungry travellers. I remember well in Jokjakarta the large number of groups of women seated in laneways, and even on the footpaths of the main streets, with their baskets of food for sale.

In the very big markets in Makassar, Batavia, Bandoeng, and other cities, the natives have permanent stalls along narrow lanes, and on market days the crowd is immense.

The Sea Gypsies constitute a most interesting group of people who live by trading from island to island in their proas, spending months at a time away from their island colonies.

In passing it is of interest to note that the European tourist has had a most stimulating effect upon the craftsmen. The tourist is keen to take home a souvenir, such as an example of brass or silver work, a piece of woven cloth or batik, a wooden carving, or a painting, and these were produced in large numbers in the cities. Many of the curio seekers bargained with the native to the last cent, their attitude being that the native would over-charge them anyhow. Actually, the native raised his price for this very reason, and allowed himself to be beaten down to a price which still showed him a good profit; he enjoyed haggling and usually managed to effect a profitable sale. In Bali, to expand their market, the wood-carvers produced a modern development in plastic work of a highly original and purely

Balinese nature; they applied their painting skill, due to the interest of European artists residing on the island, to paper and effected a remarkable art based on traditional designs upon objects of European shapes, and in many other ways adapted their skill in precious metals and gemstones to the demand of the tourist. Thus in Indonesia one sees the natives living their traditional life in the rural districts, and in the cities an existence adapted to, and part of, the changed economic conditions imposed by the Dutch in their development of the archipelago. In the markets this change is also apparent.

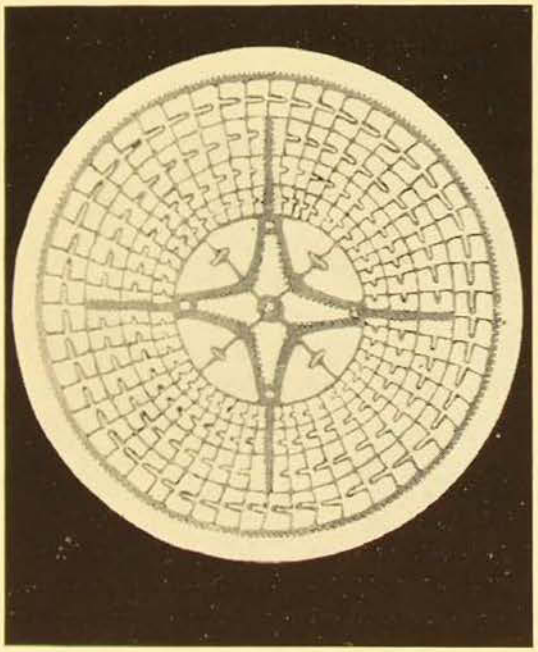
(To be concluded.)

The Solomon Islands' Ndala

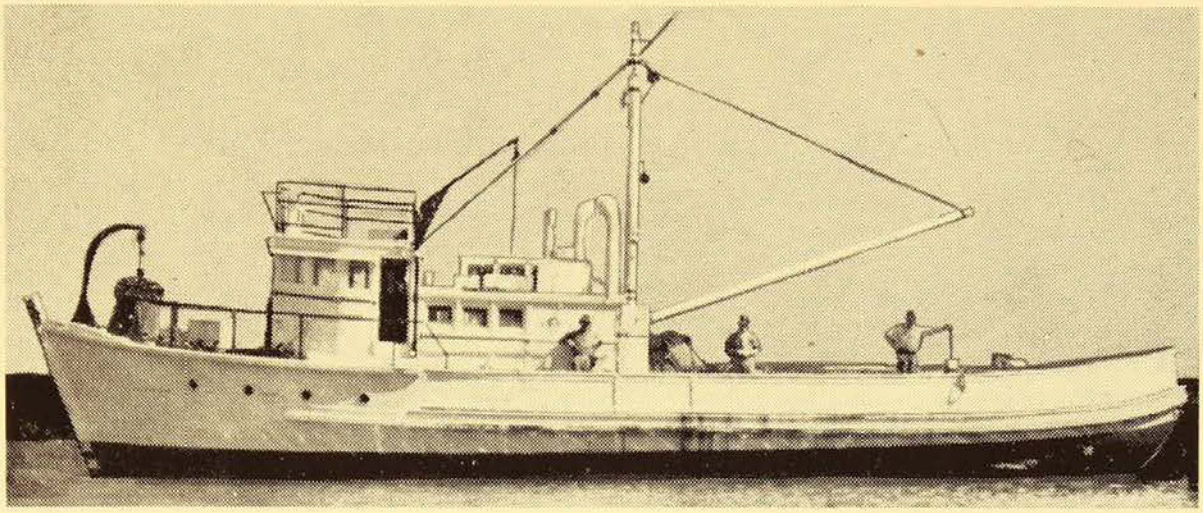
THE two accompanying photographs are from Mr. Roger Duff, of the Canterbury Museum, who, upon reading the article on Melanesian Kapkaps by Mr. F. D. McCarthy in the last issue of this MAGAZINE, in which it was pointed out that the method of making these delicate turtle-shell filigree plaques was unknown, wrote:

"I am pleased to supply the following information, which was obtained from a New Georgia Island chief named Kati Rengoso of Marovo Lagoon, about this ornament in the Solomons. It is called *Ndala* and is primarily ornamental in purpose, but as a fair barter is demanded for such ornaments they are usually obtained by men of rank whose wealth can be gauged by the number of *Ndala* they possess. The *Ndala* were made in secrecy by hereditary experts, each of whom jealously guarded the details of his own technique. The last craftsman on New Georgia Island who could make them lives at Marovo Lagoon, but he is now blind and unable to carry on with his skilled craft. The secret of the fine fretwork designs displayed on the turtle-shell plaques is that the pattern was cut by passing fibre or fine rattan saws through small drilled holes. A high degree of control was necessary to cut the complex and delicate patterns."

[In the forementioned article Tahiti was given in error for Marquesas as the only Polynesian locality for these ornaments.—EDITOR.]



On the left is shown a fine Ndala head ornament from Kumbokata village, Romongo Island, recently acquired by the Canterbury Museum, Christchurch, New Zealand. The old man on the right, decorated with white lime marks on his body, is from a village on the nearby Vella Lavella Island, and is wearing a Ndala on his forehead as is usual in the Solomons.



The "A. R. McCulloch", 66 ft. Danish Seine Vessel, Commonwealth Fisheries School, Cronulla.

[Courtesy of *Fisheries Newsletter.*

"For Their Work Continueth"

THE names chosen for two new training vessels for the Commonwealth Fisheries School for ex-servicemen at Cronulla, New South Wales, commemorate two pioneers in research on Australian fish and fisheries whose work will be an inspiration to new generations. The April issue of the *Fisheries Newsletter* announces that a 75-ft. trawler has been named the *H. C. Dannevig,* and a 66-ft. Danish seiner bears the name *A. R. McCulloch.*

Harald Christian Dannevig was the founder of fisheries research in this Commonwealth. He was born in Norway about 1860, came to Australia in 1902, and was appointed Director of Fisheries in 1908. He planned the Federal Investigation Vessel *Endeavour* and directed its unequalled discoveries of trawling-grounds in Australian seas. He went down with his ship when the *Endeavour* was lost without trace in December, 1914.

The fishes and other marine animals collected by the *Endeavour* had been sent to the Australian Museum for sorting, preservation, and study. Here a young Australian, Allan Riverstone McCulloch, worked with astounding energy and thoroughness to classify the fishes. McCulloch, who died at Honolulu in 1925 at the early age of forty, was one of the world's leading ichthyologists and his check-lists, *Endeavour* reports and numerout scientific papers (often illustrated by his own beautiful drawings) are the foundation for all future workers who realize that accurate classification of species is the only reliable basis for scientific development of fisheries resources.

The many friends of Allan McCulloch and his colleagues at this Museum were very touched by the fine tribute paid by the C.S.I.R. Division of Fisheries in naming the research and training vessel after him, the compliment being all the more admired because it was based not so much upon personal knowledge of McCulloch himself, but in appreciation of his monumental and enduring labours.

—G.P.W.

Bivalve Shells of a Tidal Flat

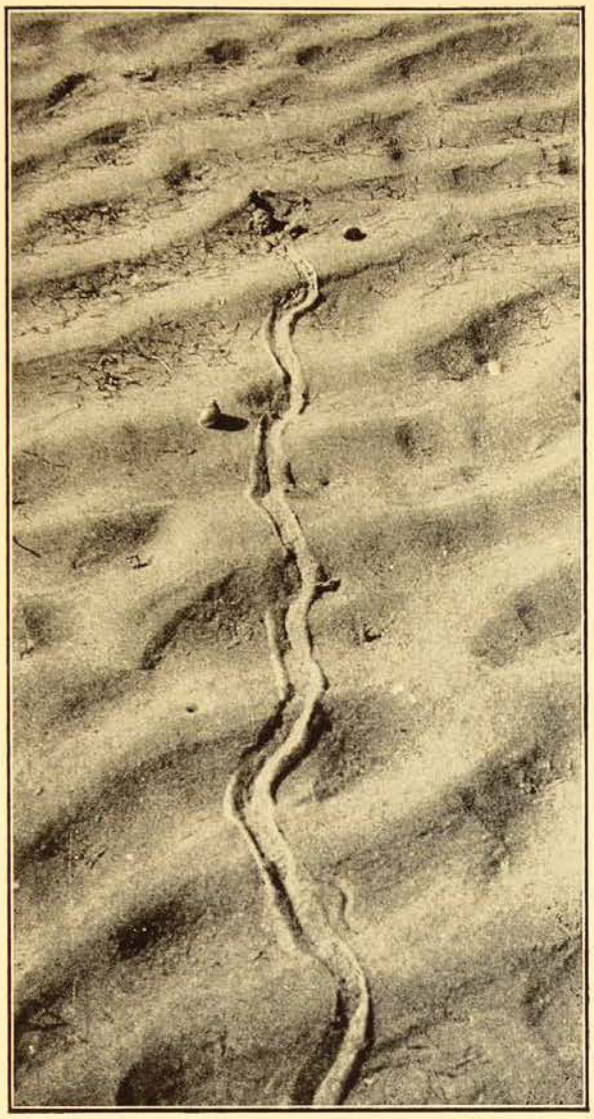
By JOYCE ALLAN

ON first sight, the tidal flat, with its muddy acreage, calm waters, and long stretches of flattened ribbon weed or eel grass (*Zostera*), presents to many observers a rather unattractive, uninteresting appearance. To them, the constantly moving, oxygen-charged surf crashing on rocky shores, or the long expanse of sun-baked, sandy, ocean beaches offers more attraction, but to the nature lover the tidal flat is a place of constant interest. This region is totally unlike the rocky shore or the sandy ocean beach; there is a difference in the type of weed growth, and a totally different animal population.

The turbulent surf of the rocky shores has been replaced gradually by calmer waters; the sand of ocean beaches has changed to a more loosely packed, sandy mud which, as you proceed far up towards mangrove forests, merges into "quicksand" mud, black and uninviting. Only the keen naturalist interested in the rather peculiar life associated with mangrove regions, and the ardent photo-

A section of one of the large cockle beds of Gunnamatta Bay, Port Hacking. The cockles in the foreground are struggling for existence against the encroaching sand, which, by a trick of the tide, has trespassed on their domain.

Photo.—A. Musgrave.



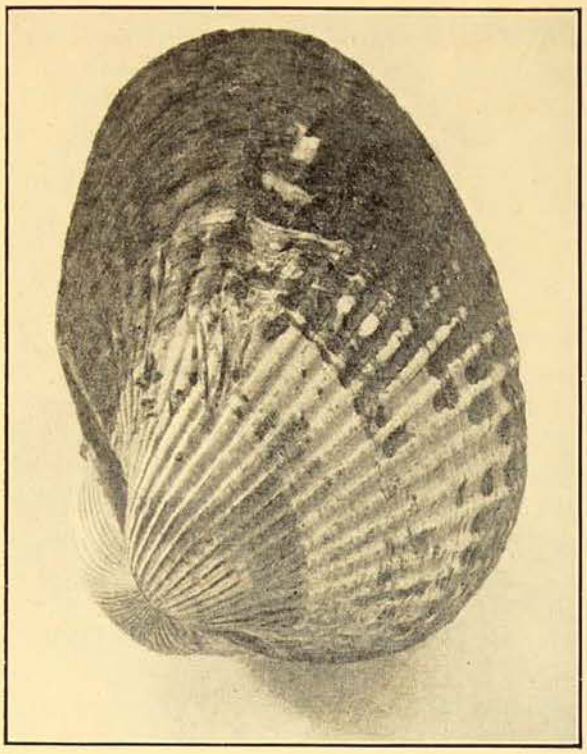
Tracks of sand snails are usually in a maze. Solitary ones, as this, are occasionally found. This one is deeply furrowed in soft sand, the eruption at the end indicating where the snail has gone below the surface. Two examples of the snail are ranged by the side of the track.

grapher, are prepared to contend with the slushing, slithering, and sinking, that usually must be tolerated if the mangrove life is to be seen. Normally, few wander up estuarine waters, beyond the typical tidal flat frequented by fishermen.

With this change from rough to calm waters, from a sandy substratum to sand intermingled with mud, and finally loose, black mud, conditions for marine life have changed noticeably. The strife and bustle characteristic of the rocky shore, for instance, is not so conspicuous; the need for quick, deep burrowing—except in a few instances, where the burrower inhabits the sandy banks, which at intervals occur throughout the flat—is not so urgent. Belts of eel weed form a thick carpet and ensure shelter for many, and also provide an excellent depository for eggs during the spawning season. This replaces the kelp, bead weed (*Hormosira*) and smaller weeds characteristic of the rocky shore and off-shore waters. Detached pieces of these, however, are frequently washed in by the tides and left on the flat, and smaller pieces may be found attached to cockles, etc. Generally, the marine life is able to sink, rather than burrow, in the soft sand-mud.

The tidal flat is an intertidal zone, that is, it depends for its depth on the rise and fall of the tide. As the tide goes out it lays bare the flat. Numerous gulls appear from almost nowhere, and gracefully move over the flat, or swoop down suddenly to snatch a fish from one of the many little streams of water left behind by the tide. Nipper prawns make a peculiar and incessant "clicking" noise, cockles open and close their strong valves, and there is an undercurrent of soft rustling sound made by hundreds of crabs moving to or from their burrows, or feeding on the water line.

There are so many tidal flats within the bays, harbours and inlets along the Australian coast, that everyone should be familiar with their appearance. Several excellent ones occur near Sydney, for example in Pittwater and Brisbane Water and in Botany Bay and Port Hacking, south of Sydney. Within Sydney Harbour there are a number in the region of The Spit and upper reaches of Middle Harbour, and along the Parramatta and Lane Cove Rivers. One of the finest tidal flats near Sydney is situated at Gunnamatta Bay, in Port Hacking, where an extremely large area of weed-covered flat is exposed during each fall of the tide. As a collecting ground, this frequently provides some unexpected treasures, and a seasoned collector knows that although many trips may prove unprofitable, there is always the possibility of some rare specimen coming to light there, or that



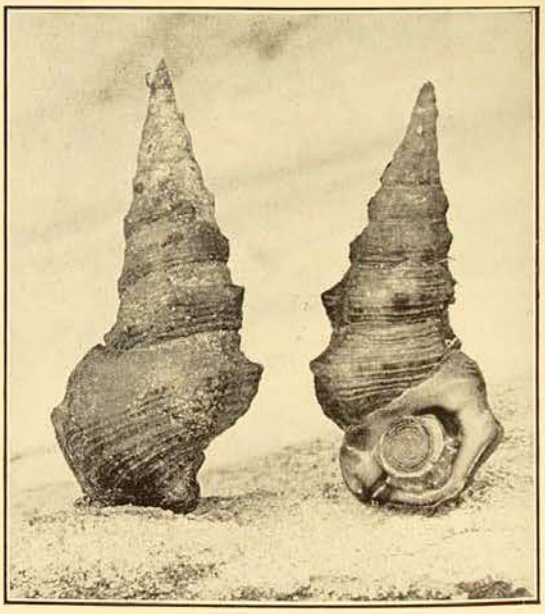
The Sydney Cockle (Barbatia trapezia), about three-fourths natural size. Note the swollen form of the valves, and some surface scars caused by the roots of a seaweed.

some interesting ecological problem will present itself.

On approaching a tidal flat, a stranger becomes conscious of peculiar ripple-like marks left on the sandy mud by the retreating tide, and the many tracks and furrows made by burrowing Sand Snails, and the Hercules Club shell, or Mud Whelk. Together with the Sydney cockle, the latter is one of the commonest inhabitants of the tidal flats round Sydney. Hundreds of this solid, dark brown shell lie about on flats and are found as high up as the mangrove regions of estuaries. Near the Sand Snails may sometimes be seen their extraordinary, collar-shaped, sandy egg-structures.

In late spring and early summer, or even later in the year, at low tide a considerable number of egg-structures of one kind or another are exposed on the tidal flat. Those of the molluscs are predominant. Apart from the collar girdles of Sand Snails, the most conspicuous are usually the tangled masses of string-like, gelatinous egg-girdles of the common Anderson's Sea-Hare, which are attached to weed or mud by one end of a thread. This sea-hare, unlike its graceful, swimming relatives of the rocky shore zones, crawls about on a broad foot, or as the tide retreats, sinks down in the loose sandy mud. Often, the only indication that one may be present underfoot, is the sudden staining of the nearby ground with a magenta-violet fluid, where the foot has trodden. This has been ejected by the sea-hare from a special gland in its body, and is a somewhat similar fluid to the sepia-toned one ejected by squids, cuttle-fishes, and octopods.

The typical bivalve of the New South Wales tidal flats is the Sydney Cockle. This shell has replaced the "pipi" of the ocean sandy beach, the bivalve population of which was discussed in a previous number of this Magazine (*Australian Museum Magazine*, Vol. ix, No. 1, 1946). As the tide retreats from high to low water, hundreds of these solid, boat-shaped, ribbed shells lie exposed on the muddy sand, or sunk for a greater part of their length below the wet surface, often with a tuft of weed attached to their uppermost end. More often, as the length of time for which they are exposed increases, they are noticed lying on the

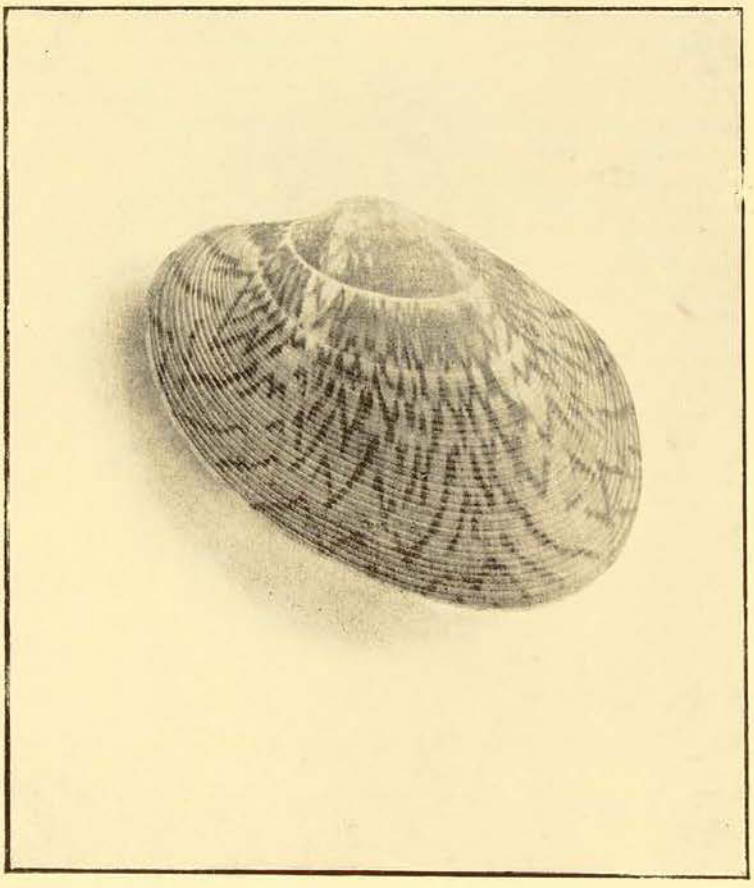


The Hercules Club Shell or Sydney Whelk (Pyrazus herculeus). About two-thirds natural size. Its structure is solid and nodular.

flat with the valves gaping open. In the early days of the settlement, these were greatly favoured as food by the blacks, as may be judged from the large masses of bleached cockle shells found in their ancient feeding grounds along the coast.

Some of the tidal flats in the vicinity of Sydney were unusually barren of marine life during the very low tides of last spring. Where a similar occurrence was noticed along the rocky shore, within the harbour, this was attributed to the presence of oil from increased shipping activities in recent years. This, however, was not the case with the tidal flat life. It was particularly noticeable at Gunnamatta Bay, yet at that time the weed growth was more abundant and healthy than it had been for some years, giving the impression that it would yield a varied and abundant fauna. On turning over large stretches of the weed, nothing came to light, even the absence of molluscs' eggs, which are usually a feature at that time of the year, was marked, and only a comparatively few Sydney Cockles were noticed over the entire flat. During the summer months, there was an unusual absence of well-known shells, but with the approach of autumn both eggs and shells became more conspicuous, and during the latter part of April and in May the flat became almost as thickly populated as in the past good seasons. Some unknown cause apparently delayed the spawning season, during which the molluscs usually appear in shallow waters. At intervals over a number of years, areas exhibit a barrenness such as this. Sometimes it is even possible to trace its cause—the presence of oil along rocky shores; an unusual influx of mud; the presence of microbes in the water; and so on. In this instance there appeared little change in the appearance of the flat to justify the unusual absence of marine life, or its later appearance.

A handsome, large bivalve shell which is frequently found lying on the flat when the tide goes out, but which normally lives a short distance below the surface of the sandy mud, between mid and low



The Tapesty Shell (Paphia turgida). From the delicately traced pattern the vernacular name originated. Natural size.

tide level, is the honey-coloured Tapestry shell. This is a favourite food of the octopus. A most amusing sight is to see one of these many-armed creatures settle over the surface where a Tapestry shell is buried. With an extraordinary "scurrying" movement of its arms, much puffing from its funnel, and the scattering of sand in all directions, it suddenly drags from the mud a strongly resisting shell. Without any more ado it scrambles away to its "nest", with the shell clutched tightly in its sucker-studded arms. Round the nest, or burrow, of the octopus can be seen mounds of empty shells, evidence of past meals. The cockles and other shells, the product of many nocturnal visits to the flats, form a rampart round the nest and serve as a protection.

Many single and double valves of the Tapestry shell, as well as those of the tidal flat pearl shell, the Scallop or Fan shell, and the Cockle, are favourite positions for the deposition of its eggs by a small fish, the Blenny (*Dasson steadi*).

Review

SOUTH AUSTRALIAN SHELLS. By Bernard C. Cotton (South Australian Museum, Adelaide, 1946). 8vo, pp. 8, 6 half-tone plates. Price 1s.

UNTIL a few years ago there were practically no popular writings dealing with Australian shells available for the use of the amateur conchologist, although there were the usual check-lists and scientific works for the use of the trained research worker. The Australian shell fauna is so large and, comparatively speaking, so little of it known, that most of the written work was necessarily of a purely scientific nature, and not helpful to the beginner anxious to commence the study of conchology.

It is only during comparatively recent years that, by popular articles and a few small booklets, this information has been coming gradually before the public, although the demand for it has been incessant.

Mr. Bernard Cotton has now presented a small booklet dealing with South Australian shells. This will be a considerable help to the beginner and the more informed amateur in identifying the common shells found in South Australia. As, however, many of these occur in other parts of Australia also, in particular its southern regions, it will be of interest to shell lovers as a whole.

A very short general account of shells is given, but wisely Mr. Cotton has concentrated in presenting as many illustrations of the common shells as possible, one hundred and seventeen of which are illustrated by Miss Gwen Walsh. In placing the popular and scientific name, and a short note of each species, opposite the respective plate in which it appears, Mr. Cotton has made identification of the shells a simple matter. Apart from its quality, the modest price should ensure its popularity.

J.A.

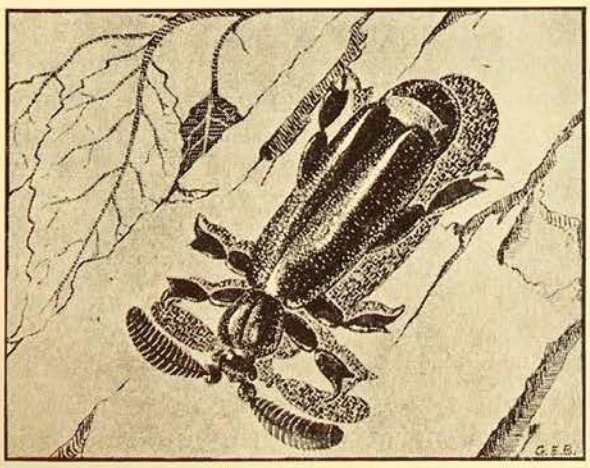
Australian Insects. XXIX

Coleoptera 6—Paussidae, Cupidae, and Rhysodidae

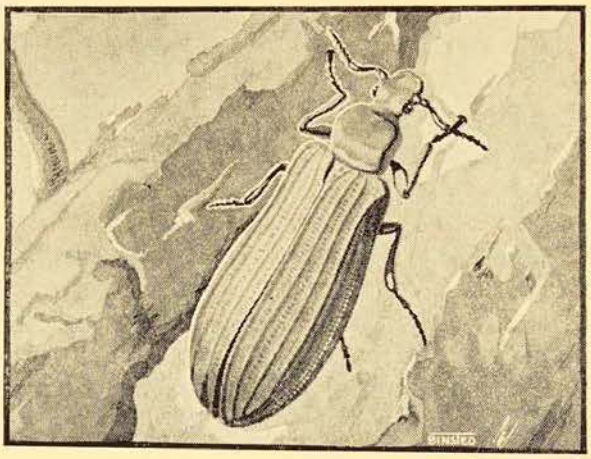
By KEITH C. McKEOWN, F.R.Z.S.

THE three familes of beetles discussed in this article of the series dealing with Australian Insects—the Paussidae, the Cupidae, and the Rhysodidae—are very diverse in appearance. They have—regrettably—one feature in common, and that is the almost complete absence of details concerning their life-history and habits. This lack of information is not confined to Australia, but seems to be common to all countries in which they occur; we are, therefore, unable to glean anything from them that might throw light on our own problems.

The Paussidae are really remarkable in appearance on account of their extraordinary antennae—their outstanding character—which are expanded into broad, flattened plates. These apparently consist of ten segments, but, actually, there are eleven; the small, rounded basal joint being concealed in the margin of the first of the series of flattened plates. Some sixty species of these remarkable insects have been described from Australia, but in individuals they never seem to be plentiful. They are sometimes to be found perched on the tops of fence-posts, or they may be attracted to lights at night. By day they are sluggish, and hide under bark or in the nests of ants.



One of the strange Paussid beetles (Arthropterus westwoodi), widely distributed in Australia.
G. E. Binsted, del.



The largest of our species of Cupidae—Omma stanleyi.
G. E. Binsted, del.

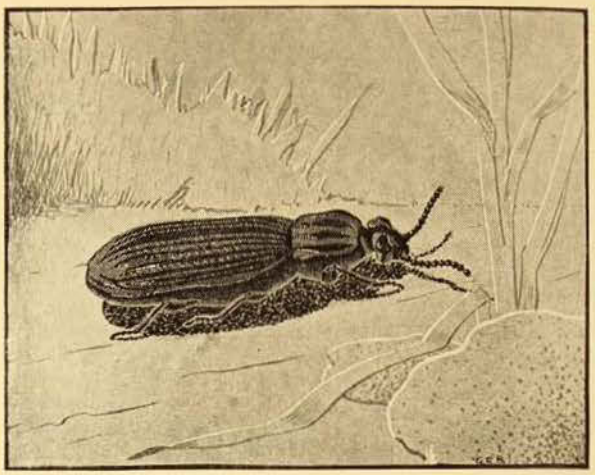
A. D. Imms, in his "General Textbook of Entomology", writes that "According to Wasmann the antennal development is correlated with the growth of a glandular exudatory tissue which produces an aromatic secretion. This tissue is found not only in the enlarged antennal joints but also in the body-wall of the head, prothorax and apex of the abdomen. Its positions are indicated by the presence of tufts of yellow hairs or groups of cuticular pores which facilitate the diffusion of the secretion. The latter is eagerly licked by the ants off the bodies of their Paussid inquilines, who are thus enabled to make a return for the hospitality they receive". Whether the relations between beetle and ant are wholly amicable is doubtful—the beetle, or its larva, may carry out the duties of a scavenger and sanitary inspector in the nests of the ants but, on the other hand, it may prey upon the larvae of its hosts—a not unusual habit with some ant "guests". We do not know. The larva of a Paussid somewhat resembles that of a carnivorous Carab Beetle.

In connection with their association with ants, H. J. Carter wrote of the

Paussids: "Sloane quotes a letter from C. Oke: 'One from Eltham taken in nest of *Iridomyrmex rufoniger*. The pair from Bendigo were obtained under a fairly large stone, well embedded in a nest of *Campanotus claripes*, being the only ones I have found in association with ants.' Lea reports *A. brevis* in nest of *Ectatomma metallicum*, and *A. angulatus* Macl. taken at Bowen by A. Simson in an ant's nest. Mjöberg found *A. piceus* West. on trunks of trees at night. Westwood records *A. hopei* as found at Port Phillip under bark and dried cowdung. Sloane says: 'I have only found *Arthropterus* under logs or at light in the evening'. In my own (H.J.C.) experience all the species captured have been found under bark, logs or stones, without apparent association with ants or termites. They are often concealed by the colour likeness to the background or by the inequalities of the surface of logs. I have found the common Sydney species, *A. brevis*, in small colonies under bark of Eucalyptus." This information, although not very enlightening, is given for the benefit of those who may have opportunities of pursuing the question further, and of discovering something of the lives and habits of these strange insects.

All the Australian Paussids are brownish in colour, and their accurate specific identification is often difficult. Most of our species belong to the genus *Arthropterus*. Perhaps the commonest form, found around Sydney, is *A. brevis*, Westw., while *A. westwoodi* Macl., about ⅜-inch in length, appears to be comparatively numerous and widely distributed, occurring in New South Wales, Queensland, Victoria and South Australia. The illustration of this insect gives a good idea of members of the family. *Megalopaussus amplipennis* Lea, from Queensland, is the largest of our Paussids, and measures about half an inch in length.

Only three representatives of the Cupidae are known from Australia; all of them somewhat slender, brownish insects with deeply and regularly sculptured elytra. The larva of *Cupes* is a borer in wood, and it is possible that those of the second genus, *Omma*, may have similar habits. That appears to be the sum of our knowledge of these beetles. Observation is urgently needed to provide the basic details of their life-histories and habits.

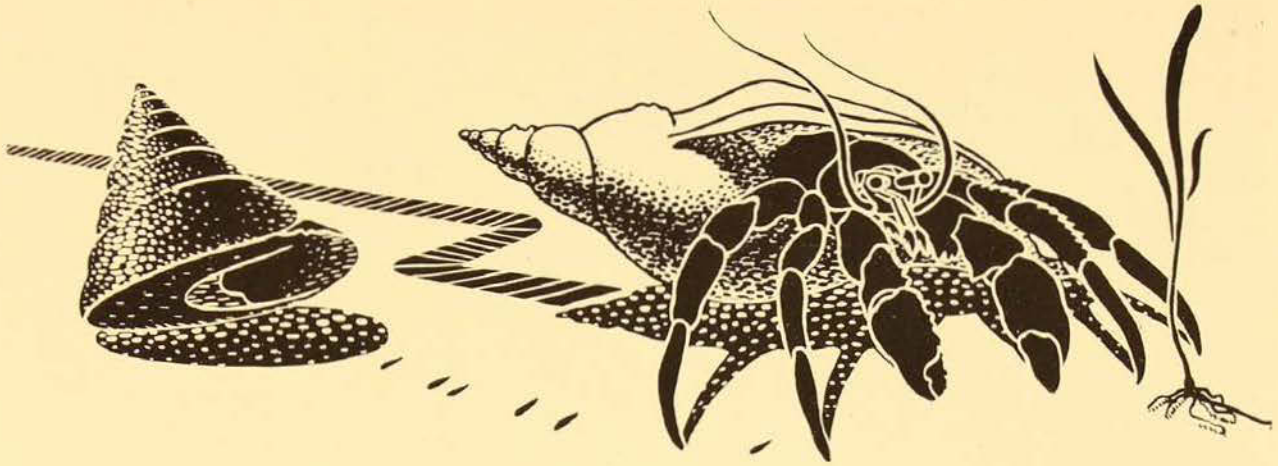


A typical member of the family Rhysodidae, Rhysodes abbreviatus. Little is known of the lives of the Rhysodids.
G. E. Binsted, del.

Omma stanleyi Newm. is the largest of our species, measuring under an inch in length, and appears to be the most numerous. I have seen specimens from both New South Wales and Queensland. This is the species selected for illustration; the picture gives a far better idea of its appearance than any long and detailed description. *O. mastersi* Macl. and *Cupes varians* Lea are much smaller.

Eight species of Rhysodidae are known from Australia—all belonging to the genus *Rhysodes*. They are narrow and slender in form, blackish, and with the thorax and elytra strongly and strikingly sculptured. The number of joints in the foot—the tarsal formula—is usually given as 4-4-4, but in all known Australian species it is 5-5-5. Both the adult insects and their larvae are found in rotting trees and under bark, but nothing is, however, known as to their life-histories. It has been suggested that the larvae prey upon those of other insects which live as borers in timber.

Rhysodes abbreviatus Lea, from Queensland, is illustrated here, and is typical of members of the family. All the species are small, and measure anything from 4 to 8 mm. in length.



The Endless House-hunt

By ELIZABETH C. POPE

IN these days, when newly married couples or home-seeking families spend months and sometimes years looking for new quarters, people will be more in a frame of mind to appreciate the difficulties of the humble hermit crab whose life is one long and tedious hunt for a new and bigger home.

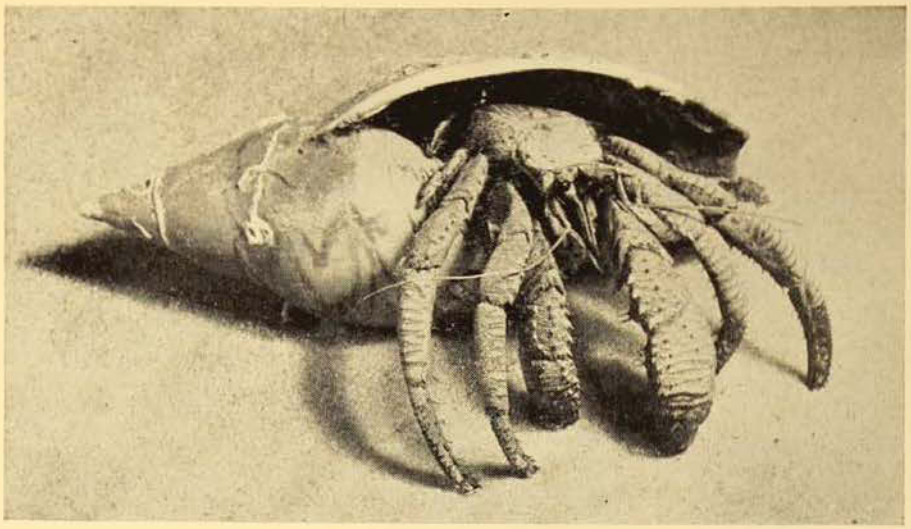
The hermit crab's difficulty is not that it is blessed with an ever increasing family which lives at home, nor is it the fact that his relatives come to stay. It is merely that, as he outgrows his old home, he must replace it with a new and more commodious one, and his troubles are accentuated by his rapid rate of growth.

Most hermit crabs, as everyone knows, have the hinder end of their bodies very soft and vulnerable and, in order to protect this "Achilles' Heel" they insert their tender back portions into something which will protect them—very often it is the empty shell of some gastropod or even a small glass bottle may be called into service. One local crab, *Cancellus typus*, scorns the ready-made homes furnished by the sea snails' shells and prefers to gouge out a hollow in a stone or clinker—an amazing feat for a worker with such feeble tools.

(*Photography by Howard Hughes.*)

At certain seasons of the year, notably in the early summer months, the seashores near Sydney seem to be alive with hermit crabs—especially rocky reefs like Long Reef at Collaroy and Bottle and Glass Rocks at Vaucluse. Here when the tide goes out, in the right season, practically every small boulder covers a large herd of small hermit crabs, for they are very gregarious little creatures. When a rock sheltering a group of these crabs is turned over, one is confronted with the sight of hundreds of small mollusc shells moving rapidly in all directions seeking new shelter. Their pace is too fast for molluscs and, though one can not always see the small bright eyes and nimble little legs of the hermits, one can pick out at once which shells are not occupied by their original owners because of their activity.

Hermit crabs are the clowns of the seashore community, but their funny antics and amusing little ways can only be appreciated when they are housed in an aquarium and watched for some time, or when one dons under-water glasses or uses some similar device to watch them in their natural habitat. One minute they are as bold as a dog barking at an enemy through his own picket fence. The



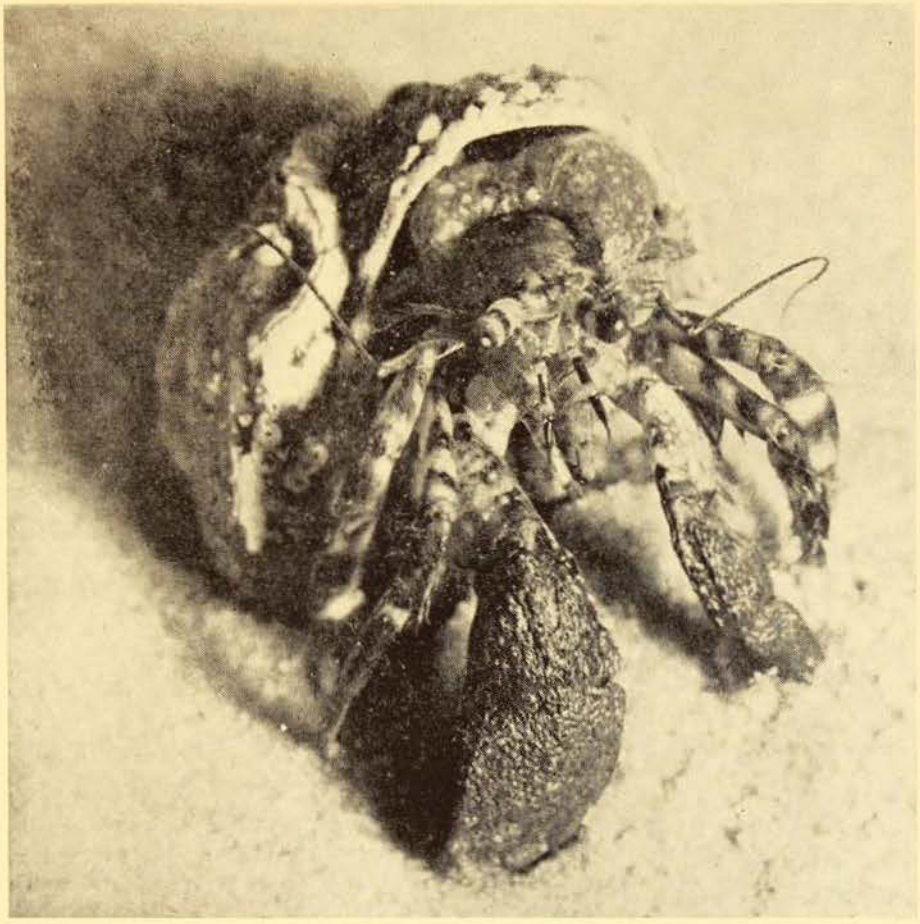
Dardanus arrosor, a hermit crab commonly brought up in trawls on the coast of New South Wales. The shell is 7½ inches long.

next minute some passing shadow scares them and they retreat in a craven manner into the fastnesses of their shelly homes, only to emerge next moment and go on with the business of the day as though nothing had occurred.

To see a hermit crab take over a new shell is a lesson in fastidiousness, equalled only by the care with which a not very hungry koala selects the next gum leaf he will eat. On one occasion I placed several hermit crabs which looked a bit large for their homes into a rock pool and then introduced an empty and slightly larger Turban shell into the pool. Soon one of the hermits encountered the empty shell while it was moving around on the bottom of the pool. It passed the shell unconcernedly and then, as though it was an after thought, turned suddenly round and moved the empty shell slightly. When the "empty" did not respond to this treatment in any way, the hermit crab apparently decided to take a big risk and look inside. Very carefully, searching feelers probed round the corners of the new shell, to be withdrawn in haste for fear of some imaginary enemy in the depths of the shell-coils. Seven times these tentative explorations with the feelers were made. Apparently satisfied now that the coast was clear the hermit ranged alongside the empty shell and began the process of changing its home. Its soft abdomen was hastily withdrawn from the old shell and carefully and slowly inserted into the new home, but all was not well! A hasty and precipitate retreat was made to the old home. After a pause the crab, deciding that the bogey was not real, began once more to probe the fastnesses of the new shell. Thinking that the whole rigmarole was to be gone through again, I allowed my attention to wander for a minute or so. When next I looked the hermit was esconced in its new home, as though it had been there a week and I had missed seeing it. The only thing to be inferred was that the final "flit" had been very rapid. A few shrugging movements settled the new house comfortably and the hermit crab walked off apparently thoroughly satisfied.

One would think that after so recent a removal to a new shell that the hermit crab could relax its house-hunting, but apparently the thought of its future need of a bigger and better house so preys upon its mind that it house-hunts all the time. As mentioned above, our hermit crab was confined to the small rock pool and soon, quite naturally, came across its old shell as it moved about. It showed no signs of recognition and investigated the possibilities of its former house just as carefully as it had done its present shell. The new home being the better it decided for the second time to abandon the first shell.

The trawlers operating off the coast of New South Wales bring hundreds of



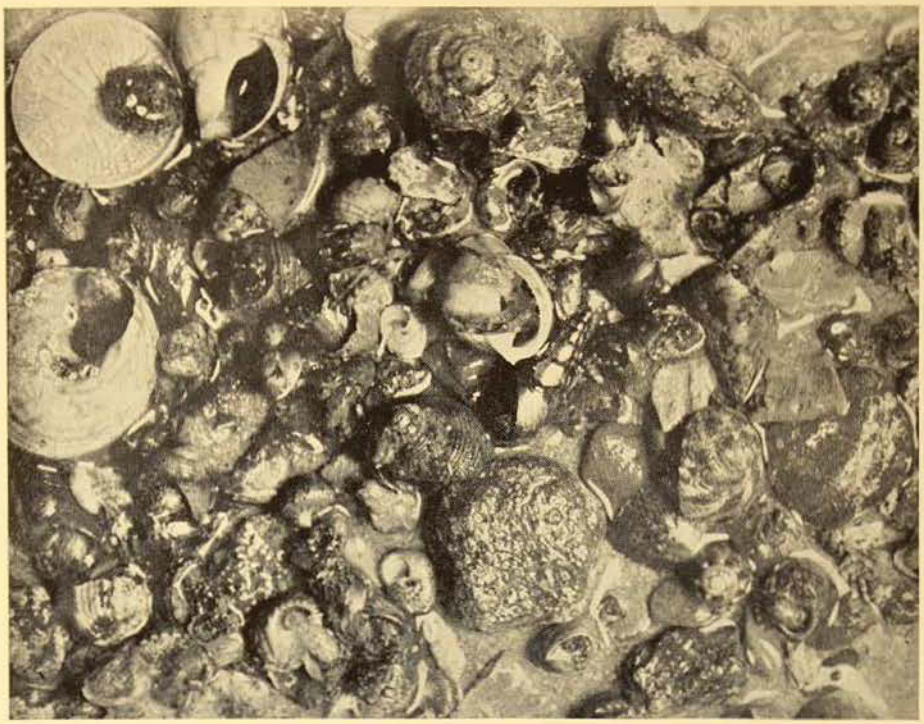
In the summer months during low spring tides one can generally find specimens of the hermit crab, Eupagurus sinuatus. Crab and shell together are two inches long or less.

quite large hermit crabs to the surface in their trawls and it is an amusing sight to see them banging and bumping about clumsily on the ship's deck as they drag their quite heavy shelly homes with them. The common trawled species, *Dardanus arrosor* and *Clibanarius strigimanus*,* are probably the most spectacular ones seen on the New South Wales coast, for their striking red colours are most pleasing to the eye.

On fairly sheltered ocean beaches such as Balmoral in Port Jackson or Seven-Mile Beach near Gerringong one can see another comical little hermit crab called *Diogenes custos* which is very much in evidence when the tide goes out. Many of them favour the rather rounded shells of the sand snails, and as the retreating wave scours the sand of the beach, they are unearthed. They cling as well as they can to the sandy bottom but their grip is of no avail in the shifting sand and their rounded shells go bowling down the slope with the last of the wave. Quickly as possible they dig into the sand again to avoid capture.

The two commonest hermit crabs of the ocean rocky reefs near Sydney are *Eupagurus sinuatus* which fancies Turban Shells as homes and the very much smaller one, *Eupagurus lacertosus*, which occurs in hundreds under boulders near low-water mark. These latter are very numerous in November and subsequent summer months. The shells they favour are mostly the small Kelp Shells, periwinkles and the like. The accompanying illustration will convey some idea of the numbers of hermit crabs which may be seen under one rock. Practically all the shells in the photograph house hermit crabs but most of them have retreated into their shells. A few may be seen poking their heads out of their homes. These latter are all *Eupagurus lacertosus* and their size may be estimated by comparing them with the threepence in the corner of the picture.

* See illustration on front cover.



Underneath boulders on the rocky seashore hundreds of hermit crabs, Eupagurus lacertosus may be seen scuttling about. The two large Turban Shells (top middle and left middle) are occupied by Eupagurus sinuatus and this illustrates the difference in size between the two species.

Another common hermit crab of the rocky coast is *Paguristes squamosus*, which usually borrows a Tent Shell for its house. Its legs bear a characteristic hairy fringe along one edge which is pale brown in colour. The underlying shell of the nipper limbs is pinkish and the spines are madder-brown. Alternating bands of brown and white are seen on some of the feelers and mouth parts.

These are only a few of the many hermit crabs which can be collected on the seashores near Sydney, for they occur in the deeper waters of the harbour or among rocks and even on the wide tidal flats of mud and sand which occur in the upper reaches of the coastal inlets. It is impossible to deal with any but the commoner species in an article of this type and in consequence of this the reader may easily come across a species not mentioned at all here. All hermit crabs will, however, repay observation, for all display comical antics if you watch them long enough.

I am indebted to Mr. G. Binsted for the titlepiece.

Some Butterflies of Australia and the Pacific

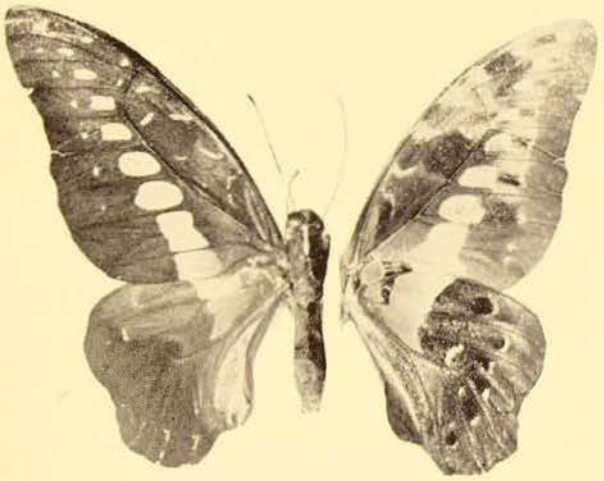
The Swallowtails—VI.

By A. MUSGRAVE

WE conclude this series of articles on the Swallowtail Butterflies of Australia and the Pacific, with the *wallacei*-group, the *macareus*-group and the Genus *Cressida*. At the end of the article will be found a scheme of classification of the Family Papilionidae, showing the sequence of the groups within the family. This should enable the student to understand at a glance the method that has been adopted throughout the series.

The Wallacei Group.

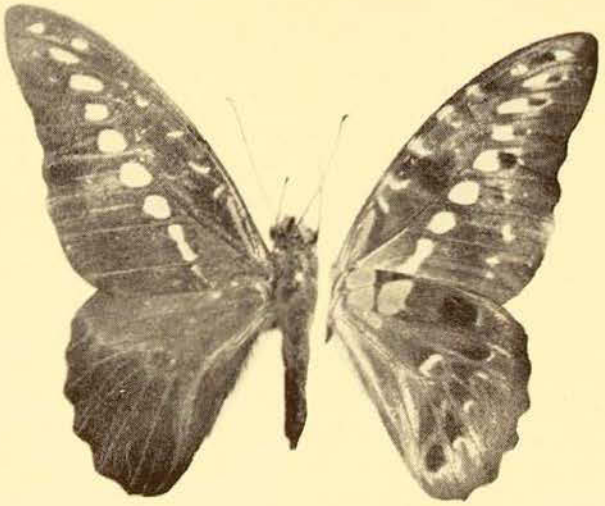
The members of this group are black-brown forms very similar in appearance and restricted for the most part to the New Guinea region.



Wallace's Swallowtail, Papilio wallacei rubrosignatus, from Batjan. Wing expanse, 3 inches.

Wallace's Swallowtail, *Papilio wallacei* Hewitson, occurs in the Aru Islands, Waigeu and New Guinea, specimens being in the Museum collection from the Aru Islands and the Mt. Lamington District, Papua. The wings are black-brown with a silken sheen. In the forewing a green streak occurs at the base of the cell and some small spots lie beyond this, a median band of greyish-green spots extends the length of the wing. The hindwing has the basal half of the wing greyish-brown on the upperside, the underside is paler with a greyish tint, towards the base with a green area near the costal border. In the typical *wallacei* the yellow-green area occupies almost half the cell and extends beyond the red and black spots near the costal margin. No red spot is present near the abdominal margin. A variety or subspecies, *P. wallacei rubrosignatus* Rothschild, occurs in the North Moluccas and specimens are in the Museum collection from the island of Batjan. In this form on the underside of the hindwing a red spot is present before the abdominal margin (dorsum).

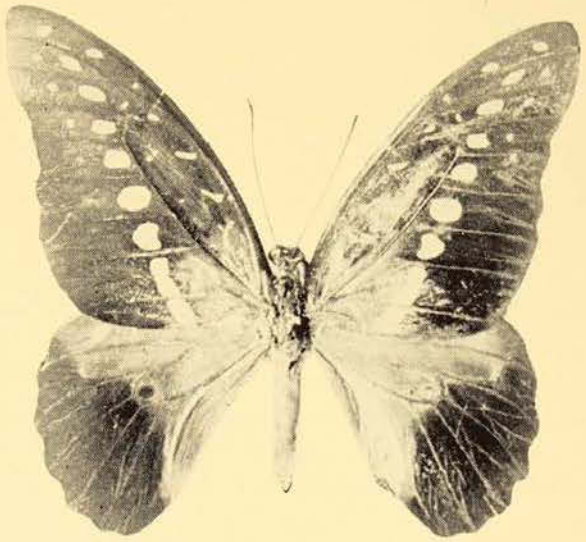
Brown's Swallowtail, *P. browni* Godman and Salvin, called after its missionary-collector, the Rev. George Brown, is found in New Britain. The median band of the forewing is narrow in this form



Brown's Swallowtail, Papilio browni, from Herbertshohe, New Britain. Wing expanse 3 inches.

and the green costal spot on the underside of the hindwing divided in the middle; a red spot placed near the costal vein, the green spot in the cell very small. Two red spots are situated between the cell and the abdominal margin (dorsum).

P. hicetaon Mathew from the Solomon Islands resembles the former, but the median band of the forewing is broader than in *P. browni*, and narrower than in *P. wallacei*.



Papilio hicetaon from Bougainville, Solomon Islands. Wing expanse, 3 inches.

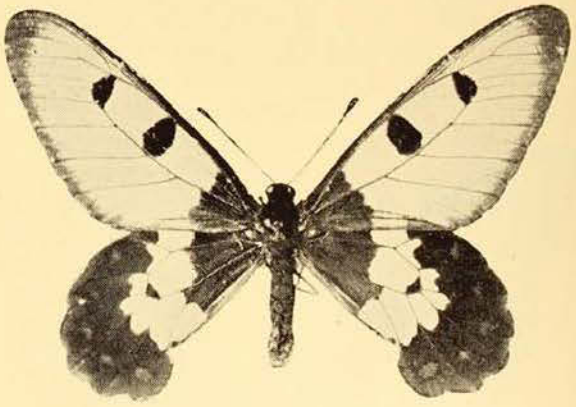
The costal spot on the upperside of the hindwing is almost absent, on the underside the green costal spot extends from the costal margin to the cell only and is margined by a red streak. No green area occurs beyond the red streak such as we find in the other forms. Two red spots are present between the cell and the abdominal margin.

The Macareus Group.

In this group the members of which mimic the Danaid butterflies, the basal colour of the wings is white or greenish while the veins are striped with black, the spaces between the light-coloured stripes (as in *Danaus*) or the space-stripes and the vein-stripes are wanting (those forms which mimic Euploeas). The undersurface of the hindwing lacks red or yellow marks though an anal spot may be present. The group includes two subgroups (1) the *phidias* subgroup in which the only representative, *P. phidias* Oberthür, from Annam, has the hindwing tailed and (2) the *macareus* subgroup, typified by *P. macareus* Godart from Java in which the hindwing is tailless. Eleven species are included in this last subgroup, and of these, *P. thule* Wallace, and its four colour forms occur in New Guinea, Waigeu and Biak Island. The other species are distributed throughout the East Indies. In *P. thule* the abdomen is without a black median line on the underside and the cell of the hindwing is very narrow. The species is extremely variable and specimens do not seem to be represented in the Museum collection.

The Genus Cressida.

In the genus *Cressida* (= *Eurycus*) we have the last representative of the family Papilionidae. The swallowtails of this genus have a larger basal cell, different antennae, the humeral veinlet of the hindwing curved towards the base (not away from it as in *Papilio*).



The Big Greasy, Cressida cressida, male example from Moa (Banks) Island, Torres Strait. Wing expanse, about 3¼ inches.

The transparent-winged *Cressida cressida Fabricius* (= *Eurycus cressida*), the Big Greasy, is represented throughout its range by three subspecies. The typical subspecies, *cressida*, was among those insects captured by the naturalists of Captain Cook's party when the *Endeavour* was being repaired at the site of the future Cooktown, north Queensland, during June to August, 1770. Its range is from Cape York to the Richmond River, New South Wales, though examples have been taken as far south as Sydney.

The male has the forewing transparent with two black spots, a large one in the cell and a smaller one at the apical end; the hindwing has the upper surface black with a series of white spots, recalling those of *P. polydorus*, extending across the wing and an outer row of red spots. The underside resembles the upperside. The female has a rubbed appearance in specimens caught on the wing, and

The Big Greasy, Cressida cressida, female example from Banks Island, Torres Strait. Wing expanse, about 2¾ inches.

resembles the male, the transparent nature of the wings being even more marked only a few scales being present, particularly on the margin of the hindwing; the spots on the underside are pinkish. According to the late R. Illidge[1] when the female first emerges from the pupa it is "really very pretty and exhibits a bright yellow radiance such as is seen in some danaid butterflies from New Guinea and contiguous islands". The life-history has been described by Illidge, and also described and figured by Dr. Waterhouse in his book, *What Butterfly is That?* In the Brisbane district the larvae, according to Illidge, feed on a small trailing *Aristolochia*, thus resembling the forms of *P. polydorus* and the Birdwing butterflies.

CLASSIFICATION OF FAMILY PAPILIONIDAE.[2]

A. ARISTOLOCHIA PAPILIOS.

Birdwings. Genera: *Ornithoptera—Schoenbergia—Trogonoptera—Troides.*

Swallowtails. Genus Papilio: *nox* group, *latreillei* group, *coon* group, **hector* group.

B. FLUTED PAPILIOS.

1. *Mimics of Danaids.*

Agestor group, *clytia* group, *castor* group, **laglaizei* group, **anactus* group.

2. *Non-mimetic forms and mimics of Aristolochia Papilios.*

Demoleus group, *helenus* group, *polytes* group, **aegeus* group, **memnon* group, *bootes* group.

3. *Gloss-Papilios.*

Paris group, *palinurus* group, **peranthus* group, **ulysses* group.

C. KITE SWALLOWTAILS.

**Antiphates* group, *payeni* group, **codrus* group, **eurypylus* group, **wallacei* group, **macareus* group (*phidias* subgroup, *macareus* subgroup).

GENUS CRESSIDA.

* Contains representatives in Australia or the Pacific Islands and which are cited in the present series of articles.

[1] Illidge, R.: Brisbane Butterflies of the Family Papilionidae, Series III, *Q'land Nat.*, 6, 1928, 55-58, pl. iii.

[2] Based chiefly upon that of Dr. K. Jordan, in A. Seitz, *Macrolepidoptera of the World*, Fauna Indo-Australica, Vol. IX (1908-10).

How Fossils Speak to Man

By H. O. FLETCHER

A PERIOD of time equal to that which has passed since the birth of the planet upon which we live is beyond comprehension; it is so vast that it cannot be visualized.

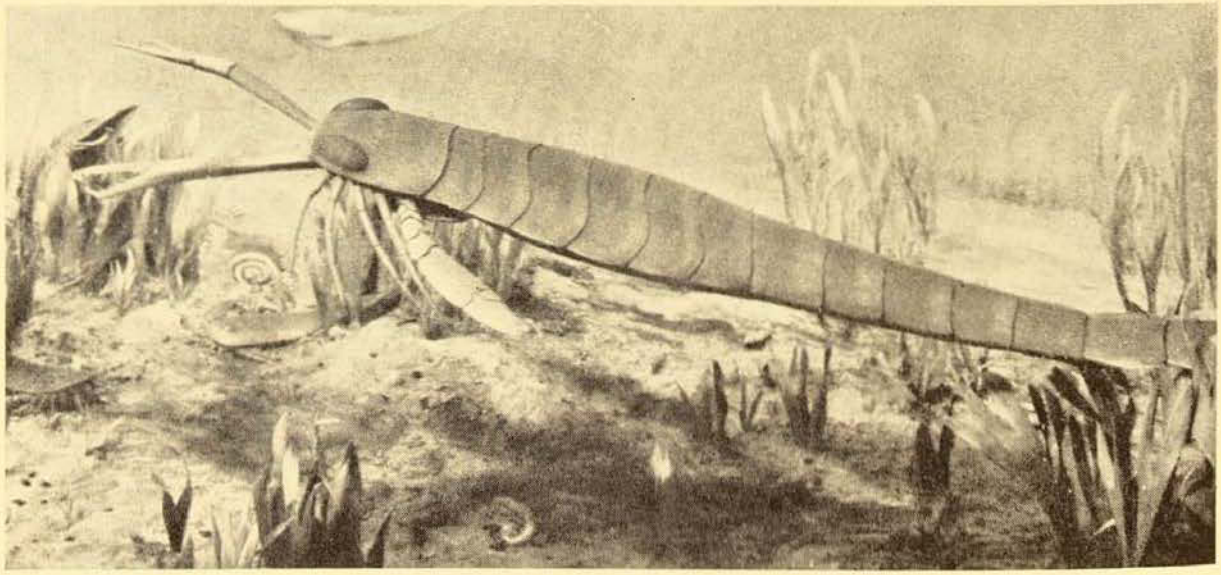
The age of the earth has been determined by a sure method of computing the amount of uranium lead in certain radio-active minerals. These minerals are found in igneous rocks of all geological periods and it is therefore possible to compute the time duration of each period. The grand total is the time interval since the very beginning of the earth and it is estimated at approximately 1,400 million years.

This method of determining geological time is accepted with very few reservations by leading scientists and it can therefore be safely assumed by the layman that the figures are by no means due to hallucinations or to an exceptionally active or fertile imagination.

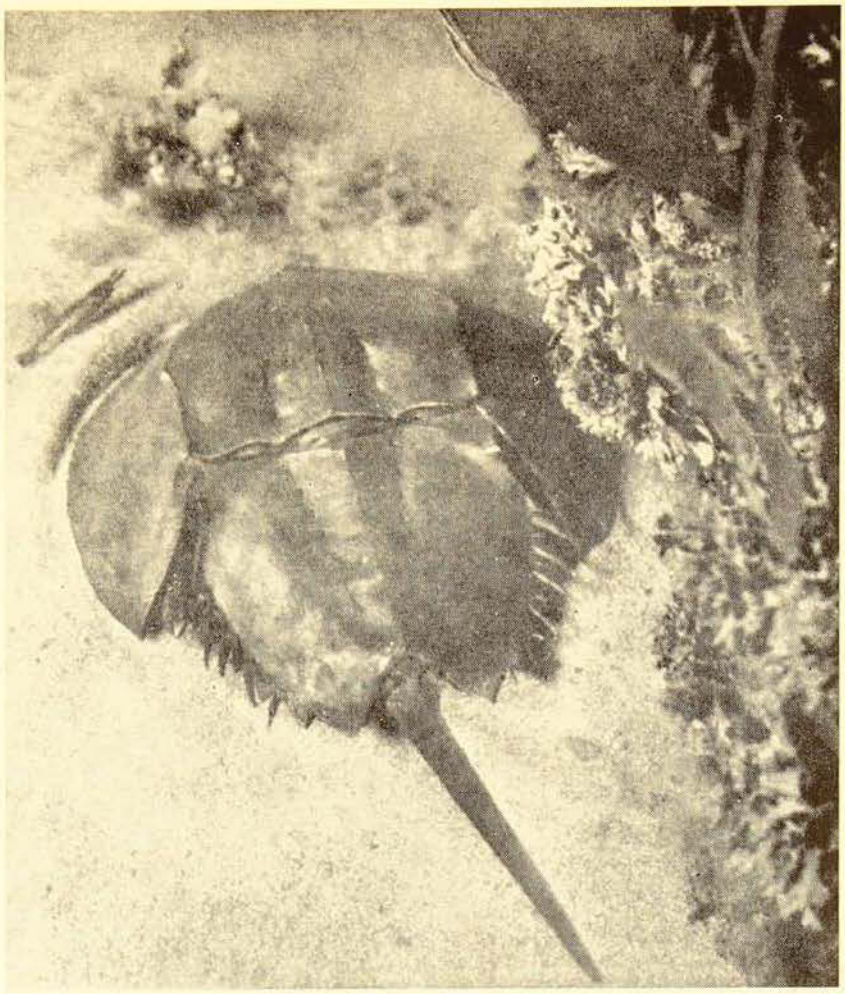
Of the enormous amount of time which has passed since the inception of the earth very little is known regarding the first 700 million years. This period one can see is equal to about half of geological time and is referred to as Archaean time.

All that is known, or rather conjectured, is that for the first 500 million years or so there was no life of any kind on the earth. Although there is no direct fossil evidence to support the assumption that the "Dawn of Life" was during the Proterozoic Period, there remains little doubt in the minds of scientists that this was the case. The days during the beginning of life and for millions of years afterwards are more or less clouded in obscurity.

The earth in Archaeozoic and Proterozoic times, these geological periods constituting the Archaean Era, was subjected to shattering changes of great magnitude.



A restoration of a giant Eurypterid, Pterygotus, which developed great size in Silurian seas. These arthropods grew to a length of ten feet and were possibly carnivorous. (Photograph courtesy Buffalo Museum of Science.)



This remarkable crustacean, the Horseshoe Crab, Limulus, is practically a "living fossil". The fossilized remains of its ancestors have been found in rocks of Cambrian age which were laid down 700,000,000 years ago.

(Photo courtesy American Museum of Natural History.)

An ancestor of the living Horseshoe Crab, Limulus, is Prestwichia, found in rocks of Carboniferous age.

World-wide upheavals due to volcanic outbursts were of frequent and long duration and the outpourings of molten lavas have never since been equalled in geological history. Great igneous intrusions slowly ate their way through the solid rocks of the earth's crust and formed extensive surface outcrops.

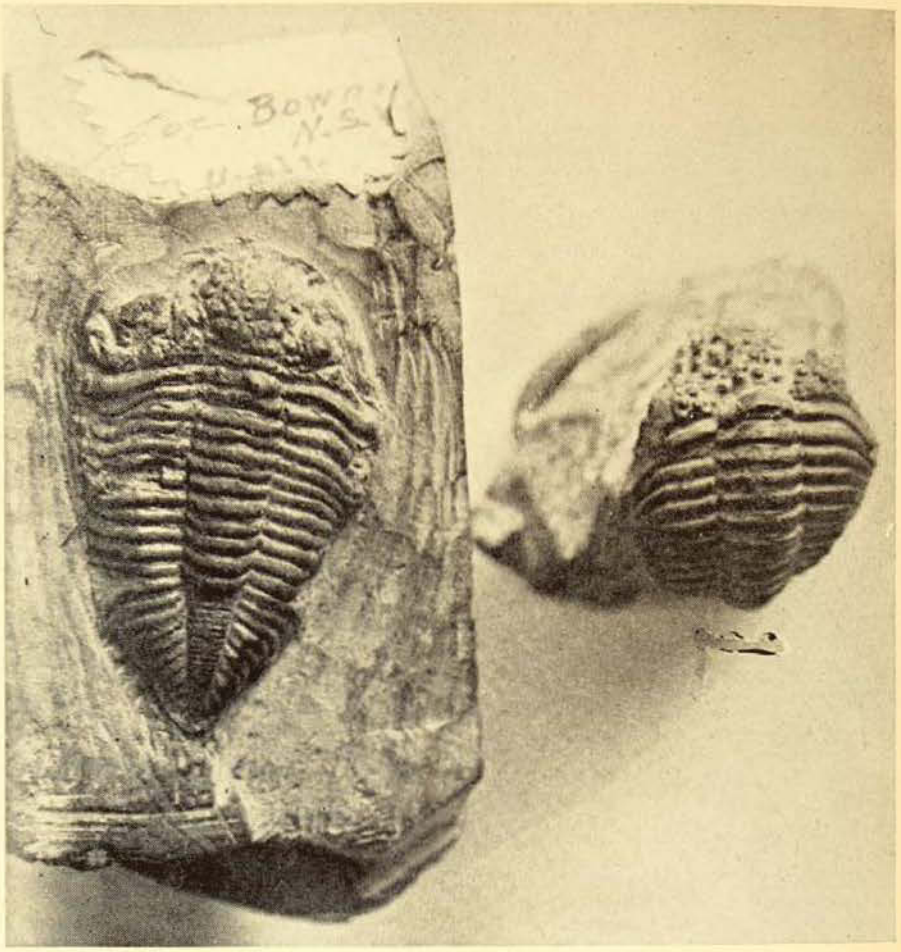
The effect of all these disturbances on the Archaeozoic rocks was naturally a very marked one. Subjected to great heat and pressure they were for the most part recrystallized and in structure were completely changed. The sedimentary rocks were the greatest sufferers and as a result almost all the fossil life which must have been preserved in the later Proterozoic rocks was destroyed.

The close of the Proterozoic saw the beginning of the Palaeozoic Era and we now see revealed in the rocks a well established marine fauna of a variety of forms and prolific in numbers of individuals.

The story conveyed by the fossils of these early days and of later geological periods has made it possible to compound a geological history of the earth almost as complete and reliable and as comprehensive as the history of past human civilizations.

The very oldest rocks of the Palaeozoic era are those of the Cambrian geological period and in them are found the first definite records of ancient life. It cannot be conceded that life began in the Cambrian seas as the complexity of structure and the specialization attained by the many different types of animals is strong evidence against this assumption. The animal kingdom had already gained a firm foothold on life and all the indications point convincingly to a long Archaean history. Evolutional change is always, or at least generally, in the direction of increased structural complexity and this feature is obvious not

The coiled cephalopod shells started out as straight cone-shaped shells in palaeozoic seas. Some forms similar to Orthoceras attained a length of twenty feet.



Silurian trilobites, Encrinurus, found in the Yass district. The joints of the dorsal shield were flexible and the bodies were capable of being rolled up as a means of protection.

only in one but many Cambrian animal groups. Even though the fossil remains of their ancestors have been lost for all time there is no doubt that life did exist on the earth in Pre-Cambrian times.

If it were possible to transfer ourselves magically back to Cambrian days, a quick survey of the earth from one of our newfangled "jet" 'planes would reveal an aspect entirely different from that of today. In the first place the distribution of land and sea was nothing like that we see on the map of the world today. The Australian continent, for example, was not nearly as large as we know it, as the whole of the eastern third was missing. It must have been a strange world, as the land was composed of bare rock with no vegetation and there were no land animals of any kind. Air breathing creatures and land plants did not begin

to develop for at least another few hundred million years.

In the Cambrian seas, however, we would find an interesting fauna, the members of which were flourishing and increasing in numbers until they formed vast swarming hordes.

A large part of this fauna was prolific in a sea which at the present time would cover a large part of the Northern Territory, and with an extension through central Australia actually ranged from the existing northern and southern coasts. The land to the east did not exist in those days, the sediments which built it up being laid down in later geological periods.

The dominant group of animals in the Cambrian seas was the trilobites and in this article it is proposed to deal more with these creatures than with their contemporaries. Our knowledge is gained exclusively from a study of their fossil remains and although immortalized in stone they convey a story of almost unbelievable interest and fascination.

The trilobites constitute a group of extinct marine animals and are related to the stock of the present-day Crustacea. They may therefore be considered as primitive crustaceans and can be claimed by the living lobsters, crabs and prawns as distant relatives. Not many families can trace their genealogy back 700 million years as can these palatable denizens of our present-day seas and estuaries.

Trilobites ranged in length from one inch to slightly more than two feet. They were covered or protected on the dorsal surface by a hard crust or carapace, which is readily preserved in the fossil state, and as a result their remains are easily recognized. The upper surface of the body exhibits a well-defined division into three longitudinal sections from which the name of the Class Trilobita is derived. The body is also divided transversely into three definite areas comprising the head, thorax, and the tail or pygidium.

The majority of trilobites possessed well developed eyes which consisted of an aggregate of facets covered by a thin cornea. The number of facets or lenses varies a great deal in the many groups of trilobites, there being as few as fourteen in some, and as many as fifteen thousand in others.

The central portion of the trilobite body, known as the thorax, is composed of a variable number of segments which are capable of movement upon one another. Trilobites thus were able to curl into a ball like the common garden "slater" of today, an action which was purely protective just as it is with certain animals living at the present time.

On the underside of the trilobite a mouth and mandibles are present, while each segment has developed on it a pair of typical jointed appendages by means of which the creature was able to crawl along the muddy floor of the Palaeozoic seas or to swim freely in the shallow waters.

One scientist, after a detailed study of large numbers of individuals of one trilobite species, observed that they consisted of broad and elongated forms, but otherwise were exactly the same in every respect. He came to the conclusion that the broad forms constituted the females while the elongated forms were the males of the species.

The geological range of the trilobites is an interesting one and they are entirely restricted to the Palaeozoic Era. As mentioned before they were the dominant animals in the Cambrian seas and reigned supreme over the other great variety of inhabitants. The trilobites continued to flourish, but with a slight diminution of numbers through the succeeding Ordovician and Silurian periods. In the following Devonian and Carboniferous times they rapidly decreased until in the early Permian, the closing period of the Palaeozoic Era, they were represented by only a few genera and very soon became extinct.

Their decline and extinction can possibly be attributed to other arthropod or near-crustacean groups containing such animals as the King Crabs and

the arachnid-like Eurypterids. These creatures, together with the giant Ordovician cephalopods and the hordes of Devonian fishes, were carnivorous and no doubt the trilobites formed their staple diet.

In the Ordovician seas cephalopods allied to our "Paper Nautilus" of present-day seas developed elongated shells fifteen feet in length, a size never again attained by any shelled invertebrate.

The group embracing the King Crabs has a geological history which ranges from the Cambrian to the present. These near-crustaceans are not true crabs but are primitive marine arthropods and are sometimes classified with the scorpions and spiders.

The most interesting of these extinct arachnid-like animals are the Eurypterids, some of which grew to a length of more than ten feet, and they possess the distinction of being the largest known arthropod. These giant Eurypterids reached their greatest development in the Silurian seas and because of their weight spent most of the time lying on the sea-floor. Two large paddle-like appendages suggest that they had developed the power of swimming but progress through the water must have been far from graceful.

It must be more than a coincidence that the rise of these giant creatures, together with the fishes of the Devonian, synchronized with the very rapid decline and extinction of the trilobites.

Australian Museum Science Lectures

The Popular Science Lectures for 1947, for many years a feature of this Museum's work, are as follows:

Date.	*Subject.*	*Lecturer.*
May 8	Insects Lead Strange Lives	K. C. McKeown, F.R.Z.S.
„ 22	Earthquakes	Father D. O'Connell, S.J., M.Sc., F.R.A.S.
June 5	The Great Barrier Reef—Where Nature Runs Riot	T. C. Roughley, B.Sc., F.R.Z.S.
„ 26	Antiquity of Man in Australia	F. D. McCarthy, Dip. Anth.
July 10	The Call of the Museum	J. R. Kinghorn, C.M.Z.S.
„ 24	The Eastern Kimberlies—Environment and Possibilities of Settlement	W. H. Maze, M.Sc.
Aug. 14	Chemical Wonders—Glass from Coal; Rubber from Petroleum	A. R. Penfold, F.A.C.I., F.C.S.
„ 28	The Zoo in My Garden	Elizabeth C. Pope, M.Sc.
Sept. 11	Insect Parasites and their Use in Destroying Insect Pests and Weeds	N. S. Noble, D.Sc.Agr.
„ 25	Post-War Development in Antarctica	H. O. Fletcher.
Oct. 9	The Charm of Birds	K. A. Hindwood, F.R.Z.S., C.F.A.O.U.
„ 23	Among the Mangroves	Joyce Allan, F.R.Z.S.

These lectures, delivered at the Museum, begin at 8 p.m., and doors open at 7.30 p.m. Admission is free. They are illustrated by specimens, films, or slides.

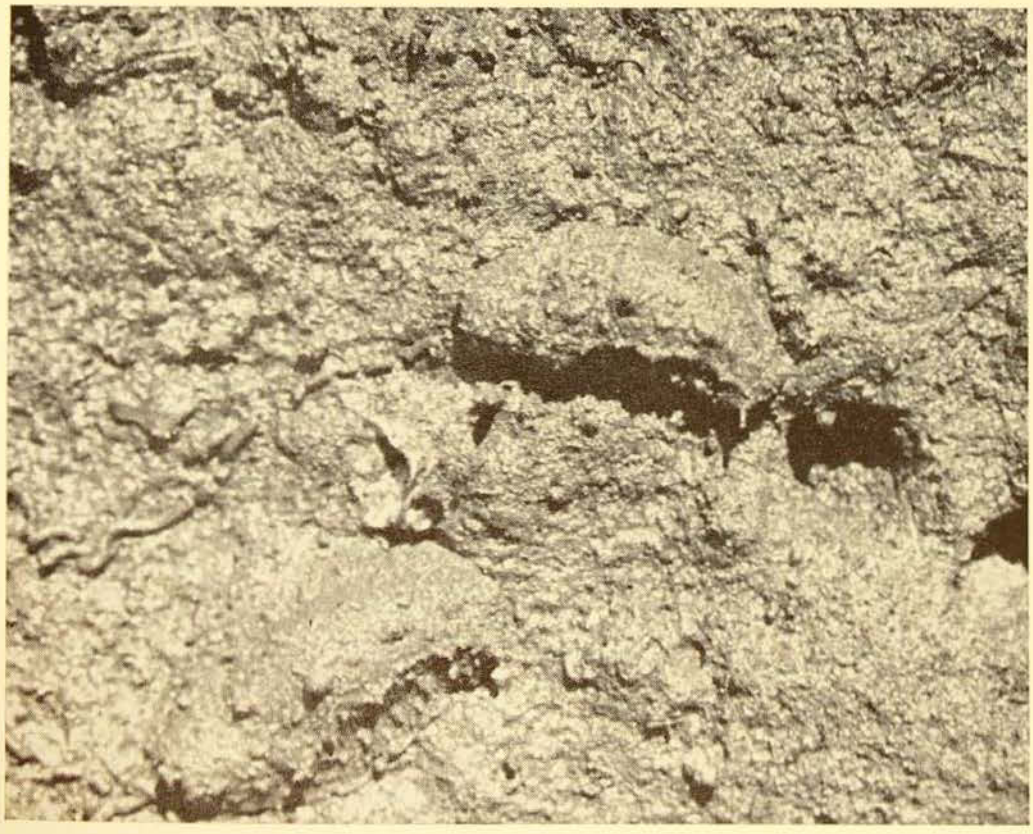
The True Sea-slug—Onchidium

By WILLIAM J. DAKIN, D.Sc., C.M.Z.S.

A FEW years ago one of the most famous of living zoologists wrote a book using a common intestinal worm-parasite as a model animal for an introduction to Biology!

No doubt the author was expressing a little sardonic humour in choosing such an unpopular and unpleasant-looking creature for the leading actor in his story. Most authors using animal actors in fiction have chosen popular examples—dogs, horses, otter and salmon, but we can remember one other writer who used an animal type to illustrate the whole science of life and that was the famous English scientist Thos. H. Huxley as far back as 1881. He chose the freshwater crayfish, a freeliving crustacean of pleasant streams. This animal scarcely excites one—pleasantly or unpleasantly. We should add that both Huxley and Professor Goldschmidt used their models with the touch of genius.

The present story of an ugly-looking sea-slug is only a very brief sketch, but it must be confessed that the animal itself provided a very strong stimulus for its writing. Here is a creature of the wild, often present in thousands, ugly to look at when seen, and not so easily seen. I have not met anyone who had any particular interest in it, which shows (and quite reasonably) that our naturalists prefer the beautiful, or at least something which they can collect and show. Yet despite the fact that Onchidium (which is its name) makes no appeal to one's æsthetic sense (and has no economic interest), several professional zoologists, especially on the continent of Europe, have devoted a surprising amount of print to descriptions of species collected from all over the world. Most came from Indo-Pacific subtropical regions and quite a number seem to have reached the Museums of Copenhagen and Stockholm!



Onchidium damelii, Semper, crawling over the soft mud of a mangrove swamp. These two creatures look like small lumps of mud, and are not easily detected, but movement and thread-like trails of mud make them discernible.
Photo.—
W. J. Dakin.

One wonders at this. Was it because it needed a careful scientific study of the animal's anatomy in order to name the species? Was its appeal to the scientist due to the fact that the determination of its very relationships to other animals was a bit of a problem? Whatever the answer, the truth remains that very few naturalists in Australia (where some of the different species can be collected in thousands) have deigned to study the living animal, and it has not collected a note about itself for over 25 years. Yet one of the first species to be named came from Australia and New Zealand, and its discovery was due to those remarkable French naturalist explorers Quoy and Gaimard who saw it on our seashores (and described it in 1832). The first species to be discovered was found by an Englishman near Calcutta and described in 1800, nearly 150 years ago.

Most zoology students learn that there are certain marine creatures, often very beautiful in colour and shape, which are called Nudibranchs. They are also shell-less molluscs, and very frequently their scientific designation is amplified by the name sea-slugs. Now you will see this is very unfortunate because they are not slugs at all, whilst the subjects of this story are not only real slugs but most species live on seashores.

The true slugs are, of course, our familiar garden pests and their allies. They are molluscs which (like their close relatives, the snails) have successfully made the course from the sea to the land. They have in their long history lost gills and developed lung-like cavities for breathing air. So they are called Pulmonates. Our real sea-slugs have a similar pulmonary chamber, and belong to the same group. Onchidium is the best known genus of half a dozen. Why, after all this evolutionary history, they should go back to the salt sea and live immersed in it for part of each day, whilst still remaining tied to the air with a lung-like breathing organ, is another unanswerable query. The species (with one or two exceptions) certainly have this in common, that they love a region between tide marks, but fairly high up, so long as they are covered by water when an ordinary neap tide comes in. And long before the tide comes in they retire to holes or nests which are submerged. They emerge shortly after the tide ebbs to promenade about and feed.

A surprising feature, however, of our common Onchidia is that whilst one species at least (that found by Quoy and Gaimard) loves the clean salt ocean water and a rocky ocean shore, several very common species restrict themselves entirely to those very special conditions of estuarine waters and to mangrove swamps. It is one of the latter which is depicted in my first photograph and I took it standing ankle deep in black mud. You can find the other species illustrated on the ocean shores near Sydney, or hundreds of miles south, on the shore near Lorne, Victoria. We have one species too, *Onchidina australis,* which still likes rather special places on estuarine shores where fresh water is more usual than salt.

In 1877, a very keen observer named Semper—one of the famous German zoologists of happier days—discovered that the upper surface of some species of Onchidium was very unusual. He found that some of the rough papillae freely scattered on this surface were tipped with eyes. There were dozens of them in little groups of two to four. And these papillae, especially their summits, can be retracted downwards and inwards rather like the periscope of a submarine. I've watched it happen and the action is decidely neat when observed under a microscope!

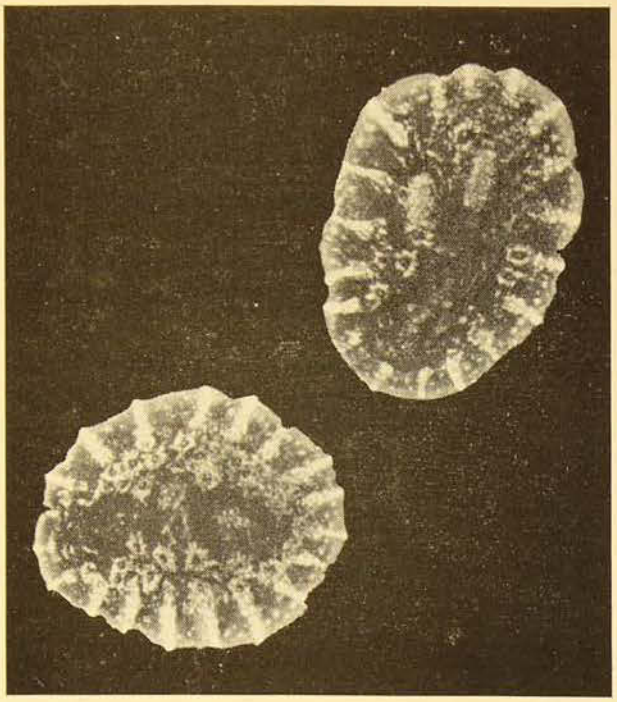
This collection of eyes is of itself distinctly curious, but there is more to come. The structure of the usual pair of eyes on the head-tentacles is like that of the eyes of other slugs and snails, but the extra eyes on the back are most surprising. They have an inverted retina, and a pierced retina with a blind spot, the sort of thing (although far more rudimentary) which characterizes the vertebrates. This startling fact is enough to draw especial attention to Onchidium, but just to puzzle us more, no-one has been able to show that the species with these eyes are more sensitive to light than those

Onchidium damelii, twice natural size.
Photo.—G. Burns.

which haven't got them—and our ocean-shore species (*Onchidium patelloides*) is one of this type. Perhaps it is only another evidence that Nature is extravagant!

In 1918, two American zoologists thought that living Onchidia at Bermuda were well worthy of study. I think theirs is the only paper which tells about the habits, a serious reflection on zoological science considering the many dry documents on the names of shrunken and discoloured specimens in the pickle bottles of old European Museums. (Maybe many exist no longer, as the consequence of other "advances" in science!) Now these Americans also noted that Onchidium came out when the tide receded and that they promenaded for a short time. But they also discovered that the specimens came out from holes or nests in which several might be found together and that after their walk they returned to the same nest even if they had been three feet or so away. They found their home hole and avoided others on the way back! This homing instinct has been noticed in the case of other molluscs but it is doubtful whether any better example than this has been observed. Once again it is impossible to say how such "finding the way" has been achieved. Obviously not by the use of the eyes.

Some New South Wales collectors found it difficult or impossible to obtain specimens of our mangrove species (*O. dämelii*) in localities where we knew it to be abundant, and there certainly seemed some vagaries in their occurence. So to settle the problem I deliberately visited a favoured swamp when the tide was still high but falling. Everything was particularly messy and the ground (just covered with water) was more than usually soft. I sank halfway up my legs in the mud. A patient "wait" was necessary, a hard thing indeed, especially as under the conditions it was impossible to sit down! Gradually the water receded from the surface of the mud. Crabs in infinite numbers (Heloecious and Sesarma) came up everywhere, out of



Onchidium patelloides, Quoy and Gaimard, the ocean beach Onchidium. Twice natural size. Photo.—G. Burns.

holes, and proceeded to feed. So long as I remained still, thousands of crabs dined about me, but the slightest movement wiped them all out. This is one of the strangest of all disappearing tricks. Still there were no sea-slugs—no Onchidia. I waited until it was approximately three hours after the time of high water and then suddenly I found the first Onchidium. Now, mark this. Within the next half hour, hundreds of Onchidia had emerged from holes in the mud and like the crabs were performing nutritional promenades. These lasted about two hours or so and then gradually, and long before the tide had risen again—in fact, probably before it was at its lowest ebb, the creatures were returning. The mangrove swamp surface dries slowly and is probably driest when the tide is well on its way back and just before submergence again. By this time, however, not an Onchidium is to be seen anywhere, only their tracks reveal where they have wandered.

This performance does not seem to have been recorded, nor is it fully realized that other molluscs, several crab species, and quite probably many animals which feed when the seashore is uncovered by the tide, do so most actively, and for a short time only, on the *falling* tide. It pays the shore collector to visit his hunting grounds whilst the tide is ebbing and to time his "finish" for the flow.

The Onchidia we have specially studied in the Sydney district and on other Australian shores are *Onchidium dämelii*, Semper, *Onchidium verruculatum*, Cuvier, *Onchidium patelloides*, Quoy and Gaimard, and *Onchidina australis*, Semper. The latter has only been recorded once before for the Sydney district when a German scientist described a specimen in the Stockholm Museum as being labelled Port Jackson—Macleay. There is surely another story behind that specimen.

One other species has been recorded for the Sydney district, *O. chameleon* Brazier. I have not seen it as yet.

It might be interesting to point out that apart from this article no Onchidium has ever been described from Victoria. Since *O. patelloides* had been found at Launceston it might have been expected on the Victorian coast. It was collected there last year for me by Miss I. Bennett at Lorne. This is the first Victorian record.

Like the land-slugs, Onchidium and its related genera are hermaphrodite and indeed have very complicated reproductive organs. One wonders whether its sex life is as elaborate as that recently divulged in amazing photographs of its humble-looking, strictly terrestrial relatives. Verily another case of there being "More things in heaven and earth, Horatio, than are dreamt of in our philosophy".

But the "lower animals" today will attract no serious attention *unless* their activities affect man. Perhaps this is as it should be when humanity needs so much medical (to say nothing of social) research. Yet all the life sciences receive too little notice from the world public in these days of machines and shallowness.

My thanks are due to Miss Joyce Allan for two specimens of *Onchidina australis*, a species recently re-discovered in the Sydney district after very many years. They were collected by Mr. Roy Mackay.