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Black Swan.

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THE AUSTRALIAN MUSEUM MAGAZINE

THE LUNGFISH GROUP IN THE AUSTRALIAN MUSEUM .. .. *Frontispiece*

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

● OUR FRONT COVER. The Black Swan (*Chenopis atrata* Latham) is by Lilian Medland. It is one of a series of post cards issued by the Australian Museum.

The Black Swan, like its white relatives of other lands, is characterized by its very long neck, which enables it to grope down for waterweeds, etc., on the bottom of shallow waters. It is unable to dive for its food, as can many ducks, but stands on its head in water in a very undignified fashion, keeping its body vertical by paddling upwards with its feet. When taking flight it raises its body gradually by beating its wings, at the same time helping to gain the necessary impetus for launching the heavy body into the air by violent lashings of the water with its feet. Black Swans fly in a beautiful formation in a single oblique line, or in a V, with the apex forwards, and it can then be seen that the feathers hidden when the wing is folded are white. They fly chiefly at night, when their beautiful trumpeting notes may often be heard overhead. They are found in suitable waters all over Australia, and wild swans still appear on Dee Why Lagoon, close to Sydney. The nest is a large structure built of weeds, and five or six large greenish-white eggs are laid.

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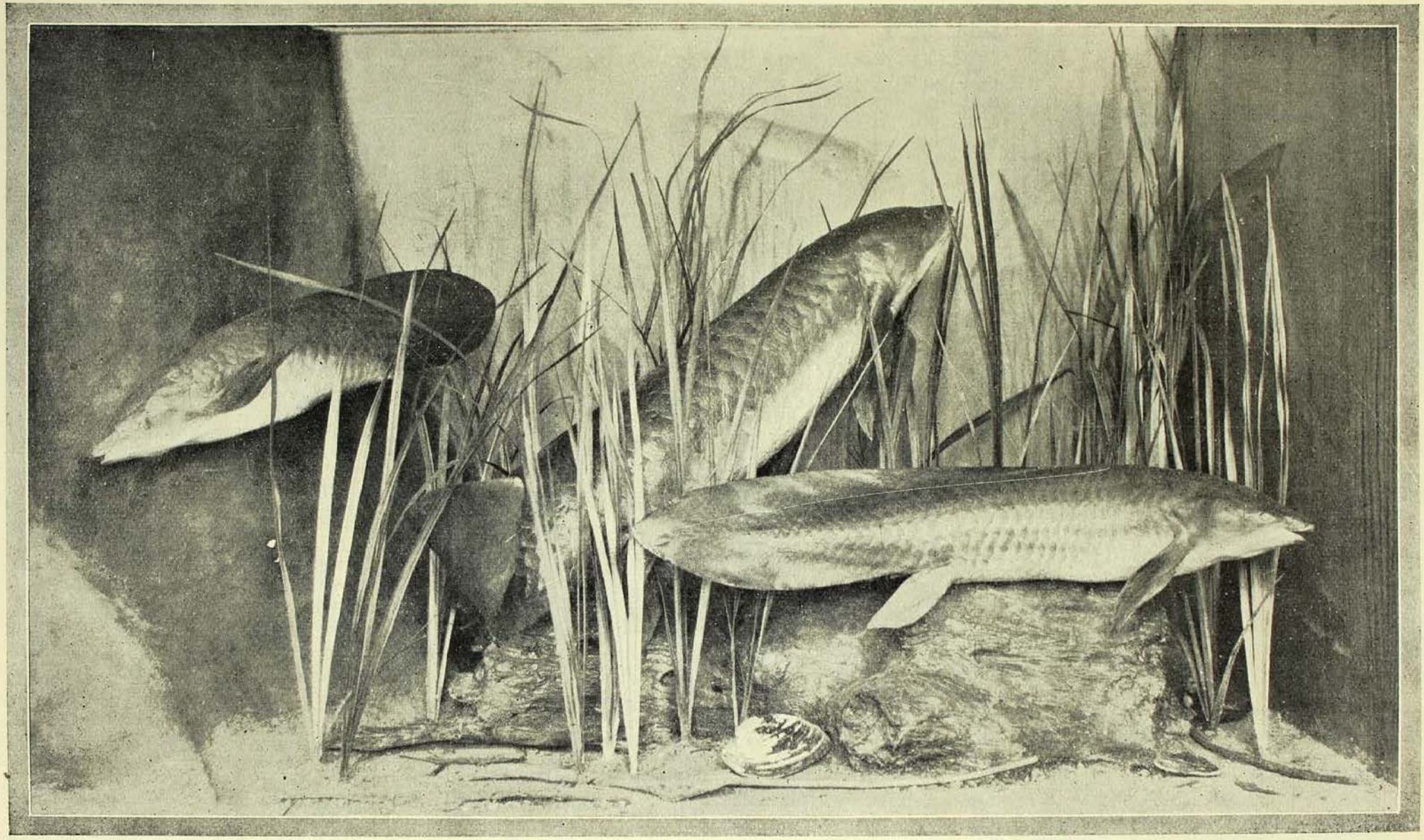

The Queensland Lungfish group in the Australian Museum. Three lungfishes are here shown swimming amongst weeds (Vallisneria) near a river-bank. The originals of the fishes and weeds, and the freshwater mussels and snails which are also shown, were specially obtained from the Burnett River, Queensland, for this group.

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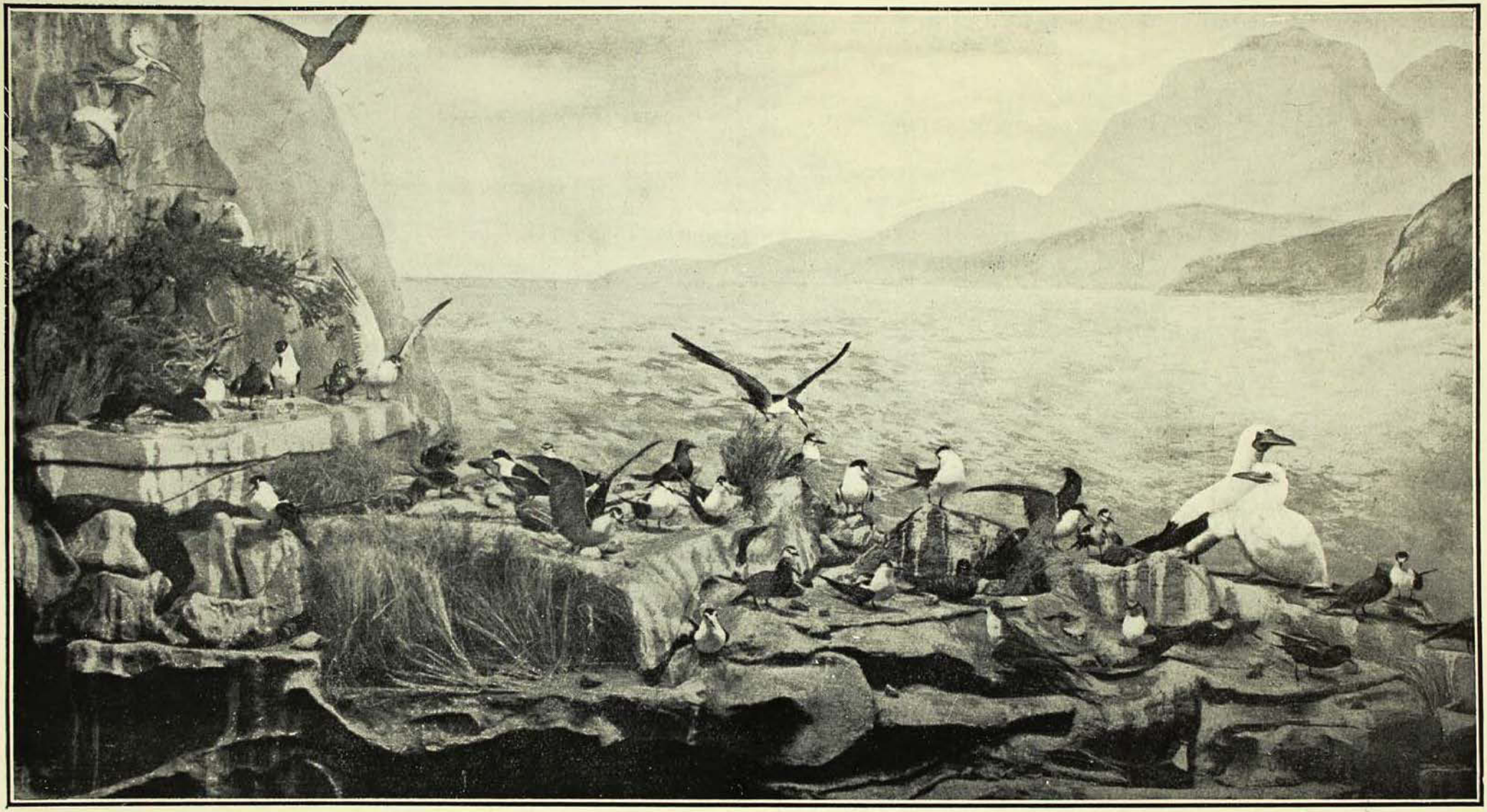
The Art of the Preparator

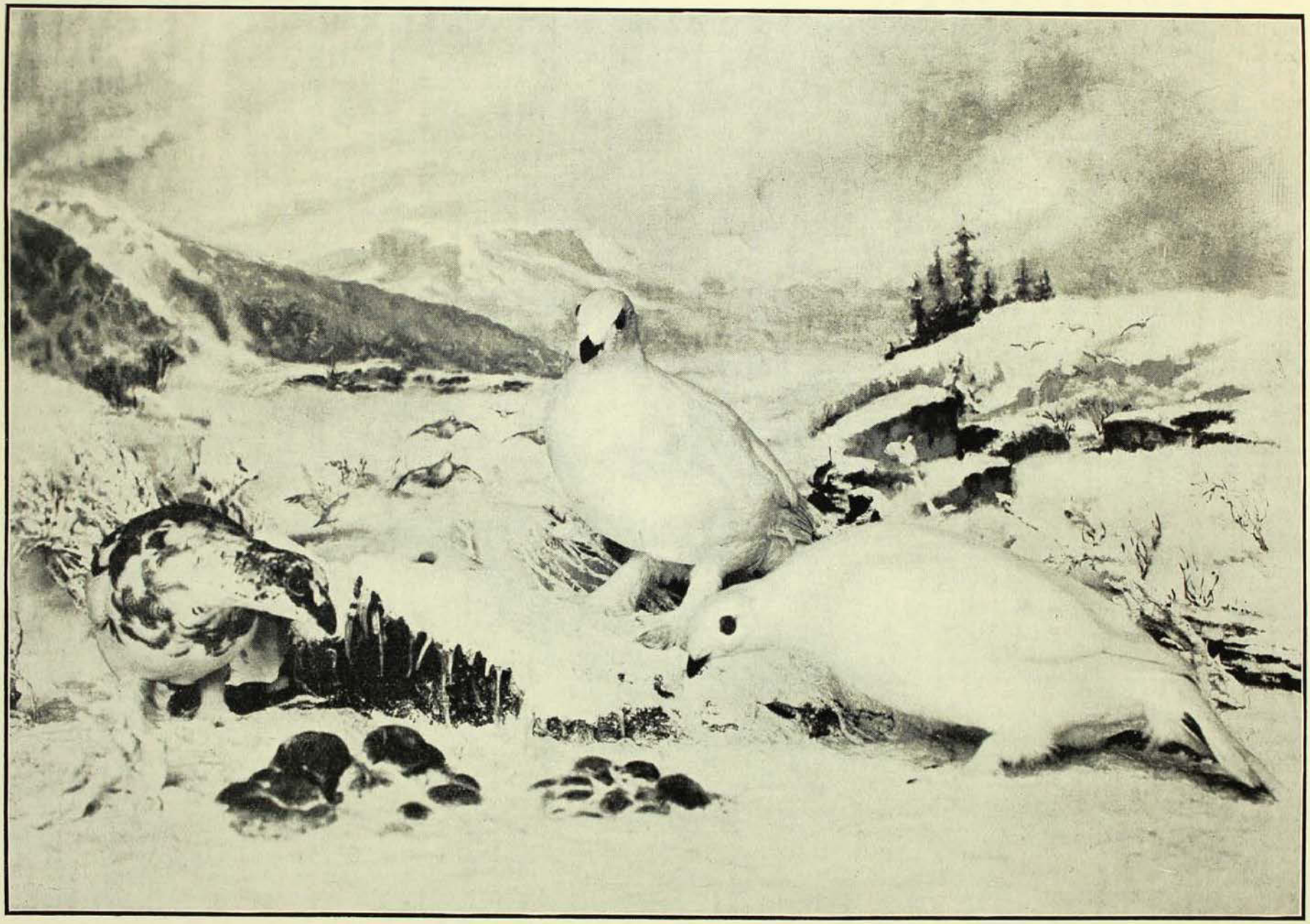
In their "Report on the Museums and Art Galleries of Australia and New Zealand", made to the Carnegie Corporation of New York, Mr. S. F. Markham, M.A., B.Litt., and Professor H. C. Richards, D.Sc., stressed the fact that, while in the record of scientific research and the publication of results Australian museums compare very favourably with similar institutions elsewhere, in the matter of exhibition they have lagged behind. The reasons for this are not far to seek. In the first place, the number of still undescribed animals in Australia is very large, and much remains to be done before our knowledge of the Australian fauna is anything like adequate. The scientific officers of the museums have, therefore, devoted their energies to preparing descriptions of new species, and the governing bodies have set aside sums from their by no means large resources for the publication of scientific papers and catalogues.

The most attractive and up-to-date form of museum exhibition is undoubtedly the habitat group, which aims at showing the animals as far as possible in a natural setting. But such groups are costly and demand the co-operation of highly skilled technicians; for not only must the animals be correctly and tastefully mounted, they must also be accompanied by various accessories, rock, bush and foliage, and perhaps a drinking pool, the whole scene creating an illusion that one is viewing the animals in their natural environment. To assist this illusion and to give an impression of distance and spaciousness, habitat groups are furnished with painted backgrounds into which the foreground merges imperceptibly. This effect is one of the most striking of the features of modern habitat groups, but one of the most difficult to obtain.

It will be seen that the successful construction of habitat groups requires the services of the carpenter, plasterer, taxi-



A habitat group in the Australian Museum. This represents a nesting colony of sea-birds on the Admiralty Islets, Lord Howe Island. Wideawake Terns, Gannets, Mutton Birds, Noddies, and Blue-billies crowd together to nest and rear their young.



A group in the Australian Museum. Willow Grouse in their winter haunts. While the bird on the left has not changed from its autumn plumage, the two on the right have assumed the complete winter coat.

dermist, modeller, artist, glass-worker, electrician and others, all working with one end in view. It can be well understood that such groups are costly; in some of the foremost museums abroad the outlay on one spectacular group may exceed the total annual income of a leading Australian museum. It is not to be wondered at, therefore, that Australian museums, with their relatively small budgets, are not in a position to command the services of the various experts required, or to bear the cost of the production of many such groups. But the governing bodies and the staffs of the various museums in Australia are eager to improve their methods of exhibition and avail themselves of the experience of others more favourably situated.

The visit of Mr. Frank Tose, Chief of Exhibits in the California Academy of Sciences, is therefore welcomed with enthusiasm. Through the generosity of the Carnegie Corporation, Mr. Tose, who was responsible for the exhibits in the magnificent African Hall in the Museum of the Academy, will be able to spend about four months in Australia, during which time he will visit the various State museums, inspect their exhibits, and give advice as to possible improvements. His visit will terminate by the holding of a class for preparators, during which he will demonstrate modern methods of mounting large animals and constructing habit groups. This class will be held in the Australian Museum, and will be attended by a number of preparators from other States. It is hoped that during the course of this work three groups, showing, respectively, the Red Kangaroo, the Rock Wallaby, and the Native Bear, will be completed. But, more important than this, it is confidently expected that, as a result of Mr. Tose's skilful tuition, Australian preparators will attain a new level of skill and obtain many valuable hints in a branch of their art which, for very good reasons, has not yet made much progress in Australia.

At the same time, the work that has already been accomplished by Australian preparators is worthy of the highest praise. With inadequate resources and with many other duties to perform, they have succeeded in constructing some very creditable groups. Like Ulysses, the preparator is a man of many devices, and the layman can but admire the results of his cunning and wonder how they are obtained. It is his aim "to hold, as't were, the mirror up to nature", and there are no limits to the possibilities of his art, although the limit seems to have been reached by Professor Allen of Cornell University. He has recently constructed two groups of birds in which, by the use of sound films and electrically driven mechanism, the birds sing and perform life-like movements. Thus, in the Ruffed Grouse Group, the male hisses while the female moves to the nest and covers the eggs; thrushes sing, the owl hoots, the woodpecker dives into his hole, and the wild goose honks. This is surely the apotheosis of the museum art, and foreshadows the day when nature knowledge will be sought in the museum hall rather than in the zoo or in the forest.

Australian museums are under a deep debt of gratitude to the Carnegie Corporation, which is financing Mr. Tose's visit, and to Professor H. C. Richards, through whose good offices, acting for the newly formed Art Galleries and Museums Association of Australia and New Zealand, the visit has been arranged.

In November Mr. Tose will proceed to New Zealand, where, after inspecting the various museums, he will conduct a similar class for preparators at the Dominion Museum, Wellington.

The Blue-Bottle—Terror of the Surf Bather

By FRANK A. McNEILL

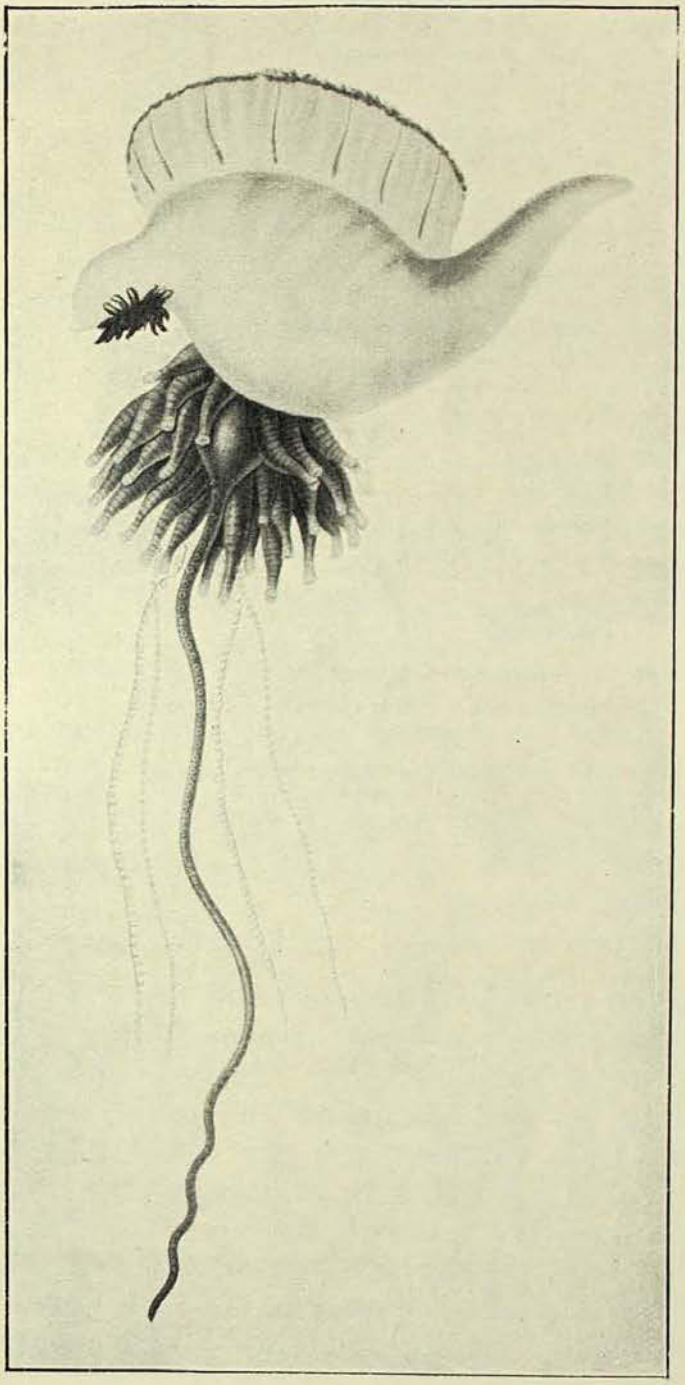
EVERY sea bather on the coast knows how the painful sting of the blue-bottle, or Portuguese Man-o'-War,* can ruin the pleasure of a summer outing. One could never mistake this blue menace as it floats shorewards on the crests of the waves. The great warm Notonectian Current which flows southwards along the coast can be blamed for yearly bringing the blue-bottle close inshore. Normally the Notonectian flows some distance out at sea, but from about November to March it moves in close to the coastline, when its eddies convey to the bays and river entrances the blue-bottle hordes which are nurtured upon its bosom.

A remarkable fact about the blue-bottle, which will be a surprise to many, is that it is not a single or simple animal. It is actually a number of individuals all joined together in a group to form what is known as a colony. Separate units of the colony are joined one with the other, and all work together for the common good. In respect to its functions and habits, the blue-bottle colony is still a perplexing problem to the scientist.

Everyone knows that the trailing threads or tentacles carry the stinging properties. With the exercise of some care these can be easily avoided and the float grasped in the fingers and transferred by an interested observer to a glass vessel or the quiet water of a rock pool. Examination of the colony in these circumstances is a fascinating lesson in nature study.

THE FLOAT.

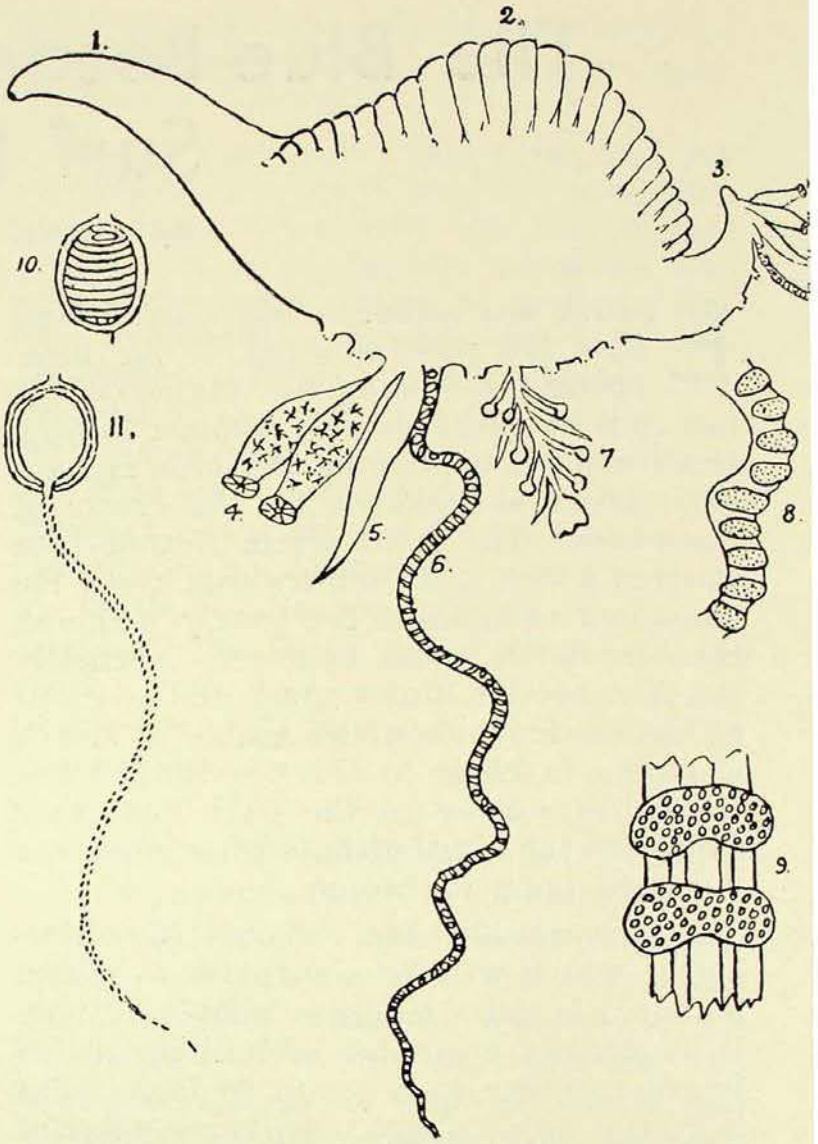
The float, or bladder, above the colony is the first structure to draw attention. This is broad and long, with an erect, wrinkled crest along the upper surface.



The Blue-bottle or Portuguese Man-o'-War (Physalia), a seafarer often stranded on our shores, is well known on account of the powerful stings which it inflicts by means of its lash-like tentacles.
After R. P. Lesson.

The front of the float is seen to protrude as a finger-like process, and at its tip is a most minute opening or pore. Unlike the front, the hinder end of the float is

* It is said that it got this name because of its dangerous armament and because ships sailing southwards first met with this seafarer in the latitude of Portugal.



The Blue-bottle or Portuguese Man-o'-War (Physalia). A diagrammatic sketch illustrating the form and character of the various parts of the colony. To avoid confusion, only two clusters or persons complete with tentacles are shown, and only a single branch of one of the grape-like bunches concerned with reproduction.

1. *The anterior portion of the float (pneumatophore).*
2. *Crest or "sail", with its gas-filled chambers.*
3. *Posterior end of float.*
4. *Feeding bodies (zooids).*
5. *A taster (palpon).*
6. *A main tentacle.*
7. *A branch of one of the grape-like bunches bearing male sacs, small tasters and a bell-like structure; a complete bunch of many branches is termed the gonodendria.*
8 and 9. *Two views of a main tentacle, enlarged.*
10. *A stinging cell removed from one of the "batteries" of a main tentacle, showing the coiled poison thread and tiny projecting trigger release (greatly enlarged).*
11. *The same cell with poison thread discharged.*

often curved up like a little tail. In its construction the float is a most ingenious piece of Nature's work. There is a double skin or wall enclosing the main air or gas-tight chamber and the whole may be inflated or deflated to render the float sufficiently buoyant to keep the blue-bottle at the surface level of the sea. The crest already referred to holds a special interest. Inside the skin which covers this part are thirty or more separate little chambers quite distinct from the main float chamber. Each of these has the means to make its own supply of buoyant gas. So, in the event of minor injury or other trouble with the main float chamber, the smaller compartments in the crest take over the task of keeping the blue-bottle afloat until normal conditions again obtain. Here is seen a wonderful example from Nature which the builders of modern airships might find of use in their experiments.

IDENTITY AND STRUCTURE OF THE DEPENDENT BODIES.

The crowded bodies depending from the underside of the float appear at first to be a confused mass, but closer scrutiny discloses a marked variation in their forms. Upon these bodies rests the responsibility of building up or multiplying the blue-bottle colony and securing the food supply from the waters of the sea. Separate groups or clusters are to be distinguished in the mass of hanging bodies. Each cluster is a separate "person" of the blue-bottle colony, conducting itself independently from its fellow clusters. The components of a "person" consist of several tube-like feeding bodies, often a sharply-pointed

bud-like body known as a taster, and a long or short tentacle. The great number of "persons" associated in one blue-bottle may be appreciated from the fact that eighty to one hundred stinging tentacles are often to be found on large examples. These are long and short, thick and thin, according to just where on the underside of the float they are attached. The several large and main stinging tentacles of the colony may measure up to four yards in length when fully extended. All the tentacles are equally dangerous to touch, even the smallest.

Each tentacle is the food gatherer for the particular cluster or "person" with which it is associated. Such a member can be likened to a ribbon strand composed of strong muscle fibres, which is capable of great extension and sudden contraction.

ORIGIN OF STINGING PROPERTIES.

When a tentacle is viewed through a magnifying glass one edge is seen to be thickened, and at regular intervals along it are minute kidney-shaped specks. With the aid of a microscope the specks along the edge may be seen each to contain great numbers of still more minute stinging cells. Each set of stinging cells forms what may be termed a battery. In a single large tentacle of a blue-bottle there may be as many as two hundred or more of these poisonous little batteries. From this fact it is easy to understand why a tentacle can inflict a burning line of stings on a bather along the whole of its trailing length. Again, under the high power of the microscope, the stinging cells making up the batteries appear as tiny specks shaped somewhat like footballs, and are all filled with poison. Coiled up inside them, as a tightly wound spring might be coiled up within an egg, are the finest of pointed threads. Each thread is connected with the most minute of hair-like triggers, showing its tip only just protruding on the outside. Hence we have a myriad triggers along the length of the stinging tentacles of the blue-bottle always ready to be released, and the slightest touch can cause the instantaneous discharge of the coiled threads resting in the poison within the stinging cells.

EFFECT OF STING.

It is the poison threads which penetrate the skin of the unlucky sea bather to inject into his flesh through their hollow centres the painfully irritant poison which causes so much distress. Try for a moment to imagine the enormous number of poison threads which would enter the skin of a bather from a single tentacle of the blue-bottle brushing across the width of his chest. The poison tends to have a paralysing effect on the muscles and nerves, and elderly people with weak hearts can thus suffer a shock from which they may chance not to recover. Severe stinging has produced fatal effects; but the stinging cells of the blue-bottle tentacles were never intended by Nature to poison human beings, and when they do, they probably suffer as much damage as the victims of their stings.

THE STING IN NORMAL USE.

In the ordinary life of the blue-bottle the batteries of stinging cells are used against small natural prey, so that when a larval fish or shrimp or other small sea creature brushes against a trailing tentacle, it is often immediately paralysed, and the poison darts which penetrate its skin anchor the prey to the tentacle. It is then drawn up when the tentacle shortens by its sudden contraction, to be brought within reach of one or more of the ever-ready tasters. Now the mouths of the special feeding bodies of the clusters, or "persons", within reach take a hand in this strange manipulation and transfer of food. The taster is a most extraordinary organ, and there is still much to learn about it. Each of the blue-bottle's larger tentacles has a taster attached at its base. In the taster there is no visible opening, so that it would perhaps be more correct to refer to it as an inspector of food.

The feeding bodies, when closely examined, are seen to be shaped so that the base is narrow and a swelling occurs

in the middle region, where the stomach is found. The extremities are opened out into trumpet-shaped mouths, and the bodies not only take in food through these mouths, but digest it for the whole blue-bottle colony. By this means the food is used for the common good, helping along those other clusters or "persons" whose stinging tentacles may not have fared so well in the chance capture of prey.

GROWTH AND PROPAGATION.

As well as effecting a general proportional increase with growth, the blue-bottle increases its bulk by the addition of more and more clusters or "persons" to the underside of its float. These are born as tiny buds near the bases of those already formed. Such budding as this is a very special property possessed by many lowly organisms, particularly colonies or communities living in an arrangement like the blue-bottle. Lowly organisms often have only a short life and a dangerous one, therefore an extra means of reproduction is a wise provision of Nature.

The principal means of reproducing new blue-bottles which come to float and live away from the parent colony is very different from the budding process just outlined, and is extraordinarily complex. At a certain stage of growth there may be seen among the crowded dependent clusters some tiny bunches, for all the world like grapes. At the ends of these bunches are bell-like cups in which develop the most minute umbrella-shaped jelly fishes. The jelly-fishes are male in sex and become released into the sea through the openings in the cups. From then on they become a mystery. Hence we have a male animal colony known as the blue-bottle, reproducing male progeny which mate with quite a distinct form of sea creature. Maybe the opposite sex is an already described sea denizen, but if so its relationship remains unsuspected.

IMMUNITY OF SOME FISHES.

Reverting to the stinging properties of the blue-bottle tentacle, it is worthy of note that some little fishes are not affected at all by the poison threads. Quite often numbers of these are to be seen swimming around with perfect ease below the float, crowding in right against the tentacles when danger threatens from the surrounding water. Nature has truly been kind to these particular finny creatures. It is hard to understand this special immunity, especially when one thinks of the delicate nature of the uncovered eyes. Not only have small fishes been observed stuck, as it were, to the tentacles, but their thin little scales have actually been found to be penetrated by the poison threads from the batteries of stinging cells.

SPECIAL PRECAUTIONS.

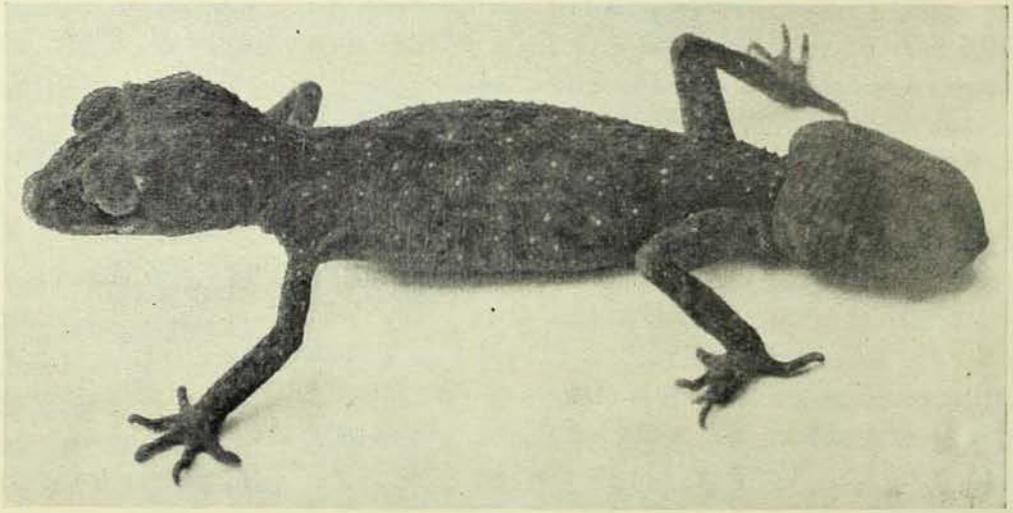
Before closing the subject of the blue-bottle, there is a special word of warning for the summer sea bathers. It is advisable to vacate the water if the blue floating menace becomes too numerous to avoid. If the offenders are sparse and can be carefully removed from the water or from where they may be stranded along the tide line, complete disposal becomes easy by burying them deeply in the dry sand. Never attack the float with some handy implement as some foolish people do. Death comes only very gradually to the blue-bottle colony, and the tentacles attached to a smashed float too often become a hidden danger as they swirl about in the surf.

Introducing the Lizards

By J. R. KINGHORN, C.M.Z.S.

Part I.

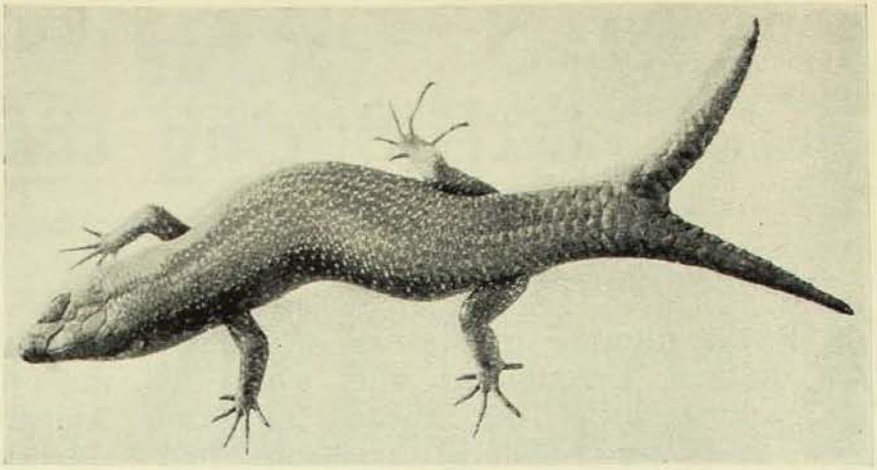
As the number of species of lizards known throughout the world is approaching the three thousand mark, it is very difficult to decide just which of them might be included in, or left out of, this abbreviated account of the group. Many very interesting kinds are to be found widely distributed throughout most temperate and tropical countries, and, whilst the great majority of them live on the ground, there are many which live in the trees, and a few which have semi-aquatic or semi-marine habits.



Geckos, of which this one (Heteronota walshi) may be regarded as a typical example, are absolutely harmless. Generally they have a nodular or leaf-like type of tail, which very easily breaks off.

From general external appearances we might be inclined to describe a lizard as a scaly reptile which walks on four legs, but this definition would include crocodiles, and, furthermore, some lizards have no external indications of legs, even though rudimentary leg bones may be present within the body wall. In quite a number of the skink lizards the legs are so reduced that they are almost invisible to the naked eye, appearing merely as tiny tubercles, but in the so-called legless lizards they are somewhat larger, and might be likened to small flaps covered with scales. Of those lizards which have no legs, the "slow worm" of Europe and the burrowing "glass snakes" of tropical America are the best known examples, the latter being regarded by many persons as the most snake-like of the whole group, though at least one of the Australian legless lizards cannot with certainty be distinguished from a small snake at a distance of a few feet.

As some lizards are so very snake-like in outward appearance it might well be asked: if some lizards are without legs, and some snakes, such as pythons and boas, have hind legs represented outwardly by spurs, and inwardly by rudimentary, but very definite, leg bones, by what characters can the two groups be separated? Briefly, we might state that most lizards have ears, represented by holes in the side of the head; snakes have no external ears. Lizards either have movable eyelids or they are represented by a circular scaly ring; snakes have no eyelids, but peer through a transparent scale. The lower jaw bones of a lizard are firmly united in front, and the bones of the skull are immovable; in snakes the lower jaw is suspended from the skull by very elastic ligaments, and two halves



Abnormal tails, with from two to five complete ends, may be formed on most kinds of lizards, particularly among the skinks. The species illustrated is Egermia striolata.

of the lower jaw are united at the chin by similar elastic tissue; thus the mouth can be widely opened to swallow large prey.

Now that we have separated lizards from snakes, how can we distinguish them from crocodiles, particularly young ones? External appearances might easily lead us astray with certain examples, but a close examination would show that a crocodile has nostrils on top of the snout which are valvular and tubular, it has five fingers and four toes, the latter being webbed, and the vent is longitudinal, whereas it is transverse in lizards. As it is with most animals, the main differences are skeletal. In crocodiles the teeth are firmly implanted, each in its separate socket; in lizards they lie side by side in a groove, either along the inner or top edge of the jaw bone. The heart of a crocodile is more completely four chambered than it is with lizards. Speaking generally, lizards are not so highly developed as crocodiles, and are placed lower in the scale of classification.

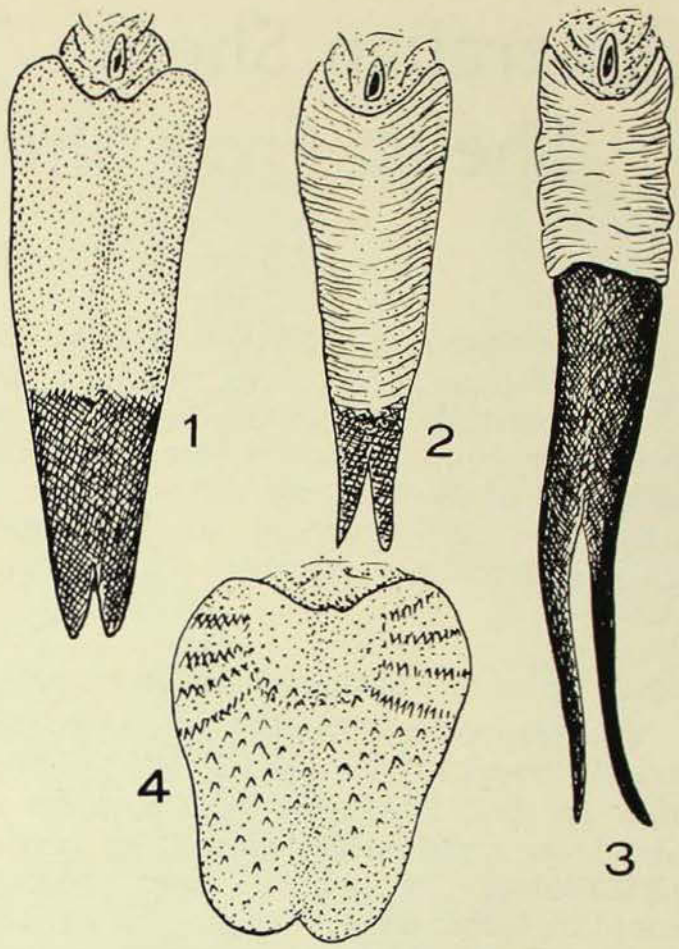
In lizards the teeth play an important part in classification, the two main types of dentition separating the Iguanidae from the Agamidae, families which contain some species that could not readily be separated by outward appearance alone. In iguanas the teeth are set deeply in a continuous groove along the inner side of the jaw, and are defined as being pleurodont; whilst in the Agamidae, a family containing the jew lizard and its relatives, the teeth are saw-like and set along the top edge of the jaw, and are referred to as being acrodont. The tongue, which is generically variable in shape and comparative size, often supplies the specialist with an additional character when classifying his collections. In the skink family, of which the Blue Tongue lizard is a well-known type, and among geckos and agamas, the tongue is flat, fleshy, and only slightly nicked at the tip, though of different shape according to type, but in the goannas it is long, rod-like and deeply forked, like that of a snake. The most extraordinary of all reptile tongues is to be found in the chameleon, in which it is extremely elastic, rod-like, and provided with a large disk at the tip; it is retractile, and can be shot out to a distance of about six inches at any insect which may be within range.

Tails, as may have been observed, are even more variable in shape and size than tongues, but cannot often be relied upon as an aid in classifying species. Tails may be leaf-like as in some geckos, and knobby in others; they may be long and covered with smooth scales, or short and spiny as in some of the skinks. In at least one group the tail is prehensile, the best example being that of the chameleon. In any kind of lizard it is not unusual to find specimens bearing abnormal tails, in which there may be from two to six distinct tips, or two or three complete tails. A characteristic of the lizards is that the tail is very brittle and easily broken off, sometimes into several pieces, but with geckos the whole tail breaks off at the base. In all cases a new "sham" tail is grown, but this has no bony supports (vertebrae) and is merely an

unsegmented cartilaginous rod. The regenerated tail is never a complete replica of the displaced one, though it is invested with muscles, skin and scales. The scales differ very considerably from the original type in geckos, skinks, and some others; however, in the lacertas, the so-called true lizards, the reproduced tail scales are of the same type as the original. It might be mentioned in passing that the tail of a snake does not break by fracture, as with lizards, and it cannot be regenerated.

With most lizards the colour changing capabilities have been very much exaggerated, many stories relating to this being on a par with the anecdote of the chameleon which burst when endeavouring to take on the colours of a tartan material when placed upon it. Actually quite a number of lizards, particularly those belonging to the Agamidae (the jew lizard family) can put the chameleon to shame where colour changing is concerned.

The great majority of lizards are harmless, though many of the larger kinds can inflict a very nasty bite, which might produce blood poisoning if not carefully attended to. It is quite generally believed that a bite from a goanna never completely heals, but that it breaks out annually into a sore at the site of the bite. Whilst a bite from some lizards might prove troublesome, as also might a bite from a dog, or a scratch from a cat, there are only two species which are definitely venomous, and they are the closely related members of the genus Heloderma, Gila Monster of Arizona, and the Beaded Lizard of Mexico and Central America. Both of these have very sharp teeth and poison fangs something like those of a brown tree snake. The fangs are grooved, and attached to venom sacs, therefore the



The tongues of lizards vary considerably in the different kinds:

1. *Tongue of a Legless Lizard.*
2. „ „ *common Skink.*
3. „ „ *Goanna.*
4. „ „ *Gecko.*

method of injecting the venom is the same as in snakes. These two lizards are regarded as extremely dangerous, even deadly, to man. In general outward build the heloderms resemble our well-known Blue Tongue lizard, but they are classified as being more closely related to the iguanas.

Up to this point, we have read what might be regarded as a general, popular introduction to the lizards; in the next issue of the Magazine some of the kinds mentioned will be introduced.

Australian Shells: The Tritons, Warped Shells, Frog Shells and Sand Snails

By JOYCE ALLAN

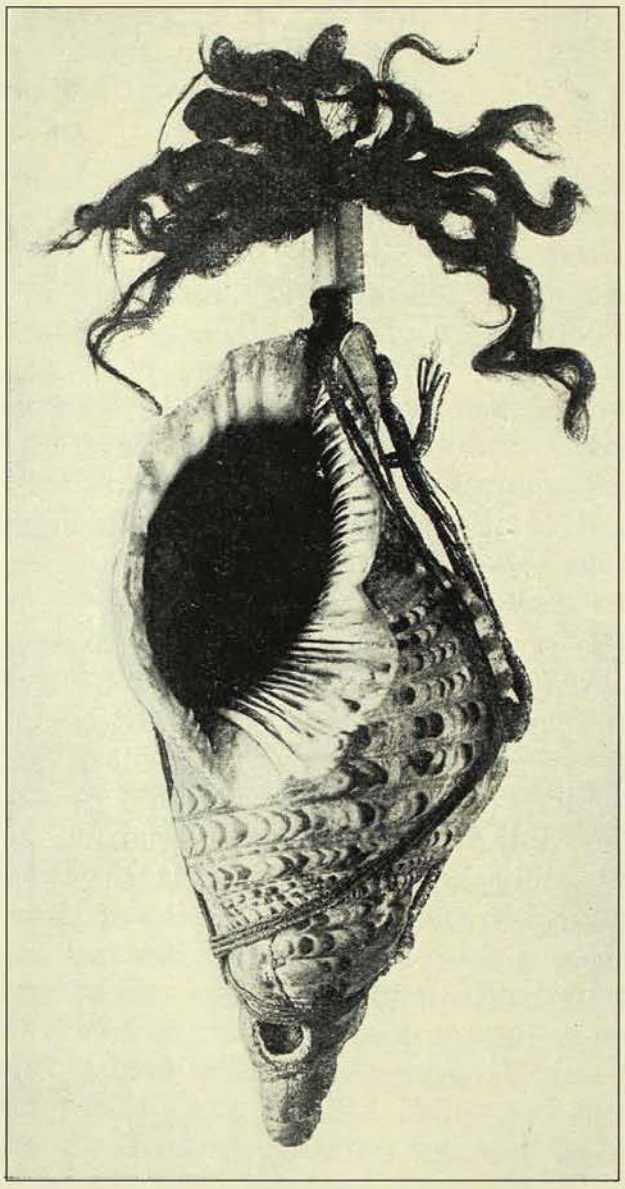
IN continuation of the articles on Australian shells, four families are dealt with here, Cymatiidae, Bursidae, Naticidae, and Lamellariidae, and the members of each family show sufficient differences in structure to be distinguished from one another without any difficulty.

THE TRITONS, WARPED, AND FROG SHELLS.

The Tritons and Warped shells are distinctly tropical in distribution, where they are found living from low water to about one hundred fathoms. The family Cymatiidae, to which they belong, contains numerous, often beautiful, species showing a great range of size and colour. The shells are usually very solid and heavily sculptured, and the animals, though they appear sluggish, can repair even considerable damage to their shells with ease.* In life, the shells of many are covered with a remarkable thick, hairy or bristly epidermis. When mature, the outer lip of the shells curls under, forming a deep gutter, which becomes filled with shelly matter. In Australia, the most beautiful species are found in Queensland waters, and the majority of these also occur throughout the South Pacific Islands; amongst the more southern Australian ones, however, are some interesting forms, especially dredged species from deep water.

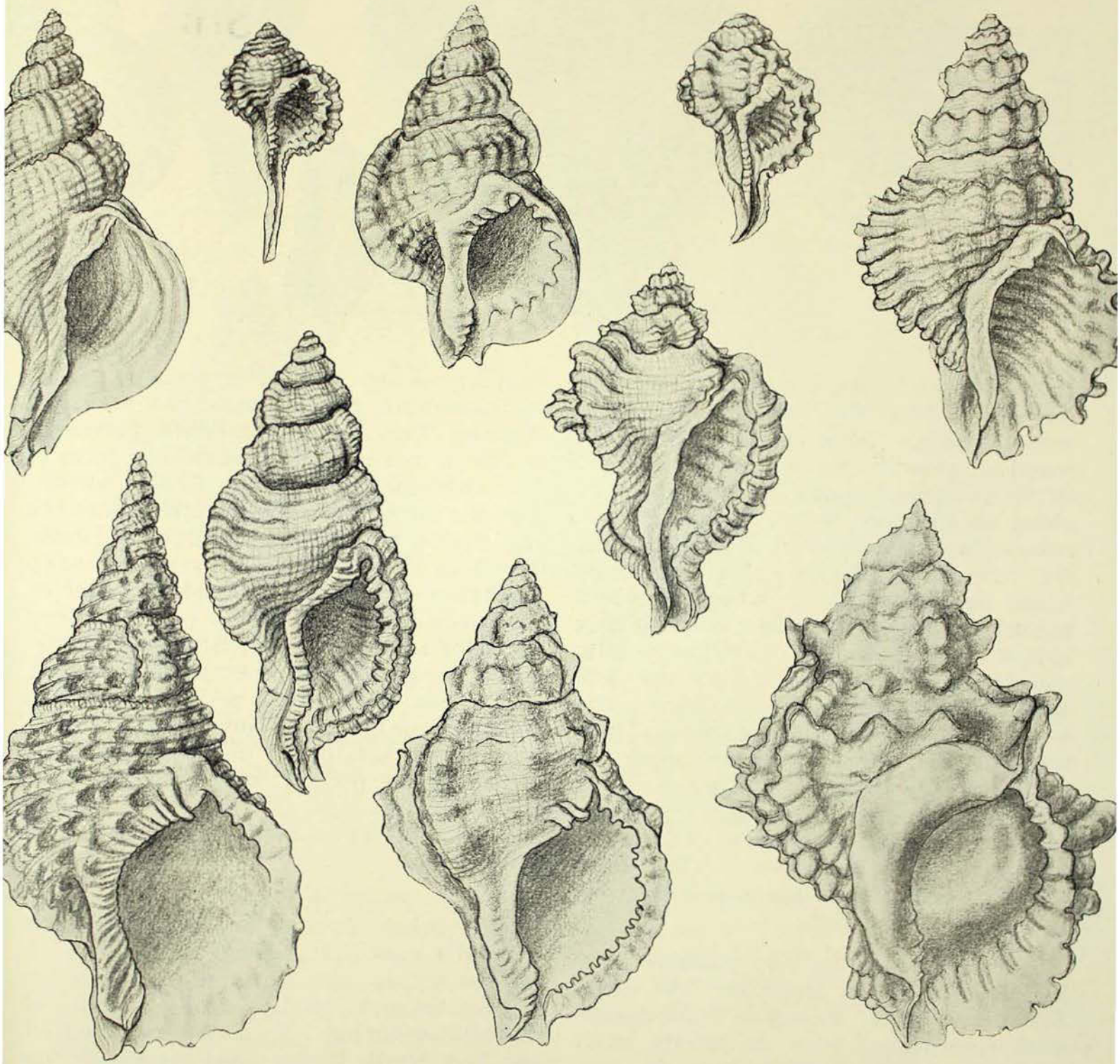
LARGE TRITON SHELLS.

The largest Triton, Triton's Trumpet, *Charonia tritonis*, one of the biggest univalve shells in the world, and probably one of the best known, reaches sixteen or eighteen inches in length. Its peculiar and most spectacular colouring, buff, brown, red and purple, laid on in crescentic patches on the spiral ridges of the shell, makes it one of the handsomest shells found. The shell has a very wide distribution throughout the Indo-Pacific, forms even occurring in the West Indies and the Mediterranean. It is also found on the Great Barrier Reef, Queensland. Pacific islanders use the shell as a

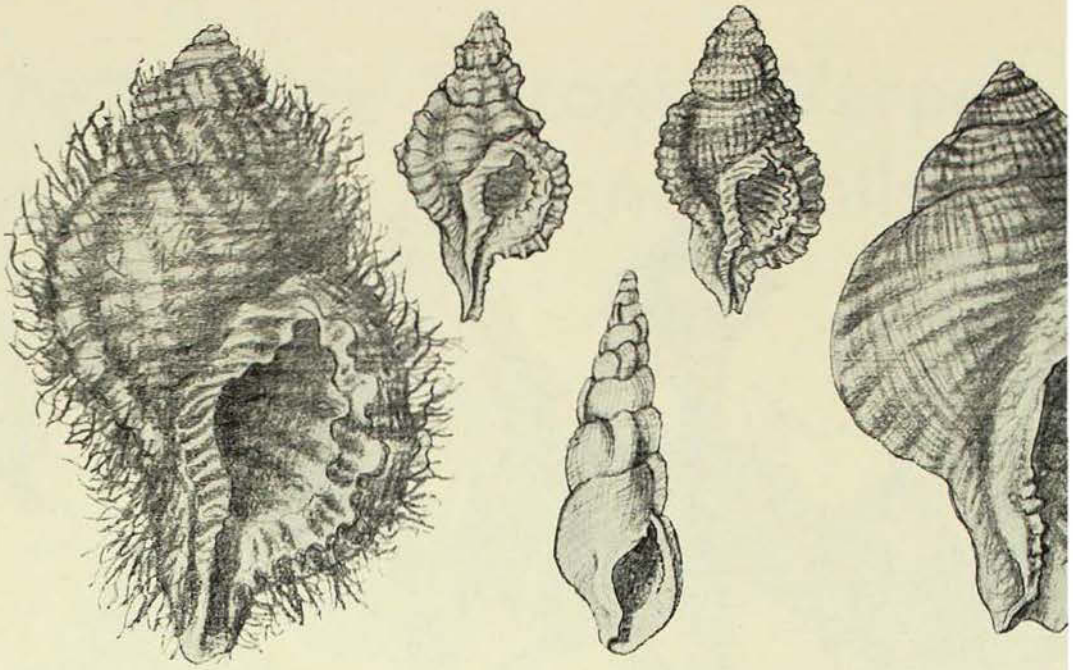


A trumpet of the Great Conch (Charonia tritonis) decorated as a battle trophy.

* Mort.—"Abnormalities Among Shells', Austr. Mus. Mag., vi, No. 3, 1936.



In the top row, from left to right, are the deep-water shell Fusitriton retiolus, Tritonocauda caudatum, Mayena australasia, Cymatium sarcostoma and Cymatilesta spengleri. In the bottom row are the Trumpet shell, Charonia tritonis, the Red Whelk, Charonia rubicunda, and the large Frog shell, Bursa bufo. Between the two rows are Cymatium aquatile and Cymatium lotorium.



The large figure on the left is the Hairy Whelk, Monoplex australasiae, that on the right is Gondwandula tumidum. Between these in the top row are Cymatium chlorostoma and Septa rubecula; the elongated one in the lower row is Obex brazieri.

trumpet after boring a hole in a whorl of the spire. It is also used by them as a teapot. Other large Triton shells are found in the southern waters of Australia. Of those a very handsome reddish shell about six or more inches high, *Charonia rubicunda*, is common at low tide along the New South Wales coast, especially round Sydney, where it is found wedged in rock crevices. Its colour is frequently hidden under a bleached coralline growth, and it is generally known as the Red Whelk. Some specimens are more nodulose than others; a deep-water form, trawled on the continental shelf off southern New South Wales in 50-70 fathoms, is thinner and larger, with little colour, and has been given the name *Charonia eucla instructa*. This form closely resembles that dredged off the west coast of New Zealand.

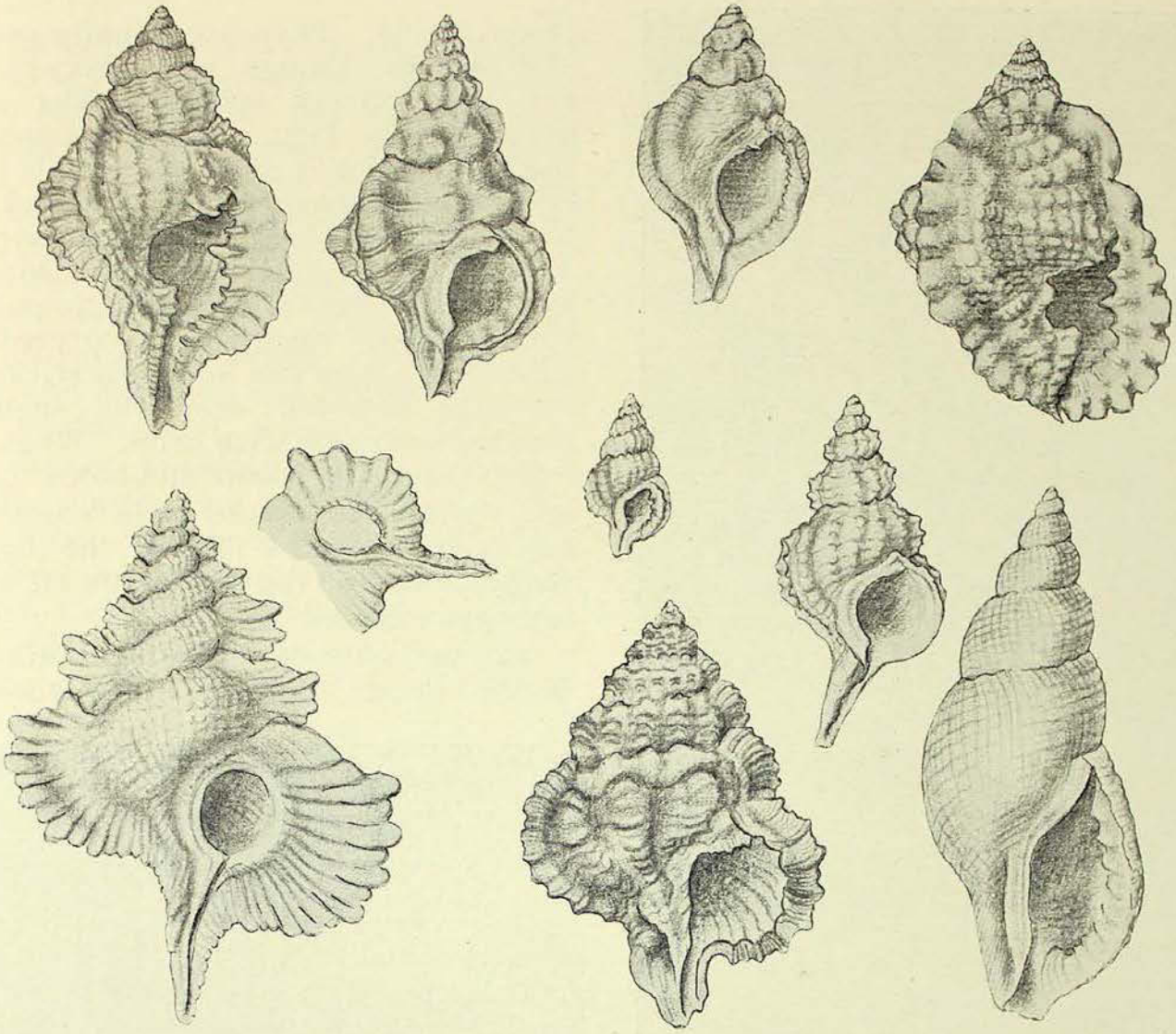
There are two other very common large Tritons in southern Australia. The Hairy Triton or Whelk, *Monoplex australasiae*, most conspicuous with its bristly hairy epidermis when removed from its surroundings among rocks and weeds at low tide, but in them well camouflaged, ranges from New South Wales to southern Queensland. The other, *Cymatilesta spengleri*, which also reaches a height of about six inches, is a typical rock-living type of shell, solid and heavily ridged, and is uniformly straw coloured. It also is one of the commonest species round Sydney, and many dead shells in the kitchen middens of the aborigines show that it was appreciated by them as a food. A Tasmanian, South Australian and New Zealand Triton, *Gondwandula tumidum*, is like a more swollen, smoother form of the common New South Wales species *Mayena australasia*. These are covered in life with a rich brown fur-like epidermis, which in the former hides reddish brown revolving lines. A smaller species, *Gondwandula bassi*, has so far been recorded only from Bass Straits. *Austrosassia parkinsoniana*, a very distinct shell, about an inch and a half long, is recorded only from New South Wales, and a very small, but closely sculptured, southern Australian species, *Cymatiella verrucosa*, belongs to a group of several species, varying in sculpture, length, and breadth.

DEEP-WATER TRITONS.

Like other deep-water forms of shells normally rock-living, the Tritons found in depths up to one hundred fathoms are much thinner shells, and devoid of definite colouring. Two species found off the New South Wales coast are *Fusitriton retiolus* and *Cymatoma kampylum*.

TROPICAL TRITONS.

Amongst important northern forms are the red-mouthed closely sculptured *Cymatium aquatile*, a somewhat similar, but smaller, red brown shell, *Septa rubecula*, *Cymatium chlorostoma*, the heavily nodulose *Cymatium lotorium*, the squat, broad, red and white banded *Apollon gyrineum*, and the small, whitish,



From left to right in the top row are Distorsio francesae, Austrosassia parkinsoniana, Gondwandula bassi, and the Warp shell, Distorsio anus. In the bottom row are the Cockaroo shell, Apollon pusillum, Apollon gyrineum and Ratifusus mestayeri. In the middle row are the side view of the mouth of the Cockaroo shell, Cymatiella verrucosa and Cymatoma kampylum.

delicately marked Cockaroo shell, *Apollon pusillum*. With the exception of the two last-named, all these are found throughout the South Pacific as well as Queensland. The Cockaroo shell is so called by Queenslanders owing to the resemblance of is mouth and canal, when held sideways, to a cock's head. These, together with another tropical Triton, the long canalled *Cymatium sarcostoma*, are easily recognized forms.

WARP SHELLS.

The Warp Shells, of which only a few species are known, have a wide distribution through the Indo-Pacific, and are noteworthy for their peculiar distorted shape. The two species figured here, *Distorsio francesae* and *Distorsio anus*, are found in the South Pacific Islands and Queensland, the former reaching as far south as Sydney in harbour dredgings.

FROG SHELLS.

The Frog Shells are large and heavy, with granulated surfaces, which, together with the squat shape of some and their sprawling, leg-like tubercles, probably account for their name. The animals are active and crawl over coral reefs and rocks in tropical seas, and the commonest species in the South Pacific and Queensland is *Bursa bufo*. This is cream coloured, stained with orange brown; it

Occasionally one finds a track of the sand snail sufficiently removed from a nearby maze to permit of photography. The one here shown is very deeply furrowed in the soft sand, and the eruption at its end marks the spot where the snail has gone below the surface. Two examples of the cone-shaped variety of snail responsible for this type of track are ranged alongside it.

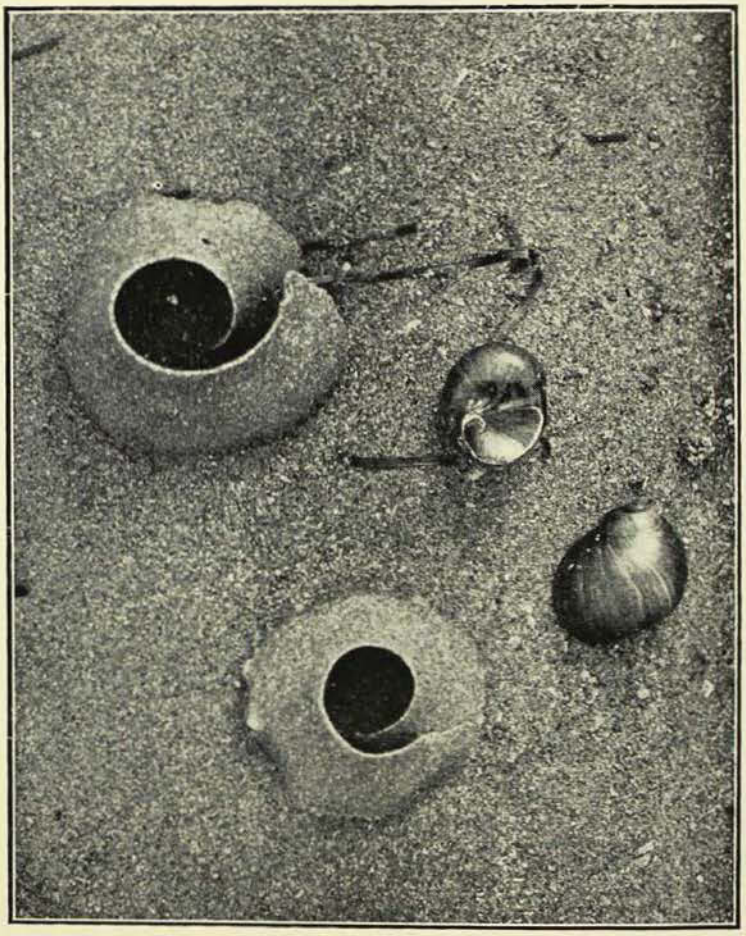
grows to about fourteen inches in length, and has an orange red interior.

Two shells, though neither Tritons nor Sand Snails, are placed here because their proper position in classification is still doubtful. These are *Obex brazieri*, restricted in its distribution to New South Wales, and *Ratifusus mestayeri*, from southern Australian to New South Wales waters.

SAND SNAILS.

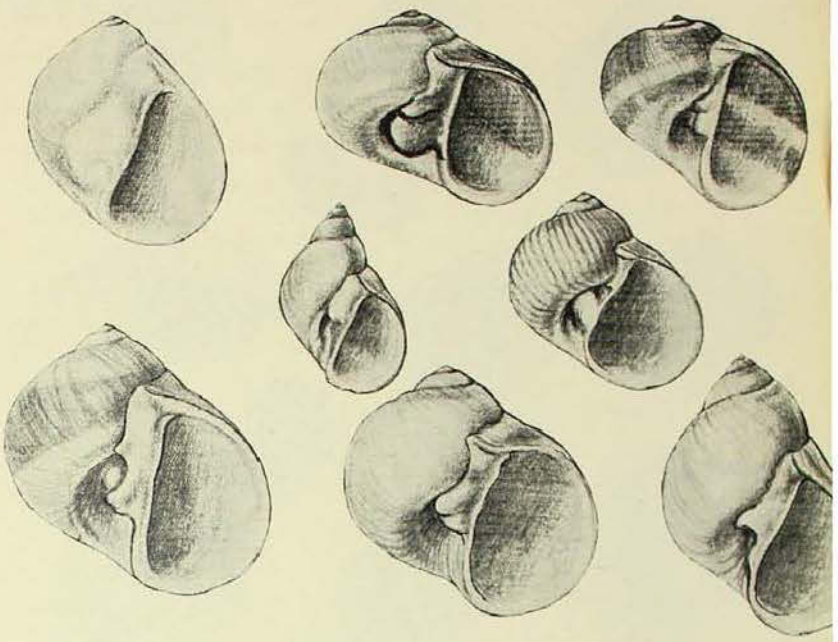
Sand Snails are sometimes known as Moon Shells. They are usually globular and smooth, though often very prettily and distinctively marked. The animal appears very large in comparison with the shell, which it often completely covers. Sand Snails burrow in the sand and sandy mud of flats where they hunt for food, particularly small bivalves. Alongside the typical forms are often found their collar-shaped egg-girdles, covered with sand. The eggs are laid in a sticky mass of jelly moulded over the shell, and covered each side with sand. When under water the girdle is soft and holds together, but when cast ashore it becomes brittle and soon breaks. When the eggs are ready to hatch, the sand falls off and the eggs are exposed.

The majority of the Sand Snails of the South Pacific Islands and Queensland

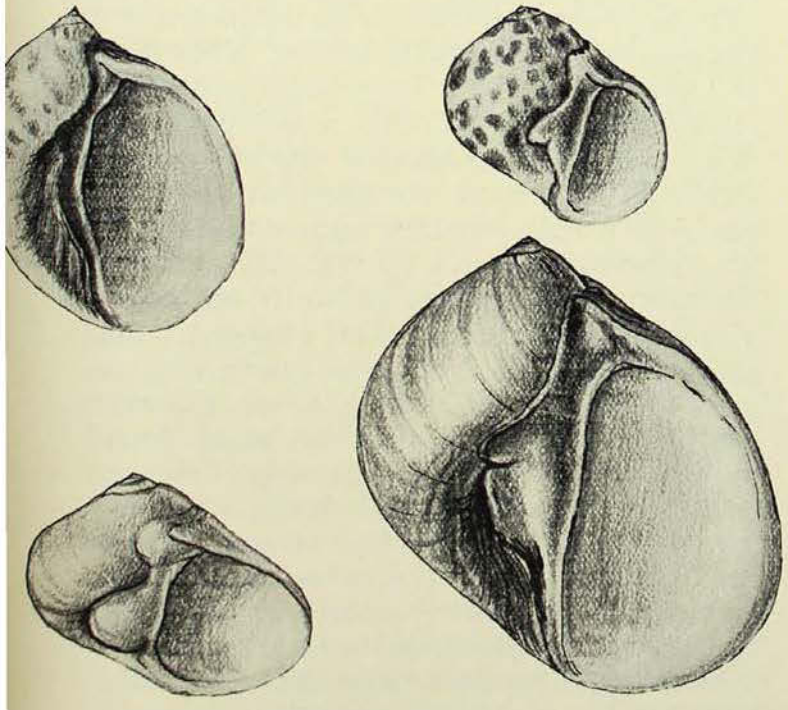


The eggs rings or nidi of the sand snails are conspicuous on the tidal flats in mid-summer. At least three varieties can be recognized, but it is difficult to associate them with the snails responsible for their building. Here are shown two live shells of the large depressed snail of the tidal flats which is believed to manufacture the big coarser nidus shown. Note the operculum or lid closing the opening of the shell of the upturned snail in the picture.

are strikingly marked with spots or wavy lines. The largest grows only a little over two inches in height, but their swollen shape makes them appear bigger. Some of the best known forms are often found with the operculum in them. This varies from a horny brown one to a shelly, solid type. The larger Sand Snails are *Polinices sordidus*, a red-brown shell found all round Australia, *Polinices pyriformis*, and a pure white Queensland and South Pacific shell, noted for its deep brown horny operculum fitting tightly into the mouth, and resembling a pale yellow form, *mellosum*. Other common large forms are an orange one, *aurantium* from New Caledonia; the brown *Polinices maura*, with a deep chocolate coloured inner lip, and the polished single-banded *Mamillaria powisiana*, both from the South Pacific Islands. Also well known are the two-toned flattened *Polinices bicolor*, and the extra flattened *Polinices incei*, which is found, like *Polinices conicus*, all round Australia. Besides these, *Natica vitellus* and *Natica lineatus* are found in the South Pacific Islands as well as in northern Australia.

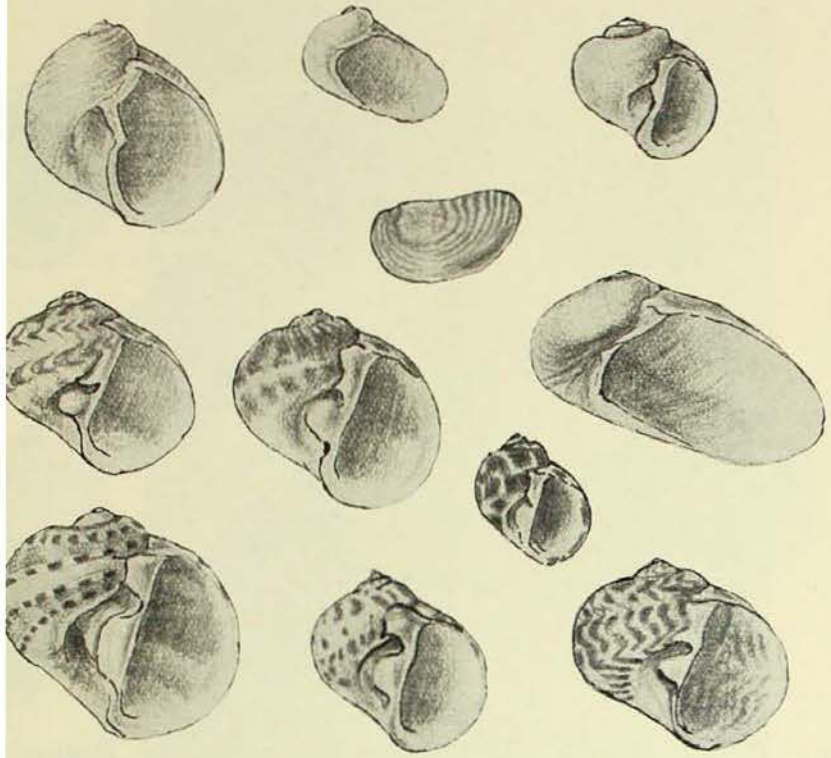


Sand Snails. The three top ones are Polinices pyriformis, Polinices bicolor and Natica vitellus. In the middle row are Polinices conicus and Natica lineata. The three lower figures represent Mamillaria powisiana, Polinices aulacoglossa, and Polinices sordidus.



The two top Sand Snails are Mamilla sebae and Natica violacea; the two lower ones, Polinices incei and Polinices maura.

Among smaller forms, about an inch in height, there are many species closely resembling one another but which on closer examination are found to have sufficient differences to make them distinct. Spots and lines predominate in these shells, and most of them have a solid shelly operculum. *Natica zebra*, with zig-zag markings on a creamy ground, and *Natica colliei*, a small elongated shell with a few broad longitudinal bands, are both found in northern Australian waters. From Queensland and the South Pacific generally come the tan spotted, violet-lipped *Natica violacea*, the brown spotted *Naticarius onca*, *Natica seychellum*, creamy yellow with interrupted brownish encircling bands, and *Naticarius alapapilionis*, whose four rows of purplish-brown bands, interrupted with white, are separated by light brown bands. A beautifully marked South Pacific shell, *Notocochlis euzona*, has several allied forms, the Sydney one, *Notocochlis cothurnata*, being a smaller more delicate



In the top row are Pervisinum dingeldeii, Marseniopsis innominatus, and Friginatica beddomei. The middle row figures represent Notocochlis euzona, Natica seychellum, with its operculum above, and Ectosinum zonalis. In the bottom row are Naticarius alapapilionis, Naticarius onca, and Natica zebra; above the last two is Natica collieri.

shell. The large cream *Polinices aulacoglossa* is one of the commonest southern Australian Sand Snails. It is frequently seen ploughing its way through the sand or mud flats round Sydney, using its large foot as a locomotive organ. With this also it can burrow into the wet sand for small bivalves, and nearby may be seen its sandy egg-girdle. A track left in the damp sand shows the area over which it has traversed.

There is also a series of Sand Snails distinguished by their non-globular shape, tiny spire, large main whorl, wide open mouth, and deep brown coloured inner lip and umbilicus, contrasting strongly with the almost white shell. These are northern Australian and South Pacific Island shells, and are represented in this article by the figure of *Mamilla sebae*. A somewhat similar shaped but heavier shell, *Mamilla melanochila*, is found in the Solomons, and a smaller lighter one is *Mamilla simiae*. These are covered in life with a pale gold epidermis, hiding interrupted brown revolving bands on the main whorl. All these Sand Snails belong to the family Naticidae, to which also belongs a small southern Australian shell, deeply channelled above each whorl and about half an inch high, *Friginatica beddomei*, shells of the genus *Ectosinum*, represented in this article by *Ectosinum zonalis*, a flat white shell from southern Australia, and *Pervisinum dingeldeii*, a pure white shell with revolving, closely arranged, flat ridges.

Near this family is placed a very small one, Lamellariidae, possessing, as far as is now known, only a few species. They mostly come from deep water and many are known from the shell only. They are said to make a nest in an ascidian in which they lay their eggs, covering them with a lid, which flies open when the fry are ready to emerge; whether this applies to those found in Australian waters is not yet known. A very small, delicate, white shell belonging to this family occurs in southern Australia, and is called *Marseniopsis innominatus*. In this family has also been placed a deep-water species, *Mysticoncha wilsoni*, from southern Australia and New South Wales. This is not a common shell, as it is obtained only by dredging. The animal, which has somewhat peculiar tessellated markings on its back, is soft and rounded and entirely encloses a thin swollen natacoid shell. At first glance it shows no resemblance to an ordinary shell animal and only by cutting along the back is the shell exposed. This species was for some time placed in the genus *Caledoniella*, which name, however, belongs to a small glassy shell found living parasitically on a mantis shrimp in Queensland and New Caledonia. There is frequently found on the Great Barrier Reef, Queensland, a species, *Lamellaria tongana*. It is known mostly by the large, warty, black animal, with its anterior end bifid and foot narrow. The shell is shining white with a brown margin, is much smaller than the animal, and is entirely internal, lying under the dorsal skin. It is species such as this that show the great diversity existing in the numerous families of the molluscan phylum.

Reviews

The Call of the Koala. By Ambrose Pratt. (Robertson and Mullens, Melbourne, 1937). Pp. 120, with 22 illustrations. Price: 6s.

Koala: The Story of the Native Bear. By Charles Barrett, C.M.Z.S. (Robertson and Mullens, Melbourne, 1937.) 8vo, pp. 31, with 17 illustrations. Price: 2s.

No Australian animal, not even the platypus, is better known at home and abroad than the Koala, or Native Bear, as it is generally called. Its quaint appearance, comical expression, and engaging ways combine to make an irresistible appeal, and it is hard to believe that anyone would willing harm, much less kill, one of these harmless little animals.

Of the two books under review, Mr. Pratt's volume is comprehensive in scope, containing chapters on the classification and relationships of the animal, some features of its anatomy, and its probable genesis; but its special feature is the endeavour to understand its ways and needs, so that an intelligent scheme may be devised for its preservation. For, sad to relate, this little Australian is fighting a losing battle. The spread of settlement, bush fires, the ravages of disease, and of the fox, wild dog, and dingo, have greatly reduced its numbers, and the author can see no hope for its salvation except the provision of adequate reserves as koala stock farms, where a fully matured supply of suitable food trees is available. Mr. Pratt has given much study to the problem of nutrition in the koala, and shows that it is not so simple as it appears. One fact that emerges is that the young and adventitious foliage, even of appropriate food trees, may be injurious because of the presence in the leaves of a cyanogenetic glucoside, which by the action of an enzyme is decomposed, setting free prussic acid. If the bears have access to a sufficient number and variety of eucalypts they are able to select the right kind of food, but when their choice is limited and hunger drives, the unfortunate bear falls back on food which because of age of the trees, or because of peculiarities of climate, soil or season, is definitely toxic. Mr. Pratt also considers that cineol, one of the constituents of eucalyptus oil, is dangerous to the health of the koala, reducing arterial pressure and body temperature, and causing muscular weakness and death from respiratory failure.

The koala is the victim of over-specialization. It is adapted to live under certain conditions, but these conditions no longer maintain in many places where the animals were once abundant. Consequently they have been forced to migrate into areas where the environment is unsuitable for the continued existence of a healthy race of Native Bears.

It is doubtful whether the author's surmise, based on its warm covering, that the koala began its history in some Antarctic region, will be endorsed by everyone. It appears more likely that it evolved in Australia from ancestors which were quite unlike the living animal.

Mr. Barrett's little work to some extent covers the same ground as Mr. Pratt's larger volume, and a special feature is the excellent series of photographs, which take up a large part of the book. Mr. Barrett is an accomplished writer of nature books, and this latest product of his pen is particularly charming. He traces the beginnings of our knowledge of the koala in the early years of last century, and devotes a chapter to aboriginal legends and myths concerning the animal, to which the Victorian blacks gave the name Kur-bo-roo, or Koob-borr, and which, curiously enough, they associated in some way with the supply of water (in a state of nature the Native Bear never drinks).

Both authors give a delightful account of Edward, the baby bear which has been adopted by Mrs. Oswin Roberts. Let us hope that Edward's future will be as safe and pleasant as the life he is now enjoying.

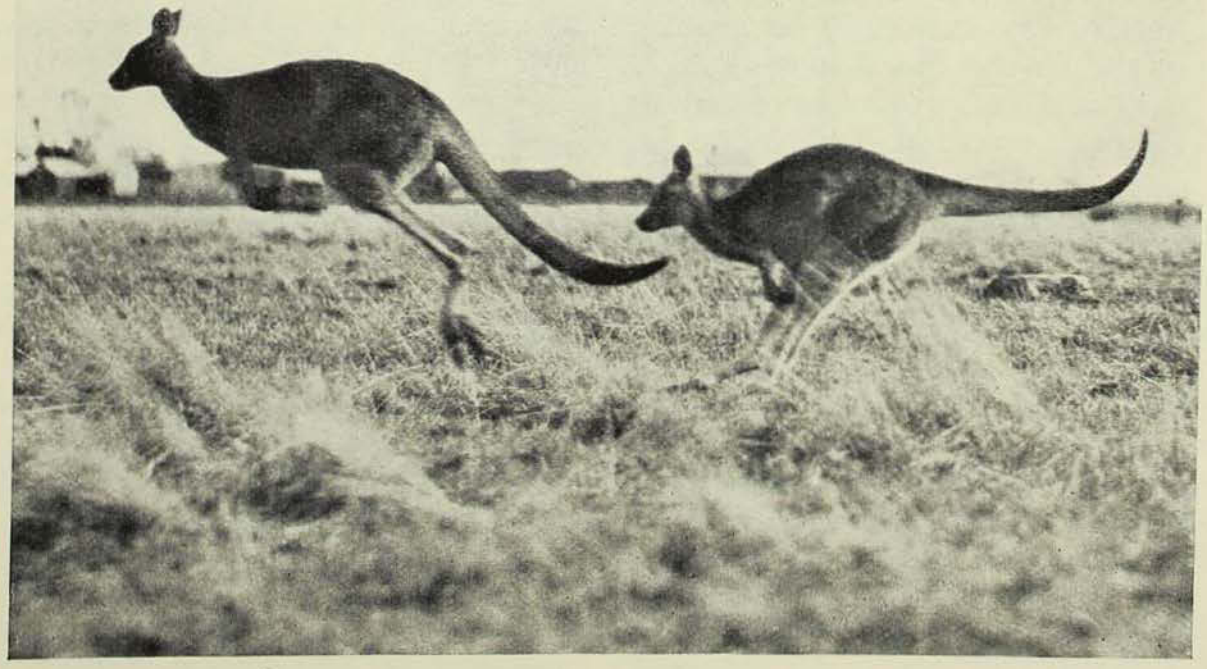
C.A.

WIDE HORIZONS: WANDERINGS IN CENTRAL AUSTRALIA. By R. H. Croll. (Angus and Robertson, Ltd., Sydney, 1937.) 8vo, pp. xiv + 158, with 37 illustrations. Price 9s. 6d.

The number of books on "The Centre" or "Inland" will soon be large enough to stock a small library, and still there seems to be room and a demand for more. The ingredients which go to form Centre pie are well known: the gibber plains, the dry river courses which sometimes become torrents, the sandy desert where "an empty beer bottle amounts to a change of scenery", the Macdonnell Ranges, that blessed word Oodnadatta, which so intrigued the late Rider Haggard, the unexpected Palm Valley, car trouble, the virtues and vices of the camel, are some of them, and there are many others, for this is truly an amazing country. And some interesting and entertaining human types may be encountered in the Centre. The hard-bitten Inlander, prospector or cattleman, the blackfellow, both the wild type and the rather pitiful but often amusing hanger-on of the white man's town or station, furnish plenty of material for him who, like our author, has an eye to observe and a fluent pen to describe.

Mr. Croll's volume is a splendid addition to the growing pile of books on Central Australia, for he has mixed his ingredients with rare skill, and the whole is flavoured with a rich literary style and many flashes of humour. It is safe to say that no one who commences this book will lay it aside before the last page is reached, and that he will find it as absorbing as the latest thriller. Whether the reader is attracted by scenic splendour, natural history, the lonely but picturesque life of the dweller in the outback, or the ways of the Australian aboriginal, this book will make its appeal to him.

C.A.



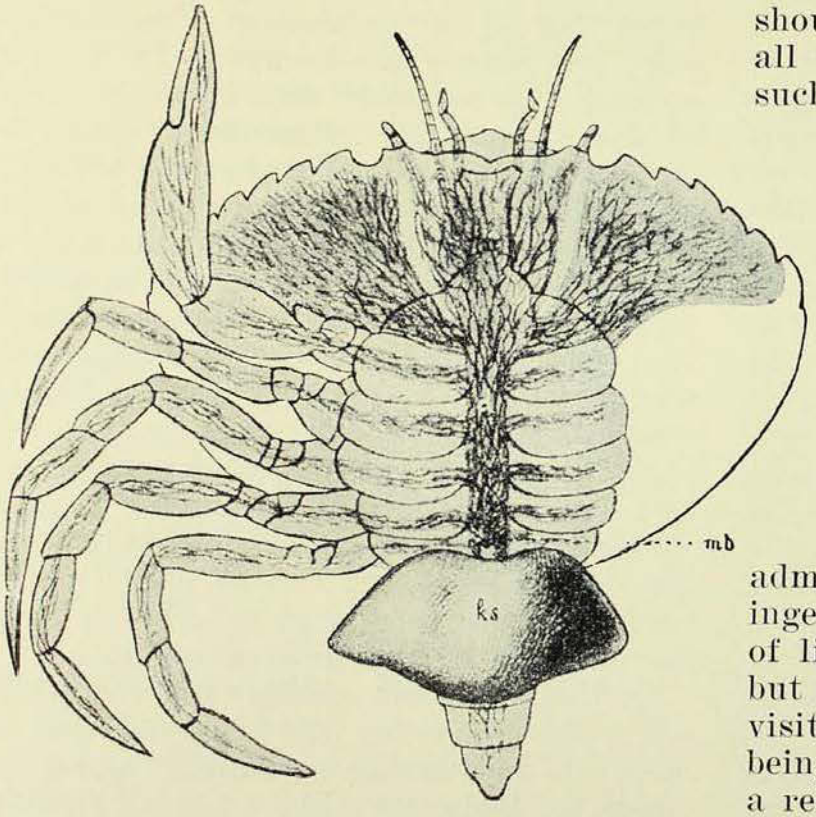
Kangaroos in action.

From Croll's "Wide Horizons."

Parasites and Parasitism

By ARTHUR A. LIVINGSTONE.

As the study of parasitology covers a vast and varied field, it will be recognized that to deal at length with any specified avenue would be beyond the bounds of this article. Therefore, it is intended that this article will serve to give only a brief outline of the subject, and perhaps a slight insight into its intricacies.



Sacculina carcini on abdomen of crab. ks, *body of parasite.* mb, *root-like processes of parasite, which are seen extending through the body and limbs of the host.*

Lang's Comparative Anatomy.

What is a parasite in nature?

A parasite may be defined as a creature inhabiting a living animal from which it receives gratis not only a permanent home, but all the necessities of life. Such lowly forms are really the "paupers" of Nature, for they have become, for the most part, too indolent to seek their own food, and rely upon the alternative of stealing from the more industrious.

Any form of parasitism is despised by most of us, but a certain amount of credit has been given to them by an eminent writer. He states: "Why does the naturalist think hardly of the parasite; why does he speak of them as degraded and despise them as the most ignoble creatures in Nature? What more can animals do than eat, drink and die tomorrow? If under the fostering care of a higher animal it can eat better, drink more easily, live more merrily and die perhaps not till the day after, why should it not do so? Is parasitism after all not a clever ruse?" In considering such viewpoints one may be inclined to admit that parasitism is certainly an ingenious method of securing the benefits of life while evading its responsibilities, but usually the parasite is an unwelcome visitor and often a menace to the well-being of its innocent host. Moreover, as a result of its mode of life, the parasite often suffers the loss of organs and finally assumes a state of total degradation. As an instance of this the parasite *Sacculina* may be exemplified. This form originated from the same stock as the crabs, prawns, crayfishes, barnacles, etc., and had the same opportunities to evolve, but evidently it tired in the inexorable struggle for existence, and as an easy way out gradually assumed a parasitic career. Such a course has resulted in its almost structureless body and its low status as compared to its hard working and highly organized ancestors. Peculiarly enough, *Sacculina* lives on the underside of the

abdomen of a relative, the crab, where it takes great toll upon the juices of its host, leaving the victim weak and emaciated.

All parasites cannot be placed in one category, for there are some that perhaps do a little for themselves as well as benefiting their host to some extent. Others simply take their food and give nothing in return, save destruction to the organs and tissues of the host. The remainder are so abject and beggarly that they have managed to do away with even a mouth and digestive organs, and merely absorb their stolen food in a digested state by a process known as osmosis.

The visitation of a parasite may be either permanent or periodic. In permanent parasitism the parasite remains with one host for the entire period of its existence, whereas periodic parasitism embraces only a portion of the life cycle of a parasite within a certain host.

Certain parasites live only upon the external surface of their host, through which they extract their food. Apart from well-known forms, there are the leaf-shaped flat-worms (*Temnocephalids*) which lead an ectoparasitic existence on the carapace, gills, and limbs of the common freshwater crayfish (*Astacopsis serratus*). This host, and attached parasites, can almost invariably be found in many mountain streams within the State. Other parasites have, during the ages, abandoned the seemingly precarious ectoparasitic (outside) mode of living for a safer and better existence within the bodies of certain hosts. Such forms are usually referred to as endoparasites. Among such are included the sheep liver fluke and the like, tapeworms, hook-worms, sleeping sickness and malarial fever parasites, and others.

Endoparasites are divided into two groups: intracellular (living within certain cells of the body) and extra-cellular (living outside the cells of the body). *Plasmodium,* the malarial fever parasite, belongs to the former group, while tapeworms and the like may be cited as representatives of the latter.

ORGANS OF ATTACHMENT, LOCOMOTION AND GENERAL STRUCTURE OF SOME ADULT PARASITES.

The structure of parasites varies as much as that of some non-parasitic creatures, though the organs of the parasite may not be so complex. The law of adaptation to environment applies to the parasite as well as it does to any other animal, and the adaptation of a true parasite must have been a very slow and gradual process. Even the step from an ectoparasitic existence to an endoparasitic one is a very important phase. Since certain parasites have come to dwell in parts of the body of man they have evolved for themselves a reasonably safe and secure anchorage. In *Taenia solium,* the common tapeworm of man, a hold upon the alimentary canal is obtained by the aid of a ring of chitinous hooks situated at the anterior end of the segmented body. In addition, the species is provided with four suckers, also placed anteriorly, but below the hooks. These also serve as means of attachment. In single-celled parasites such highly specialized organs are wanting, but the environment of such parasites may not call for their need. Locomotor organs such as cilia, or hair-like outgrowth from the tiny body, which can be used paddle-like, may be present and function to keep the parasite in any desired position.

In *Trypanosoma gambiense,* the parasite responsible for sleeping sickness in man, an undulating membrane along an elongated body, together with a whip-like flagellum, serves to propel the organism through the blood and finally the fluid of the spinal column to the brain of the host.

COMMENSALISM.

When dealing with phases of parasitism it is essential to discuss briefly the curious phenomenon termed commensalism. Broadly speaking, the appellation is given to the practice of two animals, no matter how different and distantly related, living together for their mutual benefit. In some cases food is shared from a "common table", while in others protection may be given by one

in return for food from the other. The association is one in which many curious types of animals are brought to live together. In some instances the reasons for the mateship are fairly evident, but in others it is often very difficult to determine which of the pair is deriving the benefit, if not both, and just what the benefits are.

A well-known association is seen in the inter-tidal waters of Queensland's coral reefs where the giant sea anemone *Discosoma,* which is often over twelve inches in diameter, has for perpetual associates the tiny, but gaudily coloured *Amphiprion* fishes. These fishes, with their bright colours, seem to lure to the waving stinging tentacles certain marine creatures that would otherwise fail to be attracted by the drab green colouring of the anemone. In this way the anemone is assured a sufficient food supply. In return the tiny fishes have the protection of the stinging tentacles and the scraps of food they may secure when they make periodic darts into the anemone's cavern-like stomach. These fishes are never willing to venture far from the caressing care of the waving tentacles. Within the writer's experience their lightning-like dashes rarely take them away more than a few inches, and when forcibly removed and placed in a nearby pool they become lost and swim about in a most bewildered fashion. Placed within a few feet of the anemone again, they will dart with great rapidity into its protective folds. A curious fact about the association is that the little fishes are immune to the deadly stinging tentacles of the anemone, and can cruise at will among them without showing the least discomfort.

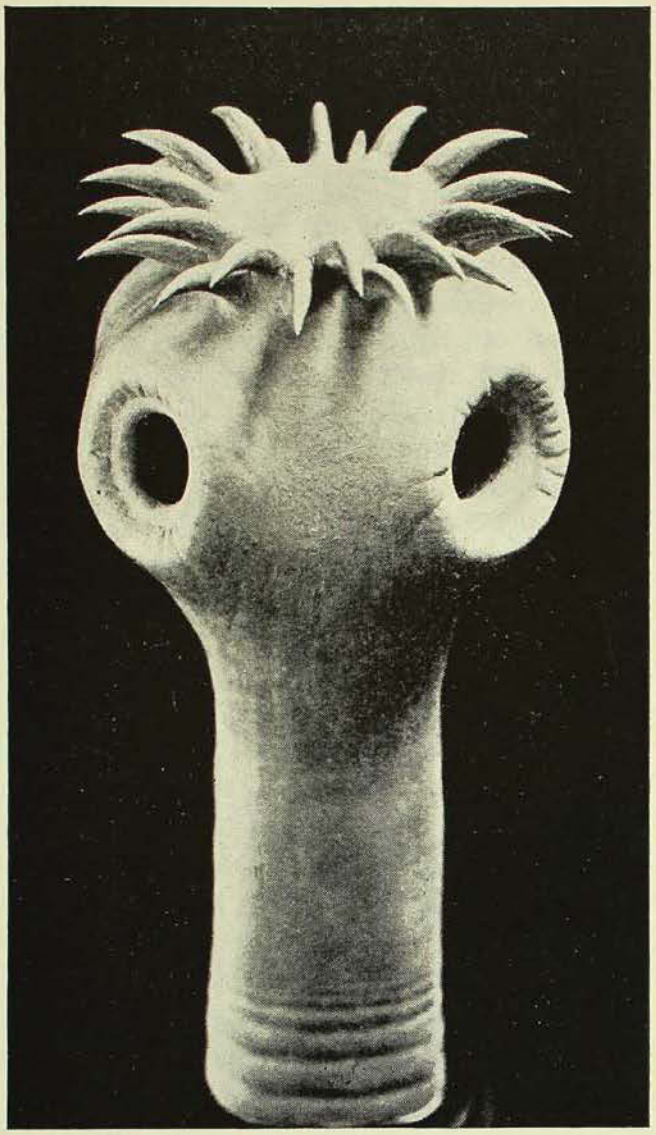
Although a commensal and a parasite may be found to be similar when their habits are compared, we can differentiate the former from the latter inasmuch as it does not feed upon the tissues or fluid of any animal in the same way as the parasite.

DISTRIBUTION OF PARASITES.

The mode of life of parasites determines the situations in which they are found. They are smaller and weaker than their hosts, and are, therefore, obliged to hide and adapt certain structures to obtain such a hold as to defy dislodgment under normal conditions. Some parasites live upon, or within, their respective hosts, but do not destroy them, while others make such drastic inroads that death to the hosts is inevitable. Perhaps no better example than the activities of certain Cymothoid fish parasites could be chosen to illustrate the latter type. These segmented, beetle-like crustaceans infest the waters of southern Australia, and, hunting in packs as they do, have earned for themselves the reputation of being "the wolf packs of the sea". A horde of them has been known to attack a large adult shark, beginning in the mouth, and eating their way right through the body, leaving the host little more than a cylindrical "shell" floating on the surface waters.

The distribution of parasites is wide, and nearly every vertebrate animal, including man, harbours at some time or another, myriads of these unwanted visitors. Frequently we find that the distribution of a given parasite is not merely confined to a single organ or even to a single animal. For instance, *Taenia echinococcus,* a tapeworm, when in the encysted stage is found in the liver or other organs of man and lower animals, but when fully matured it is found in the alimentary canal of the dog.

The chances of a parasite completing its development from the embryo to the adult stage are very remote. The reason for this is that there are so many obstacles placed in the path of natural development, such as difficulty in obtaining an intermediate host, unfavourable climatic conditions, unsuitable environment, that the undeveloped parasite may perish. However, the vast number of young or eggs liberated from an adult parasite largely compensates for the huge mortality in the "brood".



Greatly enlarged model of head of tapeworm (Taenia), showing hooks and suckers.

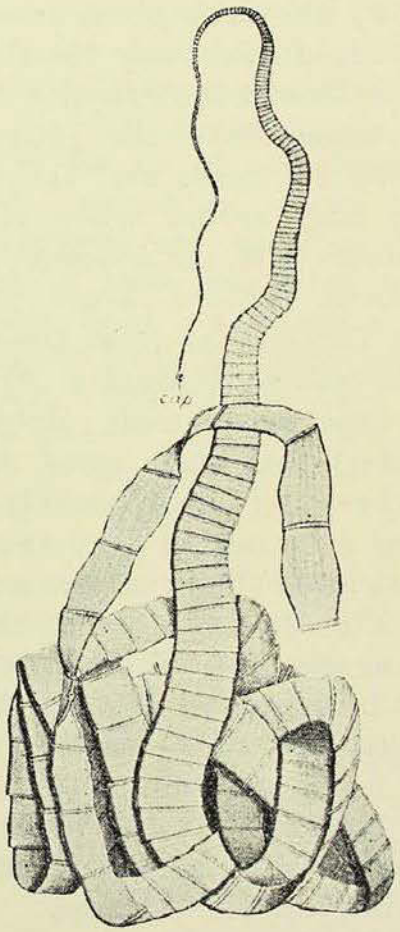
Although a parasite may be in an undeveloped condition, it does not necessarily follow that it has not reached a stage where it can set up irritation or disease.

To illustrate the ravages of a parasite in the undeveloped condition, *Taenia echinococcus* may again be referred to. This parasite, as already stated, lives as an adult tapeworm in the alimentary canal of the dog, but the bladder-worm stage is a phase in its life history which is responsible for a disease in the intermediate host (man or lower animals) known as hydatids.

Entamoeba coli is a single-celled parasite found in the upper parts of the large intestine of man. Here it feeds upon the bacteria infesting the region as well as food taken by the host. This scavenger appears to be perfectly harmless, and sometimes may prove even beneficial in checking the inroads of harmful bacteria. Being a single-celled parasite, the structure of this creature is very simple and its size microscopic. Like all single-celled animals, it is made up of a nucleus (or "heart", so to speak) surrounded by a mass of jelly-like protoplasm. It feeds by the simple process of absorbing food through the general body surface.

EFFECTS OF PARASITIC INFECTION.

From the foregoing it will be seen that the influence of parasites upon their



Complete tapeworm as seen when removed from host. Note the comparative smallness of the head (cap) depending from the long thread-like neck.

After Leuckart.

hosts, so far as health and general welfare are concerned, is of considerable importance. The injurious effects of many parasites is by no means a modern discovery, for their drastic activities have been known since earliest times. Peculiar views regarding them, however, have always been held by many, even by eminent men, in the past century. Such workers in science held that intestinal worms aided digestion, and one in particular states that such worms are "good angels and unfailing helpers of children". Modern science has made a marked advance upon these erroneous ideas, and has done much towards giving us a fuller and truer idea as to the structure and habits of parasites.

From what is learned of the life histories of parasites it must naturally occur to anyone that if steps were taken to do away with intermediate hosts where possible, certain diseases could be checked. Such a course was attempted in the case of malarial fever when the building of the Panama Canal was in progress, and met with success. It has also been adopted in certain parts of the tropics in order to do away with the Anopheline mosquito, the intermediate host and carrier of the malarial fever parasite, *Plasmodium*. Again, if the conditions necessary for a parasite to breed and produce its kind are altered, or taken away, success is naturally met with. For instance, if the eggs of *Fasciola hepatica*, the sheep fluke, be restricted to dry ground and not allowed to enter water or damp soil, they will eventually become useless and the disease checked. Draining land of surface ponds and dampness not only tends to do away with the moisture required for the development of fluke eggs, but also helps to eradicate the pond snail, which is the natural intermediate host of the parasite.

Prevention can be brought about only when we are familiar with the peculiarities and life cycles of parasites, but in all like matters progress in solving the enigmas which confront us today is very slow.

In recognition of their various services to the Australian Museum, the Board of Trustees has been pleased to elect Messrs. Roy Johnson, A.M.I.E. (Austr.), J. Manski, and H. S. Mort, B.E., as Honorary Correspondents.

* * * *

Recently we received from America a letter which is more than usually interesting and gratifying. The correspondent is Mr. Frank Silver-Feather, an Indian of the Cree race, who writes from Chicago:

"Esteemed Sir: During a recent lecture at one of our clubs the word 'Australian Museum Magazine' came to me, and it was stated at that time that this little magazine contained a world of information regarding various native peoples of Australia and surrounding territories, so I have become rather interested to know more about this little publication.

"I shall appreciate most highly if you shall let me know the cost of this publication per year as a subscription, and also how many issues are published yearly.

"Perhaps you can favour me with a sample copy or two, perhaps of back numbers, which will give me an idea as to the contents of this widely spoken of magazine. It is never been my pleasure to have seen one of them."

Insect Musicians

By KEITH C. McKEOWN

PART II.

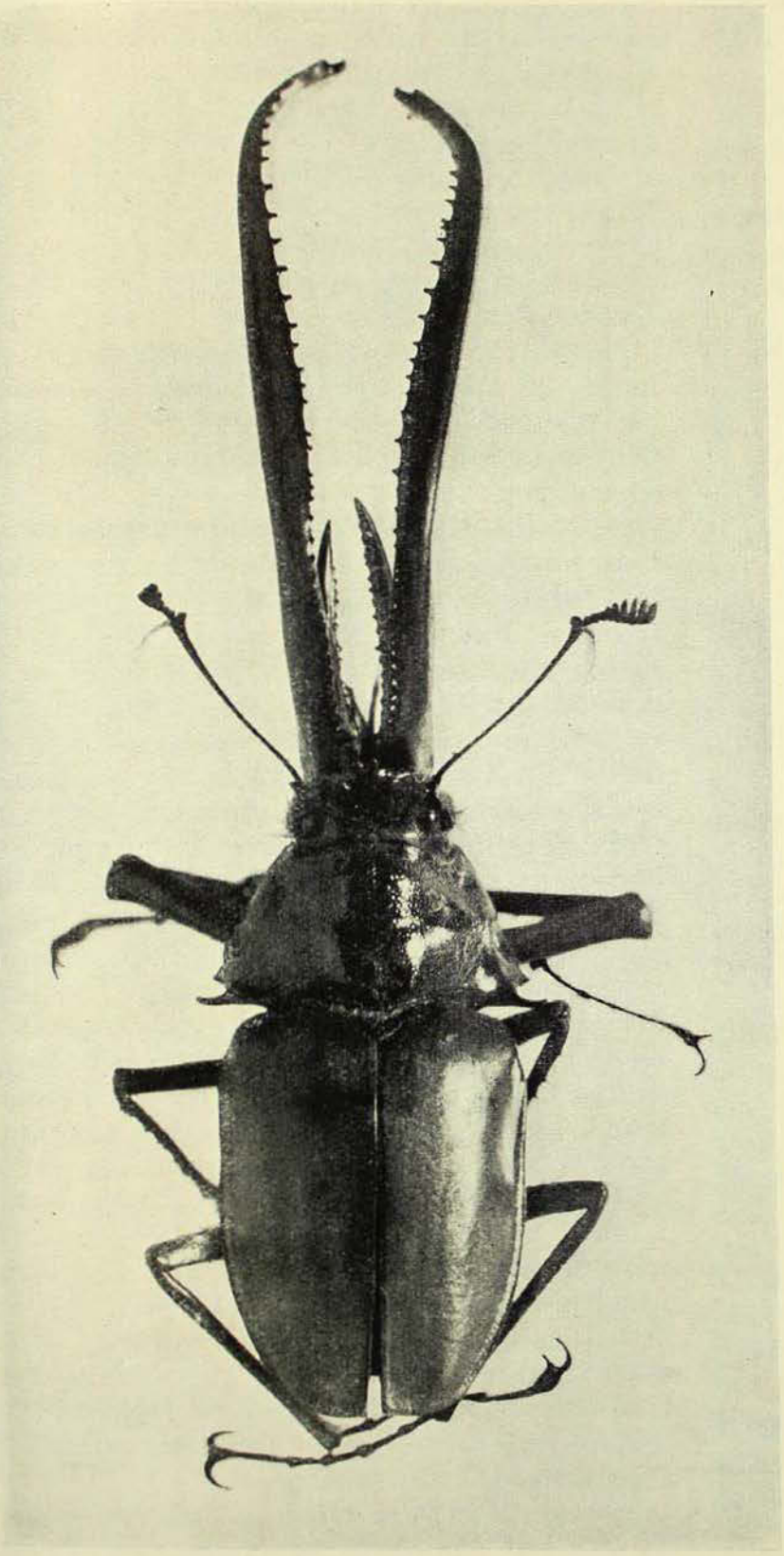
HUMMERS.

THE buzzing or humming of flies, mosquitoes, bees, and wasps is familiar—possibly too familiar—to everyone. It is generally attributed—perhaps in some cases correctly—to the rapid vibration of the wings while the insect is in flight or hovering almost motionless in the air. The blowfly, which produces the sound of F, vibrates its wings about three hundred and thirty-five times a second, and the bee, which produces A, four hundred and forty times per second. In many insects, however, while the beating of its wings may have its effect, there would appear to be some other factor contributing to the volume and pitch of the sound, for it has been proved by experiment that the buzzing is still produced in some insects, although in a different key, even when every portion of the wings has been removed. It is believed that part, at least, of the sound is caused by forcing the air at high pressure through the tracheæ of the thorax. These tracheæ are the breathing tubes which carry the air throughout the body of the insect, and which open upon the exterior by minute openings or spiracles. These spiracles are often guarded against the entry of dust particles by a palisade of fine hairs, while in other species they may be contracted and expanded at the will of the insect by means of folds of integument, thus controlling the passage of air through the body. If the spiracles are closed by a coating of gum or wax the sound ceases. In other insects the sound may be caused and controlled by the contraction of the thoracic muscles, which sets up vibration in the body wall. The buzzing of the common blowfly (*Calliphora* spp.) appears to be of this type, and is familiar to all. The deep hum of the botfly of the horse (*Gasterophilus equi*) is a full-toned hum, so distinctive that it is recognized at once by horses and throws them into a state of terror.

It is well known that the humming of the common hive bee (*Apis mellifera*) differs among the different castes which form the bee community. That of the drone or male is a deep resonant hum, while in the queen there is a similar but more subdued hum, or under certain circumstances a comparatively shrill note. Anyone who has worked among bees knows the range of tones in the worker, varying according to the mood of the insect, and indicative of contentment, anger or, in fact, the whole gamut of its emotions.

This variation in tone is especially true of the wasps. Stand unseen near a colony of the familiar paper-nest wasp (*Polistes variabilis*) and listen to the full-toned buzz of satisfaction as the insects are busy about their daily occupations, gathering food, feeding the larvæ or constructing additional cells to the papery honeycomb-like mass that constitutes their nest. Disclose your presence by moving suddenly, and immediately the sound changes its pitch and becomes shrill—almost savage—and even the inexperienced will realize that it is filled with menace, and that the time has come to beat a hasty retreat. The high-pitched war-song of the wasps is unforgettable.

The mud wasps, or mason and potter wasps, are peaceful creatures, and will retaliate only when interfered with or otherwise provoked. When busy about the construction of the mud cells of the nest, or plastering the mass over with a thick coating of clay, as it flies backwards and forwards carrying its load of building material, it emits a full hum. When it alights upon its nest and commences to mould its ball of clay into the smooth walls of the cell, its note changes into a shrill singing which somewhat resembles the despairing sounds that issue from a blowfly entangled in a spider's web; but in the wasp this is no note of distress, but one of



The giant Chiasognathus of Chile, one of the most remarkable sound-producing insects, the males of which stridulate in anger or defiance. The huge toothed jaws are found in the males alone, their mates bearing quite small mandibles. In life the beetle measures over three inches in length.

sheer contentment. While the wasp is working, and producing this music, the wings are motionless, and no vibration is visible, so that the sound is probably produced by means other than by their vibration.

The buzz of the mosquito is too familiar to everyone to require description, but it is necessary to refer to it here since it is largely a love-song to the insects themselves, even though it may be only a source of annoyance to us. In the female the antennæ are comparatively simple and studded here and there with scattered short hairs or bristles, but in the male they are truly complex structures, being large feathery plumes of hairs. For many years their purpose was a mystery, and gave rise to many widely differing hypotheses, but it has now been conclusively proved that the antennæ act as organs of hearing in the male, for when a note corresponding to that of the female is sounded on a tuning fork, the hairs of the antennæ are thrown into a state of rapid vibration. It is to this note, and to this note only, that they respond; by all other sounds, irrespective of pitch, they are in no way stimulated. The same remarkable development of the antennæ occurs in those near allies of the mosquitoes, the Harlequin Flies or Chironomids.

The Death's-head Hawk Moth of England and Europe produces a very remarkable squeaking sound, over which there has been much controversy, but it is now believed to be produced by forcing the air through the long tubular mouth parts. The adult moth is a robber of bee hives, and the bees seem to recognize and fear the note of the Death's-head Moth, so that it has possibly some value to the insect in preventing attack by the bees. The larva or caterpillar of this moth makes a strange hissing sound when disturbed, but its cause is unknown. Its purpose seems to be that of frightening enemies.

STRIDULATORS.

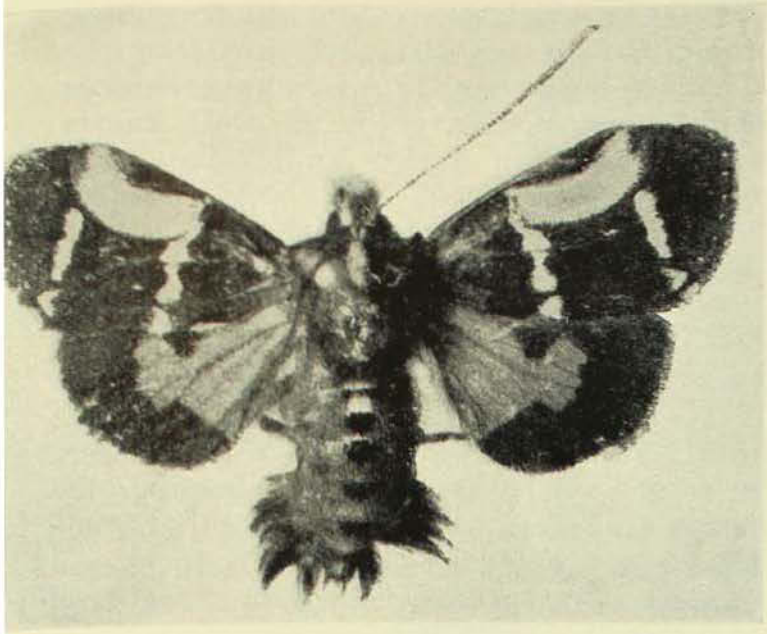
We now come to those insects that produce sounds by stridulation—the rubbing of one part of the body against another which is specially adapted for its part by a fine file-like area, upon which a similar formation or a sharp ridge is scraped. It may be surprising to many to learn that many species of ants make sounds by stridulation, and in a few instances the noise is loud enough to be heard by the unaided human ear. These sounds made by ants are produced by apparatus similar to that just described.

Many of the beetles, especially the Longicorns (Cerambycidae), the weevils (Curculionidae) and the Scarabaeidae, produce chirping or squeaking sounds by similar means. In some groups the stridulating apparatus is confined to the male, in others to the female, or it may be present and developed to an equal degree in both sexes. Charles Darwin, in discussing this question, says: "In the case of the Heliopathes and Oryctes there can hardly be a doubt that the males stridulate in order to call to or excite the females; but with most beetles the stridulation apparently serves both sexes as a mutual call. Beetles stridulate under various emotions, in the same manner as birds use their voices for many purposes besides singing to their mates. The great Chiasognathus stridulates in anger or defiance; many species do the same from distress or fear, if held so that they cannot escape; by striking the hollow stems of trees in the Canary Islands, Messrs. Woolaston and Crotch were able to discover the presence of beetles belonging to the genus Acalles by their stridulation. Lastly, the male of Ateuchus stridulates to encourage the female in her work and from distress when she is removed."

The little water bugs (*Corixa* and *Notonecta*) stridulate by means of a very fine file-area. Their shrill chirping can be heard for a considerable distance. The male "sings" while swimming during the courtship ceremonies, and he follows the female a few inches to the rear chirping continuously the while.

Mr. H. M. Hale, Director of the South Australian Museum, describes the courtship and music of a water-boatman (*Anisops hyperion*) as follows:

"The courtship is most fascinating: the male, stridulating rapidly the while, poises below and a little behind the female, and in this position accompanies



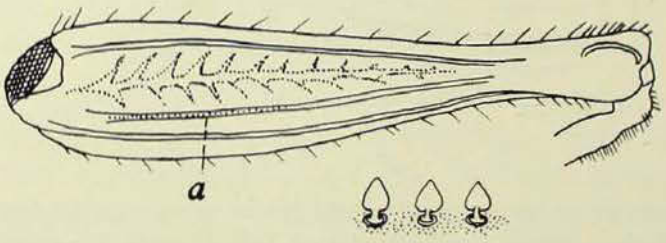
The Whistling Moth (Hecatesia fenestrata), which makes a shrill chirping when flying at dusk.

her every movement. . . . He is not, however, in any way faithful to one consort, for if another female passes near, and the first has not responded, position is taken below the newcomer. . . .

"When *A. hyperion* is stridulating . . . the sound is often maintained for long periods; in mid-winter one example continued its song intermittently during the whole of one day, as is the case during breeding. Stridulation commences with a rapid series of squeaky notes, not loud, but continued for a minute or more; the notes then become slightly louder and more metallic, and finally merge into a shrill and loud chirrup, which is not sustained, the song soon sinking to *pianissimo* or ceasing altogether. When sitting near an aquarium containing stridulating *Anisops*, the effect is that of a distant grindstone at work, and the sound borne very faintly to the ear."

In this place it may be well to mention the remarkable Australian Whistling Moth (*Hecatesia fenestrata*, Sub-family Agaristinae), a beautiful little creature with the fore-wings marked with black and white, and the hind-wings black and yellow. In the male there is a stout, horny projection upon the foreward edge of the front wing, and a glassy area behind it which acts as an amplifier; this, when the moth first emerges, is thickly clothed with scales like the rest of the wing. The caterpillar feeds upon the Dodder (*Cascuta*). The adult moths usually appear about sunset, flying about with a curious circling flight, and uttering their peculiar whistling note. It is not yet definitely known how the insect produces this sound, but it is probably by some form of stridulation.

Attention must now be paid to the true insect instrumentalists, the long-horned grasshoppers (Tettigoniidae), the locusts, or, as they are popularly called, "grasshoppers", and the crickets. Here the music is produced by stridulation, but among these insects the spined legs may be rubbed against a horny ridge on the wing-covers, much in the manner of a bow drawn across the strings of a violin, or by means of a ridge upon one wing-cover rubbed upon a file-like structure on the other when the wings overlap, the wing-covers themselves acting as resonators to amplify the sound.

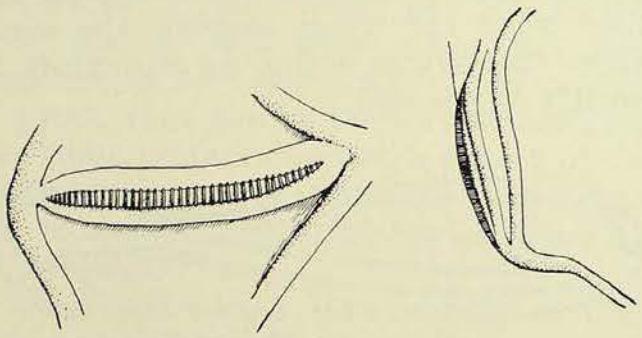


Hind thigh of a locust. a, rows of pegs, three of which are shown greatly enlarged.
After A. D. Imms.

The story is told of a somewhat deaf professor of science who was passing a church in which the choir was practising hymns. A friend, who was standing outside listening with rapt attention to the music, greeted the professor. "Isn't it beautiful?" he remarked. The professor, whose mind was probably filled with the ways of grasshoppers, paused, and, cupping his ear with his hand, listened intently for some seconds, and then exclaimed, "Wonderful! Wonderful! You know, they make that music by rubbing their legs together!"

In the common plague locust—or grasshopper (Calataria)—and its allies, the sounds are produced by rubbing the thighs, which are studded with a row of very fine peg-like teeth, against a ridge on the tegmina or wing-covers. The wing-covers are somewhat raised and are set in vibration by this scraping and amplify the sounds. In some cases there is a special amplifying area or tympanum. On a hot summer's day these insects may be seen sitting about on the warm ground, fiddling away to their hearts' content. The sound produced is a sharp "Tzitz, tzitz".

Another locust, the Long-headed Locust, produces a rapid clicking or crackling sound when in flight, but the method of sound-production in this instance does not seem to have been investigated; it is in all probability due to the friction of portions of the wings with the wing-covers, since the spined hind-legs are carried behind them when flying.



Sound-producing apparatus of a Grasshopper. Left: Lower surface of left wing-cover, showing file. Right: Upper surface of right wing-cover, showing scraper.

Nancy B. Adams, *del.*

Among the long-horned grasshoppers and the crickets we find the most skilled exponents of instrumental music in this group. The long-horned or tree-grasshoppers are in many cases also very fine illustrations of the art of camouflage, being decked in concealing tints of green and brown which render them almost invisible among the foliage in which they rest or are warningly coloured. Sounds are produced by the rubbing of a hard, crested ridge upon one wing-cover on a fine file-like structure upon the other. There is very considerable variety in their music, ranging from sharp clicking sounds, through chirps and shrill pipings, to notes that are distinctly bird-like.

To the long-horned grasshoppers belongs the American Katydid, so well known from American story and verse. The notes of this insect have been vocalized as "Katy-did! Katy-did-she-did! Katy-did-n't", but what Katy actually did to cause the emphatic statements has yet to be discovered. Some of these insects have passed into the realm of folk-lore in Tuscany, where one of them is known as the Cavalletta. When a Cavalletta enters a room where a child is sleeping, the mother catches the insect, ties it by one leg with a long thread to the bedpost, and chants certain verses which have been translated as follows:

O Katydid, as good as fair,
Who brings good fortune everywhere;
Since now into this house you've come,
O bring good fortune to my home.
Unto me and everyone,
But most of all unto my son!
Bring it unto me, I pray!
Do not take the least away.
In life you were a lady, full
Of talent good and beautiful;
Let me pray, as this is true
You'll give my child some talent, too;
And when you fly from East to West
May you in turn be truly blest,
For though an insect form you wear,
You're still a spirit good and fair.

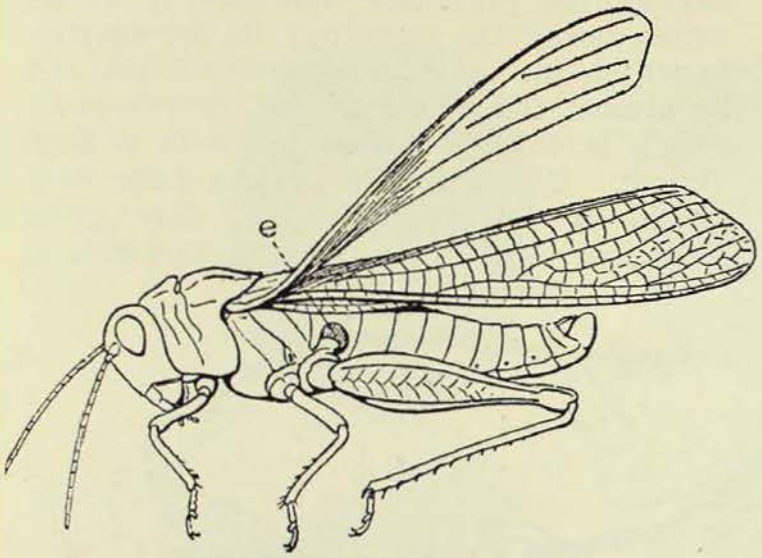
Then, when the child is old enough to understand, he must repeat whenever he sees one of these insects:

I am but little, as you see,
And yet I may a genius be!
And if when grown I shall be great,
And make a name in Church or State,
I'll not forget that one fine day,
As I in cradle sleeping lay,
How all my wit, as mother bid,
Was brought me by the Katydid.

With the grasshoppers we may interpret their music as love songs, and there is keen rivalry among the males for the affections of the female. In some of the tree-crickets (Oecanthus), although the male is an accomplished musician, he does not trust to melody alone to woo his bride, for at the base of his thorax he has a cup-like depression filled with an attractive secretion with which he regales the female during courting. It is possible that the song of the male informs the female where she may find a store of the coveted confectionery, and guides her to

it; but in any case, whether it is the music that allures her or the wedding breakfast, the end is the same.

The true crickets (Gryllidae) are amongst the finest of the insect musicians, and the summer evenings are filled with their serenades. The males are very sensitive to rivalry, and will redouble their efforts in song. It has been found experimentally that a male cricket will sing frenziedly when stimulated by the notes of another male cricket broadcast



A typical locust or short-horned grasshopper, showing the position of the "ear" (e) at the base of the abdomen.

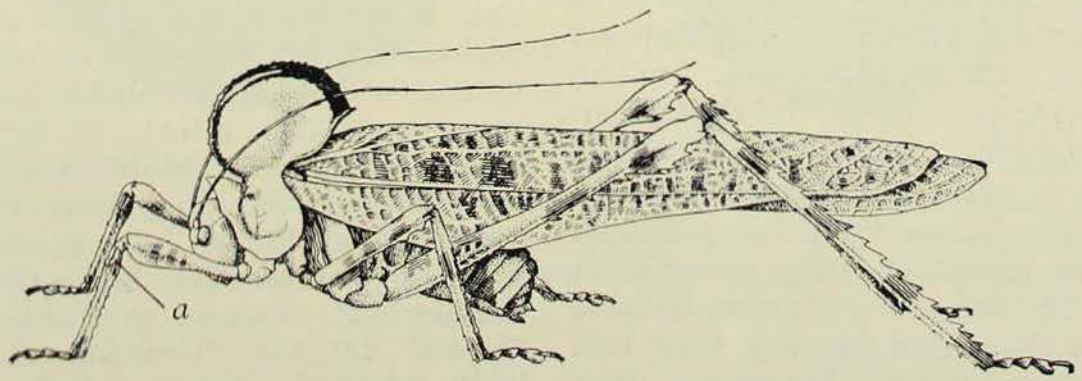
After Snodgrass.

from another room. The Japanese have an appreciation of cricket song, and enclose the insects in small cages so that they may enjoy their music in their homes, and at certain times of the year many of these captive crickets are on sale in the markets. Male crickets are inveterate fighters, especially when in the presence of a female, so they are also kept by the Japanese for fighting; large sums are often wagered upon the outcome of these battles, and a fighter of repute is greatly cherished.

In Australia the notes of the Mole Cricket (*Gryllotalpa*) are easily distinguished, they are churring, bell-like and liquid in tone. These crickets burrow in gardens and in moist places such as the banks of a creek. They are specially adapted for their work of digging, having remarkable flattened spade-like forelegs for the purpose.

The little black cricket (*Gryllus servillei*) sings with a triumphant note, shrill and tremulous. They are persistent fighters during the breeding season, although it is seldom that damage greater than the loss of a leg is incurred during these combats. While the males sing or fight, the female waits demurely in the shelter of some low-growing plant to await the outcome of the contest of song or strength. The defeated suitor makes his way hurriedly from the spot, to try his luck elsewhere.

The power of song or music implies of necessity the sense of hearing, and we find accordingly that the locusts, grasshoppers, and crickets are admirably equipped in this respect. In the locusts or short-horned grasshoppers the ear—or perhaps we should say the organ of hearing—is situated at the base of the abdomen, while in the long-horned grasshoppers and crickets it is curiously situated in



The Crested Grasshopper (Alectoria superba). a, ear.

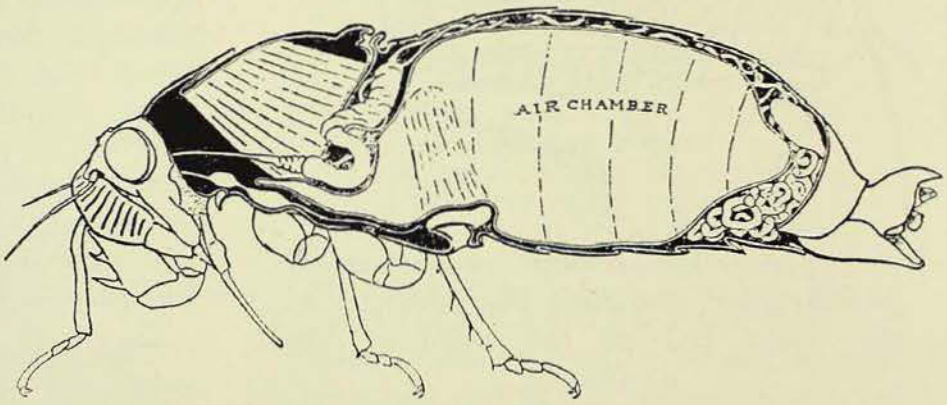
Nancy B. Adams, *del.*

being placed in the foreleg. These grasshopper or cricket "ears", although apparently simple when viewed from the exterior, are really remarkably complex when their mysteries are revealed by dissection, being complete with tympana and resonating cavities, and richly provided with sensitive nerves.

Perhaps the singing, or musical, insect most widely known throughout Australia is the Cicada—or, as it is popularly, but erroneously, called, the "Locust". Most of us are familiar with its life-history, but, summarized briefly, it is this. The eggs are laid by the female in slits cut in the branches of the trees frequented by the adults; the young on hatching resemble large fleas. They throw themselves from the branches, and, falling to the ground, hasten to burrow into the soil, where they establish themselves upon a tree-root and suck up the sap. Here they remain for a number of years—a period that seems to vary considerably according to the species concerned and is possibly also affected by the seasons. In Australia, although not definitely known, it appears to be some four to six years, but an American species remains in the underground stage for seventeen years! With the coming of spring, the nymphs tunnel upwards and emerge from the soil, and climb up the trunks of trees, where their skins split, and the perfect insect emerges. As soon as the wings are dry they join in the chorus in the branches above. Only the males are musicians; the females are voiceless, as the old Greek poet Xenarchus, who must surely have been hen-pecked, said in his rhyme:

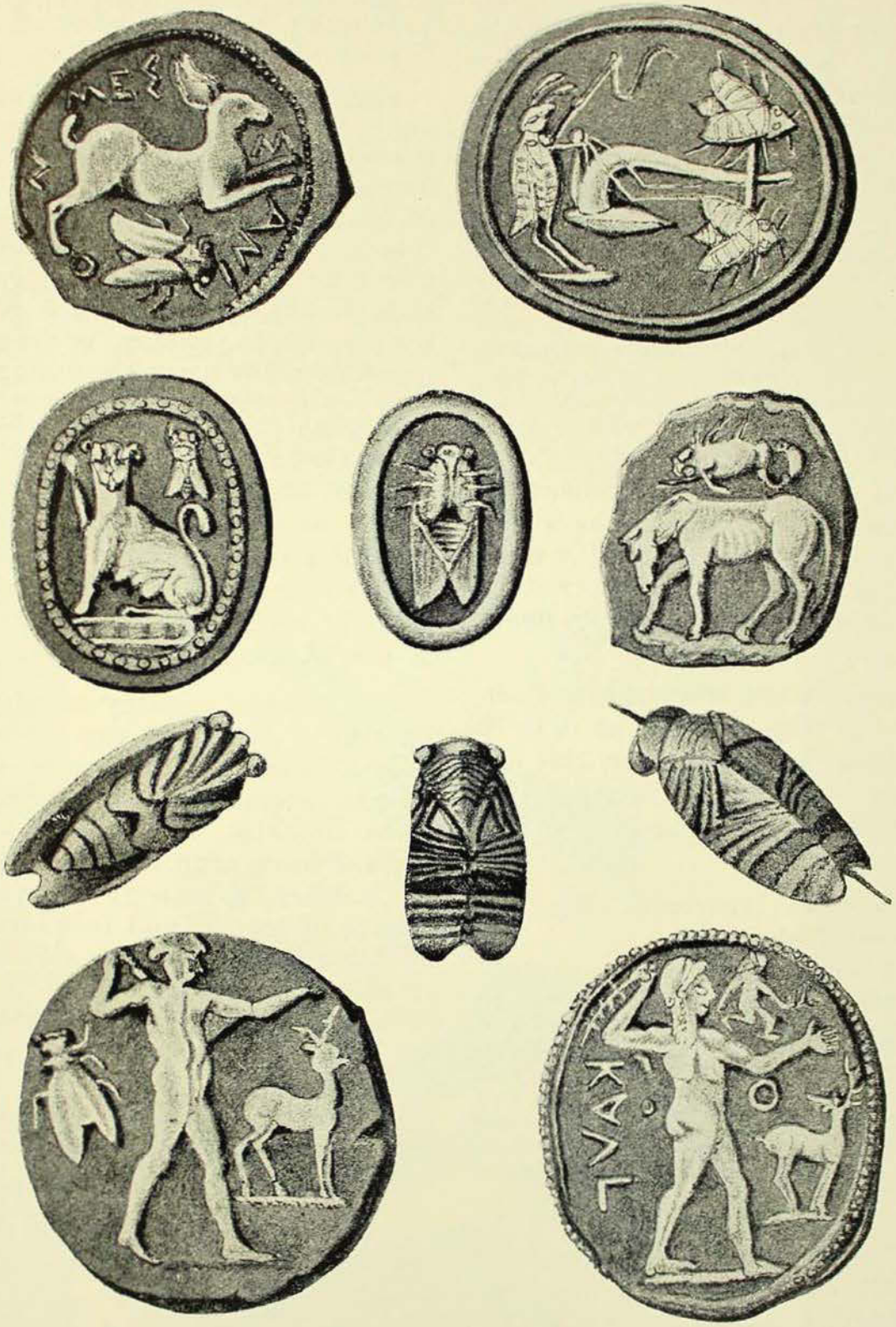
Happy are cicadas' lives,
For they have only voiceless wives.

The sound-producing apparatus is located at the base of the abdomen. This consists of a thin membrane which is pulled in and out by strong muscles, much in the way the thin, curved bottom of a tin dish may be pushed backwards and forwards by the fingers, thus producing a crackling sound. This sound is magnified by the plate-like opercula or drums which cover the openings to the cavities in which the musical equipment lies, and by almost the whole of the insect's body, which is largely taken up with a huge air-sac. The internal organs have been sacrificed to provide for this great resonator, and are pushed downwards so that they occupy an extremely small space; sound production is placed before everything else. In one species of cicada, *Cystosoma saundersi*, the abdomen is inflated and expanded into a huge bladder-like mass solely for the purpose of amplifying the sound produced. This species has a particularly shrill note. It is recorded that the note of one Brazilian cicada is distinctly audible for a distance of over half a mile! It is remarkable that, although the males have voices, and we may presume they have them for the purpose of being heard, no organ of hearing has as yet been found in the female. It seems probable that she "hears" by the vibration of her whole body, which is also air filled, to the notes of her serenader—for here again, as with so many insects, the music is a love song,



Section through the body of a male Cicada showing how the internal structure is subordinated to sound production. Note the huge resonator or air chamber.

After Snodgrass.



Ancient Greek coins and gems bearing figures of cicadas, etc. Top right shows a locust or "grasshopper" driving two cicadae harnessed to a plough. Lower middle shows an onyx cicada (drawn from three points of view), and illustrates the method of suspending it on a cord.

After Buckton.

and a gathering cry for the great courting assemblies.

The song of most of our cicadas is discordant, and few would acclaim it as musical. George Bennett described the notes of an Australian cicada in this way:

The most common is the incessant drumming, for which they are so well known; but it is not confined to this: the Ziz, ziz, ziz is often interrupted by a loud, shrill note, Ohoi, ohoi, ohoi, almost immediately varied to Whocky, whocky, whocky, and the voice suddenly ceases. Sometimes a prolonged note of Alrite, alrite, alrite is heard, varied to Ohoé, ohoé, ohoé, the last note being prolonged, followed by Whocky, whocky, whocky, in very shrill tones; then the Ziz, ziz, ziz continues for some time, followed by Yoicky, yoicky, yoicky; after which the din suddenly ceases.

In view of the musical attainments of our own cicadas, it may come as a surprise to know that the ancient Greeks considered the cicada to be the personification of music, and even placed its image upon their coins and gems.

Perhaps the earliest reference to these insects that has come down to us is to be found in Homer's Iliad, where the discourse of the "sage chiefs exempt from war" is compared to the shrilling of the cicadas.

The Greek poet Anacreon sings its praises in one of his odes:

We call you happy, O Cicada, because after you have drunk a little dew in the tree tops you sing like a queen. All the good which you see in the fields and which the seasons produce in turn, are yours. You are the friend of the worker, to whom you do no wrong. You are worthy of the homage of mortals, you, the charming prophet of summer. The Muses love you. Phoebus himself loves you; he has given you your loud song. Old age reaches you not, O wise one, O daughter of the earth, O friend of music, O you who suffer no pain since you have neither flesh nor blood. You are truly like the Gods!

The Greeks also told how, when Ariston and Eunomus were competing in a musical contest, one of the strings of Eunomus' lyre broke, and it looked certain that he must be defeated, but a cicada perched upon the lyre and supplied the missing note and gave him the victory. Theocritas tells us that the Greeks kept cicadas in cages for the pleasure of hearing them sing.

In Australia our own aborigines long knew that it is only the male cicada that is noisy, and Bennett records how a blackfellow said to him that: "Old woman Galang, galang no got; no make a noise". In New Zealand a very popular Maori *haka*, or war song, was based on the notes of one of the larger species.

In whatever country cicadas are found they have attracted the attention of the people, and the children's love of the insects seems to have been universal, since brightly coloured clay figures of cicadas have been found in the graves of the kiddies in many countries. A great wealth of legend and folk-lore has grown up about the cicada in all lands, but, in spite of the fascination of these tales, it is impossible to discuss them here. In closing, I give a translation of a Japanese poem:

Lo! on the topmost pine, a solitary cicada
Vainly attempts to clasp one last red beam of sun.