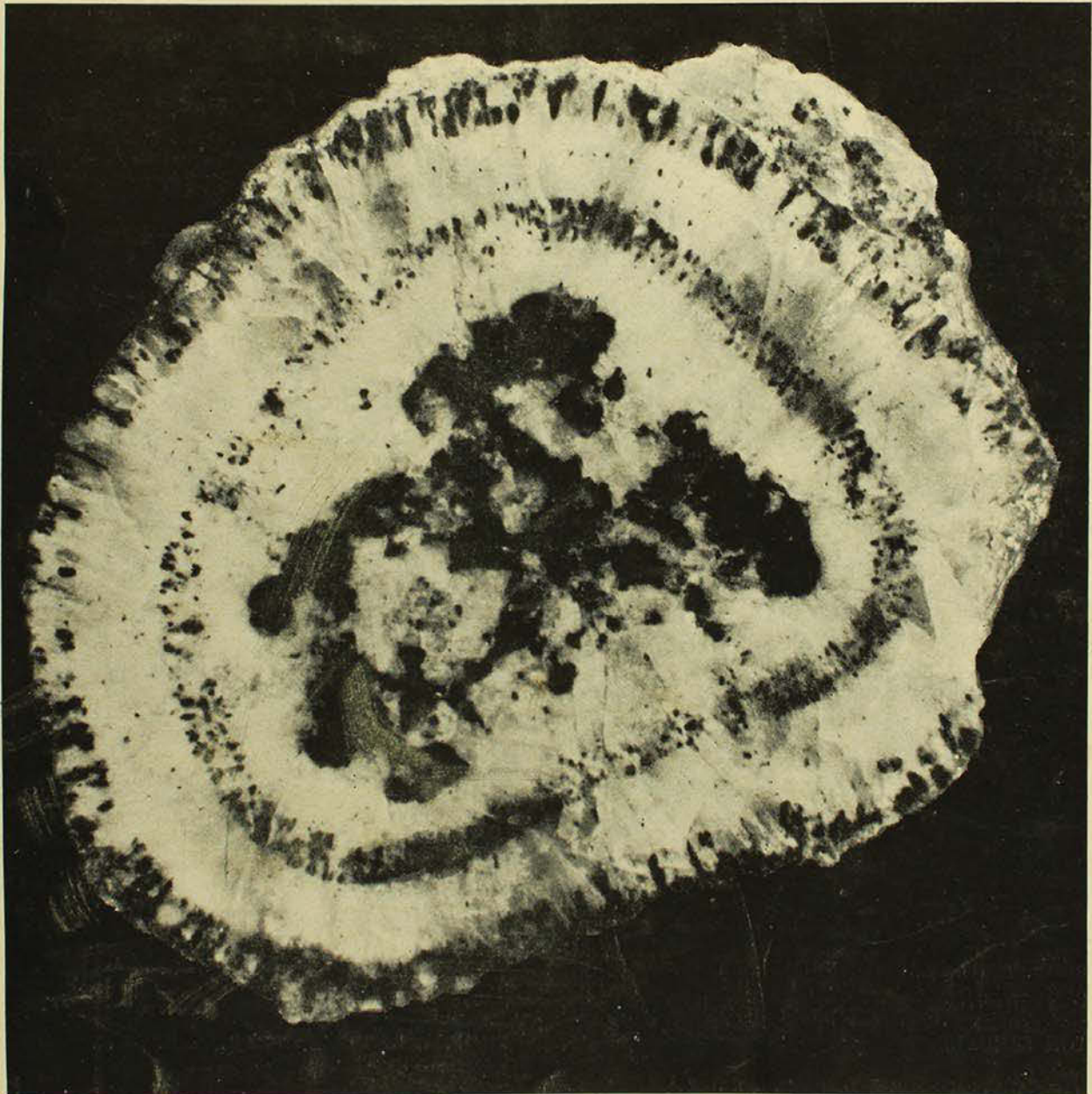


The AUSTRALIAN MUSEUM MAGAZINE

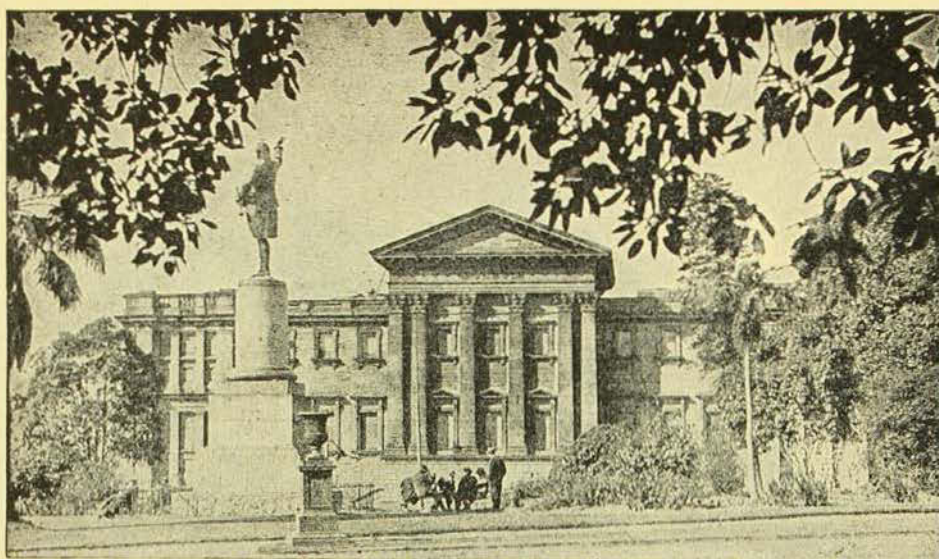
Vol. IX, No. 3.

JULY-SEPTEMBER, 1946.

Price—ONE SHILLING.



Spheroidal Granite.



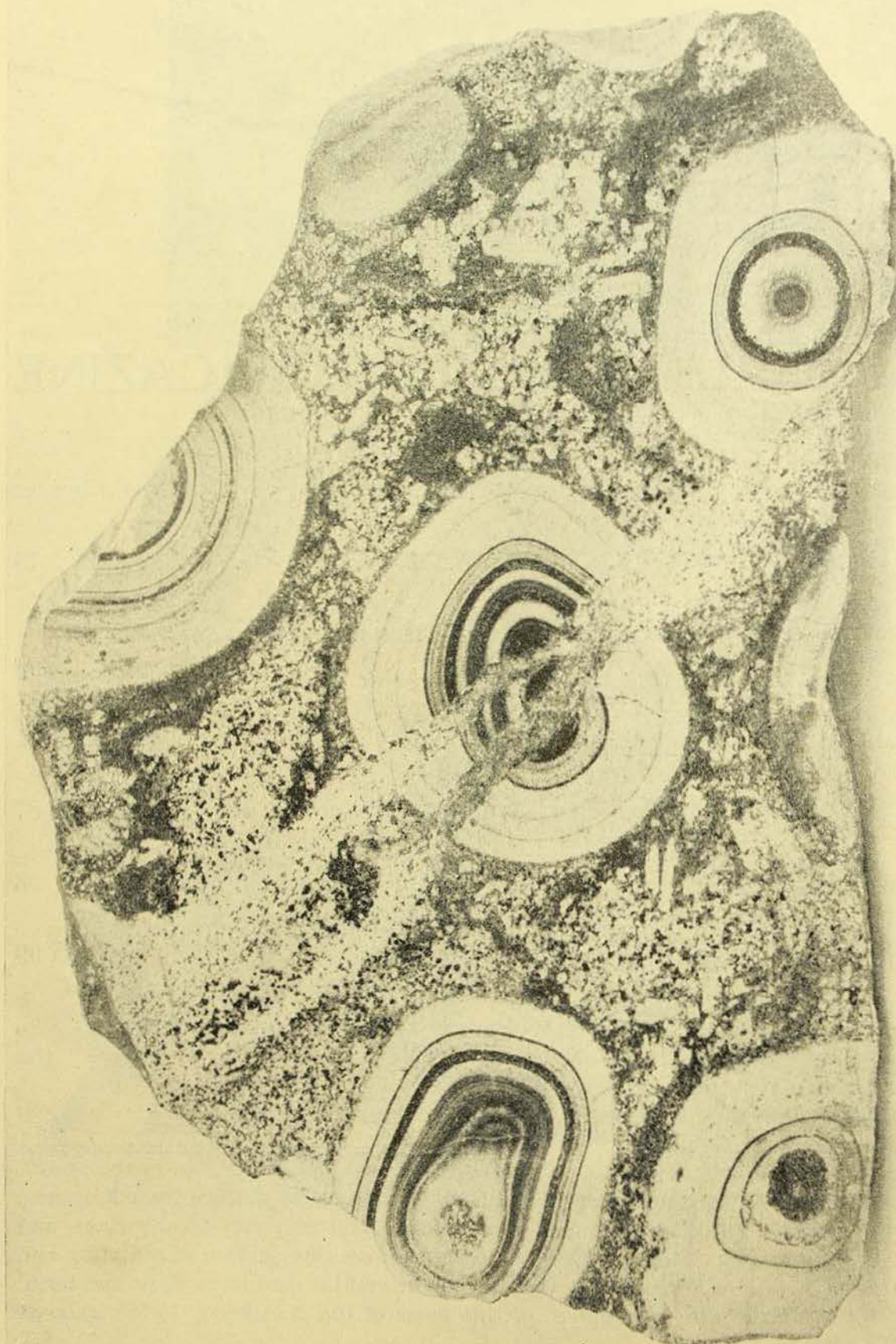
THE AUSTRALIAN MUSEUM MAGAZINE

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

● OUR FRONT COVER. A polished specimen of a spheroid occurring in granite from Karamea, South Island, New Zealand. The white mineral is plagioclase feldspar, variety oligoclase, and the black mineral is mica, variety biotite. This specimen shows a combination of radiating and concentric structures of a type different from that shown in another and even finer specimen, an illustration of which forms the frontispiece of this issue of the MAGAZINE. It is displayed in the Museum.

Photo.—Howard Hughes.



This handsome polished slab of spheroidal granite measures two feet six inches by one foot nine inches, and comes from Karamea, South Island, New Zealand. The sectioning of these rare spheroids shows to a high degree of perfection the concentric structure of the alternating layers of white oligoclase and black biotite. This is certainly one of the finest specimens of spheroidal granite to be seen anywhere in the world and is displayed in the Museum.

Photo.—Howard Hughes.

THE AUSTRALIAN MUSEUM MAGAZINE



Published by the Australian Museum - - - - - *College Street, Sydney*
Editor: A. B. WALKOM, D.Sc. Annual Subscription, Post Free, 4/4

VOL. IX, No. 3.

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Spheroidal Granites

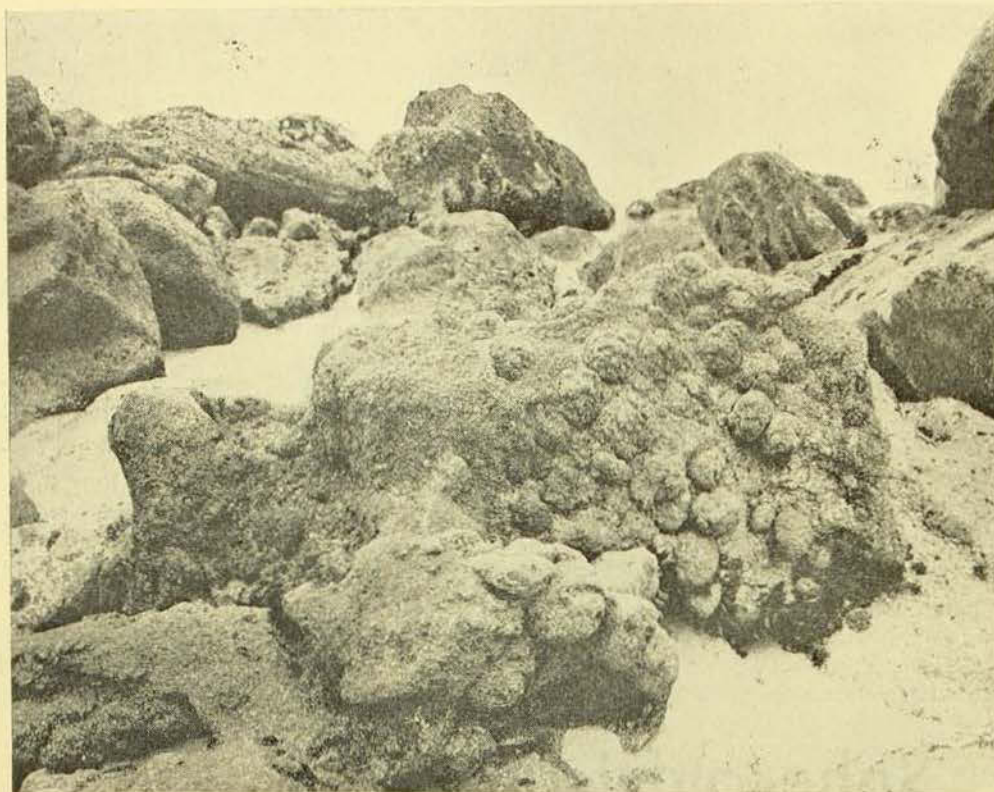
By P. MARSHALL, D.Sc., F.R.S.N.Z.

IT is probable that few rocks are so widely known as granites. It is generally understood that the rock granite is composed of crystals of three different minerals—feldspar, quartz and mica—which are irregularly mixed together in the rock in crystalline grains. Though these mineral grains have the structure of crystals it is but seldom that the form of their crystals can be distinguished in the rock.

Generally each of these minerals is present in the form of rounded grains which are not easily distinguished from one another. The mica, however, often makes an exception to this general statement, for it usually has the form of glittering scales which often attract attention. The other two minerals are not so easily distinguished, but it is generally the case that the feldspar is rather opaque though it often breaks along bright cleavage planes. The quartz is the most transparent mineral of the three and the hardest. Both the quartz and the feldspar are usually white or colourless in a hand specimen of granite.

In a few scattered localities a rare type known as spheroidal granite occurs. Within recent years such occurrences have been discovered at Karamea and the Wangapeka River in the north-western portion of the south island of New Zealand.

The spheroidal granites, of which the samples from Karamea are outstanding types, sometimes have their mineral grains arranged in such a way as to give rise to distinct spherical objects in the midst of the confused mass of the irregularly shaped mineral crystals. This structure is, however, extremely rare and the spheroids that have been found at Karamea are stated by the Keeper of Minerals at the British Museum to be the finest that he has seen. Other but less conspicuous examples are found in the granite of Kaiteriteri and boulders have been found in the Wangapeka River of Nelson though the spheroids in these are small and far less strikingly developed. The spheroids which are found at Kaiteriteri contain no black mica and have a much less interesting



Spheroidal granite occurring as an isolated mass in ordinary granite at Kaiteriteri. Note the individual spheroids closely massed together and protruding as rounded shapes from the main body of the rock. The largest of these specimens is some seven inches in diameter. Photo.—New Zealand Government.

structure than the Karamea examples. In these two types the feldspar and quartz are arranged radially and even in the Wangapeka type there is only a little black mica to punctuate the development of the structure of the spheroids. It is at Karamea that the spheroidal granite has its most remarkable and spectacular development. Whilst it is true that some of the boulders that are found there have a similar structure to those from the Wangapeka River there are others that have a most spectacular appearance, though it is true that very few of these have been found. Some of these boulders are large—one was as much as three feet in diameter—but others are quite small.

In these extremely rare examples the spheroids vary from four to eight inches in diameter. They are composed of alternate layers of black mica and white feldspar, but there is no quartz in them. Although the dominant appearance is due to alternation of concentric spheres of these minerals the real structure when studied closely is found to be actually radial in spite of the striking appearance of alternate black and white shells of mica and feldspar.

When such a granite as this is cut into slabs the two minerals, mica and feldspar, appear on the flat surface that has been cut through a spheroid as successive circular rings. Such a cut surface will seldom pass through the centre of a spheroid. In these sections a series of concentric rings are seen but these are fewer in number and rather less sharp in outline than those that pass through the centre of the spheroids. Sections of Karamea spheroids which pass through the centre have a diameter of some eight inches. They have a white or light coloured central area which may be four inches in diameter. This generally includes two or three thread-like rings of black mica of greater or less distinctness in different examples. Round this light coloured central area three black rings of mica and three white rings of feldspar occur alternately but without any special regularity in width. If closely inspected, however, it can be seen that each black ring of mica includes a few narrow rings of white feldspar. In these spheroids the whole structure ends in an outer ring of white feldspar. (See frontis-

piece for illustration of a magnificent polished slab of this material.) In these spheroids the whole structure ends in an outer ring of white feldspar.

The spheroids at once give the idea that they are foreign bodies, that by some freak of chance have become embedded in the granite. This, however, was certainly not the case. Each of them was without doubt derived from the fluid molten magma from which the rest of the granite itself was formed. It must once more be emphasized that this regular and sharp arrangement of concentric rings with their strongly contrasted colour is at present known in one other locality only. This is at Kangersala in Finland where only one boulder has been found. Granite itself, of course, is a common rock of world wide occurrence, and the fact that spheroidal structure of this perfection is of such extreme rarity indicates that most unusual conditions of consolidation of the granite are required before this extraordinary rock can be formed.

The ingenuity of geologists has been taxed in efforts to explain how the spheroids have been formed from the molten material. Generally it may be said that opinion often favours the idea that some foreign material gained access to the magma before it solidified but this explanation is largely discarded now. Some authorities think that some patches of basic mineral material have been absorbed by the magma. There is no evidence of the absorption of any basic matter in the Karamea specimens that have been examined so far.

The only explanation which seems possible to the author is based on the action of volatile substances, especially water vapour, on the molten magma at the time that it solidifies. It is, of course, well known that all rocks of igneous origin such as granite contain a considerable amount of water.

In these spheroidal granites the crystallization of mica certainly requires the presence of a considerable quantity of dissolved water vapour, feldspar probably requires a good deal less. It must be noted that the spheroids were formed

before any regular crystallization took place within the magma. It has to be supposed that in spheroidal granites some conditions within the magma which cannot at present be exactly stated caused crystallization of feldspar to take place in radial groups which in acid rocks of which granite is a type is not infrequently the initial stage in the development of crystalline structure, in a magma.

The feldspar contains no water and no iron and some other of the components of mica are wanting in it. The formation of the crystal groups of feldspar would cause the percentage of water and iron compounds to increase in the residue of the magma. It is quite possible that water vapour has not a uniform percentage throughout the magma. The crystallization of feldspar from the magma might cause the percentage of water to reach such an amount as to permit of the crystallization of mica. This would continue until the amount of water was reduced partly by crystallization of mica and partly perhaps by radial movement of the volatile matter. At a certain point of this reduction of water the conditions created by its withdrawal might no longer allow of the formation of crystals of the mica. The subsequent removal of these substances by the crystallizing of mica might alter the composition of the magma in this restricted area to such an extent as to allow the crystals of feldspar to begin to form again. This formation of feldspar could once more, especially if it may be imagined that volatiles might be added from other portions of the magma, allow of the formation of mica in its turn. Later a repetition of this series of changes by withdrawal of water might allow feldspar to form once again. By such a process a succession of these alternate conditions could be supposed in this free magma to build up a sphere of alternate layers of feldspar and mica such as is found in these spheroids. This might continue until very little of the magma remained and the remnant might be unsuitable in composition to allow the alternate mineral formation to continue or perhaps cooling had taken place to such an extent as to prevent free move-

ment of the chemical substances to the regions of crystal formation at the margins of the spheroids.

In support of this explanation it may be mentioned that the spheroids in any one boulder or in a number of boulders from any one locality show a general similarity. There is the same number of rings in each spheroid and these have a similar breadth in different spheroids. This statement, however, has to be interpreted with a considerable amount of latitude.

This suggestion has no definite basis of observation; for except at Kaiteriteri, where quartz feldspar spheroids mentioned above occur in a local patch in

the granite, the samples of spheroidal granites here described occur only as boulders. In the quartz feldspar spheroids the structure is radial with intergrowths of the two constituent minerals from centre to margin, a condition generally thought to be associated with the presence of abundant water when crystallization took place.

Similar specimens have been sent to the British Museum (Natural History), and polished slabs are also to be presented to leading museums elsewhere.

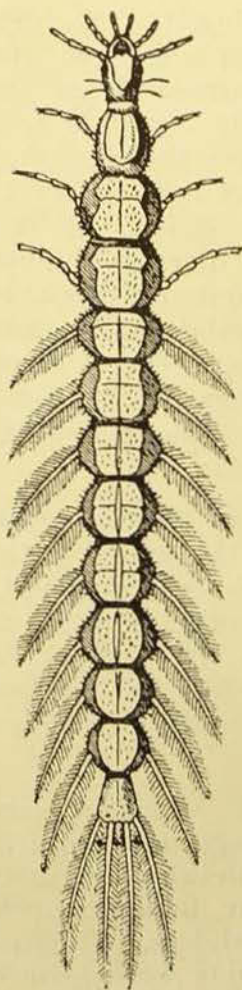
[The cutting and polishing of these large slabs was arranged by the New Zealand Department of Internal Affairs, from which department we received the example herein described.—Editor.]

Australian Insects. XXVIII

Coleoptera 5 — The Whirligig Beetles

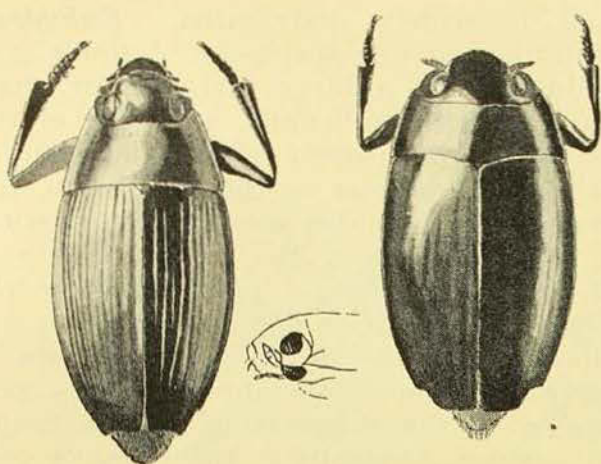
By KEITH C. McKEOWN.

THE Whirligig beetles, although they comprise only a small family—the Gyrinidae—are well known to practically everyone on account of their gregarious habits and the whirling, darting movements which swarms of these insects perform upon the surface of waterholes and streams, where they assemble in parties which may range from some half-dozen to several hundred individuals. On the slightest indication of the approach of possible danger the madly whirling swarm disappears, each beetle diving beneath the water to cling to the submerged weeds or swim to some secure hiding place. When they descend, each beetle carries a small bubble of air attached to the hind extremity of the body—a bubble which gleams like quicksilver in the sunlight. The greater portion of this air supply is enclosed beneath the elytra. As soon as danger has passed the insects return to continue their evolutions on the surface. It is from their mazy whirling that these beetles have gained their popular name and such attention as they have attracted, for the details of their life-history are very inadequately known.



Larva of *Gyrinus marinus*,
a European species.

After Schiodte.



Gyrinid beetles: *Enhydrus latior* Clark (left) and *Macrogyrus striolatus* Guer. (right); head of a Gyrinid below, showing divided eye. N. B. Adams del.

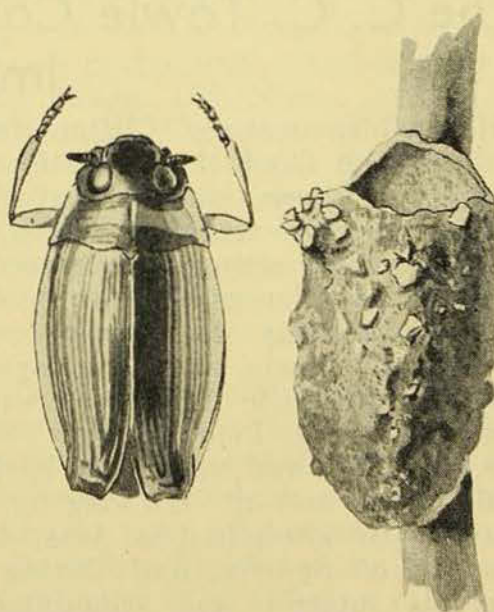
The adult beetles seem to feed upon both animal and vegetable matter, but where their animal diet is concerned they are rather scavengers than predators, feeding upon the bodies of such insects as may be unfortunate enough to fall or be blown by the wind into the water. The larvae, however, are strictly predaceous, feeding upon the body fluids of almost any aquatic animal of a size they can capture and control.

The elongate eggs of the Gyrinids are deposited upon the stems and leaves of submerged vegetation in masses in which they are sometimes arranged in regular rows. In one or two weeks these eggs hatch and the small larvae swim away in the water ready to prey on any little aquatic life they may encounter.

The larva (see illustration) is an active creature, long and slender—about three-fifths of an inch in length—with long, slender legs, and each of the abdominal segments bearing a pair of tapering, fringed gills, while the terminal segment bears two pairs of these appendages. These delicate gills ensure an adequate supply of the oxygen necessary to the insect's life. The larvae appear to frequent reedy tangles, and are usually rarely encountered, even in situations where the adult insects are plentiful. As far as known, the pupae of most of the Australian species have not been recorded—one only is known to me, that of *Aulonogyrus strigosus* Fabr., which is

enclosed in a small oval case, apparently formed of mud, attached to the stem of a reed. It is said of the few overseas species of which the life-histories have been recorded that pupation always takes place out of the water. The pupal case, formed of a variety of materials, is constructed by the mature larvae either upon the ground or attached to the leaves and stems of plants growing above the surface of the water.

The perfect Whirligig Beetle is well adapted to its aquatic environment, being stoutly built, stream-lined, distinctly flattened and somewhat keeled along the sides beneath. The forelegs are relatively long and well fitted for clinging to aquatic vegetation or claspings the floating bodies of drowned insects when feeding upon them. The last two pairs of legs are short and stout, with the joints flattened into overlapping plates and fringed with stiff, flattened hairs along the outer border, adding greatly to their efficiency as paddles in swimming and diving. In the event of it becoming necessary for the insects to seek out fresh ponds and streams in dry seasons, they are capable of prolonged flight, in common with other aquatic beetles and bugs. One very curious feature to be found in these beetles is a divided eye—each of the large compound eyes being in two completely



Aulonogyrus strigosus Fabr. with pupal cell attached to the stem of a Rush. N. B. Adams del.

separated sections with the base of the antenna situated between them. It has been suggested that one portion is for vision above the water surface, and the other below. No one seems actually to have tested the truth of this theory experimentally, so the exact purpose of this strange development remains obscure. A somewhat similar eye structure occurs in certain longicorn beetles, but, since they do not go near water, the suggestion cannot hold in their case.

Some twenty-eight species of Gyrinid beetles have been described from Australia, but it is possible that in some instances the same species may have been recorded under more than one name, so the number may have to be reduced when the group is revised—revision is obviously necessary. Five genera are represented in Australia, but most of the species included in them are superficially very similar in general appearance and coloration; most are black or greenish-black in colour. Detailed descriptions of them are unnecessary in a popular article. Typical of the genus *Dineutes* is *D. australis* Fabr. in which the comparatively smooth elytra are abruptly truncated, leaving the extremity of the abdomen exposed. This insect measures about one-third of an inch long.

and is widely distributed. *Enhydrus* contains but one species, *E. latior* Clark (illustrated), a large insect, more than half an inch in length, with the elytra strongly and closely ridged longitudinally. *Macrogyrus* is the largest of the genera and contains some fifteen species, of which, perhaps, the most striking is *M. striolatus* Guér., a broad insect nearly three-quarters of an inch long with almost smooth elytra bearing only faintly impressed lines. Its appearance is well shown in the illustration. It is found in eastern Australia. *Aulonogyrus* contains only one small species, *A. strigosus* Fabr. (see illustration), which has already been referred to above in connection with the pupal case. It is narrow, greenish in colour, coarsely ridged, and with the elytra margined with yellow, and yellow legs. It is distributed over almost the entire continent. The cosmopolitan genus *Gyrinus* is represented in this country by one small species, *G. convexiusculus* MacL., a small, glossy beetle far more convex above than any of the other forms.

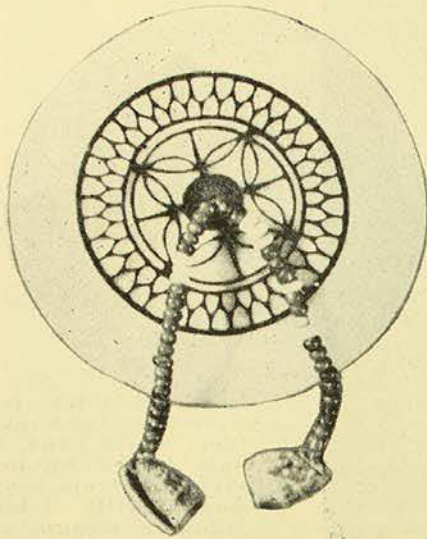
To anyone who has the opportunity of investigating the lives of these beetles, the study should provide a fertile field where much that is new still awaits discovery and recording.

The C. C. Towle Collection of Aboriginal Stone Implements

THE sudden death of Clifton Cappie Towle, on 22nd March, 1946, after a short illness, was a great shock and a loss to those who had known him. A man of serious nature, he devoted his leisure to the sciences of anthropology, geology, astronomy and botany, also literature and music, and he enjoyed to the full a cultural life of his own creating. He was born at Penrith, New South Wales, in 1891, and spent his boyhood in this town and at Wollongong and Bathurst. He graduated in Arts at the University of Sydney, and during the course his interest was stimulated in anthropology by Sir Edgeworth David's lectures on ancient man. He began

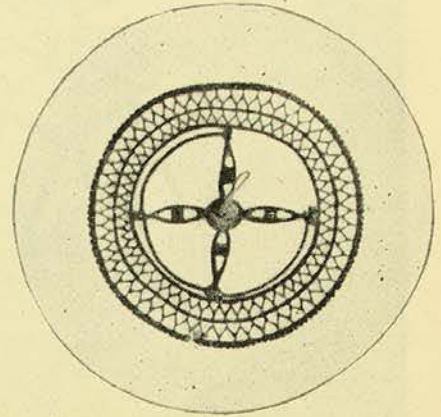
collecting stone implements in New South Wales in 1922. At his death he had accumulated a magnificent collection of approximately fourteen thousand specimens, comprising cylindro-conical stones, axe-heads, percussion stones, grindstones, fish-hook files, ritual stones, knapped and trimmed implements of all kinds. The collection was made in many parts of the State, and was the finest private collection of New South Wales implements. It has now been bequeathed to the Australian Museum. Needless to say, it includes many unique specimens and fills numerous gaps in the Museum's collection.

F.D.McC.



Melanesian Kapkaps

By FREDERICK D.
McCARTHY.



KAPKAP! That's an unusual word, isn't it? I wonder what it means? Well, it's a New Ireland native name for a very attractive ornament worn on festival and ritual occasions. The kapkap consists of a circular or oval mount of white shell to which is tied a filigree plate of turtle shell. Although the kapkap does not appear, strangely enough, to have any sacred significance, it is highly valued by the Melanesians as an ornament, and possesses, at least, a social value inasmuch as with ownership of exceptionally well made ones belongs a certain amount of prestige. A wealthy native or a chief wears one or more fine kapkaps with great pride. One reason for the purely decorative function of this ornament is that the majority of the carved designs are peculiar to it, and comparatively few local art motives of a sacred nature are embodied in them. Another reason is that the idea of the kapkap has apparently spread from north to south in the Pacific islands, and it does not, therefore, belong to the older and traditional ritual of the islands in which it is so highly esteemed today.

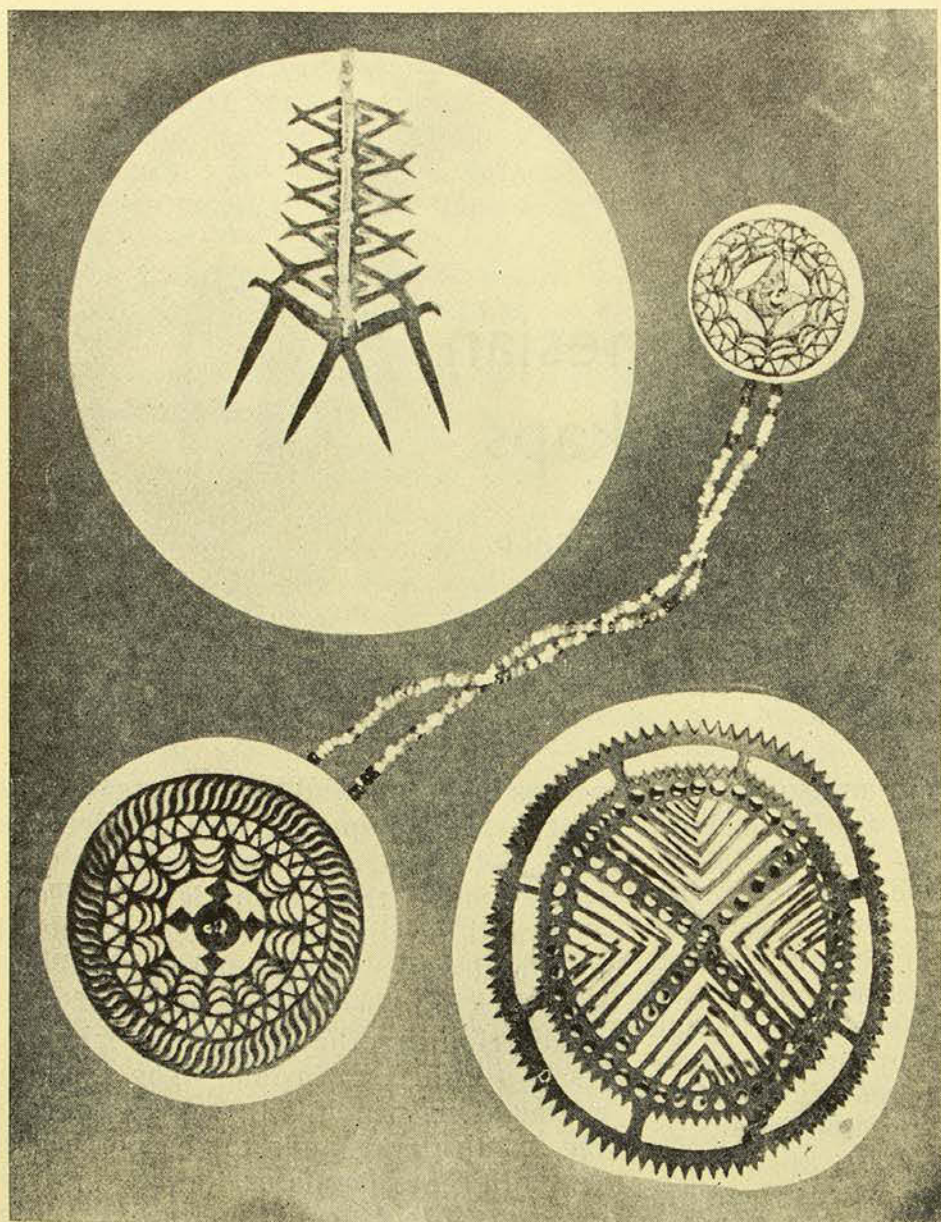
The distribution of the kapkap is of some interest in this connection. It

occurs in Assam and other parts of South-east Asia, and sporadically in Micronesia and Melanesia, with an isolated occurrence among the Polynesians in Tahiti. The well organized trading systems by land and water maintained by the Pacific islanders have been one of the chief means of distributing the kapkap so widely in its southward diffusion. The principal routes along which it travels extend from the Admiralty islands to the north coast and adjacent islands of New Guinea and also to New Ireland, another manufacturing centre from which a trade extends via Tanga and Nissan to the western Solomons. Furthermore, the kapkap has spread from northern New Guinea overland to the Papuan Gulf as part of an extensive cultural diffusion. The shell mounts are traded more widely than the complete kapkaps, but both possess a recognized trade value.

It is both extraordinary and unfortunate that the methods employed in making the clam-shell mount and filigree turtleshell plate have never been recorded, as is the case with other Melanesian arts and crafts. The finest mount is made out of the shell of two species of Giant Clam, *Tridacna gigas* and *gigantea*; the slab is chipped or pecked into a circular shape

* The two kapkaps used as title-pieces are from New Ireland.

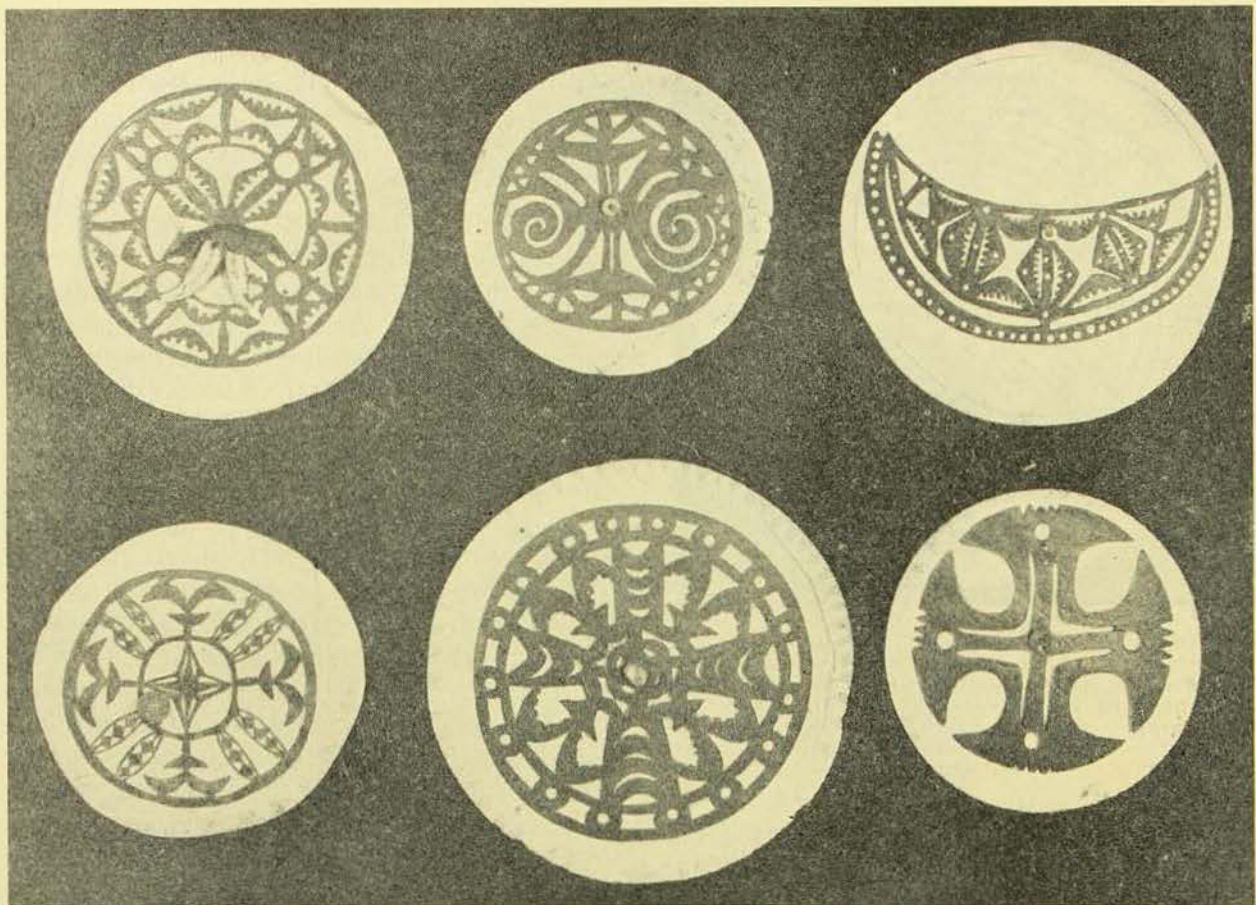
[Photographs by Howard Hughes.]



In the top left is a well-designed kapkap from Santa Cruz, the pair joined by bead strings is from Aropa, Bougainville Island, Solomon Group, and the one on the lower right is from Aroma, Papuan Gulf, New Guinea.

and then ground down to the required thickness on a coral or sandstone grindstone. The shells are either live clams from the reefs, or semi-fossilized specimens. The finest *Tridacna* mounts are highly polished and well shaped, particularly those from New Ireland, the Solomons and Santa Cruz islands. In the Admiralties the edge of the mount is decorated with cross-hatched triangles in black. Occasional substitutes noted on specimens in our collection comprise the base of a *Conus* shell, discs of gold-lip oyster and black mussel, and portion of the side of a Pearly Nautilus, all of which serve the purpose, and are shaped with little trouble by chipping and rubbing the edge.

The filigree turtleshell plate is made from one of the easily removed ventral plates of the Hawksbill turtle, which supplies the commercial "tortoiseshell", as it is commonly but wrongly called. The plate is rubbed down to a thickness varying from 1.5 millimetres to that of thin paper. The design is then scratched on the surface, as shown on an unfinished one in our collection, and is then apparently cut out with narrow-edged tools made of shells, teeth, or obsidian, whilst the drill is used to make the rounded perforations. It is further probable that the turtle-shell plates are heated to facilitate the cutting which leaves a vertical or bevelled edge, rarely smoothed. The design consists of a continuous line



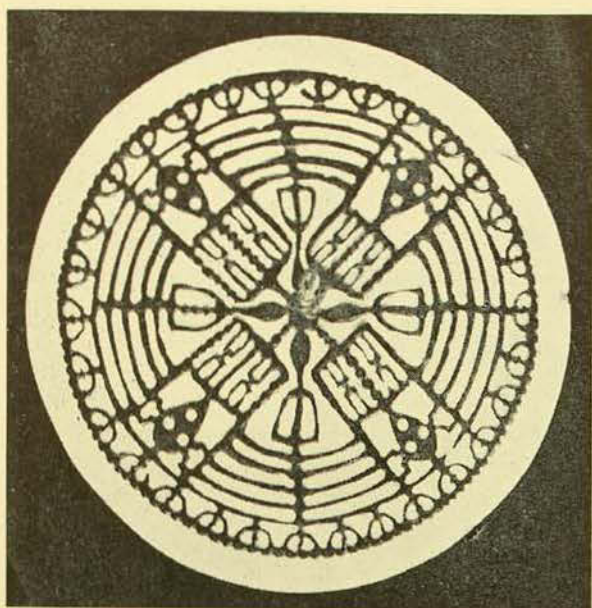
Six Admiralty Islands kapkaps showing the broad and rather crude treatment of the design in sectors. The three lower examples embody the buffalo-horn motive.

or band, and great skill is required to carry out this process without breaking any of the connecting sections, particularly where, as on the finest examples, the line is like a thread of fine cotton. Whilst many kapkaps are made out of dark pieces of turtle-shell, many others display the attractive dappled pattern, particularly if they are wetted.

In the Admiralties and New Ireland, kapkaps are worn as breast ornaments, suspended on a string of shell disks or trade beads. In both groups of islands, as the illustrations demonstrate, the art motives on these ornaments are similar, but a wider range of both central and border ornaments is featured by the Admiralty carvers. Motives used in both groups of islands comprise the central figure of a circle, cross, star, flower, or wheel, as they may be conveniently classified, all of which are treated in a variety of styles. They may be in the solid or outline, barred or toothed, or otherwise

decorated, there are from four to five arms in the cross and star, and from three to eight rounded or diamond-shaped petals in the flower. This central motive frequently occupies the whole surface of the design in Admiralty kapkaps, but rarely in those from New Ireland. The motives carved in the concentric outer bands of the designs include a zigzag line, the crescent, lozenge, oval, triangle, scallop, and toothed edges or figures. The number of motives embodied in the designs is considerably less again in the Solomons. Thus—as we consider the distribution of the kapkap from the north to the south in Melanesia—the motives decrease, a feature commonly associated with diffused ideas which are usually more complex at their place of origin than elsewhere.

Then, too, the filigree designs of each main island group possess certain local peculiarities. In the Admiralties the uncut portions are broad unpolished



A splendid example of carver's art—a beautiful kapkap from Malaita, Solomon Islands. It embodies a human face motive in a field of eight sectors combined with a concentric arrangement of the design elements. The surface is smooth and polished.

bands frequently edged with blunt teeth. The circular design is arranged in four, five or eight sectors as a rule, but sometimes there are more. Each sector contains the same motives which thus radiate from the centre to the periphery of the plate. In the Admiralties, moreover, additional motives are to be seen. Thus, one series of designs includes a pair of curved horns in each sector, sometimes separated by a lizard, a herring-bone panel, or other motive. The human figure, too, with bent arms and legs, or a simple spiral, may be carved in each sector or quarter. Circular bands of human limbs and cut-out anvil figures are also peculiar to Admiralty kapkaps. Finally, it might be mentioned that the craftsmen in this group of islands have produced a more varied range of broadly cut designs than any other kapkap-producing centre in the Melanesian islands.

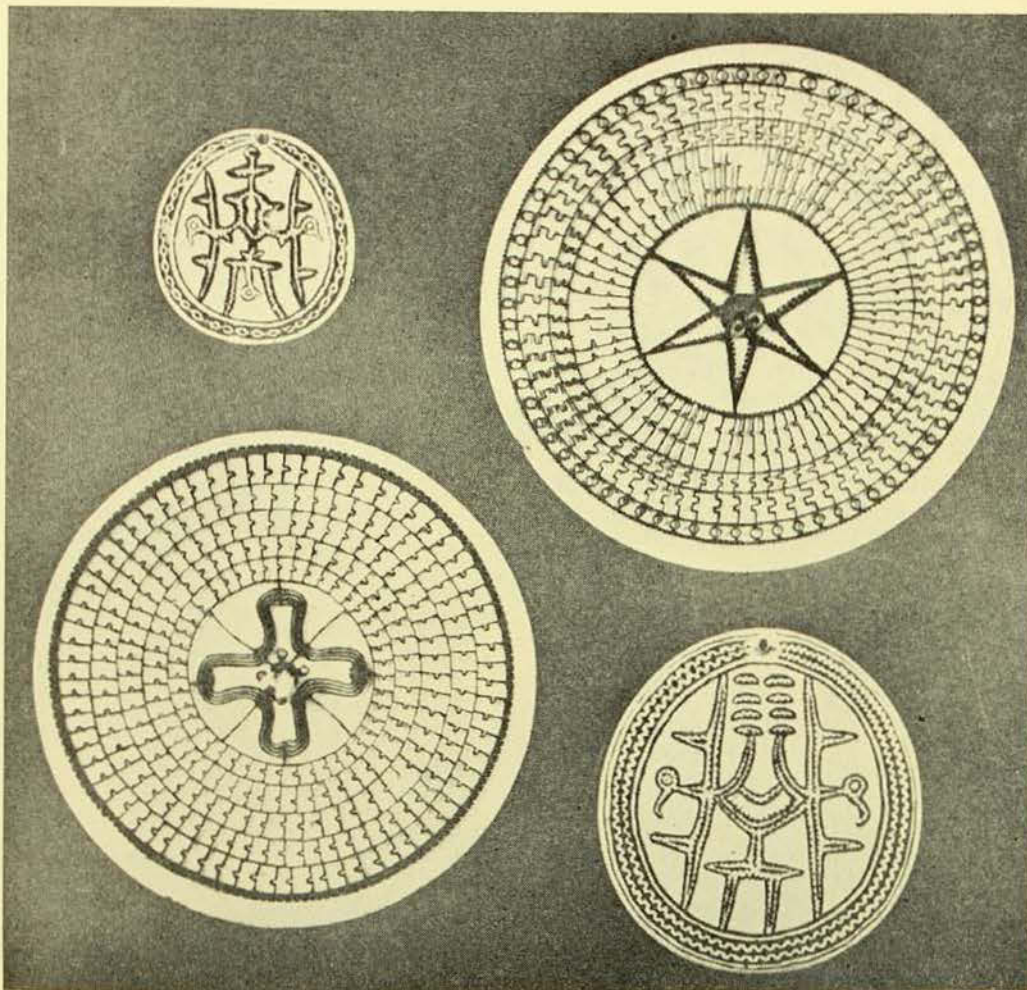
In New Ireland preference is shown for fine curved lines, and designs feature broad cut-out spaces. The surface is polished, and the workmanship is much better than in the Admiralties. Moreover, the design is built up on a different principle, that of using a number of concentric bands of motives around the central

panel, and omitting the radial arrangement employed in the Admiralties. Additional patterns incorporated in New Ireland designs include the trident in the central panel, and long curved teeth, vertical lines, and a chain motive in the outer concentric bands.

Further southwards in the western Solomons particularly beautiful kapkaps, which the men wear on the forehead and side of the head at feasts, ceremonies and on fighting expeditions, are made in a limited but most attractive series of patterns. The central cross, star or flower is elaborately designed, and the rays or petals frequently extend to the periphery of the turtle-shell plate and thus subdivide the design into from four to six sectors. In addition, however, to this radial treatment of the circular field, the design exhibits a marked emphasis upon concentric bands of fretted lines, single and multiple zigzags, outline crosses, concentric "U's", and toothed triangles pointing outwards around the outer edge. Unusual additions to the kapkap motives generally are the occasional introduction of a frigate-bird or human figure in each of the blank sectors of the central panel.

On two other interesting ornaments the Solomon islanders incise the design in the shell mount, thus doing away with the turtle-shell plate. On both, too, the incised design is blackened. One consists of a disk of *Tridacna* shell bearing frigate-bird and bonito-fish designs; it is a highly valued ornament, and our specimens are from Malaita and the southern Solomons. The other one is a disk of black mussel shell, on which the central motives are similar to those on New Ireland kapkaps, while the numerous concentric bands are typically Solomon in nature. These attractive ornaments are made by the sons of chiefs as gifts to favoured girls, and the women wear them as part of their marriage dress.

A distinctive type of kapkap is worn as a breast ornament in the Santa Cruz islands. The *Tridacna* mount is exceptionally well finished and is sometimes very large. The polished turtle-shell plate is ladder-like in arrangement, rather



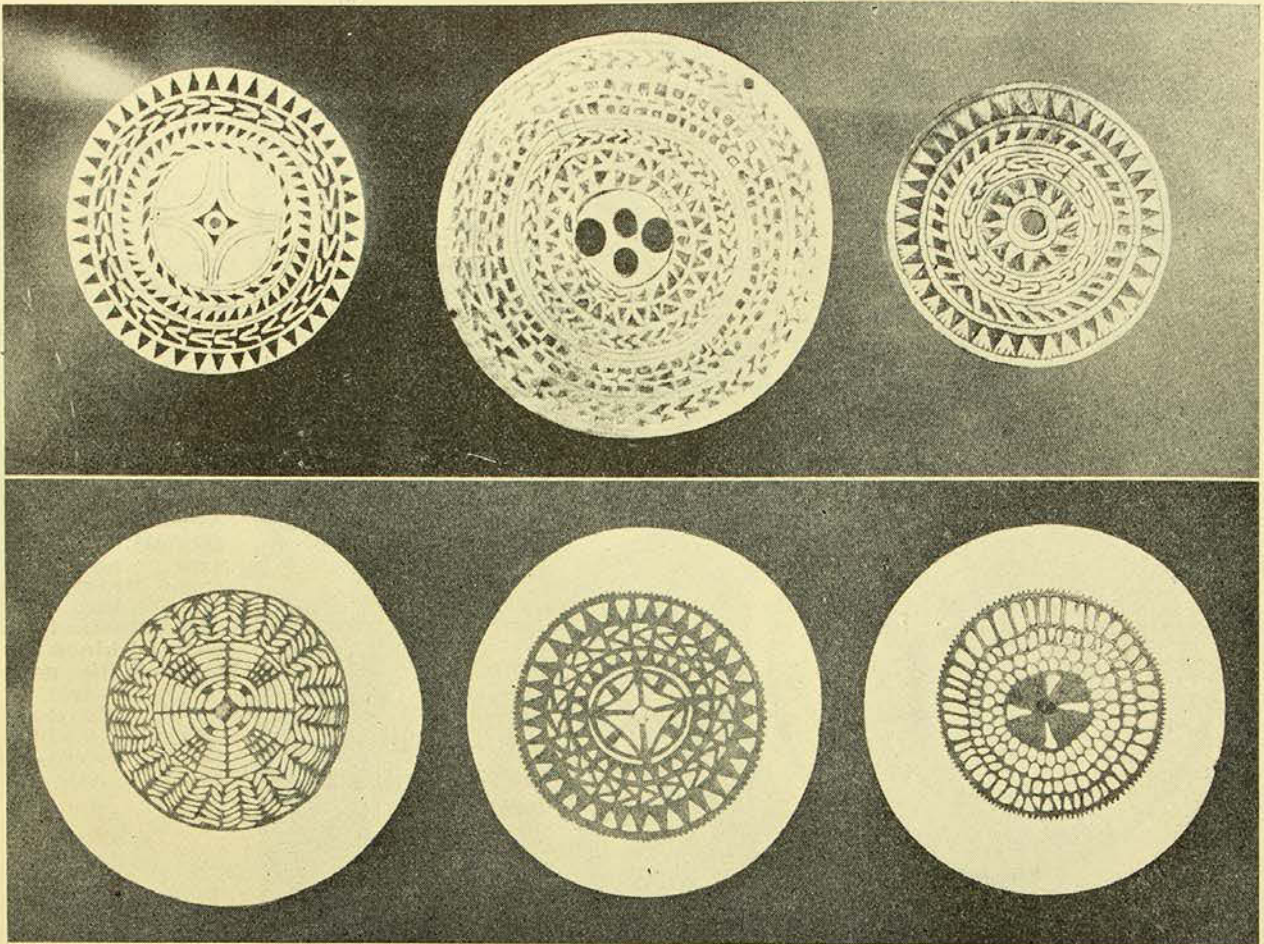
Two large and finely-cut kapkaps from the Solomons in which an outer concentric arrangement of design elements is combined with a central star (Malaita Island) and a flower-like motive (Roviana Lagoon, New Georgia Island). The other two specimens, from Malaita, are frigate-bird designs incised and painted black on a clam-shell panel.

thicker than those from elsewhere, and the edges are rounded. It is attached by a binding which runs from the central perforation to the edge of the mount. The designs consist of what appear to be variations of the frigate-bird and fish motives so widely used throughout the Solomon islands to represent the hosts of the spirits of the dead. The headless bird is carved at the base in a conventionalized manner, while a series of outline or solid triangles extend upwards from the middle of its top edge. At the apex of the open triangles the sides are usually extended into a fish-tail or open bird-wings. In some of these designs a fish-like figure is placed directly above the frigate-bird base. This interpretation of the Santa Cruz designs implies that they are based upon local and sacred naturalistic motives. Miss Reichard,¹ however, regards

them as an arrangement of triangles, and an old resident of the Solomons told me recently that they are commonly believed to be genealogical records.

Most of the New Guinea kapkaps are mounted on oval concave pieces of shell. Those from the northern coast, particularly in the Sepik and Ramu Rivers district, embody a human figure, with bent limbs, as the central motive, surrounded by a border of toothed triangles which are sometimes tanged. The filigree plate is mounted on *Cymbium* shell. The kapkap is mounted on a stick and worn as a hair-pin by the men. The uncut portions of the design are broad and the work is often coarse and uneven. Another type from the Huon Gulf bears an elongate turtle-shell plate in the form of a double-headed lizard. It is mounted on a very large disk of *Melo diadema* or Baler shell, as are those from the Papuan Gulf on the southern coast. Here, the well finished carving consists of simple designs divided

¹ A detailed analysis and description of kapkaps is given by Miss Reichard in her monograph entitled *Melanesian Design*, pp. 88-124, plates xciii-exl.



Upper: Three black pearl-shell breast ornaments worn by women as gifts from male admirers. They bear kapkap designs incised on their inner surface. They are from New Georgia Island, Solomon group.

Lower: Three New Ireland kapkaps displaying the characteristic radial treatment of the design. The workmanship is finer than that in the Admiralty Islands series.

into quarters of equidistant chevrons flanked by plain, toothed or zigzag bands. Lines of oval links like a chain sometimes separate the quarters, and on rare examples a flower or cross is carved in the middle. These Papuan kapkaps are only worn by the initiated men who had, in the old days, secured the head of an enemy, but the latter qualification is now no longer required. The exact position of the kapkap on the head-dress is important, and the various designs are thought to be the property of clans. These kapkaps are also worn on special occasions by girls who have undergone their puberty rites.

Throughout Melanesia, it might be mentioned, kapkap designs are incor-

porated in the decoration of woodwork, gourd and bamboo containers, turtle-shell armlets, bark-cloth and other objects. One interesting occurrence of their use in this manner is on a large standing stone in Bougainville.

The size of kapkaps varies considerably. The diameter of the turtle-shell plate ranges from 2.5 to 13 centimetres on specimens in our collection, those from the Solomons and Admiralties being bigger on the average than elsewhere. The mount is a few centimetres larger. Preference is shown for a narrow border of shell around the carved plate in the Admiralties and the Solomons, but in New Ireland a broader white frame of shell is the rule.

Chætopterus—A Strange and Beautiful Worm

By ELIZABETH C. POPE, M.Sc.

TO most people the word "worm" conjures up a vision of something long and wriggling—something they have been brought up to despise and regard as the lowest form of life. No marine zoologist should, however, agree with this idea, for he would know that the marine, bristle-footed worms number among their members some of the most elegant and delicately coloured creatures in the world.

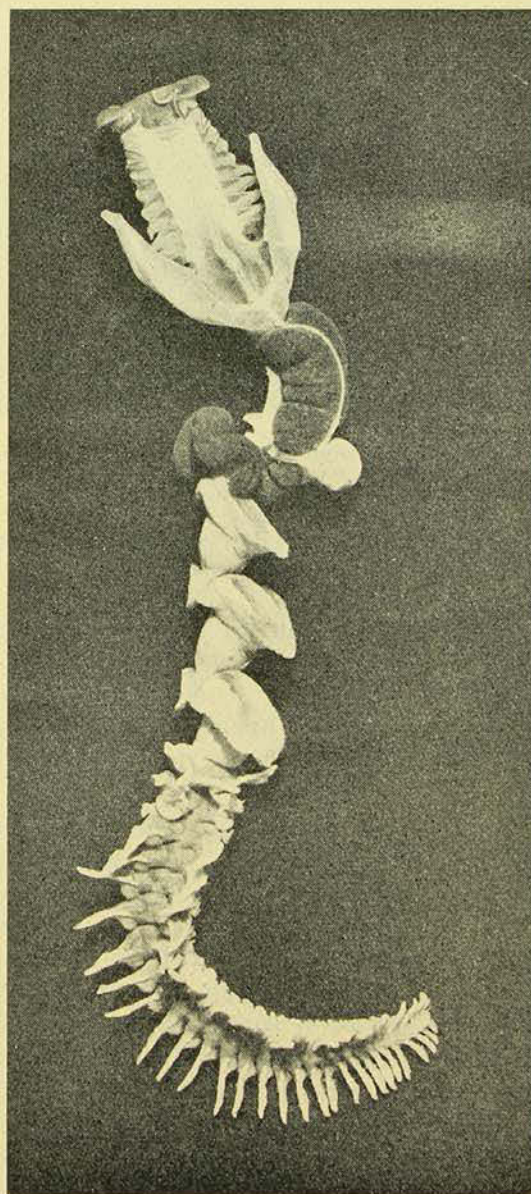
Chaetopterus, the worm about to be described, is certainly weird in shape, even for a worm, and must truly be one of the world's most bizarre animals.

Our specimens were captured in the muddy sand of Careel Bay in Pittwater, but only after an afternoon's digging and at the expense of several blackened and broken finger nails. It cannot be claimed that these worms are rare, for signs of their U-shaped, tube-like homes may be seen on many a mud flat in the vicinity of Sydney. However, the job of digging them out all in one piece requires much patience and not a little technique. Consequently few worms find their way into museum collections. In fact, we found that although The Australian Museum had several fine specimens of chaetopterid worms, all were imported species. We therefore determined to catch several of the local species and preserve them properly. This is not such a simple matter as it sounds, as you will see.

Overseas the popular name Parchment Worm is given to this creature because the tube in which it lives has white papery ends looking rather as though they were made of thin parchment or as if someone had left a series of drinking straws sticking up through the mud. These papery ends project above the level of the mud and sand, sometimes as much as two or even three inches.

As already mentioned, the tube the worm builds is U-shaped and therefore

has two entrances. The tube walls below the ground level are muddy in appearance and much wider than the portion above the ground. When the tide is high and covers these outlets, the worm can create a current of water flowing in at one end and out at the other by flapping the



Chaetopterus luteus has a most fantastic shape.

Photo.—G. C. Clutton.



Digging the worm from its home in the mud. Top left: The *Zostera*-covered mud flats of Careel Bay, Pittwater, where the worms were found. Top right: Blowing down one of the tubes to find its 'back door'. Lower left: Having trenched round the worm's tube, the two parchment-like ends are left projecting from an island of mud. Lower right: The whole U-shaped tube is successfully removed from the mud.

Photos.—Prof. W. J. Dakin.

three large, pale-coloured paddles or fans seen in the accompanying photograph, in the middle region of the body. Food particles, oxygen for breathing and other needs are obtained from this stream of water.

To say the least of it, the shape of *Chaetopterus* is fantastic. It has to be seen to be believed. In fact, several people who have seen the worms have likened them to some strange orchids, and not without reason, for there is some faint resemblance between the labellum of some kinds of orchids and the front region of the body. A careful examination will, however, disclose the fact that the body is divided into a series of segments or rings and that bunches of sharp little bristles stick out from the projections at the sides of each of these body segments.

The creature therefore belongs to the group of worms known as polychaetes. This group also includes such other well-known forms as the giant bait worm of the ocean beaches (*Onuphis*) and the "pump" or "squirter" bait worms of the estuarine beaches (*Nereis*). Another polychaete worm well known to the public and particularly to the men who dock and scrape ships is the one which builds for itself a limy tube and is known locally as "coral". Its scientific name is *Galeolaria*, but when a rock or a boat's keel is covered by packed thousands of their small hard tubes there is some excuse for using the name "coral" if one judges the nature of the growth from a mere cursory glance. The *Galeolaria* worm lives exclusively in its protective tube and its body is specially adapted for

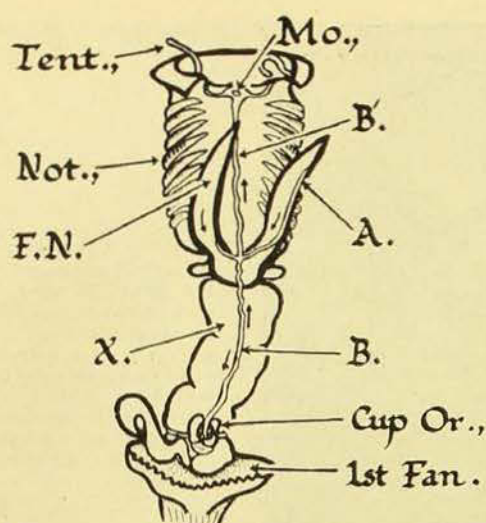


Diagram of the anterior region of *Chaetopterus*. 'A', 'B', 'B' are food-collecting grooves; Cup. Or., cup-shaped organ for making food pellets; F.N., food-collecting notopodium; Mo., mouth; Not., ordinary notopodium; Tent., tentacle or cirrus; X, liver region of the body.

E.C.P., del.

such an existence. Not only are its breathing gills concentrated at the front end of the body instead of being distributed all along its length (as in errant polychaetes) but in addition to other adaptations the body has developed an organ called the operculum by means of which the worm can plug up the entrance to its tube when it has retired there for safety. Many sea snails also adopt this means of defence.

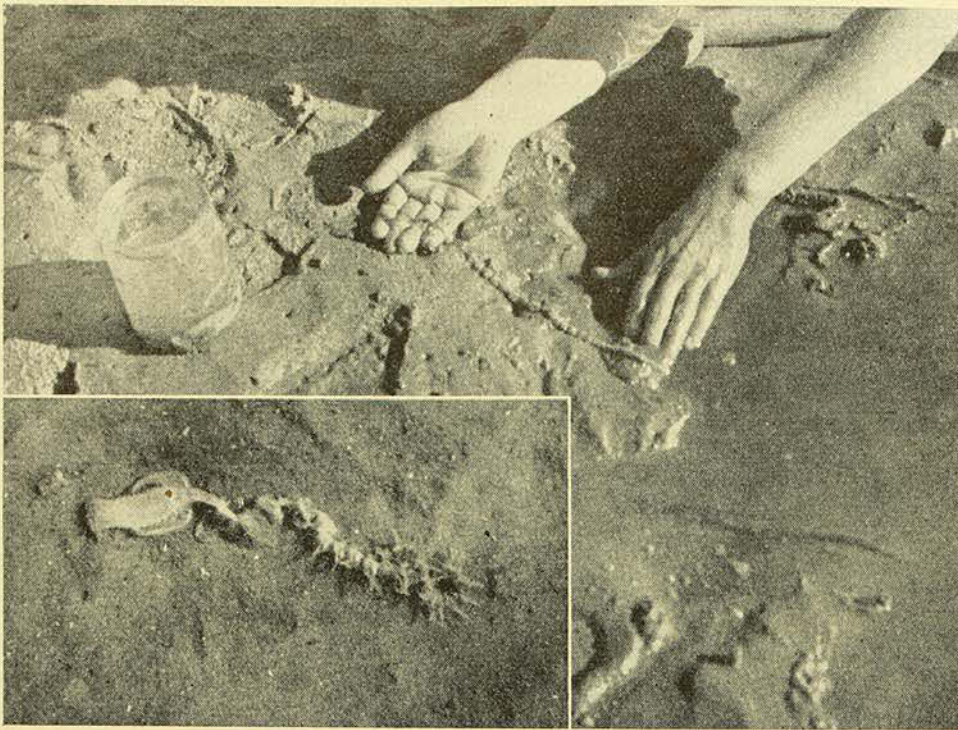
Chaetopterus, like *Galeolaria*, leads a tube-bound existence and is probably the most adapted and specialized of all such worms leading this kind of life. As already mentioned, an efficient water-pumping mechanism (the three paddles or fans) can create appreciable water currents through the worm's tubey home, for the worm fits its house but loosely, and there is plenty of room for water to pass by its body.

The accompanying line drawing of the front region of the body may help to explain how food is passed to the mouth. It is extracted from the passing currents by a complicated arrangement of food-collecting grooves and a special food-collecting notopodium (F.N.) situated immediately behind the front region of the body. Solid particles from the water are entangled in a slimy mucus, produced

by the body in the front region, and this slime is driven along by tiny currents produced by thousands of waving hairs or cilia situated in the grooves (marked A in the line drawing) on the enlarged food notopodium. From these grooves it is passed back along the similarly ciliated groove (B) to the cup-shaped organ (Cup. Or.) where food balls are formed. These food pellets are passed again along the groove (B), but this time forwards. Thence they pass via the groove (B¹) to the mouth (Mo.) and here the food enters the gut itself—a very roundabout way of feeding, but one which would appear to be quite effective judging by the numbers of worms present on the mud flats and in shallow waters.

In the middle region of the body lie the three large paddles or fans which ceaselessly wave back and forth to create the currents of water through the tube. Several of the worms we captured were placed in three-quarter inch wide glass tubes and these latter immersed in a basin of fresh seawater. We were thus able to observe how *Chaetopterus* behaved when in its tube. The most obvious feature of the worm's behaviour was the ceaseless oscillation of the fans which may be seen clearly in side elevation in the accompanying photograph. Also of interest was the creature's ability to anchor itself to the side of the tube by means of a series of sucker-like developments on the lower surface of each of the body segments in the middle region of the body. Three of these flat plates are clearly to be seen in profile in the illustration, to the left of each of the fans. Were it not for the clinging action of these suckers the waving of the fans would soon propel the worm from its tube.

In the photograph which was taken when the worm was heavily doped with alcohol and therefore motionless, the food-collecting groove is particularly distinct and may be seen leading back to the cup organ which consolidates the food into balls before passing them forwards to the mouth. As a rule, the two large food-collecting notopodia are held a little closer together than shown here, thus creating the side walls of a groove of



This *Chaetopterus*, newly removed from its tube, is more than one foot long. Inset shows same worm after exposure for some moments to the bright light. The body contracts to a length of seven or eight inches.

Photos.—
Prof. W. J. Dakin.

which the body itself forms the bottom. This arrangement ensures that the water currents pass along the "business side" of the body and run the gauntlet of the food-collecting grooves. The dark, much convoluted part of the body, just behind the food-gathering notopodia, is the liver region.

Each of the body segments in the hinder part of the body has a finger-like cirrus growing out from the upper surface on each side. In the breeding season, before the eggs or sperms are shed into the water, these outpushings are filled by the sex cells and lend a note of bright colour to the body; for ripe eggs are a beautiful salmon pink in hue and the male sex products are lemon yellow. In February of 1946, when these worms were first captured, both the males and females were full of ripe sex cells, but by the end of May most of the females we captured had shed the majority of their salmon-coloured eggs into the water. Most of the males, on the other hand, still contained a plentiful supply of yellow sperms in their bodies which they promptly shed when captured.

It is possible that the original specimens of *Chaetopterus* which were captured by the American scientist, Stimpson, on Boxing Day in the year

1853, when he scraped them from our harbour's floor with a naturalist's dredge, were all males, for he described them as having lemon-yellow coloured bodies and named the species *Chaetopterus luteus*. The adjective, *luteus*, comes from Latin and may refer to the fact that the worms had a yellow colour or else to the fact that they came from muddy surroundings, for *luteus* can have either of these two meanings.

The digging out of these worms and their tubes is no easy matter. After much trial and error we found the following method to be the best. On locating a patch of mud flat where the papery tubes are evident, it is better not to dig at random and much time is saved by establishing which of a number of tubes are in direct connexion with one another. A piece of conduit piping or a short bit of rubber hose-pipe to use as a blower is a great help. Place the end of your tube over one of the parchment-like worm tubes and seal off the bottom of the blower by pressing it into the mud. Next blow powerfully down your tube and observe which of the neighbouring worm tubes spurts water. Generally only one does so, and this is, therefore, the "back door" to the one originally chosen. Occasionally



The slit tube reveals the worm in situ.
Photo.—Prof. W. J. Dakin.

a tube has a side entrance as well and when excavating begins, care must be taken to include any such side parts, otherwise the worm will retire there and evade capture.

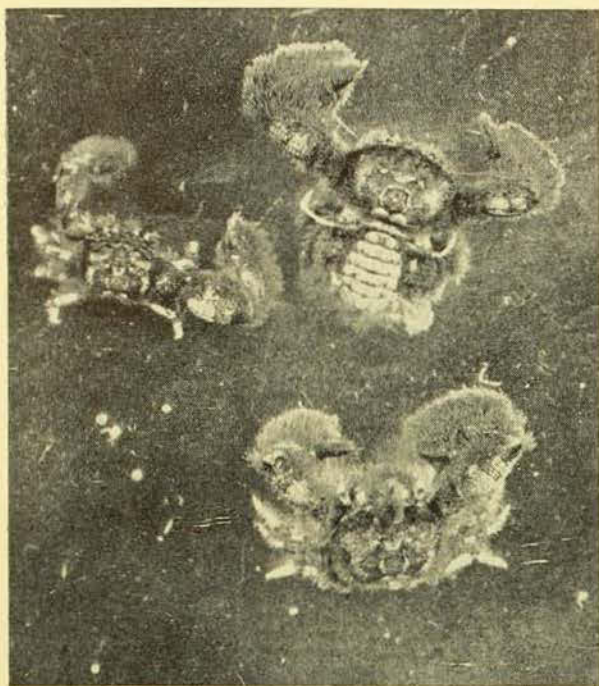
Once having decided on the particular tube to be dug out, the next step is to trench round the whole area, leaving the worm's home in an island of mud in the middle, as shown in the accompanying photograph. This may seem an unnecessarily laborious step, but it does drain the water away from the worm's home and allow the digger to see better. After these preliminaries, all that remains to be done is to dig out the delicate papery tube without tearing the "tissue-papery" walls. Bare hands are probably the best implements because the sense of touch is necessary in order to follow the course of the tube through the mud and rubble. Some of the tubey homes are only a foot or so long, like the one illustrated, but some three or four feet long were dug out—no mean feat, on account of the delicate walls.

Once the tube is dug out, it is a simple matter to slit it gently and float the worm out into a jar of seawater or a shallow pool, where its reactions may be observed.

The worm has enormous powers of expansion and contraction, as may be seen in the picture which shows, between the collector's hands, a worm, newly taken from its tube. It is over a foot long. A few moments later the bright light had caused this same worm to contract itself to the size shown in the inset.

Although the worm is both the architect and builder of its tube, it is not, as a rule, the only occupant. A small, very hairy "crab" called *Polyonyx transcrsus* also makes its home there. Crustacean and worm appear to be commensals or messmates; i.e., the crab cannot be classed as a parasite although it appears to be unable to live in any other situation. One, and sometimes two, *Polyonyx* may be found in a tube. In the latter case they are generally found to be male and female. Three of these crabs are shown in the photograph—two large females and one smaller-sized male. Below the male, three round, whitish eggs and one tiny zoeal larva-stage are seen. These were shed into the water by one of the females while photography was in progress.

No doubt the long hairs on the crab's limbs, and jaws, are used to strain off the food particles from passing water currents. Lest the reader should imagine that the crab is lazy and uses the worm as a kind of aquatic punka wallah, it must be stated that this idea is soon abandoned when the behaviour of live crabs, placed in glass tubes, is watched. The crabs can, and do, create powerful water currents of their own, by flapping their much enlarged tail portions or abdomens. In the illustration the abdomen of the top, right-hand crab has been untucked and even the most casual observer can see at once that this part of the body is proportionally much larger than in the more orthodox types of crabs. In fact, *Polyonyx* is not a true, brachyuran crab at all, belonging rather to the hermit crab group—the *Anomura*. Distinguishing characters are, firstly, its well developed, functional abdominal region (though this region is carried tucked under the body as in normal crabs); secondly, only three pairs of walking legs are visible behind the enlarged nipper



A peculiar, small crab, *Polyonyx transversus* makes its home in the worm's tube. Two females and one small male are shown.
Photo.—G. C. Clutton.

limbs (four are seen in true crabs); and thirdly, the fifth pair of "walking" limbs is much reduced in size and is carried folded up and hidden from sight in the gill chamber. In the female crab in the photograph, where the abdomen has been spread out to view, these fine, whitened back limbs can easily be seen.*

The difficulties of photographing live *Polyonyx* are greatly increased on account of the active flapping movements of the abdomen, by the waving of the feeding brushes on the jaws and also because the crab does not appear to be content till some portion of its body is pressing hard up against something such as the walls of its own tube or the sides of the dish in which it is placed. Time and again the crabs were posed artistically in the

dish but the moment that an attempt was made to make an exposure they would sidle off to the margin of the dish and huddle there.

Much could be written about the peculiar relations between these crabs and their worm hosts, or of the peculiar bouncing mode of locomotion they adopt for moving about their tubular quarters, or we could tell how, after nightfall, our *Chaetopterus* worms in our home-made aquarium treated us to a splendid display of luminescence, but space will not permit. Why a worm which spends its life below ground and hidden from view should have this ability to give out a ghostly, phosphorescent light is a mystery that has not as yet been solved. One suggestion that has been made is that the glow may issue from the tube entrance and attract small plankton towards the mouth of the tube. These would then be drawn into the tube by the water currents and provide repast for both the worm and its crab messmates. However, the behaviour of worms in captivity is no criterion of their behaviour in a normal environment. Perhaps our excessive handling of them caused them to give off light and they may not do this in their own homes. This is a question that remains to be answered. A careful amateur naturalist with a boat, patience and time to float over the mud flats at night might well find the answer to it by locating some *Chaetopterus* tubes during the day, marking the spot and going back there after dark, when the tide is high, and watching patiently to see what happens. This is only one of the many fascinating queries that remain to be answered about *Chaetopterus* worms and the interested shore collector will certainly find that the trouble of digging out a few specimens will repay the effort expended.

The Board of Trustees has recently suffered the loss by death of two of its members. On 24th November Sir Samuel Walder, Kt., passed away. He was prominent in commercial circles and had participated actively in the civic government of Sydney; for a period he was Lord Mayor. On 7th December Mr. C. A. Sussmilch, F.G.S., died. Mr. Sussmilch

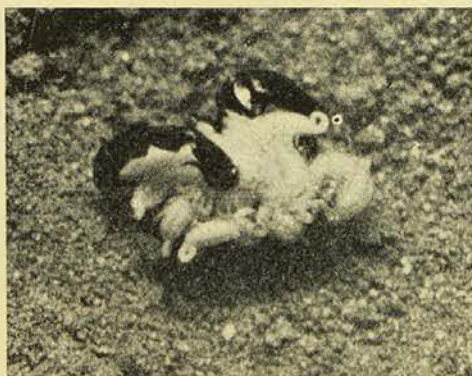
was well known for his geological researches and scientific interests. For many years he was attached to the Technical Education Branch of the Department of Public Instruction.

Both these gentlemen devoted considerable time to the affairs of this Museum and were interested in all phases of its work.

Scorpions

By L. GLAUERT, B.A.

"THE Scorpion is one of the great animals of ancient lore and tradition. It and the crab are the only two invertebrates which had impressed the minds of early men sufficiently to be raised to the dignity of astronomical representation."¹ When, therefore, some years ago, a visitor to the Western Australian Museum presented a female of our common western sand scorpion *Urodacus novae-hollandiae* with her young family upon her back it was not surprising that my interest in the group was aroused and I decided to study the habits of some of our local forms.

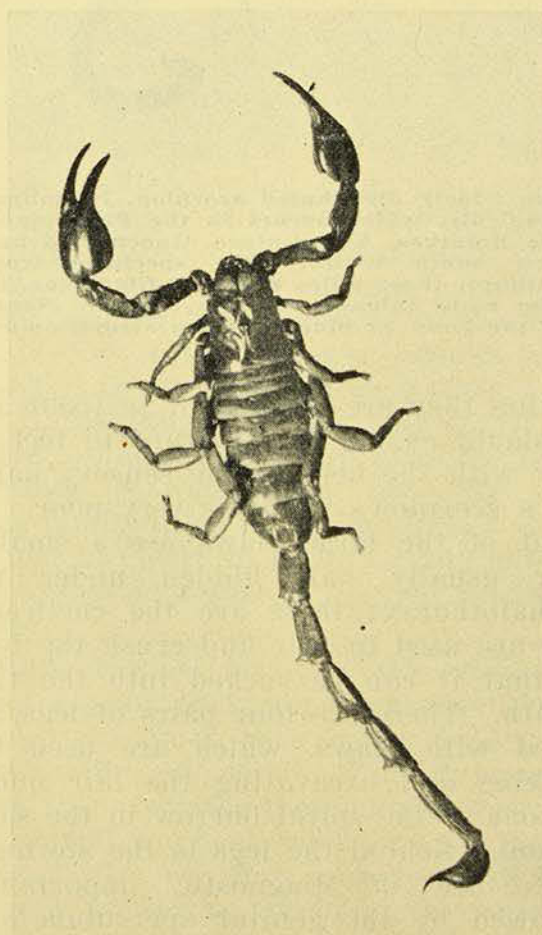


Urodacus manicatus and young.

Photo.—Prof. F. Wood Jones.

Scorpions are members of the Class Arachnida which are readily distinguished from the Class Insecta by the possession of eight instead of six walking legs. Their own peculiar features are a pair of crab-like claws, a rather elongated body and a slender tail terminating in a swollen poison-holding "vesicle" and a sharp curved sting. Actually the "body" consists of the head and thorax, the so-called cephalothorax, united under the carapace as in spiders, and a seven-jointed abdomen which may be considerably expanded in a gravid female or when

stretched to the utmost after a heavy meal. The tail is divided into five segments at the end of which is attached the poison apparatus consisting of the poison "vesicle" and the sting. Anatomists would reduce the abdominal segments to six, adding the last to the post-abdomen or tail for excellent reasons, but we prefer the popular terminology.



One of our largest Australian scorpions, *Urodacus planimanus*, a male. It measures about four inches in length. This specimen came from Darling Range, near Perth, Western Australia.

The most prominent appendages are the pair of large claws which are used by the scorpion in various ways: when in

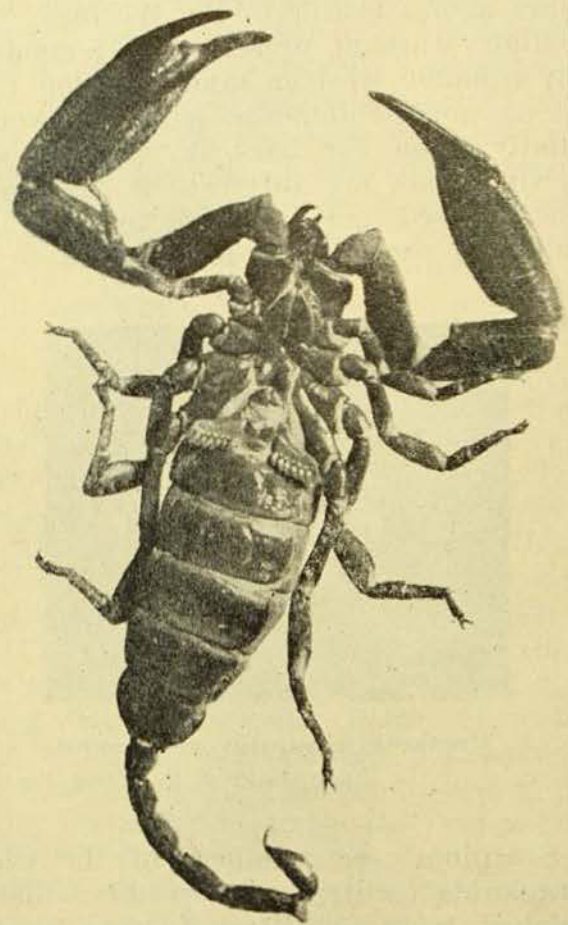
¹ Lankester, E. Ray: *Quarterly Journal of Microscopical Science*, Vol. 48, Pt. 2, 1904, p. 234.



The widely distributed scorpion, *Hormurus caudicula*, which occurs in the Philippines, the Moluccas, New Guinea, Queensland and New South Wales. The specimen from Calliope, three miles north of Gladstone, Q. The male (alone) has the movable finger of the hand or pincer with a strong spine.

motion they are spread out in front and no doubt enable the creature to feel its way with the help of the sensory hairs, for a scorpion's vision is very poor. In front of the large claws are a smaller pair usually half hidden under the cephalothorax; these are the chelicerae and are used to tear and crush the food so that it can be sucked into the tiny mouth. There are four pairs of legs, all fitted with claws, which are used for walking and excavating the lair under a stone or the spiral burrow in the sand or soil. Behind the legs is the sternum, a feature of diagnostic importance, followed by the genital operculum and the pectines or combs, the function of which is not yet understood. The next four sternal plates carry the openings to the breathing organs, the so-called "lung books". The next and last tapers to the "tail"; as it has no special features it is considered to be anatomically the first segment of this appendage.

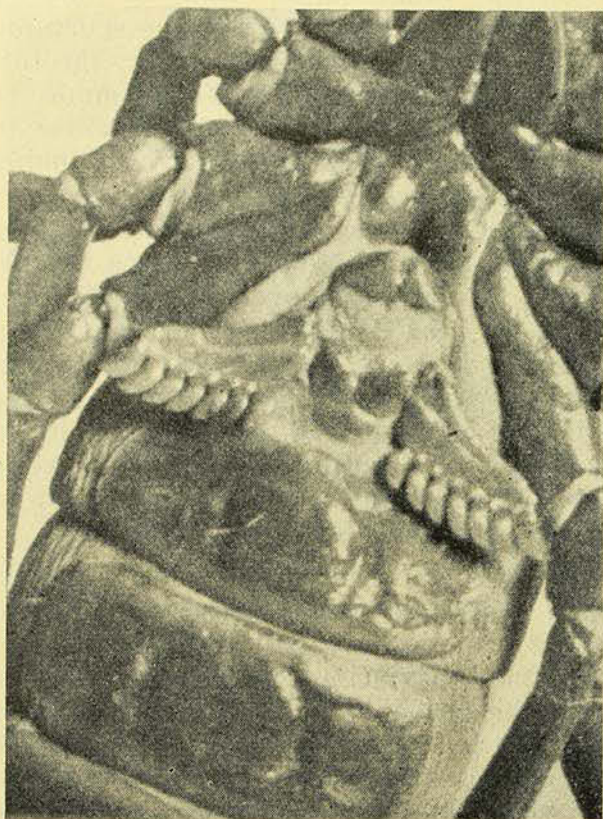
Although it is generally held that scorpions are creatures of the desert, this is not confirmed by a study of our Australian forms which are known from the high rainfall area of the north, from the agricultural districts and from the heavy timber country in the far south. In Eastern Australia they range to southern Victoria and even Tasmania where a single species, *Cercophonium squama*, has been recognized as a constituent of the island fauna for more than a century.



Undersurface of *Hormurus caudicula* showing the combs or pectines which are special tactile organs.

Relying at first upon the accuracy of an opinion so widely held, I provided the first scorpions kept alive for study with loose dry sand in which to burrow and a piece of stone should they prefer that as a covering. Some burrowed in the sand, others crept under the stone, but all soon died. It was then realized that

moisture was necessary. On one occasion a sand scorpion was placed in a tall jar of damp sand where it soon excavated a shallow burrow using its front legs, not its claws, for the purpose, pushing out the material excavated with its hind legs and sweeping it away sideways with its



A magnified illustration of the combs or pectines of *Hormurus caudicula*.

tail. As the sand dried, the scorpion dug deeper in the form of a spiral until the bottom of the jar was reached. Water was then sprinkled on the sand, after which the scorpion seemed more at ease and survived in confinement for several months.

Similar burrows are known to occur in Nature. *Urodacus fossor* has been collected near Broome, N.W.A., at the bottom of a spiral burrow four feet underground and recently the Western Australian Museum received a sand scorpion "found in sand at Bullsbrook, W.A., at a depth of approximately six feet".

It would seem that dampened or a humid environment is essential for the creature's well being and that when this

is provided a scorpion can be kept under observation for months. Nevertheless, scorpions do occur in the more arid parts of Australia, where, in some favourable districts, they are remarkably abundant. But they are creatures of the night, spending the day underground and emerging after dark when the air is cool and damp to hunt for their prey or to search for their mates at the proper time of the year.

Very little is known of our scorpion's mating habits. On one occasion a male sand scorpion was seen dragging a female by the claws in an endeavour to take her under a nearby stone, and once a pair were revealed in the attitude described by Fabre² when a flat stone was suddenly lifted. As scorpions are essentially nocturnal, it is not surprising that so little has been discovered by means of daytime observations.

In due course the young are born. Scorpions do not lay eggs, the young developing inside the mother's body. They are tiny white colourless creatures with black eyespots. They at once climb on to the back of their mother, where they remain for several weeks. Should one fall off it is replaced by the mother who lifts it carefully with her claws if it is unable to find its way back unaided. This solicitude is remarkable, for once the young family leave the parental back they are just as likely to be killed and eaten, as is any other creature, by their heedless parent.

Whilst carried about in this way the young do not feed, but they shed their skin several times, their colour becoming darker with each moult. Finally hunger forces them to leave their mother's back; they scatter and henceforth fend for themselves, beginning that solitary existence which is unbroken, except at the mating season, until death.

This solitary mode of life so characteristic of *Urodacus novae-hollandiae* and its relatives is not universal for I have found the Little Marbled Scorpion, *Lychas marmoreus*, in clusters of 30 or so under

² *Life of the Scorpion*, English Edition (1923), p. 149.



The small scorpion, *Lychas marmoreus*, from the Nepean River, New South Wales, occurs widely over Australia and in New Guinea.

logs, old bags, planks, and even the bark of trees at the end of summer.

The third common genus of South-western Australia, *Cercophonius*, resembles *Urodacus* rather than *Lychas* in its mode of life. Our Western *Cercophonius sulcatus* seems to flourish best in the more humid parts of its range where it may be found under logs or stones. I have not known it to burrow when kept for observation in a jar with damp sand and small stones.

All our scorpions are predatory. They will not touch carrion. They can take enormous meals and fast for weeks after a gorge. The mouth of the scorpion being so small that food can only be taken in a liquid form or as comminuted fragments, several experiments were arranged to watch the animal's mode of procedure.

Where a small fly was offered and the scorpion hungry, the prey would be seized with the claws and passed to the chelicerae which at once began to tear the victim to pieces, the two appendages working alternately. It was noticed that the sting was not brought into play.

On the other hand when a buzzing blowfly was held in front of the scorpion, again *Urodacus novae-hollandiae*, the tail was brought over and efforts made to insert the sting in the head, or close to the head of the insect. Not being successful, the scorpion eventually carefully inserted its sting into the softer abdomen. After a few convulsive twitchings of the legs all movement on the part of the fly ceased and the scorpion began to feed. The chelicerae were now alternately protruded and withdrawn and the lacerated abdomen of the fly brought in contact with the diminutive mouth, when the soft substance was sucked up and passed into the stomach.

On another occasion an American cockroach that had been injured was offered to the scorpion which at once accepted the proffered victim. As in the previous case, the insect was held by the claws and torn by the alternately moving chelicerae. All the soft parts and most of the chitinous skin were eaten by the scorpion.

The poisonous property of scorpion venom has been known since ancient times, so it is not surprising that its virulence has been much exaggerated. Fatalities are rare, even in countries where large species abound. The only Australian case known to me occurred at Pemberton in South-western Australia

Urodacus novae-hollandiae attacking a spider.



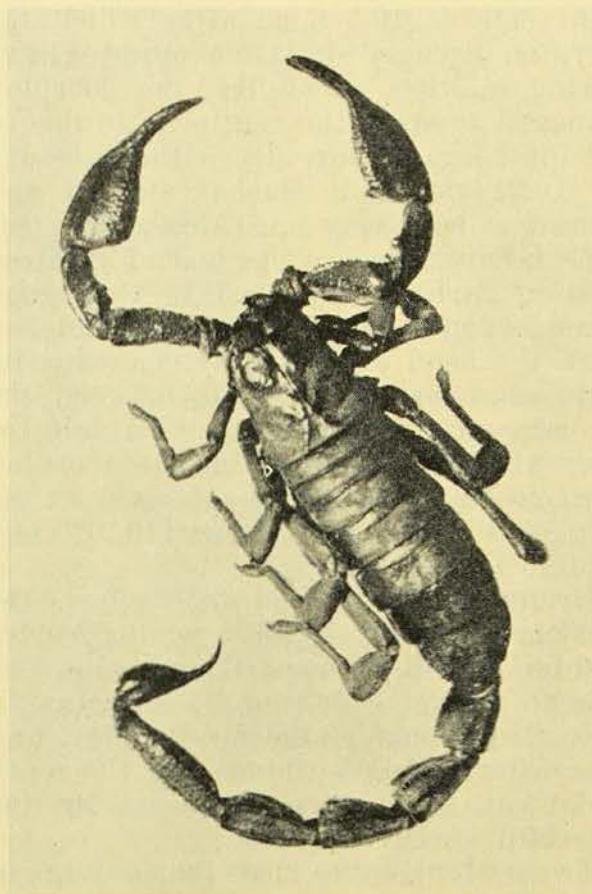
in September, 1929, the victim being a baby. Unfortunately the scorpion was destroyed before its identity was established.

The flow of poison is not automatic as in snakes, but can be regulated and controlled by the scorpion through the muscles covering the poison reservoir. An irritated scorpion may therefore be induced to expel venom even before the sting is brought into use, the tiny droplet of water-clear liquid becoming visible just below the tip of the sting.

To test the effect of the poison upon animals larger than those normally destroyed by scorpions, I irritated a full-grown *Urodacus novae-hollandiae* until a droplet of the venom appeared, and then thrust the spine into the thigh of a two-inch-long Striped Burrowing frog, *Limnodynastes dorsalis*, keeping it there for about three seconds. There was no immediate result, except an audible squeak from the frog as the spine was inserted; some minutes later the movements of the frog became sluggish and the next morning it was dead. I have information concerning only a few cases of human victims. In 1924 a child whilst digging round the pampas grass was stung by a sand scorpion, the result being "a very bad swollen finger".

Three cases of stings by the Little Marbled scorpion, *Lychas marmoreus*, have come under my notice, the specimen concerned having been forwarded to me by my informant in each case. One victim reported that it throbbed like a boil for about three hours, immersion in hot water easing the pain a little. The second case, also a sting on the hand, reported that the fingers and hand became swollen and pained for three hours although kept in hot water and ammonia to ease the pain. The third victim was stung on the arm: "it smarted at first and then burnt, but got alright afterwards."

In most instances complete recovery after three hours or so was reported, although Dr. H. Flecker³ cites cases where the pain was still felt 12 hours



The well-known West Australian scorpion, *Urodacus novae-hollandiae*; the specimen from Perth.

later. The quantity of venom injected is evidently the controlling factor.

It would seem that in Australia adults have little to fear from a scorpion sting beyond a few hours' pain and inconvenience which may be reduced by holding the injured member in hot water to which some ammonia has been added.

Several experiments were arranged to study the behaviour of scorpions when brought in contact with creatures they would meet under normal conditions and to observe the results of stings administered to the foes.

A Western sand scorpion, three and a half inches long, which had been kept in a glass jar for some days was confronted with a centipede, *Cormocephalus auran-tipes*, measuring four and three-eighths inches. When first placed together both seemed timid, but later they came to grips. In the course of a tussle the centi-

³ "Injuries Caused by Australian Scorpions", *Medical Journal of Australia*, June 5, 1937, p. 875.

pede bit the scorpion in the 4th leg on the right side at 10.5 a.m., after which the scorpion disengaged. A few minutes later during another encounter, the scorpion managed to sting the centipede in one of the hind legs, apparently without result. At 10.21 the final combat started and proved to be a very one-sided affair, perhaps because the centipede had received a sting earlier. By good luck or good management the scorpion was able to seize the head of the centipede with its right claw and fix its left between the second and third segments. In spite of the writhing of the victim the scorpion inserted its sting in the soft skin at the side of the ninth segment (10.24) and held it there.

Gradually the poison took effect, the movements of the victim becoming feebler and feebler till, at noon, the scorpion was able to relax the grip of its left claw in order to prepare to devour its prey, and soon after 1 o'clock the head of the centipede was being torn to pieces by the powerful chelicerae.

Twenty-four hours later the contents of the first four segments had been abstracted by the scorpion which then ceased feeding. Twenty-nine hours after the insertion of the sting the legs of the last few segments of the centipede were still capable of vigorous movement and even after forty hours life was not yet extinct in the headless body.

On another occasion a female Sand Scorpion and a centipede, *Scolopendra*

morsitans, were placed together in a jar and induced to fight. When the first grapple took place, the latter managed to reach the head of the scorpion and administer a bite. Within five minutes the scorpion was disabled and in half an hour was dead. It will be recalled that *S. morsitans* is considered to be the most dangerous and poisonous of our centipedes.

To test the oft-repeated statement that scorpions are immune to the poison of the species, two sand scorpions, a male and a female, were induced to fight. In the course of the combat both managed to insert their sting for a longer or shorter period, the male apparently showing signs of distress. The next day it appeared to have recovered but the female was dead; a day later the male also succumbed.

On another occasion two males were irritated until tiny droplets of poison appeared near the tip of the sting. The tail of the one was then seized by forceps and the sting inserted in the elastic skin on the right side of the other between the penultimate tergite and sternite and kept there for several seconds. Forty minutes later the victim was bleeding but showed no other ill effects. However, the next morning it was dead.

It seems probable that, though scorpions will devour the beaten enemy and suffer no ill effects, like venomous snakes they will die if the poison enters the body except through the mouth.



Gorged female, *Urodacus novae-hollandiae*.

E. M. Tothill del.

Birds of a Tropic Isle

By FRANK A. McNEILL.

VIVID memories are not easily erased and first impressions are lasting ones. This is what I have come to realize to the full while penning four previous instalments describing a memorable visit to that speck of coral-built land—Nor'west Isle in the Capricorn group. Subsequent years have brought me new and rich experiences on many other parts of Australia's Great Barrier Reef, but these all lacked that newness of my initial introduction to the tropics. Admittedly I could not have selected a better place, for nowhere else is there to be found such a concentration of representative fauna and flora. Every part of the island and its surroundings was literally teeming with life. So much so that in my reminiscences to date the reader has been introduced to little more

than the encircling reef and the beach zone of Nor'west. Only passing mention has been made of the myriads of sea birds whose presence enriches this island wonderland.

Now I intend to penetrate beyond our camp site to explore the fascinating interior—the breeding ground of countless white-capped noddy terns and the mutton birds known as wedge-tailed sheer-waters. Stepping only a few yards in from the bright sunlight of the strand one felt the encompassing effect of the thickly-foliaged *Pisonia* trees, throwing out their long fantastically-shaped limbs. From high above, the light was filtered through countless layers of pale green leaves—soft wide leaves five inches and more in length. In many places the foliage was barely free of the ground, but an easy



As the light is fading the birds head homeward from the sea. The air is crowded with the winging hordes seeking sanctuary before darkness descends.

Photo.—A. Embury.



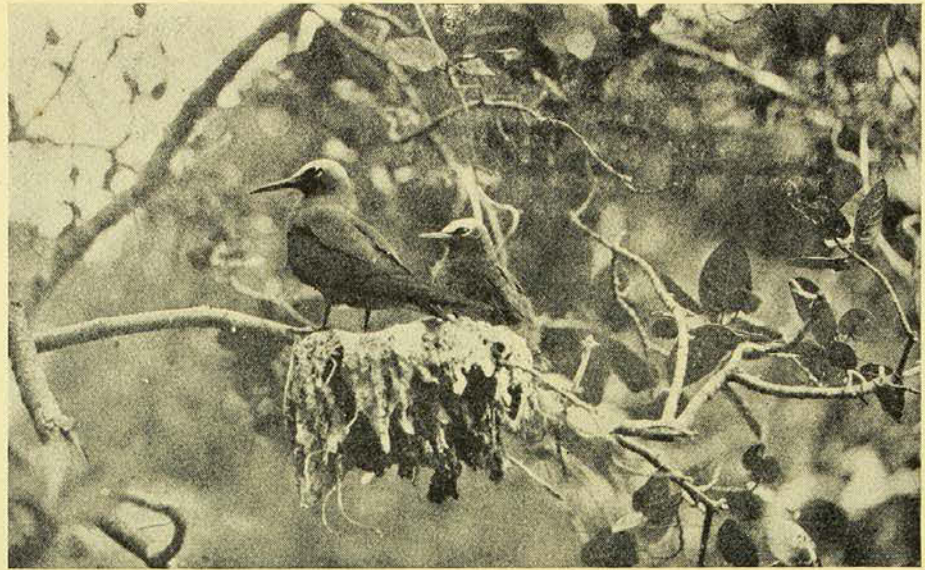
The enveloping soft light green leaves of the Pisonia trees provide bounteous shade for this camp site at the edge of the forest on Nor'west Isle.

Photo.—F. A. McNeill.

way could be made over and between the limbs while we padded the yielding mould of the forest floor. In this strange new world among the interlacing trees the air was quiet. The only sounds that came to us were the high-pitched piping calls of the noddy terns. These delicate little long-billed birds were everywhere—countless numbers of them upon and around nests that appeared to weigh down the branches like crops of fruit. Even the most precarious perches were at a premium. I had never before imagined such a spectacle. Many of the trees carried eighty and more nests—be-draggled affairs built with freshly fallen pisonia leaves which overhung the edges. They were little more than level platforms, and we marvelled that they could safely accommodate the single pigeon-sized eggs the birds were hatching. If our movements were careful, the birds would remain on their nests while we passed within a few feet. Our clumsiest passage through the forest caused only a passing disturbance, for the fluttering shapes lost no time in settling down again to their ordered existence. The swirling clouds of birds wheeling and banking above the trees was quite a normal thing. From them came most of the cries that filled the air. During the daylight hours their numbers never seemed

to change. The occasional glimpses we got through the leaves indicated that there was a continuous shuttle-like service between the nests and the surrounding sea. Mate appeared to be interchanging with mate as each left the nest either to feed or to gather food for a small fluffy offspring. Among those myriads of birds, there must have been remarkably few accidents through the long breeding season; no chicks could be found which had tumbled headlong from the nest. The adults are the ones which have to face the greatest danger to life, for towards the end of the summer, many accidentally become fouled with the extremely sticky bunches of pisonia seeds. Picked up on their feathers either in the trees or when gathering fallen leaves to build a nest, the seeds often hopelessly impair flight. Thus the victims face a speedy end from starvation while floundering about helplessly on the ground. It is nature's design to propagate the pisonia trees on similar islands afield, but the best laid plans will often go astray. The same tragic fate is also met every year by hundreds of the mutton bird population of Nor'west. As late as the month of May dozens of weakened and emaciated victims may still be found lingering on the sands near the water's edge. They stagger out from their haunts in the forest

White - capped Noddy Tern and fledgling in a typical bedraggled nest of *Pisonia* leaves.
Photo.—A. Embury.



to be mocked by a sea which was once their salvation. The end comes slowly with mutton birds, for they have a large store of fatty tissue from which the body can draw sustenance.

Having now introduced these sooty-black birds, I must hasten to record that they too held our wrapt interest during the exploration of the pisonia forest. While the noddy terns had the trees to themselves, the mutton birds occupied exclusively the basement accommodation on the islet. This we soon learnt as we penetrated farther in among the trees. At times it proved impossible to take two steps without plunging almost knee deep into one of their underground burrows. Over great areas there was

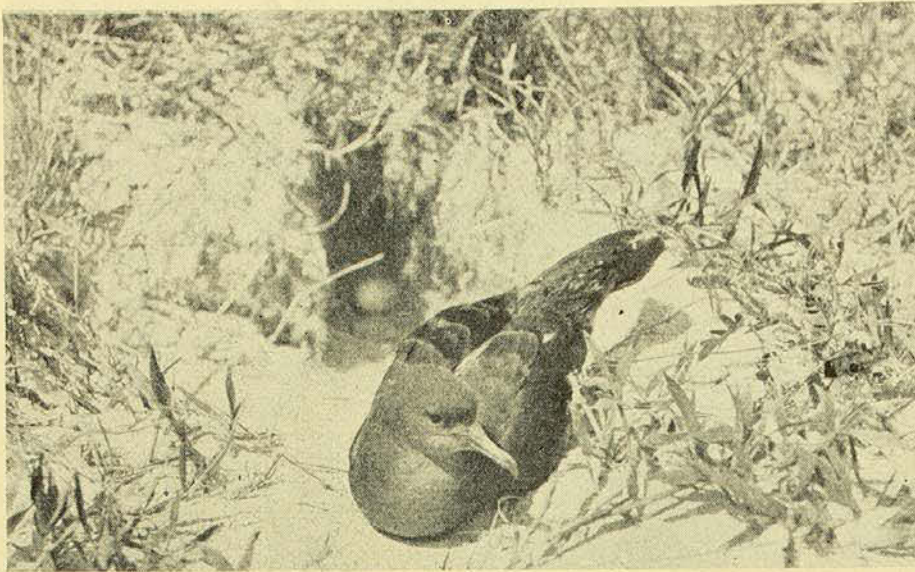
hardly a square yard which had not been honeycombed down to a depth of some eighteen inches by these industrious birds. In these dark nesting places the single eggs are laid and hatched, while the birds concerned scold and chatter in their strange avian language.

Comparatively few mutton birds were found occupying burrows during the day in this earlier part of the breeding season; most of them were out on foraging flights miles and miles away over the sea. But as often as not a dusty feathered body would scamper into the open as we went crashing our way through the earthy roofs of the underground abodes. On land the birds were easily captured. They would run stupidly about in a blundering fashion and were incapable of taking easily to flight. We soon learnt to grasp them at a point where the long wing tips crossed one another over the base of the tail. This not only prevented a lot of disconcerting flapping, but saved a captor the discomfort of a sharp peck from a strong hooked bill.



A White-capped Noddy Tern with wing and body hopelessly fouled by a bunch of exceedingly sticky seeds of the *Pisonia* tree.
Photo.—F. A. McNeill.

It is just after nightfall that the total bird population is gathered on the islet—truly a vast host. A keen student of ornithology with our party estimated there were at least twenty millions of each of the two kinds in the limited space of this lonely breeding ground. With the late afternoon the homecoming noddy



Female Mutton Bird squatting at entrance to a partially excavated burrow. The single hen-sized egg is extremely pointed at one end.

Photo.—A. Embury.

terns increase to unbelievable numbers in their race against the fading light. Then as if by mutual arrangement the main flight of the bigger mutton birds follows as the sun drops below the horizon. In the fast dimming twilight the flying bodies literally peppered the air as far as the eye could see. Out of the distance the myriad wheeling, banking specks gradually materialized into winging hordes which staggered the imagination. On and on they came as though in a never-ending procession. More than once at the top of the strand I stood fascinated at this mightily spectacle—stood there spell-bound until, with the darkness, only the sharp cries of the multitudes of late-comers came to me from above. How these numerous stragglers ever find their homes and mates in such a throng is a mystery which the bird specialists cannot explain. Maybe they never do, and this would perhaps help to explain the restless mutton bird wanderings and their other strange behaviour throughout the hours of darkness.

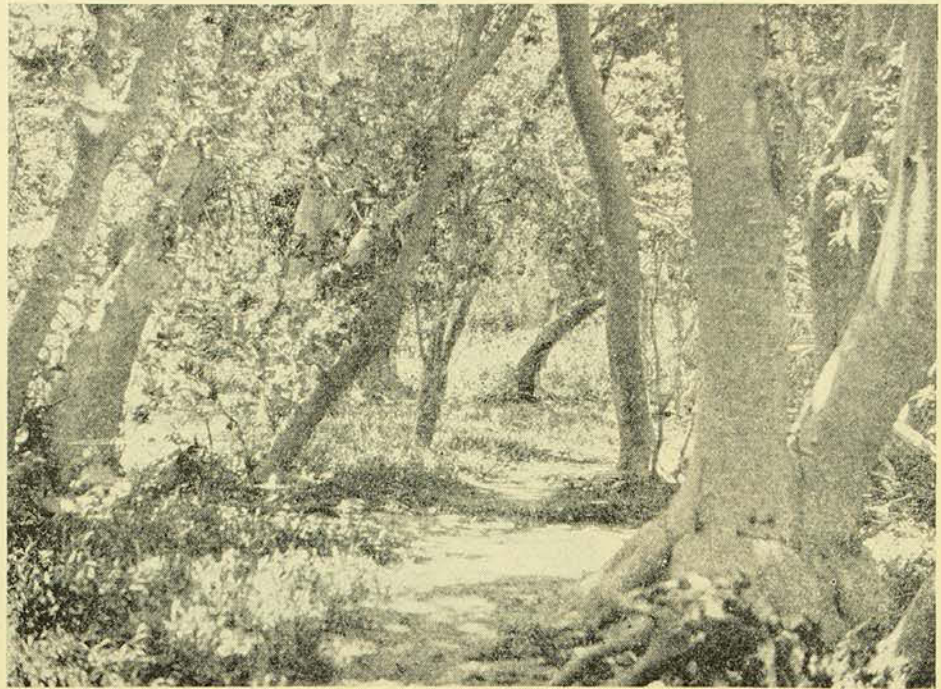
The noddy terns are mild little birds which soon settle down contentedly for the night. They seem to be able to ignore completely the continuous disturbances below them on the forest floor. Here the mutton bird host is so agitatedly on the move that the very earth seems to pulsate. They shuffle and hop about in seemingly endless procession and appear to travel

regular routes from place to place. In parts the wide, clearly defined tracks appear as though made by human feet. At the edge of the forest one of my companions occupied a tent through which mutton birds wandered all night long. But all this was only a minor part of the strange nightly programme. Until we got used to it, our slumbers were disturbed by the eerie wailing cries of the birds—cries continuous in volume and rising and falling in cadence. In the stiller nights the noise completely filled the air. Its mournful notes could only be likened to the agonized meowings of countless suffering cats.

By human standards the mutton birds are half dazed, stupid creatures while on the land. They appear deliberately to plunge into every sort of danger. Maybe, like moths, they are irresistibly attracted to light, for quite commonly their flying bodies would blunder through the open flap of a tent. This could be most disconcerting to the occupant if it were totally unexpected. There was, however, an ever present reminder of something impending with the regular thuds of other bodies against the yielding fabric of the top and sides. These adventures caused the birds no apparent inconvenience; they quickly regained their composure and shuffled away into the night. Many less fortunate ones crashed and stunned themselves on the corrugated

In places on Nor-west Isle well-defined tracks meander through the trees. These are the intriguing pathways trodden by the mutton birds in their nocturnal peregrinations.

Photo.—F. A. McNeill.



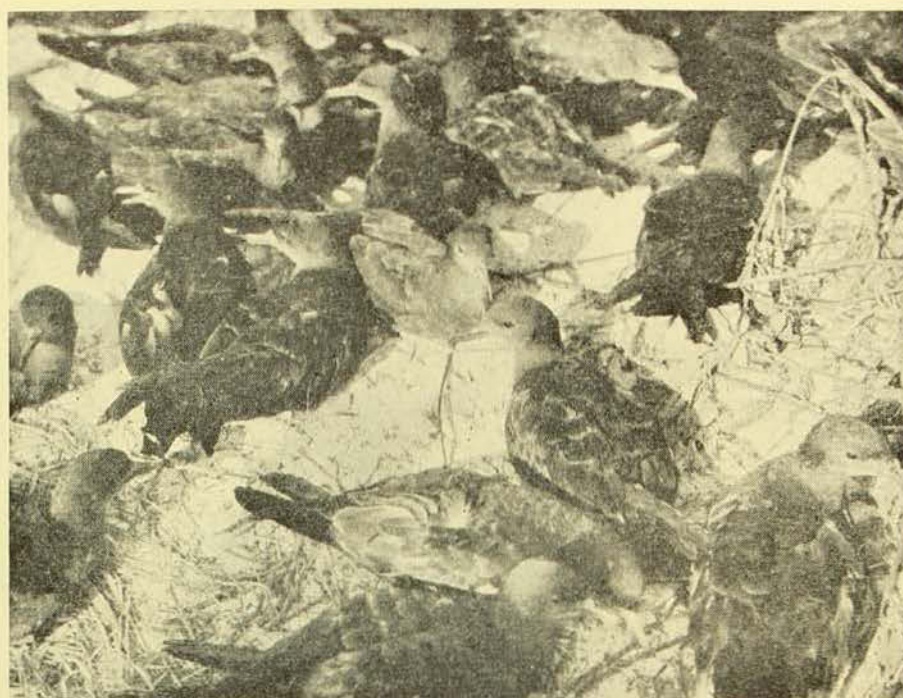
iron roof and walls of our disused turtle-canning factory headquarters. Then as though determined to be as aggravating as possible, numbers wandered in under the roof and waddled stupidly over the cement floor among the squatting members of the party. Invariably these intruders were grabbed in one hand by tail and wing tips, and cast unceremoniously back again into the darkness from whence they came. Even out on the open strand above the beach one was liable to receive a thump in the chest from a low-flying bird which appeared suddenly from nowhere. Others well away from their regular haunts would start up from the grass at your very feet and go scuttering blindly away. Such new and strange experiences could not fail to impress. They made me fully realize the interloper I was in this strange company and place. But the more convincing and astounding sight was yet to come.

With the first grey light of dawn the wailing and the hubbub came mysteriously to an end. Its place was taken by a low rustling sound among the trees as dusky-garbed figures came scrambling from their earthy dungeons and from every nook and

cranny in the forest. The open spaces were alive with the shuffling and hopping birds, moving along their highways and byways to assembly places on wide tracks which ended at a number of points at the top of the islet's circular beach. A number of nights we took pillows and blankets to these outlets of the forest runways. Our sleeps in the open were well rewarded. As our eyes became accustomed to the dim light under the trees we could detect the great moving masses of birds. The very ground seemed to be in motion, so thickly was it clustered by the jostling throng. Above rose a faint cloud of dust like that made by travelling sheep on a dry day. At dawn, this strange rally of literally millions of bird inhabitants of tiny Nor-west Islet creates an eerie sensation among puny human spectators. Now and then there is a flutter and a swirl as some disturbance breaks out, but order seems to be quickly restored, and the seemingly inexhaustible stream flows purposefully on. At last the open is reached at the top of the strand. Then a swift run and a glide, and the vanguard is sailing out to sea. More and more follow, wave after wave, until by the

Part of the vanguard of a shuffling mass of Mutton Birds awaiting a dawn take-off near the outlet of a runway at the top of a beach.

Flashlight photo.—
A. Embury.



time the new day's sun has flushed the sky the migration is complete. Out over the water the dusky battalions go soaring and dipping in a cloud like motes of dust in a beam of sunlight. Such is

this mutton bird enigma—that bird which seemingly pays its eggs the scantiest of attention, and endures the rigours of the long hot day flying above and floating on the sea.

Some Butterflies of Australia and the Pacific

The Swallowtails—V.

By A. MUSGRAVE

IN the last article we completed the *payeni* and *codrus* groups and here we now consider the *eurypylus* group.

THE EURYPYLUS GROUP.

In the *eurypylus* group are about fifteen Indo-Australian species, six of which are represented in the area under discussion. The members of this group have the body dark-brown above but lighter on the under surface and with a light stripe on each side. The wings are mostly black with green or yellow scaleless markings forming a medium band which, in the various

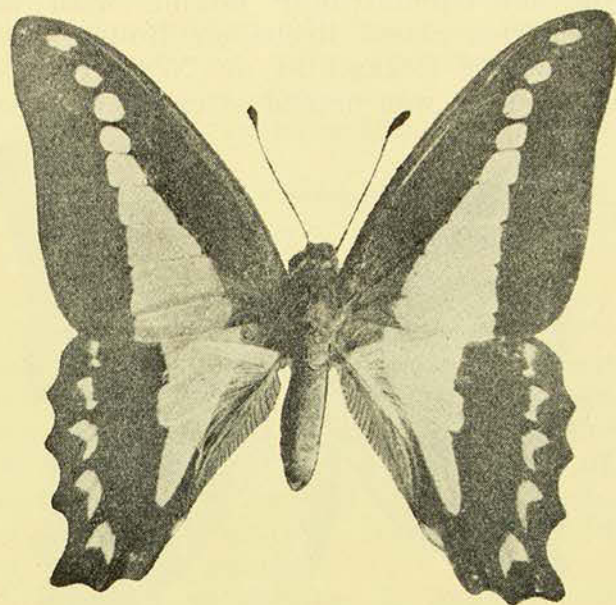
species, becomes progressively broken up into spots. The underside of the hind-wing bears red or yellow discal spots extending from the cell to the anal angle, while red or yellow spots are always present near the base of the wing.

Perhaps the best-known species in the *eurypylus* group is *P. sarpedon* Linné, many subspecies are found throughout its range from northern India eastwards to the Solomon Islands and Australia. These races all have the same general pattern. The Australian race, *P. sarpedon choredon* Felder, occurs in the islands of Torres

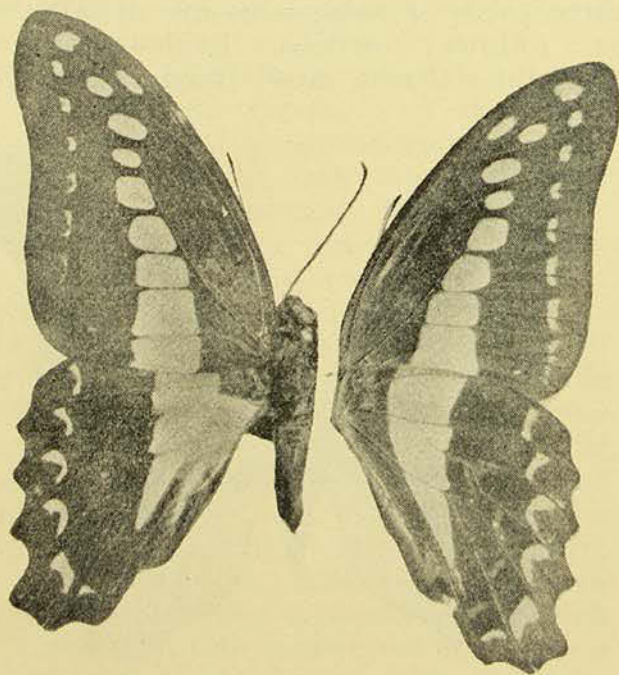
Strait and down the east coast to about 100 miles south of Sydney. About Sydney it is seen from September to April. Popular names applied to this butterfly are Blue Fanny, Blue Triangle and Peacock Butterfly.

The upper surface of both wings is black and a blue band traverses their centre, while on the hindwing near the outer margin is a series of five curved blue spots. The under surface is lighter in tone and of a bronzy-brown colour with the blue pattern repeated but, on the hindwing, a red spot occurs at the base and series of red spots below the cell.

The life-history is well-known having been described and figured by Dr. Waterhouse and other authors. The larvae feed on the young leaves of the introduced Camphor Laurel though the native food plant is the Sassafras, *Geijera salicifolia*. The fully-grown larva is smooth green, sometimes spotted with white or yellow; a yellowish line links the lateral spines on the third thoracic segment and a yellowish line runs above the legs along the sides of the body. The pupa is greenish with a long, very pointed horn from which four keels extend backwards. In *P. sarpedon messogis* Fruhstorfer, from Key Islands, Aru Islands, New



The Blue Fanny, *Papilio sarpedon choredon*, common butterfly in Sydney gardens.
Photo.—A. Musgrave.

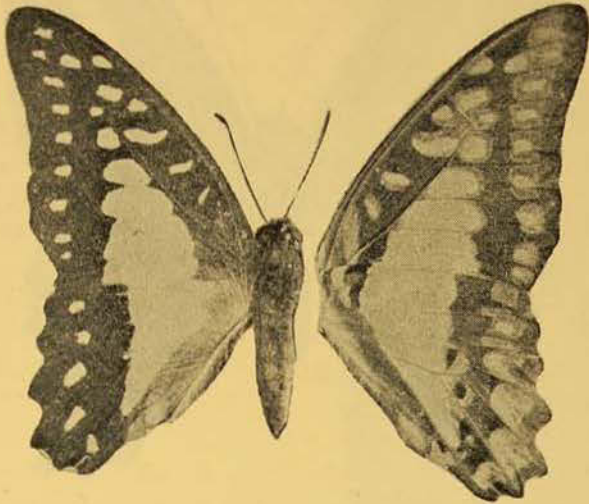


The Solomon Island Blue Triangle, *Papilio sarpedon isander*, Bougainville, Solomon Islands. Wing expanse, 2½ inches.

Guinea, Waigeu, D'Entrecasteaux Group, Woodlark Island, Louisiade Archipelago, and Vulkan Island, we have a subspecies resembling *choredon*, but with the band of the forewing narrower and the submarginal spots of the hindwing smaller. *P. sarpedon imparilis* Rothschild from the Bismarck Archipelago, represents a form darker on the upperside and underside, and an additional spot may be present in the fork of the subcostal vein. *P. sarpedon impar* Rothschild from New Georgia and nearby islands in the Solomons Group, serves as a link between *imparilis* and the next subspecies. The spots in the band on the forewing are larger than those in *imparilis*, and a spot is always present in the fork of the subcostal vein. On the undersurface of the forewing are indications of whitish spots which become markedly evident in the next subspecies. *P. sarpedon isander* Godman and Salvin from Bougainville, Shortland Islands, Choiseul, Ysabel, Guadalcanar and Florida, resembles the above form, but differs chiefly in the presence of a row of submarginal spots in the forewing on the upper and under surfaces.

Mendana's Swallowtail, *Papilio mendana* Godman and Salvin, occurs in the Solomon Islands, the typical form occur-

ring on Guadalcanar Island, with the subspecies *acous* Ribbe on Bougainville and *neyra* Rothschild on New Georgia. The species was named after the Spanish



The Pale Green Triangle, *Papilio eurypylus lycaon*. A specimen collected at Yeppoon, Queensland, by the author. Wing expanse, 2½ inches.

Photo.—A. Musgrave.

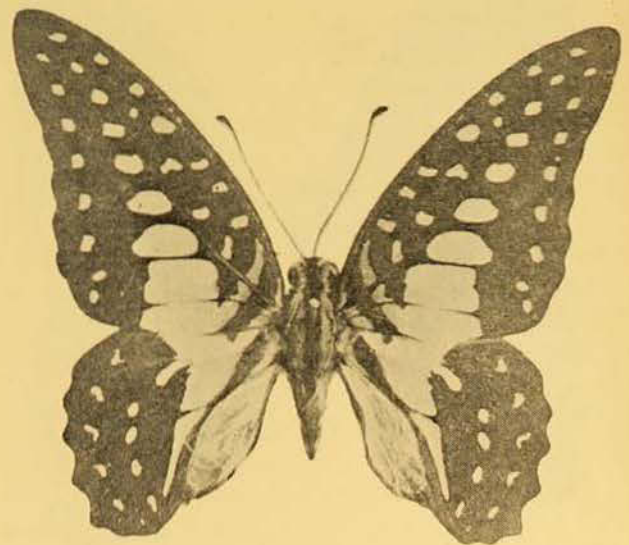
discoverer of the Solomons. In the typical form the wings are black, the forewing with a central row of bluish-green spots the one near the wing margin (dorsum) largest; the hindwing bears a band which is green in the male and white in the female. In shape and markings this Swallowtail recalls *P. codrus pisidice*, but the black underside is relieved with some red spots. The wing expanse is 4.3 inches. It has been suggested that the species forms a link between *P. sarpedon* and *P. codrus*.

P. eurypylus Linné, from the South Moluccas, Goram, Ceram, Amboina and Buru, gives its name to the group. Subspecies of *eurypylus* range south to Australia and eastwards to the Bismarck Archipelago. This species is represented in Australia by two subspecies or races, one of which is *P. eurypylus nyctimus* Waterhouse and Lyell, found in the Darwin district during the wet season. This race differs from the other Australian form in the much narrower band across the wings. The second subspecies, *P. eurypylus lycaon* Westwood, popularly called the Pale Green Triangle or the Spotted Fanny, has a range from Cape York to Sydney, though at the southern limit of its range it is rarely met with.

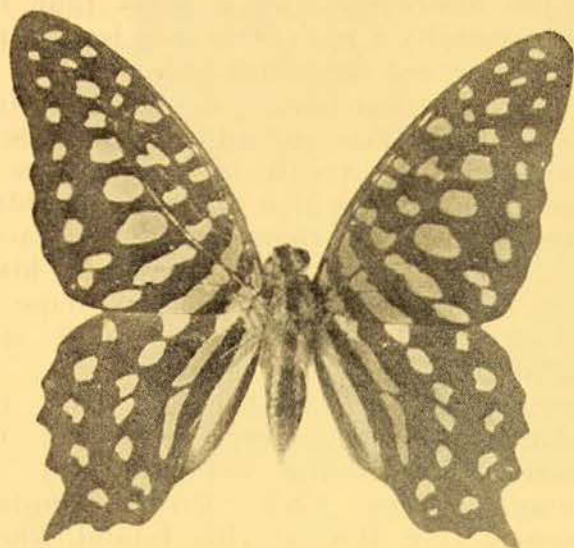
The upper surface of the forewing has some green spots in the cell and a median pale green band broad on the hind margin tapering at the apex where it is broken into spots; on the hindwing is a somewhat similar median green band, and pale green spots occur along the margins of both fore- and hindwings. The under-surface is much lighter in colour, with the median bands and marginal spots whitish, while, on the hindwing, a red spot occurs basally and red spots occur beneath the cell. The life-history has been described by Dr. G. A. Waterhouse, the larvae feeding chiefly on the Custard Apple as well as on *Melodorum Leichhardtii* and *Diploglottis Cunninghami*.

P. eurypylus lycaonoides Rothschild is the subspecies that occurs on Waigen, Jobi, German New Guinea (Mandated Territory) and Fergusson Island. This form is larger than *lycaon* and darker on the underside, and the median green band of the forewing is broader than in *lycaon* while the submarginal spots are smaller.

A species somewhat resembling *P. eurypylus* and *P. agamemnon* is *P. macfarlanei* Butler, and the typical form occurs in the Moluccas, Waigen, Salawatti, Misol, Jobi and New Guinea, while its three races or subspecies are distributed as follows: *cestius* Fruhstorfer in Amboina, Ceram and Buru, *admiralia*



The Green Triangle, *Papilio macfarlanei macfarlanei*. Aru Islands. Wing expanse, 2½ inches. Has a wide range from the Moluccas to Queensland.



The Green Spotted Triangle, *Papilio agamemnon ligatus* (or *mynion*). From Macknade, Herbert River, Queensland. Wing expanse, about 2½ inches.

Rothschild in the Admiralty Islands, and *seminigra* Butler in New Britain.

The typical race, *P. macfarlanei macfarlanei* Butler, popularly termed the Green Triangle, is also recorded by Waterhouse from the islands of Torres Strait and occurs along the Queensland coast south to the Herbert River. In this species the green band on the black forewing is even more broken up into spots than in the forms of *sarpedon* and *curpylus* we have considered, while green spots are present as a double row in the cell and a single row of spots is present near the margin (termen) of the wing. In the hindwing a double row of spots occurs towards the outer margin. The underside is paler than the upperside. The life-history has been described by Dr. Waterhouse who records the larva feeding on Custard Apple.

In *P. agamemnon* Linné we have a still more spotted species, and one which, like *P. sarpedon*, has many subspecies. These races, which occur throughout its wide range from China and India to the Solomon Islands and Australia, differ only in minor details. The larva, according to Dr. Jordan, feeds on the young plants of the order Anonaceae of which the Custard Apple, *Anona reticulata*, is a well-known member.

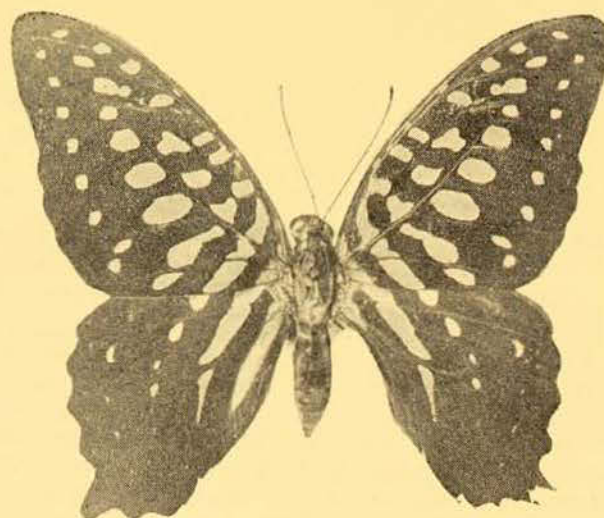
In this swallowtail, in a typical form, the upperside is black and dotted with

green spots which usually do not touch one another, and the hindwing is provided with a short tail. The undersurface is greyish and the spots are paler; red spots are situated near the base of the hindwing.

In *P. agamemnon argynnus* Druce from the Key Islands the spots on the hindwing are even more reduced than in the subspecies *plithenes* from the southern Moluccas. In this last named there are still traces on the hindwing of the two outer rows of spots, though these are wanting or only faintly indicated in the Key Island race. In two specimens of *argynnus* in the Museum collection from Key Island the spots in the cell tend to fuse with one another.

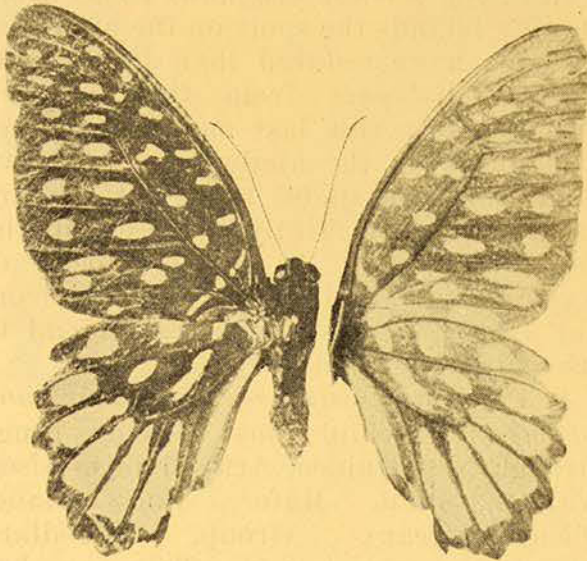
A Papuan subspecies, *P. agamemnon ligatus* Rothschild, has a wide range through New Guinea, Aru Islands, Misol, Waigeu, Jobi, Mafor, Ron Island, D'Entrecasteaux Group, Woodlark Island, Yanarba Island. This race has broader wings than the typical *agamemnon*, the tail is shorter, while the forewing is bigger with the spots of the median row larger. The larger spots of the hindwing and only three red spots on the underside serve to distinguish it from *plithenes* and *argynnus*.

The Green Spotted Triangle, *P. agamemnon mynion* Fruhst., is the race found on the islands of Torres Strait and in Queensland from Cape York to Mackay. Fruhstorfer regards the Australian race



Papilio agamemnon salomonis from Bougainville, Solomon Islands. Wing expanse, 3 inches.

as differing from the more northern *ligatus* Rothschild by the somewhat longer tail. Dr. Waterhouse calls the Australian form *ligatus*, and he has described the life-history, the larva feeding on Custard Apple.



Meek's Swallowtail, *Papilio meeki*, from Empress Augusta Bay, Bougainville, Solomon Islands. Wing expanse, about 3½ inches.

In *P. agamemnon salomonis* Rothschild, a subspecies with a wide range through the Solomon Islands, the spots of the forewing are larger than in the Papuan subsp. *ligatus*, though the submarginal spots are usually smaller. The hindwing has the submarginal spots smaller and, in the female, the discal spots are smaller and may even be wanting; the undersurface

of the hindwing always bears four red spots, usually a red costal spot is situated before the red subcostal lunule.

In *P. agamemnon neopommeranus* from New Britain and adjacent islands of the Bismarck Archipelago, we have a striking form in which the spots are blue-green and smaller than in the other races. The markings on the brown-black hindwing are reduced to a single stripe in the cell and sometimes a small spot outside it.

Papilio meeki Rothschild from the Solomon Group is represented in the Australian Museum collection by an example from Piva Riva, Empress Augusta Bay, Bougainville Island, where it was collected in November, 1945, by Mr. E. D. Watson, while serving with the Australian Forces stationed there. The specific name *meeki* recalls a collector who made extensive collections in New Guinea and the Solomon Group for the late Lord Rothschild's museum at Tring, England.

This butterfly is larger than *agamemnon*, and the hindwing is less pointed. The forewing has the light green spots more evenly distributed; the hindwing has an outer row of large wedge-like green spots, three white spots near the fore (costal) border, a green stripe in the cell and a green spot beyond it. The spots on the underside are whitish. The wing-expanse is about three and a half inches.

THE AUSTRALIAN AQUARIUM AND OUTDOOR POND.
Vol. i, No. 1, Nov., 1946. Aquatic Publications, 128 Darlinghurst Road, Sydney. 32 pp. Price 2s. monthly.

THE rebirth of a monthly magazine for amateur aquarists and fish fanciers is an encouraging sign. There have been several attempts in the past to publish such journals, but the war ended them all. Now, with a very attractive coloured cover, the first number of *The Australian Aquarium* makes its appearance and contains a good variety of articles on fishes, plant life, prevention of fungus, the food of fish, hints on ponds and water, answers

to correspondence, etc. Some Australian enthusiasts have kept alive their hobby during the war years and have bred a great variety of foreign and local fish so that a rich display was recently exhibited in Sydney in spite of the fact that no imports of fancy fishes have been made in the last six years. The experts of the Aquarium Society of New South Wales freely pass on their knowledge in the pages of this magazine so that beginners and veterans alike will derive helpful advice on the problems which arise so frequently. We offer congratulations to the editor of *The Australian Aquarium*, with best wishes for its continued success.