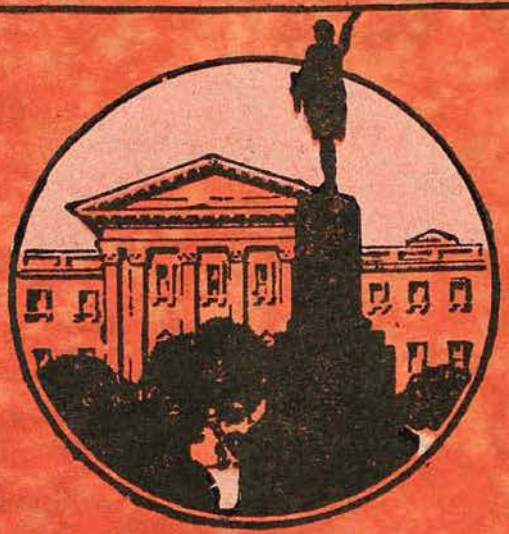
The AUSTRALIAN MUSEUM MAGAZINE

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



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THE AUSTRALIAN MUSEUM MAGAZINE

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Communications regarding subscriptions, advertising rates, and business matters generally in connection with THE AUSTRALIAN MUSEUM MAGAZINE should be addressed to the Secretary.

A reconstruction of a Fairy Martin colony in the Australian Museum. These birds construct bottle-shaped nests under rock shelves, dry river banks, culverts and similar "cover." Each nest is built by a pair of birds, and four to five eggs are laid at a sitting. Fairy Martins occur commonly throughout eastern Australia and are migratory, usually arriving in August and departing again about the end of April.

[Photo.—*G. C. Clutton.*

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VOL. II., NO. 6. APRIL-JUNE, 1925

Editorial.

THE recently issued annual report of the Wild Life Preservation Society again stresses the need for more effective protection for our indigenous mammals and birds. This is a theme on which we have already touched more than once, but it is sufficiently important to warrant further reference. Laws restricting the killing and capture of wild animals have been enacted, and we are prepared to assume that these are enforced as strictly as circumstances will permit. But the best way to secure protection of wild life is to educate the people, and particularly the young, to an appreciation of the beauty, the interest, and the usefulness of wild creatures. That is the direction in which the Wild Life Preservation Society, the Gould League, the Naturalists' Society and other bodies are doing such magnificent work.

The fact that the Australian fauna is one of the most important and most interesting in the world has often been insisted on. Australia has been isolated from the rest of the world for a very long period, and therefore it contains a wonderful series of archaic forms, which in other regions have been exterminated through the competition of more recent and better equipped rivals. But now with the advent of man and the domestic and other animals which follow in his train, the indigenous animals of Australia are in imminent danger. Dr. Colin Mackenzie, Director of the National Museum of Australian Zoology, proposed to be established at Canberra, has, we understand, expressed the opinion that the Australian marsupials will be extinct in twenty years' time. This is surely an unduly pessimistic view, but there can be no doubt that, in this continent as in others, the end of the age of mammals is approaching, and comprehensive measures should be taken to postpone their fate.

The factors which are contributing to the decline and fall of our mammals and birds have been often enumerated. The spread of settlement and the ravages of introduced animals such as the fox, the cat, and the rabbit, are perhaps the most potent agents of destruction. Sir Baldwin Spencer has pointed out that even the Australian earthworm is being ousted by the European form. The export of skins for profit must also be a serious drain on our marsupial fauna. Messrs Clive Lord and H. H. Scott, in their recently issued *Synopsis of the Vertebrate Fauna of Tasmania* mention that during the last open season over one million 'possums and wallabies were trapped in that State.

Another aspect of this question is one that closely concerns this and other scientific institutions. If, as seems probable, many of our animals are marked for extinction in the not very distant future, it is incumbent upon us to see that all available information concerning them is obtained while this is still possible. Owing to their nocturnal habits comparatively little is known concerning the mode of life of many of the Australian marsupials. And, on the other hand, it cannot be said that any of our national museums contains an adequate collection of indigenous animals. Field observations and scientific collecting should be prosecuted far more vigorously than is done at present. But this involves expenditure of money, and we live in hopes that the various Australian governments will see fit to place larger funds at the disposal of the various Australian museums, and that wealthy citizens of our country will be induced to emulate the generous donors who support the American museums in so lavish a manner.

Notes and News.

Mr. Ernest Wunderlich, F.R.A.S., Trustee, sailed on December 27th on an extended trip to Africa and Southern Europe. He was farewelled by a number of his fellow Trustees, and the President, Dr. T. Storie Dixson, presented him with a boomerang and Mrs. Wunderlich with a bouquet.

On Friday 13th February the President and several members of the Board of Trustees paid a visit of inspection to the Museum galleries in connection with impending alterations and improvements suggested by the President.

Among recent visitors to the Museum were: Mr. T. N. Faulconer, Director of the Zoological Gardens, San Diego, California; Messrs. Sydney Ure Smith and Leon Gellert, Mrs. Margaret Preston, Miss P. MacMahon and others connected with the mazagines *Art in Australia* and *Home*, to select subjects from our ethnological collections for illustrations in these publications; Professor T. T. Flynn, Hobart, Tasmania; Colonel F. W. Roller of Newark, New Jersey, U.S. America.

Mr. Thomas Steel, F.L.S., has presented a valuable collection of skulls and stone implements from Fiji and elsewhere. We are already indebted to Mr. Steel for a fine donation of planarian worms, *Peripatus*, and other interesting and valuable zoological specimens, the gatherings of many years.

From Mr. F. J. Bethune, K.C., we have received a fine series of Fijian clubs, which were collected by his father, Captain C. R. D. Bethune, R.N., about eighty years ago.

At Gunnamatta Bay, Port Hacking, the falling tide lays bare a great expanse of sand and mud. This makes a splendid collecting ground, and on three occasions lately a Museum party has secured a rich haul of alcyonarians, crabs, molluscs, echinoderms, and other marine creatures. On the occasion of another visit to the same locality an aboriginal shelter was excavated and a number of bone and stone implements were found.

On Thursday 26th February, Mr. W. W. Thorpe, Ethnologist, lectured to a number of students from the Kindergarten Training College, Darlinghurst, on Primitive Man.

Dr. J. C. Dana, Director of the Newark Museum, New Jersey, U.S. America, writing to Mr. W. W. Thorpe, ethnologist of the Australian Museum, said: "The copies of THE AUSTRALIAN MUSEUM MAGAZINE have been received and I want to thank you for them. It is a pleasure to see the scope of your Museum's work. The magazines will also be a great help to us in organizing our own Australian collection." It is gratifying to learn that the MAGAZINE finds such recognition and appreciation beyond the limits of the Commonwealth.

The Birth and Growth of an Oyster.

By T. C. Roughley.

WHAT is an oyster ? You will probably answer that it is a delicious mouthful, barricaded by a stony wall that is very difficult to breach. But how many of you have ever stopped to consider what it is composed of ? Most people have a hazy notion that it is an animal of some sort, but few have any idea of how it lives ; whether it has organs in any way similar to those possessed by higher animals, and whether it feeds and breeds in a manner comparable, for instance, to what we find in fishes. Of course, no matter how small an animal is, no matter how shapeless a mass it may appear to be, it must feed and breathe for it cannot otherwise live. The purpose of this article is to show that the oyster has quite an elaborate anatomy, and that the account of its growth from a tiny egg, too small to be seen with the naked eye, is a fascinating story of Nature's wonderful handiwork.

Let us first examine the shell. This is composed of two parts or valves, the upper valve being flat and the lower one more or less deeply concave, forming a cup-shaped bed in which the oyster lies. These valves are joined together at the front or anterior end by an elastic ligament which has a tendency to open them. Each shell is composed of three layers, an outer one of horny con-

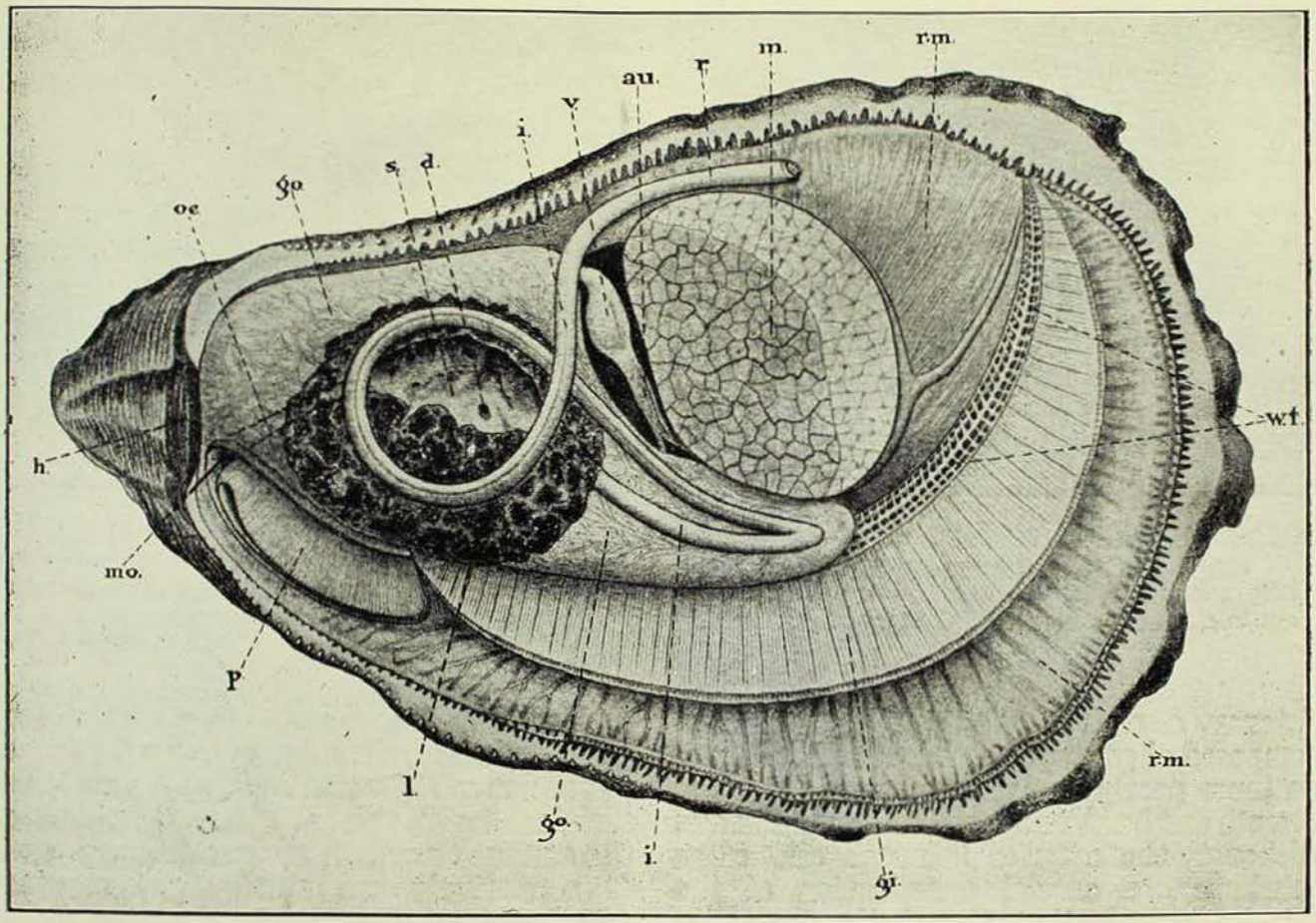


Fig. 1. Diagram of an oyster, dissected to show its principal organs. The whole of the left mantle and the uppermost palp have been cut away in order to expose the gills and the mouth respectively.
oe. oesophagus ; *go.* gonad ; *s.* stomach ; *d.* duct from liver ; *i.* intestine ; *v.* ventricle ; *au.* auricles ; *r.* rectum ; *m.* muscle ; *r.m.* right mantle ; *w.t.* water tubes ; *gi.* gills ; *l.* liver ; *p.* labial palps ; *mo.* mouth ; *h.* hinge.
[*T. C. Roughley*, del.

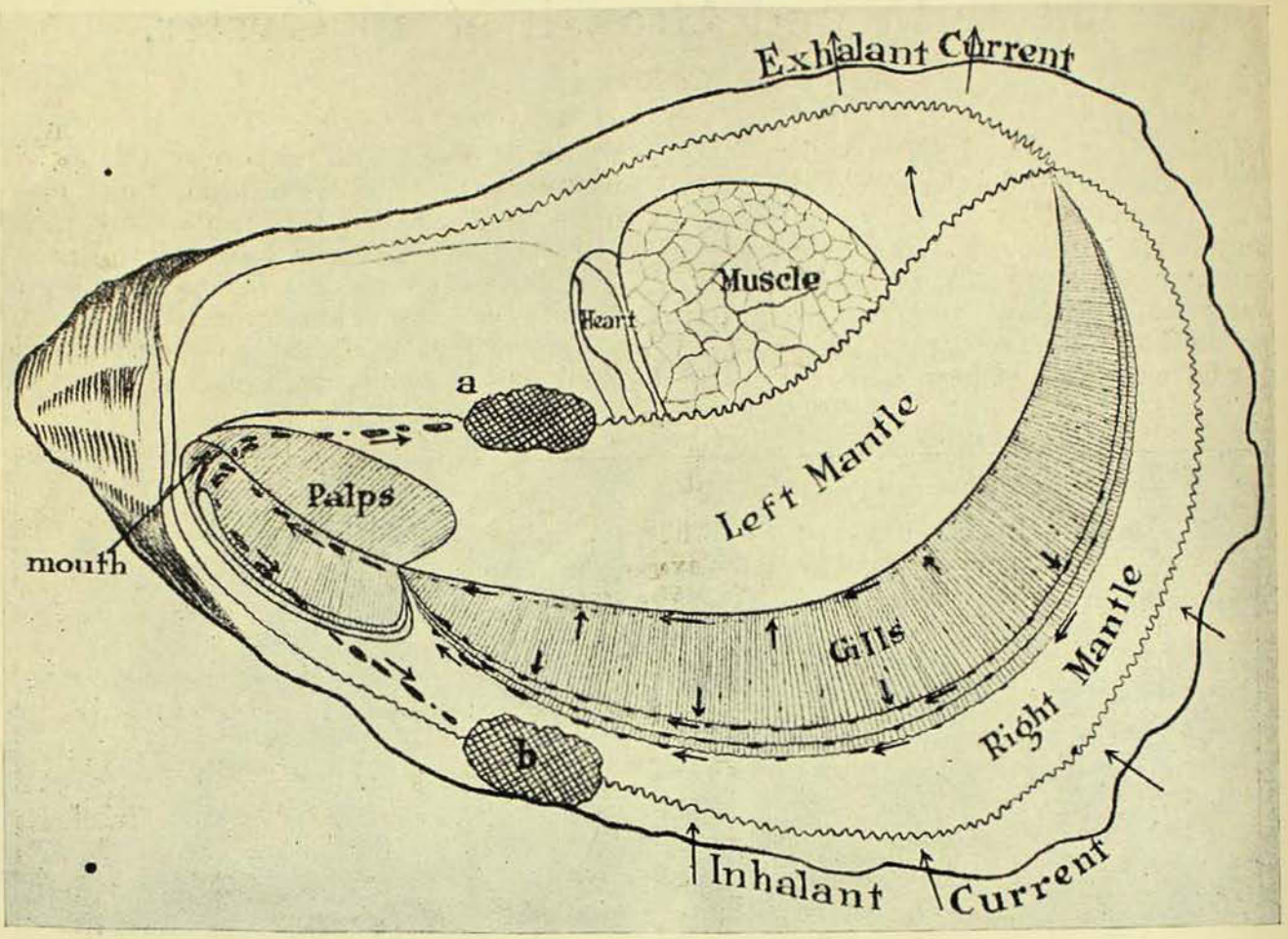


Fig. 2. Diagram of an oyster to show the course taken by the food. The left mantle and the uppermost palp have been folded back in order to expose the gills and underlying palps. Normally the edges of the mantles are in close apposition, and the two accumulations of rejected material *a* and *b* are a common mass.

[*T. C. Roughley*, del.

sistency, a middle one, somewhat chalky, composed of prisms of carbonate of lime, and an inner pearly or nacreous layer, which is smooth and hard, and more or less iridescent. Although the exterior is rough and often misshapen, a careful examination of the interior reveals that the shells are really masterpieces of an unerring craftsman. They fit together so accurately when closed that not a drop of water will leak through them. When it is considered that they often grow on objects of most irregular shape, and must follow each irregularity, the consummate skill of the animal becomes at once apparent. Man, under similar circumstances, would require a pad of rubber or leather to keep the chamber watertight.

Having opened the oyster by forcing a knife into the edge farthest from the hinge and cutting the muscle close to the deep shell, we find that the oyster lifts out attached to the flat or right shell, so that we are therefore looking at the left side. It appears on the surface to consist of four different parts, (1) a relatively firm muscle (fig. 1, *m*) which when contracted serves to close the shells; (2) a white mass, the reproductive gland (*go*) between the muscle and the hinge (*h*); (3) a smaller oval area, the pericardium (*pe*) somewhat darker in color, lying between the muscle and this white mass; and (4) the mantle, frequently known as the "beard," hanging freely from the body of the oyster. The mantle consists of two thin leaf-like folds that lie against the inner sides of the shell, fitting round the more compact parts of the body much the same as a man's coat fits over his body, but with this difference—it is

firmly adherent along the sides and is a real part of the living animal. The edge of the mantle is provided with tentacles, and can be protruded beyond the shell, but in opened oysters it is withdrawn well within the margin. The principal functions of the mantle are to protect the organs that lie beneath it, and to secrete the shell. The outer and middle layers of the shell are secreted by the edge of the mantle, and the inner pearly layer by the whole of its surface.

The reproductive gland produces the elements, eggs or sperms as the case may be, by means of which the young oysters are propagated. When this gland is large and swollen the oyster is said to be fat or in good condition.

The muscle is a powerful organ which serves to close the shells. When it relaxes, the elasticity of the hinge ligament forces the shells apart, so that, when an oyster dies and the muscle is no longer capable of functioning, the shells usually gape.

The pericardium is covered by a thin-walled extension of the mantle, upon the removal of which the heart is disclosed. This consists of two auricles (*au*) and a ventricle (*v*); the former receive the blood from the gills and by contracting force it into the single ventricle, which in turn pumps it into the aorta, whence it is conveyed through many channels to the various organs of the body. The blood is quite colourless and contains innumerable blood cells capable of movement in a manner exactly similar to amoebae, those most primitive of all forms of animal life. The heart may beat for some hours after the oyster has been opened, and, if the oyster is put back into the water, it may continue to beat for several days. The pulsations are regular and vary with the temperature.

If the mantle is lifted up, two different sets of organs are exposed to view; the first, situated near the hinge, consists of four leaf-like folds, the labial palps or lips (*p*); the second, long and sickle-shaped, extends from the lips to the distal extremity of the body behind the muscle. This also is a four-fold organ and constitutes the gills (*gi*), which serve the double function of aerating the blood and procuring the food. Each gill leaf is covered by myriads of microscopic hairs, or cilia, which vigorously vibrate in such a way that a continuous stream of water is drawn towards them when the valves of the shell are open. The water passes into minute holes in the surface and is conducted upwards through water tubes (*w. t.*) in the interior to be expelled through apertures along the upper edge. From here it enters a space known as the supra-branchial chamber and leaves the shell above and behind the muscle. As the water passes through the gills the blood is aerated in much the same manner as the blood of a fish, but the gills of the oyster serve also to strain the water. All matter in suspension is collected by the cilia and passed up or down towards the edges, along which it is conducted forward to the bases of the palps (fig. 2). The latter, also covered with cilia, pass this matter forward towards the mouth. The palps sort out the food from the waste matter, the former being drawn into the mouth, the latter being conveyed back along their outer margins, and over a well defined track to the edge of the mantle. When a sufficient amount of rejected material has accumulated, the oyster snaps the shells and ejects it. The food of the oyster consists for the most part of microscopic vegetable life, composed principally of diatoms and other unicellular algae, which abound in salt water practically everywhere.

After entering the mouth (fig. 1, *mo*), the food is conducted along a narrow tube known as the oesophagus or gullet (*oe*), which opens into an irregular cavity, the stomach (*s*). Surrounding the stomach on all sides, and completely enclosed by the reproductive gland when the latter is well developed, is a dark brown organ known as the digestive gland or liver (*l*). This continually pours a secretion into the stomach through several branching channels (*d*), and by means of this fluid the food is digested. Leaving the posterior extremity of the stomach, the food passes into the long and narrow intestine (*i*), which runs downwards and backwards into the projection of the body lying beneath the muscle; here it turns forward and coils round the stomach, finally as the rectum (*r*) passing over the pericardium and muscle, above which it terminates.

The oyster has a primitive though adequate nervous supply, consisting of two main nerve centres, or ganglia, and many branching nerves. It has also paired kidneys situated one on each side below the muscle.

What appeared at first sight to be a shapeless unorganised mass has now, with a little careful dissection, disclosed a highly specialised anatomical structure, capable of performing such intricate and involved functions as breathing, feeding, digestion, blood circulation and excretion. So you see the oyster is something more than a mere mouthful of deliciousness.

Vital to an oyster's existence as are all the foregoing functions, the propagation of its young is no less vital to the continuance of the race, but before relating the romantic side of an oyster's life, it must be clearly understood which oyster is being described. There are two species of oysters of commercial importance in Australian waters, the rock oyster (*Ostrea cucullata*), and the so-called mud oyster (*O. angasi*). The life histories of these species differ in several well-marked particulars, and it will be necessary therefore to treat each separately. The more important rock oyster will be considered first. In this species the sexes are separate, *i.e.*, each oyster is either a male or a female and remains so throughout life. Now, as the oyster grows, the reproductive gland becomes a much swollen organ, and gradually comes to assume relatively enormous proportions. In the female it is actively developing eggs or ova, and in the male sperms. When the oyster is sexually mature, these eggs or sperms are extruded from the reproductive gland through two openings, the gonaducts, situated one on each side of the body directly beneath the muscle. When this process takes place an oyster is said to spawn.

The matter expelled from the reproductive gland appears to the naked eye to be a white fluid resembling milk. When examined under the microscope, however, the fluid from the female is seen to consist of an enormous number of eggs which vary considerably in shape (fig. 3) ; they may be rounded, oval, or more commonly pear-shaped, and measure approximately 1/500th of an inch. Several million eggs may be ejected from a female oyster in one spawning season, which usually occurs during late summer. The liquid from the male is seen to consist of extremely small actively swimming organisms known as sperms or spermatozoa. These are composed of a minute head and a long, flexible tail, which enables them to swim very

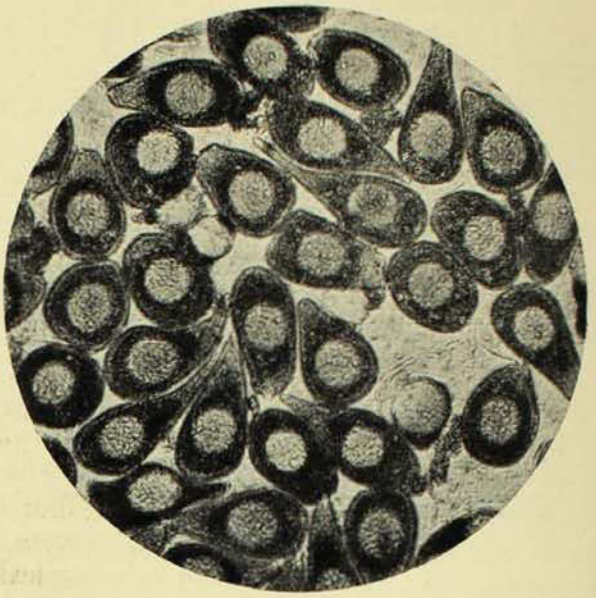


Fig. 3. Ripe eggs or ova of a rock oyster (Ostrea cucullata), 1-150th of an inch in width. Magnified 150 times.

[Photomicrograph.—*T. C. Roughley.*

vigorously. Small though the eggs are, the spermatozoa are very much smaller, and it would take several thousands to make up the bulk of an egg. Thousands of millions of them may be ejected from one oyster during a single spawning period.

As the milky liquid accumulates inside the shells, the parent oyster at frequent intervals smartly snaps the shells together, and throws it out in the form of a white cloud. Once in the water the spermatozoa dart in all directions in search of eggs, and when one spermatozoon has effected an entrance inside an egg, fertilisation is said to take place, after which no more can enter. If an egg remains unfertilised it cannot further develop. Very soon after fertilisation marked changes take place within the egg ; it quickly divides into two unequal parts, the smaller half again dividing into two, and so on till, in a short time, the single original egg has changed to a globular mass of very much smaller cells. While these changes are taking place there is no increase in size, but, in the course of a few hours, minute hairs develop at one end, and by means of their active vibration, the embryo, as it is now called, begins to swim about. Although under the microscope it appears to travel at a wonderfully fast rate for its size, its move-

ments on a scale comparable with surrounding objects are very feeble. It cannot swim against a current, but is carried about at the mercy of wind and wave. After a day or two as a small, naked cluster of cells, shells begin to form on each side and rapidly grow downwards till they completely cover the body, when they can be opened or closed at will. At this stage the hinge uniting the shells is a straight one. Portion of the body can be protruded beyond the rim and by means of hairs or cilia propel the embryo. Oyster embryos can be raised to this stage by means of artificial fertilisation, *i.e.* the mixing of spermatozoa from a male with eggs from a female in a vessel containing sea water, but when the shells develop the embryo begins to feed, and no practical method has yet been devised to supply the food, some idea of the size of which can be gathered when it is remembered that the whole animal is still little more than 1/500th of an inch long.

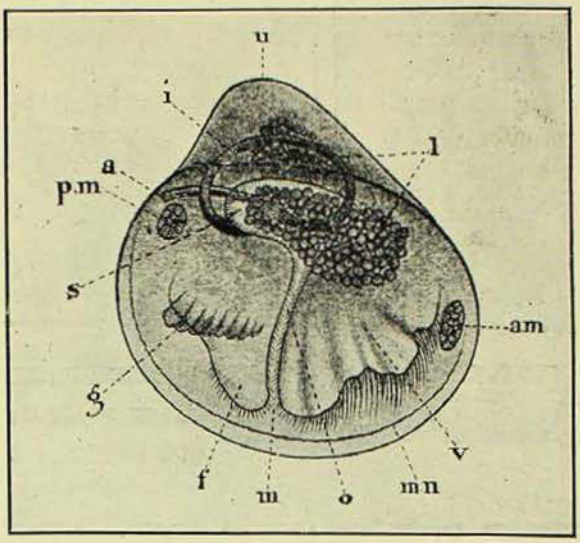


Fig. 4. An oyster larva, 1-90th of an inch wide showing its principal organs. Magnified 140 times.

m. mouth; *f.* foot; *g.* gills; *s.* stomach; *p.m.* posterior muscle; *a.* anus; *i.* intestine; *u.* umbo; *l.* liver; *a.m.* anterior muscle; *v.* velum; *mn.* mantle; *o.* oesophagus.
[*T. C. Roughley*, del.

From the time of the fertilisation of the egg till the shells envelop it, the developing oyster is called an embryo, from the early shelled stage till it attaches itself to an object it is known as a larva, and after attachment as a spat. From the early straight hinge stage growth is rapid, the shell daily increasing in size and the organs of the body becoming more specialised. When the larva is about half grown and is about 1/150th of an inch wide, a marked change begins to take place in the shape of the shells. They begin to grow upwards on each side of the hinge, the growth of the left shell being considerably greater than that of the right one, so that when seen lying on the left side, the projection of the left shell appears as a well defined prominence. The inequality of these outgrowths of the shells, or umbos as they are called (fig. 4, *u*), serves to distinguish oyster larvae from those of other bivalves, which, in the earlier stages of growth they resemble to a remarkable degree. With the advent of the umbos there appears another organ peculiar to this period of an oyster's development; this is known as a foot (*f*), and by its means the larva is enabled to crawl about. The foot can be extended for a distance approximately equal to the width of the shell, becoming narrower as it protrudes. It is covered with cilia, strongest at the tip, and by attaching the extremity to an object and then suddenly contracting, the shell is dragged after it. By repeating this movement the larva can crawl quite considerable distances, and extricate itself from mud or other debris which might for the time being imperil its further existence.

Reference to figure 4, which is an enlarged drawing of an oyster larva 1/90th of an inch wide, will show that it already has a highly specialised set of organs. The swimming organ or velum (*v*) provided at its edge with very strong cilia, can be protruded and opened out somewhat after the manner of an umbrella (figs. 5 and 6), and the rapid vibration of the cilia enables it to swim about at will. The foot (fig. 4, *f*), is already fairly well developed, and lying in close apposition to it are the rudimentary gills (*g*). Between the velum and the foot is situated the mouth (*m*) which leads into a long and narrow oesophagus (*o*), a ciliated channel that serves to conduct the food into the stomach (*s*). This, too, is lined with actively vibrating cilia which serve to keep the food in a constant circular motion, while the digestive juices from the liver (*l*) convert it into a form suitable for assimilation. The intestine (*i*), after leaving the stomach, coils over on itself and terminates as the rectum above the

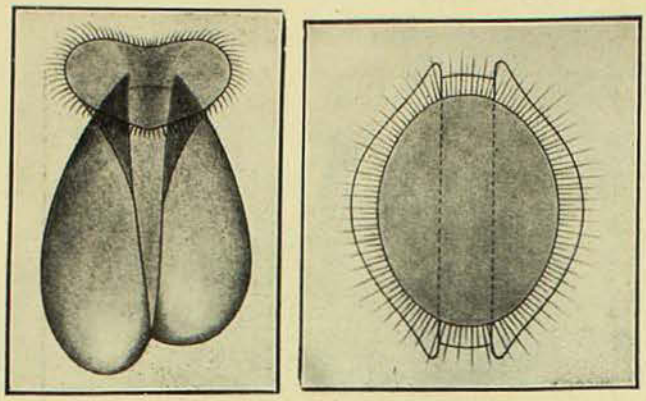


Fig. 5. Oyster larva with velum or swimming organ partially extended. Magnified 110 times.
Fig. 6. Oyster larva with swimming organ (shaded) fully extended. Magnified 110 times.
[*T. C. Roughley*, del.

posterior adductor muscle (*p.m*). During its larval life the oyster is provided with two muscles, an anterior (*a.m*) and a posterior (*p.m*), but soon after it is fully grown and attaches itself to an object in the water, the anterior muscle is absorbed, and the posterior muscle develops into the large adductor muscle of the adult oyster.

It will be seen that the most prominent organs possessed by the oyster in its later larval life are the velum or swimming organ, and the foot which enables it to crawl about. This is of course to be expected in an organism in which locomotion plays so important a part, but having completed its free swimming existence it begins to search about for a clean surface where it may attach its shell and take up its permanent abode. Should no such surface present itself within two or three days after larval development is complete, it must perish. If it is fortunate enough to encounter a stone, shell, or stick, for instance, it immediately cements its deeper left shell to it, and there it remains for the rest of its life, or until some ruthless oyster cultivator knocks it off for market. Having now become definitely and indissolubly fixed, it has no further use for the swimming organ and foot which therefore quickly degenerate and are absorbed.

The size of a newly attached oyster, known to oyster growers as a spat, averages about 1/75th of an inch in length, and it is asymmetrical, the left shell being larger than the right and projecting above the hinge (fig. 7). Immediately after attachment the spat shell grows rapidly, and is in close contact with the surface on which it lies. After about twelve months the edge of the shell furthest from the hinge begins to grow upwards and away from the surface, and the depth of the oyster to increase largely.

The length of time that elapses between the fertilisation of the egg and the attachment of the subsequent spat has not been determined in Australian waters, but about New Jersey, in the United States of America, where the summer temperature of the water is frequently similar to that which prevails in New South Wales, the time taken is approximately a fortnight. It takes, on an average, three years for an oyster to grow to a good marketable specimen, though under favourable conditions of food, temperature, and salinity, it may reach that size in two years.

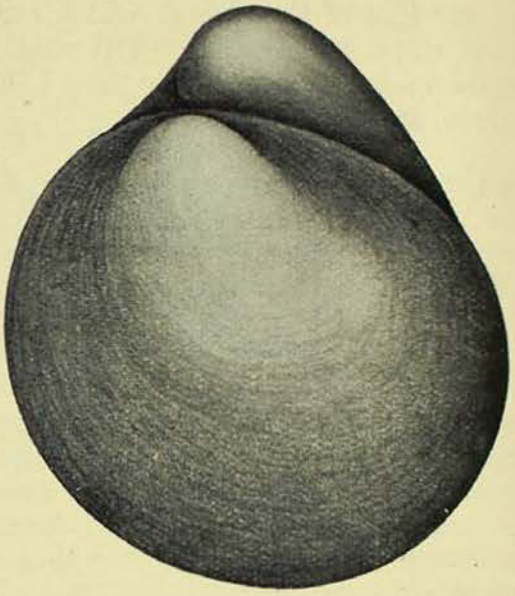


Fig. 7. A rock oyster spat, 1-75th of an inch long immediately after it has attached its shell to an object in the water. Note the prominence (umbo) of the lower, left shell. Magnified 175 times.
[*T. C. Roughley*, del.

Now it must be clearly understood that the life history just described refers to the rock oyster, which differs in several important particulars from that of the mud oyster. The latter is hermaphrodite, or in other words each oyster is both a male and a female, though it cannot fertilise its own eggs, and does not function as a male and a female at the same time; it may, however, function as a male and eject sperms early in the summer and develop eggs later in the same season. Unlike the rock oyster the eggs are not fertilised in the water, but after

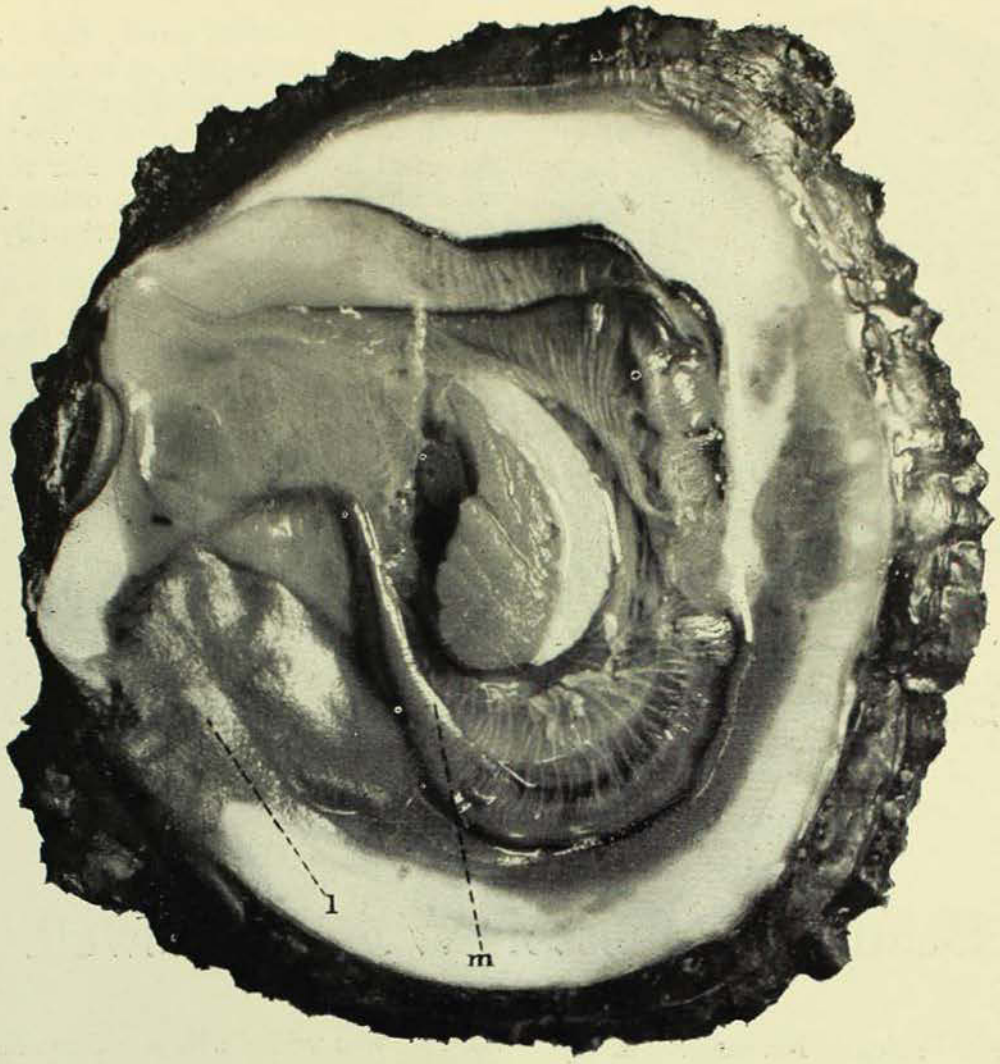


Fig. 8. Mud oyster (Ostrea angasi). The left mantle (m.) has been turned back to show the mass of developing larvae (l.). Two-thirds natural size

[Photo.—*T. C. Roughley.*

leaving the gonaduct of the parent are retained between the mantles, where sperms from other oysters, drawn in with the current of water, effect fertilisation. About half the larval life is passed here under parental supervision, during which time the larvae develop shells, and in the mass appear to resemble extremely minute sand grains, at first light in colour, but later changing to a dark grey (fig. 8, *l*). When ready to be ejected these shelled larvae have a straight hinge and a well developed set of organs, and measure about 1/150th of an inch long (fig. 9). Having been cast into the water they at once begin to swim about in search of food. From then onwards development is precisely the same as is that of the larva of the rock oyster at similar stages of growth.

This method of development is not peculiar to the Australian mud oyster, but is common also to the commercial oyster of England and France (*Ostrea edulis*). You have no doubt heard that oysters should not be eaten during the months of May, June, July and August, those months, in other words, which do not contain the letter "r." This obtains with the English oyster, for during those months the oysters spawn, and a percentage of them will be found with developing young in the mantle cavity of the parent. These, being enclosed in shells, would feel like fine grit in the mouth and therefore are undesirable gastronomically, but it must also be remembered that there are upwards of a million larvae in each oyster ; each of

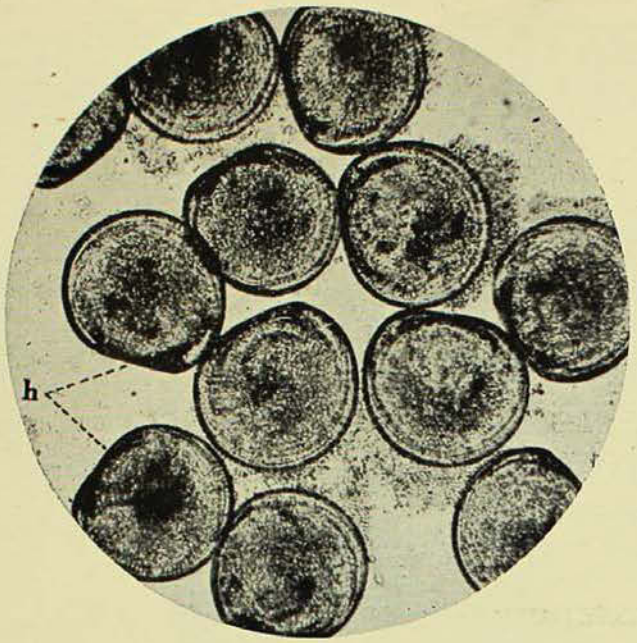


Fig. 9. Mud oyster larvae, 1–150th of an inch wide, extracted from the mass shown in Fig. 8 (1.). Magnified 100 times. h. hinge.
[Photomicrograph.—*T. C. Roughley.*

these is a potential adult, and for the conservation of the supply, it is vitally necessary that it should have an opportunity of development, which would be lost if the parent were removed from the water. For these reasons therefore, oysters are not eaten in England during the months which normally constitute the breeding season.

Australian rock oysters may be eaten freely during all months of the year. They are of finest flavour previous to spawning, when the reproductive gland is well developed. If the spawning has been a heavy one, or in other words, if the whole of the sexual elements have been ejected, the oyster becomes thin and unpalatable. Fortunately oysters in different rivers on the coast of New South Wales spawn very irregularly and the market can usually be kept supplied with oysters in good condition throughout the whole of the year.

Death of Professor W. A. Haswell.

THE death of Professor Haswell, for thirty-three years a Trustee of this Museum, has removed one of the outstanding figures of Australian science. He was one of the world's leading zoologists and had long been recognized as the highest authority on zoology in Australia.

He was born in Edinburgh in the year 1854 and was educated at the university of his native city, where he had an exceptionally brilliant record as an undergraduate. Coming to Australia in 1879, he was in 1880 appointed Curator of the Queensland Museum, and in 1882 became demonstrator in zoology at the University of Sydney, serving in the following year as Acting Curator of this Museum. In 1890 he was appointed Professor of Biology in the University of Sydney, occupying this position until, in the year 1915 the Chair of Botany was created when he became Professor of Zoology. He retired in 1918 with the title Emeritus Professor of Biology, but continued his researches with unabated vigour despite indifferent health till on January, 23rd he was seized with a sudden illness which carried him off on the following day. At the meeting of the Board of Trustees of February 6th a motion of condolence with Mrs. and Miss Haswell was passed.

Haswell's work covered a wide field in invertebrate and vertebrate morphology. He was perhaps best known as the joint author with the late Professor T. Jeffrey Parker of " Parker and Haswell," which has long maintained its place as the leading textbook of zoology wherever the English language is spoken.

Professor Haswell was rather retiring in disposition, but those who were privileged to come into contact with him always found him extremely kindly and considerate. He was one of the most modest and unassuming of men, and on his frequent visits to the Museum his unfailing courtesy and readiness to place his stores of knowledge at the disposal of even the youngest member had endeared him to the whole staff. We esteemed him for what he was and what he did and sincerely mourn his passing.

A Visit to the Barrington Tops Plateau.

By T. G. Campbell.

THE Barrington Tops Plateau is part of the Mount Royal Range, which rises north of Maitland, and continues in a more or less northerly direction, until it links up with the Great Dividing Range north-east of Murrurundi. The Barrington Tops district is situated almost due east from Scone, and about midway between the latter place and Cape Hawke, on the coast. This plateau is one of the highest areas of land of any noticeable extent in New South Wales. It has an average height of about five thousand feet, and has been estimated to have an area of some seventy-five square miles. Mount Kosciusko is higher, being in the vicinity of seven thousand feet.

In January of this year I had the good fortune to be a member of the University expedition which visited the Barrington Tops under the leadership of Professor Launcelot Harrison. This was not the first occasion of a visit by a large scientific party, for in December, 1915, Mr. W. J. Enright, of West Maitland, organised a party, of which Mr. C. Hedley and Mr. A. Musgrave of this Museum were members. Their stay, however, was of brief duration, occupying about a week, and it was not possible to see more than a few of the points of interest, though even in this short space of time many rare insects, shells, etc., were collected, some of which were new to science. The object of our recent expedition, the largest and best equipped that has yet visited the "Tops," was to find out (in the short space of four weeks) all we could about the flora and fauna of the interesting plateau region, as well as to gain some knowledge of its geology and topography.

One of the most interesting plants on the Barrington Tops is the Australian Beech, *Fagus Moorei*, usually found growing in small patches at the head of creeks or rivers. Sometimes these beech forests are of fairly considerable size, and one below the trig. station extends along the spur for over a mile. Barrington Tops is one of the few small areas in New South Wales where this typically alpine tree still survives. Here it is nourished by the rich basalt soil, and is not found below an altitude of three thousand feet. A deep gloom pervades these beech forests, which are the haunt of many rare and interesting insects. Many of these insects occur in no other situation, and the naturalist can spend many hours searching under logs and on tree trunks with excellent results.

Three species of eucalypts grow on Barrington Tops. *Eucalyptus rubida* may be distinguished by the reddish hue of its leaves and bark. It is not so plentiful as the other two forms. The Snow Gum, *Eucalyptus coriacea*, which also occurs on Mount Kosciusko is very plentiful here. The trunk is streaked with grey and white, and the butt, which is of a blackish colour, has a spirally twisted appearance. The leaves of this tree are larger than those of *Eucalyptus rubida*. *Eucalyptus saltata* resembles *E. coriacea*, but the trunk is cleaner at the base, and the leaves are smaller.

In the open spaces the ground is covered with a carpet of beautiful flowers, the chief of which are the Pink Trigger Plant, *Stylidium*, a White *Pimelea*, and Yellow Everlastings, *Helichrysum*, while the Blue Bell, *Wahlenbergia*, is also very plentiful.

The mammals met with on the trip did not represent a very large number of species, due no doubt to the high altitude and rigorous winter climate. Two species of rats were secured by means of traps set at the bases of trees and baited with raisins; pouched mice were also caught in this manner. Among the tufts of Snow Grass and at the bases of trees were the burrows of the wombat, *Phascolomys mitchelli*. These burrows were very numerous among the timber, and, as many of them were hidden in the grass, they constituted a grave menace to horsemen. The reptile most plentiful on the "Tops" is the Superb Snake, *Denisonia superba*; locally this snake is called the "Copper-head" or "Snow Snake." Black and Tiger Snakes are also said to occur in this region, but we did not see any during our month's sojourn on the "Tops."

It is hoped in a subsequent article to deal more comprehensively with the natural history and chief points of interest of this fascinating plateau region.

The Homes of Birds.

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

Nest of the Wedge-Tailed Eagle on Nullabor Plain, South Australia. Usually the eagle builds high up in the tallest of trees, but in desert areas, it, like other birds, has to take what is available as a building site.
[Photo—*Charles G. Gibson.*

AT some time or other during their life, most of the higher animals require a home, and in the building of these homes the birds have proved themselves to be among the greatest architects.

The object of a nest is to contain the eggs and later the young, but, as the period of occupation is short, it is not necessary for the structure to be massive, yet though some nests appear to be very fragile, they can usually withstand gales and heavy rain.

Were we to take a walk through the bush we should find that the range in types of nests, as well as of sites chosen, is very great, the simplest being a mere depression in the earth, while others would rank among the most elaborate structures in the animal kingdom. On looking round you might ask, "Why so many types of nests even among birds which appear to be very closely related? Why is it that any two species, which to the untrained eye appear to be merely varieties, always build nests of such a different character and yet so conformable to type?" To fully understand we must be students of evolution, but we may gain a very fair idea of this "nature wonder" by reading the works of some of our greatest scientists both of yesterday and to-day, and they will take us back to prehistoric times, where we will find from evidence collected, that birds have reached their present form by a very slow process of change from the earliest types which were closely related to the reptiles.

Exactly how this change, or evolution, came about, even those best qualified to speak do not entirely agree, but the hypothesis

most generally favoured today is that of Darwin, known as *natural selection*. Natural selection means the interaction of living organisms one upon another, of like against like, and like against unlike, whence arises a struggle for existence in which the fittest survive and the unfit are eliminated, the unfit being those which cannot adapt themselves to changes in their surroundings, or, in other words, their environment. Just as no two people are exactly alike so it is with the birds. Of two birds which appear exactly similar one may have a more efficient beak, sharper claws, or more powerful flight. Even slight differences of this kind may be very important factors in enabling the better endowed individual to survive and rear its young, which will, to an extent at least, inherit the parental characters. In this way characteristics which make for success in life's battle are transmitted and become fixed by means of natural selection. It is an established fact that the search for food, that is to say the struggle for daily bread, plays the greatest part in bringing about the changes known as evolution.

Nests and eggs of Yellow-breasted Robin. The nest is a round cup-shaped structure made of strips of bark and grasses. It is lined with fibrous roots or thread-like leaves, and usually has a few dried eucalyptus leaves placed in the bottom. The exterior of this nest is decorated with pieces of lichen, though others are highly ornamented with strips of bark attached in pendulum fashion by means of cobweb. Usually three inches in diameter, and nearly as deep, they are customarily built in trees at a height of from five to fifteen feet from the ground.

[Photo.—*A. J. North.*

The Black-fronted Dotterel's eggs are laid on the bare ground, their protective colour assimilating closely to their surroundings. A favourite situation for the dotterel to select is the dry bed of a creek or river covered with small, rounded, or oval stones much about the size and colour of the eggs. These particular eggs were found close to the Talbragar River, near Cobborah, N.S.W.

[Photo.—*A. J. North.*

Let me take you back to the earliest times when birds presumably did not build nests, but laid their eggs in the hollow of some decayed stump, or amid the thick crowns of some kind of evergreen tree, or in any other available place in the dense forests areas where they lived. We may be fairly certain that over-population of these forests, with its accompanying struggle for food, drove many of the birds further afield so that some became inhabitants of the more open country, while others went further still, eventually reaching the plains. In the new surroundings that had been forced upon them, those birds which could not adapt themselves perished, while those which could (the fittest) survived. It has been suggested that at first eggs would be deposited on the bare ground, no special provision being made for their safety, and therefore two selective features would commence to operate, one being the elimination of all eggs not protectively coloured, the

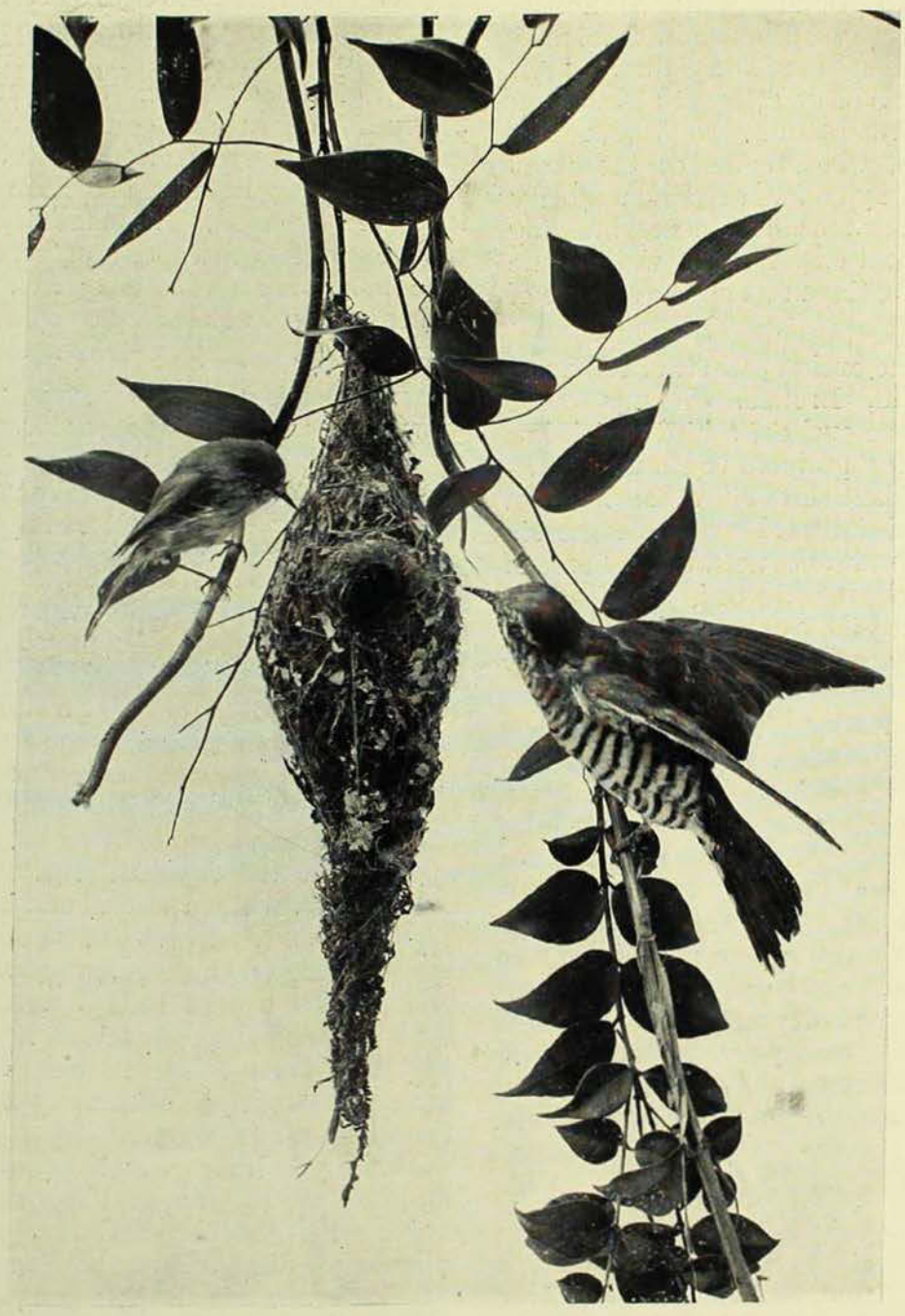
Nests and eggs of the White Ibis, near Ulmarra, Upper Clarence River, N.S.W. In swamps, such as the one here shown, the ibis breeds in numerous small colonies consisting of twenty to forty nests. The nests, which are built upon platforms of broken down rushes, are very crude, and consist of reeds and other aquatic plants placed in criss-cross fashion, with occasionally a few stems and leaves for a lining.

other being the rotting of such eggs as came in contact with persistently cold and damp earth. Here our imagination must carry us on and we will see that sooner or later some of the birds would commence scraping together a few sticks or stones on which the eggs would be laid. Whether this was done for the sake of the bird's own comfort rather than from any preconceived idea of protecting their eggs will remain a mystery, but it is certain that only those birds which adopted this or a similar plan would rear young. It is only natural to assume that a fair percentage of the offspring would inherit the same instinct, and so as time went on a habit was formed and the first nests built. The next step was to get away from ground-prowling enemies ; to avoid these some of the birds must have taken to placing their crude stick nests in shrubs or trees and nests and nesting sites thus underwent a gradual change. Parallel with the change in environment of nests, sites, and search for food, came a change in the types of birds.

A certain food was available only to those birds which were adapted for collecting it, the others either perished or branched off in another direction seeking different foods; but the change in food and its collecting called for a change in the form of the bird. For example, birds which lived on the edge of a swamp might take to wading along the edges in search of minute aquatic creatures, and in course of time, as they waded deeper and deeper, longer legs, necks, and bills were evolved, then perhaps would come fringed toes and eventually webbed feet. On the other hand the birds of the plains developed stout legs and feet and strong bills for quick work among different kinds of insects ; some

lost their power of flight through the same causes whilst in others it became further developed. Whatever the change, we may be sure that the struggle for food was the great driving force.

With the change in the form of the bird came a further change in the type of nest. Some birds died, others survived, the survivors undergoing gradual changes according to environment, and each species constructing the type of nest most suited to it and its surroundings, the fittest surviving, the unfit perishing throughout the long ages, until to-day we can count about 19,000 species of



Nest of the Brown Bush Warbler, with its rightful occupant and the Bronze Cuckoo. The entrance to the nest, which is only slightly hooded, is scarcely large enough to admit the diminutive owner, which may be seen on the left. On the right may be seen the Bronze Cuckoo, whose eggs have been frequently found in these nests without the entrance having been enlarged. Instances have been recorded where the cuckoo's eggs have been covered with a thick layer of lining material to prevent its incubation. The illustration is of a group from the Museum galleries.

[Photo.—*H. Barnes.*

birds throughout the world, nearly 800 in Australia, with almost as many distinct types of nests. This, I hope, will give a very clear idea of the position, and answer the questions, "Why so many birds? Why so many nests?"

During your rambles in the bush you may have noticed that some birds are tunnellers, some nest on the ground, and their homes may be beautifully modelled and fashioned with grass, or the eggs are laid on bare earth or rock, with little or no attempt at building at all. Many birds build in the grass, reeds, and low bushes, where some of the most beautiful nests may be found. The majority build in trees, a few are cliff dwellers, building beautiful mud and clay houses, while some prefer to build floating nests on the surface of the water.

We have in the cuckoo, whether it be the Fantailed, Pallid, Bronze, or any other species of the true cuckoo, a bird which has solved the housing problem to its own satisfaction and so rids itself of all responsibilities. Like all other birds it must have a nest wherein to lay its eggs, but it does not build a home of any sort for itself, it believes in boarding out the egg and later the young cuckoo, and in free board at that. When a small bird, say a thornbill, is away from home, the cuckoo takes the opportunity of depositing an egg in that home, after which it hurries away to safer quarters. It is not definitely known how the cuckoo gets its eggs into these nests, many of which have such small openings that it could not possibly enter without smashing them. It is surmised that it lays its eggs either on top of the nest or on the ground, whence it manages, with its feet or beak, to carry and deposit it in the nest. Here the young bird hatches, and, after crowding out the rightful owners, thrives on the worms brought along by its foster parents.

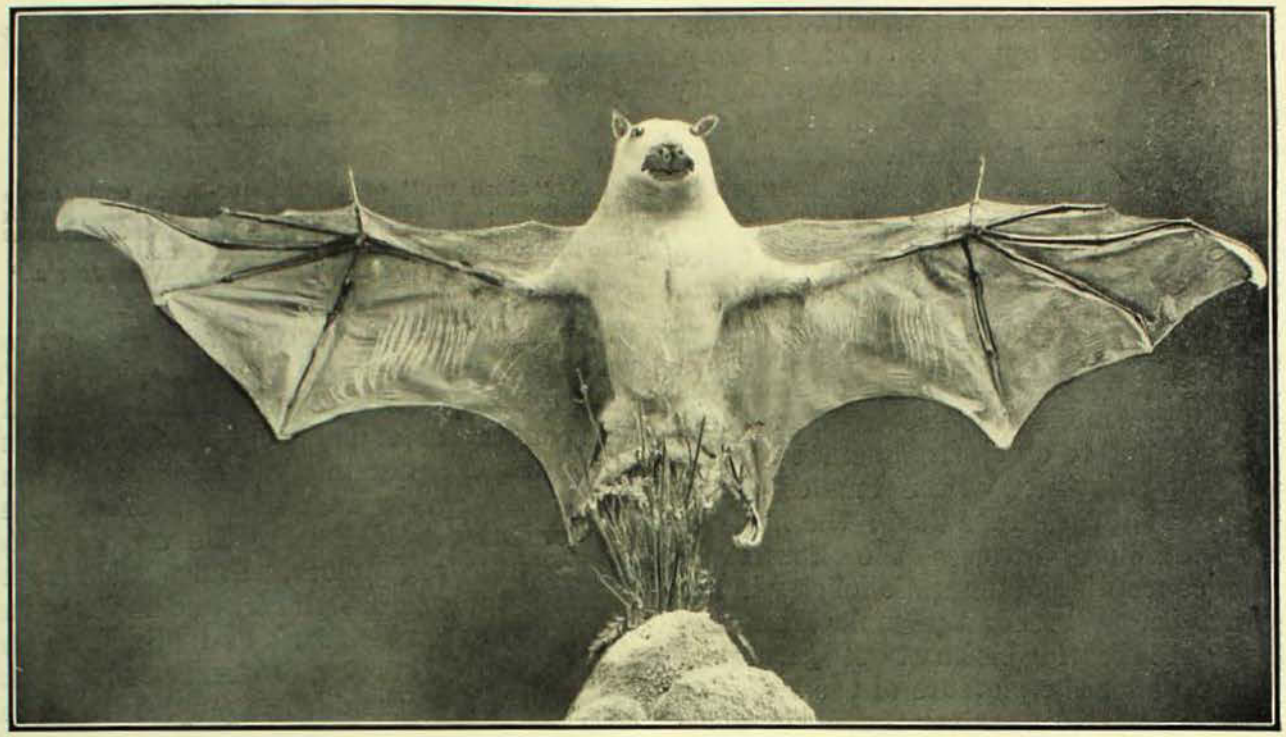
This brings us to a very important question—do birds build by instinct or by imitation? One scientist held that it is the latter, stating that the young bird took a careful survey of the nest in which it had lived for so long, and that it paired with a more experienced mate. It seems extraordinary that such an opinion should have been expressed by any authority in face of almost overwhelming evidence to the contrary, evidence which leaves no doubt that nest building by imitation is out of the question. Here are some of the arguments which support the conclusion that nest building is instinctive. Wild birds have been taken from the nest before they could see, they have been kept in captivity until old enough to care for themselves, and when put into large aviaries have eventually constructed nests true to type, typical of their species. Surely this cannot be imitation in any sense of the word; it is instinct, instinct and not imitation is nature's greatest provision for creatures of the wild. A spider spins a web, the web is true to type, a caterpillar spins a cocoon, similar to those constructed by its forbears, yet neither the spider nor the caterpillar has any previous experience in spinning. If imitation is one great driving force why is it that a cuckoo does not construct a nest but inherits the habit of seeking out the nest of some other bird in which to lay its eggs?

For those who make a hobby of egg collecting, that useless and selfish pastime, and for those of you who wish to learn more about Nature and all her works, may I be permitted to add these few words. When next you go rambling and feel tempted to take an egg to add to your collection, pause for a moment, look carefully at the nest, and think back to the time when a pair of happy birds first chose the site, placed the first twig in position, and tackled the problem of getting that first twig to stay while a second and third had yet to be added. Think of the many hours spent sitting on the eggs, guarding them from all enemies except selfish men. Were the birds keeping the eggs for us? No! Then why take them? It is surely far better to have hundreds of cheerful whistling birds than thousands of eggs.

When you know something about the nest and its construction, and how each nest compares with another, and that the only implement available is the bird's beak, you will consider its work all the more wonderful, and you will have found something more to interest you when you next go for a walk in the bush.

Some Strange African Fruit Bats.

By Ellis Le G. Troughton.



The Hammer-headed Fruit Bat is the largest of the African bats ; in the male the larynx is greatly enlarged and everything appears to be subordinated to the organs of voice, the rapidly reiterated " pwoks " or " kwoks " of an assembly of males suggesting a chorus from a pondful of large and noisy frogs.
[Photo.—*G. C. Clutton.*

BATS have a very wide range, being found over almost the whole world to the limits of tree growth, and, the world over, they are prone to weird facial distortions which almost excuse the quite unnecessary dread evinced for them by some people. In the last issue of our Magazine I showed that Australia possessed some peculiar varieties of bats, such as the quaint tube-nosed fellow. As the latter attracted considerable attention and enquiry, one feels that readers may also be interested in the equally, or even more strange species of foreign climes, such as the queer-looking Hammer-headed Bat of Central Africa to be seen in the Museum gallery, which certainly challenges the supremacy of our tube-nosed friend in grotesque physiognomy, though both might possibly win a beauty competition in batdom for the most original facial make-up.

Though the largest of all the bats, the Malay Kalong, has a body one foot in length and a wing expanse of five feet, some of the African bats are far more interesting than their Asiatic relatives. For instance, as pointed out by Lang and Chapin in their interesting article in the *American Museum Journal*, on the bats of the Belgian Congo, though the body of the largest African bat, the Hammer-head, is only ten and a quarter inches long and the wing-spread three feet two inches, it is one of the strangest of bats, and the males are unique amongst vertebrates in the following respect at least.

VOICE CULTURE OF THE MALES.

The larynx of the adult males is almost completely ossified, and so greatly enlarged that it actually occupies two-thirds of the body cavity and crowds the heart and lungs back towards the pelvic region ; the vocal chords are also greatly broadened in proportion. Indeed, in no other creature is the body structure so subordinated to the arrangement of the vocal apparatus, which has apparently been designed to produce continuity rather than loudness of sound. They also have on each side of the neck an air sac which can be inflated at will as in certain varieties of frogs. The noise made by an assembly of these bats, possibly a legislative one judging by the amount of conversation, resembles that arising from a pond full of frogs, transferred to the tree tops and magnified many times. The Congo natives assured the American collectors that these poor males had to croak from sunset to sunrise for the enjoyment of the females, which the natives suppose to be deaf ; the natives' theory therefore reverses the humorists' popular conception of domestic felicity in the human race. Whether the male Hammer-headed Bat is beating his heart out in a sort of anvil chorus for the pleasure of the ladies or whether it is merely a matter of vocal exercise one cannot tell. Whatever the reason for the rapidly reiterated frog-like cries, the creatures are either fearless or dull of hearing while creating the din, as they do not mind the flash of a lamp or even the sound of a gunshot, though extremely shy at other times.

ADAPTATIONS FOR FEEDING.

It is the peculiar leafy skin-folds on the muzzle which present the most striking feature of these bats, as in the male, and to a lesser degree in the female, there is a warty shield-like expansion of the enormous muzzle giving a repulsive appearance, which is rather suggestive of a very ugly caricature of the head of a mule. This shield and the voluminous extremely mobile lips are undoubtedly adapted to the method of feeding upon the favoured " fruits in season," as the following account of Lang and Chapin shows. " In their manner of feeding, these bats are equally interesting. Their relatively large teeth (canines) merely lacerate the outsides

A " close up " of a Hammer-head, aptly named monstrosus. The popular name arises from the peculiar enlargement of the muzzle with its large indiarubber-like lips and hardened ruffles on the nose.
[From the " American Museum Journal."

of fruits. The hardened ruffles on the nose probably are used in the manner of a pig's snout, to loosen the pulp inside the fruit. The tongue, instead of becoming slender when stretched out, assumes the form of a spoon, and a triangular rasp-like set of papillae, conveniently placed near the tip, helps to gather pulp and juices. The whole face in front of the orbits is loose, and in its upper parts the channels reach as far back as the ear ; the lips function evidently as muscular pouches to squeeze out the pulp of the fruits. The oesophagus (gullet) is so narrow that only juices can pass. This fact offers an explanation for the great patches of fresh pulp often found together with the remnants of spoiled fruits underneath the boughs which appear to be used as their habitual dining halls."

HABITS AND FOOD.

According to our American observers " These hammer-headed bats occur singly or in small flocks, rarely exceeding thirty, and are most frequently seen shortly after sunset when leisurely flapping across the rivers or open expanses of water. We often observed them, too, stealing ripe fruit in the government posts. They are especially fond of guavas, mangoes, and sour sops, and take ripe bananas even from underneath the roofs of houses where natives have stored them." Figs and plums also form a favoured article of the menu.

There is usually only one young bat born at a time, which clings tightly to its mother's

abdomen with its hind claws, its mouth usually grasping one of the parent's teats. So closely does the young one nestle that it is invisible except when viewed quite closely. When at rest the parent folds one or both of her wings over the baby bat, the membranes acting as coverlets to keep it dry and warm, secure from the glare of daylight or prying eyes. Until able to fly the young one is transported everywhere by the mother, who often displays amazing strength and endurance in lengthy flights while supporting the oft times fairly heavy juvenile cargo.

THE DISCOVERY.

This strange species was first brought to light by the African explorer Paul Du Chaillu, who captured a specimen during his travels in the interior of western Africa, in country previously unexplored by Europeans, about the year 1858. For a time, until his specimens and data were checked, Du Chaillu's strange narrative of the extraordinary and hitherto undescribed species seen, led to his being regarded as a sort of de Rougemont of Africa. So keenly did the traveller feel the ill-considered strictures of his arm-chair critics, being guilty at the most of slight exaggeration owing to the weird happenings and strange sights encountered, that he wrote, more in sorrow than in bitterness: "The position of an explorer of unknown countries in England is peculiar and very difficult. If he returns home with nothing new or striking to relate he is voted a bore, and his book has no chance of being read; if he has some wonders to unfold, connected with Geography, the Natives, or Natural History, the fate of Abyssinian Bruce too often awaits him; his narrative being held up to scorn and ridicule, as a tissue of figments." Hence his narrative describing many animals unknown to science was at first condemned, until the various species, such as the Hammer-headed Bat, were described by scientists. Thus was Du Chaillu's honour vindicated and most of his contentions proven, as even were many of the statements of the much less credible and truly remarkable de Rougemont.

THE EPAULETTED FRUIT-BATS.

These bats are confined to that portion of Africa lying to the south of the Sahara Desert and derive their name from a peculiar pouch or depression on each shoulder from which project tufts of long yellowish-white hair, giving the bats the appearance of wearing epaulettes, and imparting quite an air of distinction. These epaulettes are absent or rudimentary in females but on the ears there are white tufts of hair which are present in both sexes, and the lips are large and loose, though not so distorted as in the hammer-headed variety.

The head of a male Epauletted Bat showing the tufts of stiff white hairs growing out from the glandular shoulder pouches. The white patches are suggestive of epaulettes, giving rise to the popular name of several species of African Bats, and impart quite a distinctive air to their otherwise somewhat dog-like expression.
[From the "American Museum Journal"

Well known to most of the residents of South Africa, the Epauletted Bats inhabit the forests and wooded kloofs, and in fact wherever trees are abundant. The bulk of the body is about that of a man's closed hand, and the wings when stretched to their fullest extent average twenty inches from tip to tip; the male is slightly larger than the female.

FOOD AND FEEDING HABITS.

The capacious lips of these bats are admirably adapted to retain and swallow without loss the juicy contents of the fruits which form their entire menu. Of their habits, Fitzsimons gives an interesting account in his "Natural History of South Africa," from observations made in the wild and captive state.

Ripe fruit, he points out, is easy of digestion, and a considerable quantity of the watery diet is necessary to provide the

requisite food-elements for the bodily needs of these large bats and as a result their appetite is prodigious. He fed one in captivity with bananas, and when allowed to eat to repletion it actually ate four times its own weight in one day. All kinds of fruit are eaten and the havoc wrought in orchards is very great. The method of dining upon soft fruits is much as adopted by the Hammerhead, a special adaptation of the lips, gullet, and wind-pipe making an efficient suction engine of the mouth. A nice squashy fruit is enveloped by the indiarubber-like lips, the skin is pierced by the long front teeth, whereupon the lips squeeze out the soft pulp, the vacuum cleaner process is applied and the fruit-cup quickly swallowed, the skin and stone or pips being rejected. A friend of Fitzsimons tried enclosing his figs in muslin bags to outwit the marauders, but the wily bats simply used the bags as strainers and doubtless appreciated the polite attention to detail, whilst sucking the pulp through the bags. Fruits from which the pulp cannot be extracted by the suction process may be carried in the mouth to a quiet retreat where, hanging by one of its hind legs and with the aid of the other leg and its hooked thumbs, the fruit is eaten and the skin or pips dropped to the ground. Sometimes the bat may hang by one of its thumbs, using the other members for holding the fruit. It is said that in a little while sometimes as much as a barrow-load of leavings may accumulate.

ECONOMIC EFFECT. MAN'S ENEMY.

It is not surprising that the opinion is often expressed that fruit-bats are without redeeming qualities as far as man is concerned, and in the face of that mysterious and delicate force known as the balance of nature, who can positively affirm or deny the impeachment. They not only eat a great quantity of fruit but are also very wasteful, some actually taking bites as they fly to and fro, thus slightly damaging or knocking down more than they eat. It is, therefore, hard indeed to find an excuse for their existence, and the only one I have heard of is advanced by Lang and Chapin. These authors point out that "as the seeds are dropped to the ground, the bats unwittingly contribute to the distribution of valuable fruit trees beyond the confines of plantations, for, under the favourable influence of the moist climate, these seeds readily sprout and grow into trees." They consider that fruit-bats play quite an important rôle in the propagation of certain fruit trees, possibly even surpassing birds and monkeys, which usually receive the bulk of the credit in this respect.

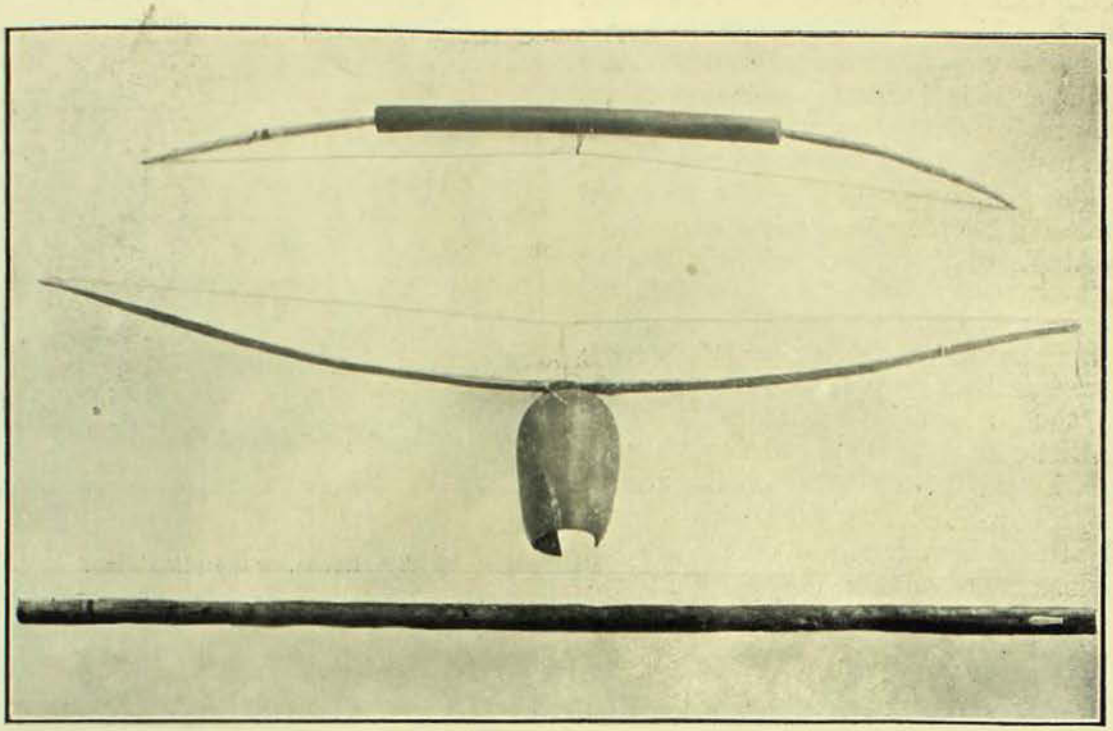
Though the above is not an adequate recompense to hard working orchardists for nightly raids, yet, while the fruit-bats are justifiably exterminated in fruit-growing areas, it is comforting to know that the creatures are at least helping to spread useful trees in unsettled places. If this slight service is not considered worthy of notice we can only assume a broad toleration for the fruit-bats for the sake of their little insect-eating relatives all of whom are friends of man, allying themselves with the insectivorous birds in a nightly campaign against man's insect enemies.

In the last issue of the MAGAZINE reference was made to the valuable collection of Broken Hill minerals which the munificence of Sir Hugh Dixon had made possible for the Museum to acquire. It contains much that is of value, more particularly as many of the minerals will never again be found in the Broken Hill lode. Some of the interesting items are anglesite, specimens of which surpass any that the Museum previously had; embolite, a mineral not now being found anywhere in the world, is represented by some beautiful examples showing mode of occurrence and associations. Other additions are cerussite, pyromorphite, native copper, azurite, smithsonite and many others, all characteristic of minerals found during the early days of the Broken Hill lode.

The community's thanks are due to our generous patron for enriching the Museum's collections to such an extent. By obtaining such collections the Museum is performing its principal task, that of collecting and holding for investigation, now or in the future, material of value to research students.

Primitive Musical Instruments.

By Keith Kennedy.



Upper.—Bantu banjo, or single-string harp bow. Centre.—Kaffir bow fiddle. Lower.—The goura.

[Photo.—*G. C. Clutton.*

MUSIC, that which employs sound as a medium of artistic expression, has been said to be the oldest, as well as the youngest of arts. Oldest, because a time is unimaginable when man did not use his voice for the expression of emotion, youngest because the other arts attained maturity centuries before it, from its crude beginnings, became a real art. Records of early developments are wanting, but by examining the music of those primitive peoples, yet with us, something of the origin of our modern instruments can be learned.

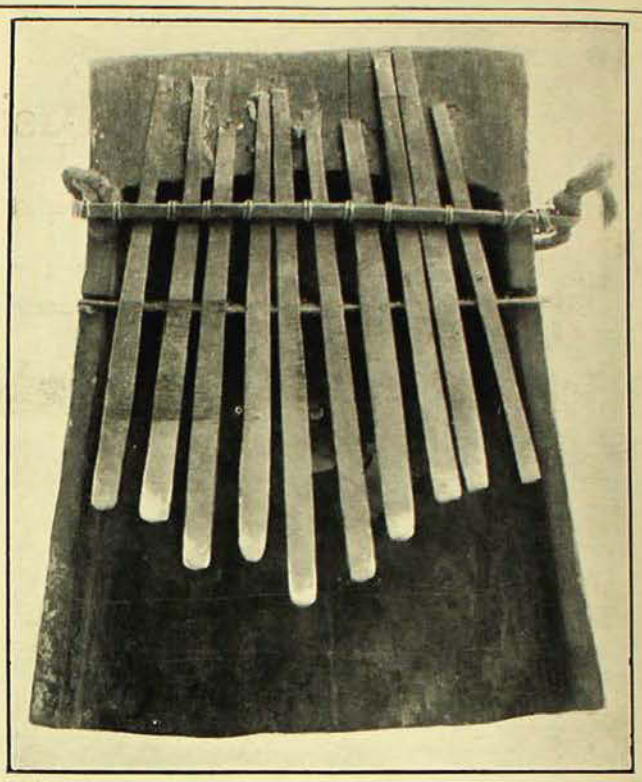
During a number of visits to South Africa, and the adjoining regions, I have made a point of observing the instruments and the methods used by the natives in playing them. My notes, unfortunately, are very brief, yet I hope they will prove of interest. Most of these instruments may be seen in the galleries of the Museum, and are well worthy of an inspection.

Amongst the Bantus of South Africa can be found the rudimentary form of several of our modern orchestral instruments. The simplest kind of stringed instrument they use is the single string harp bow, a bow made of three pieces of wood and strung with a copper wire. This wire is tied to the centre by a piece of tendon which divides it into two vibrating parts, each making a separate note. It is played by biting on the thick part of the wood and flicking the string with the thumbnail of the right hand : the sound, needless to say, is rather feeble, hence the idea of biting it, which carries the vibrations through the jaws to the auditory nerves of the player. A development of this instrument can be seen in a bow-shaped harp on the monuments of the ancient Egyptians.

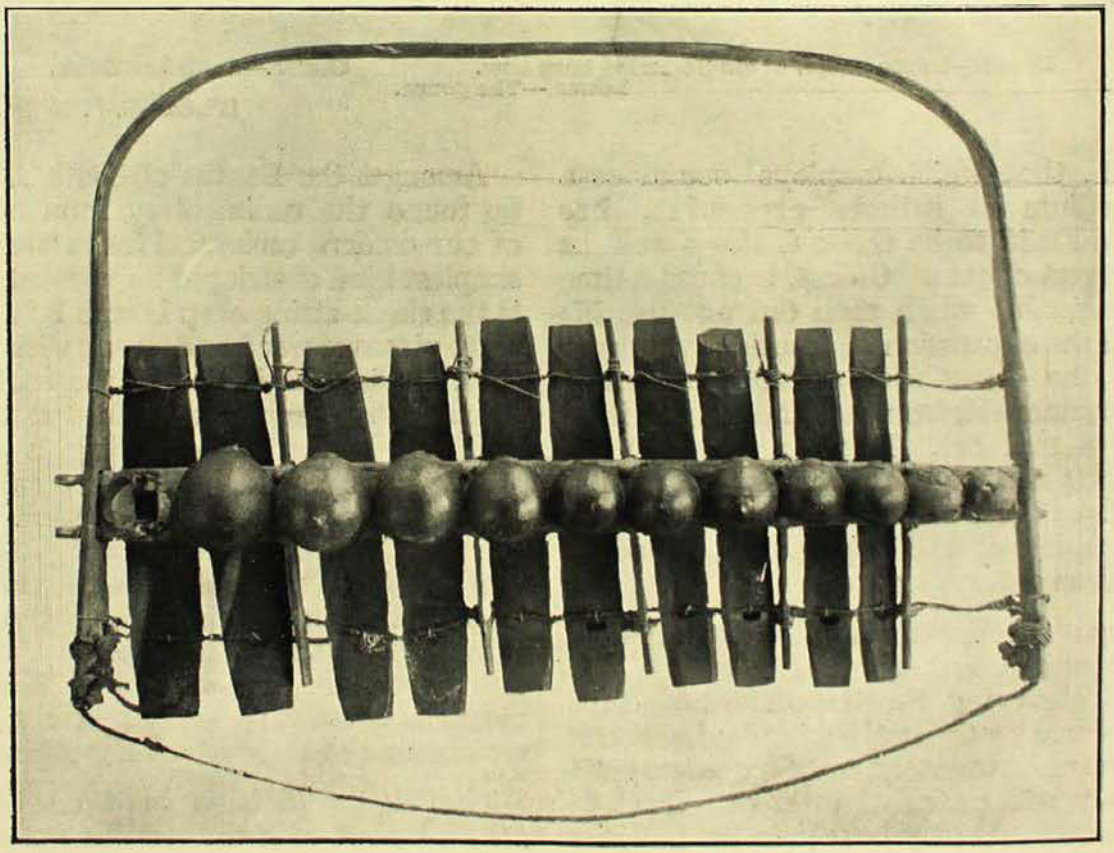
The Kaffir fiddle is built on the same principle, but with the addition of a hollow calabash to amplify the sound. It is played differently, the string being struck by a piece

of reed or elephant grass. The bow is held in the left hand and the calabash pressed against the body, by occasionally lifting it a crescendo is obtained. It is a favourite instrument of the women, and the one shown in the accompanying illustration I obtained from a Zulu girl at a kraal close to Eschowe, in Zululand. Like the harp bow just referred to, its sound is very faint, and the enthusiasm of the player is in inverse proportion to its volume. A musical bow with a gourd attached to the end was the prototype of our harp. The gourd was eventually replaced by a sounding board. The guitar and violin also owe their origin to the primitive string bow.

On one occasion, whilst on the mountains, near Maseru in Basutoland, I heard a peculiar droning sound. Following it up, I came across a little Basuto shepherd boy dressed in sheepskins ; he was playing on the goura, or lesiba, a bow-like instrument with a piece of quill attached to one end of the string. It is a much more advanced type of instru-



The lisese, or metallophone.
[Photo.—*G. C. Clutton.*



The xylophone.
[Photo.—*G. C. Clutton.*

ment than those just mentioned, and, moreover, it is in reality a wind instrument despite the string, for it is played by taking the quill in the mouth and inhaling or exhaling upon it. Most boys have at some time or other indulged in the practice of holding a blade of grass between the thumbs and blowing upon it. The sound produced is caused by the vibration of the edge of the grass, which is rapidly deflected from side to side by the blast of air. The quill of the goura acts similarly, and the little Basuto lad was enjoying himself as much as his white brother with the grass blade. The sound produced is supposed to resemble the cry of the ostrich. The goura is in common use amongst the Basuto shepherds, who play it while watching their herds ; by its sound the cattle know where the shepherd is.

The lisese I got in Rhodesia. It is sometimes called a Kaffir piano, a name which is applied to the xylophone, but the designation metallophone is much more suitable for it. It comprises a sounding board with iron tongues, or strips, of different lengths attached ; the iron is mined and forged by the natives of Manikaland and adjoining regions. It is played by holding it in the palms of the hands and plucking the tongues with the thumbs. Though the sound is faint, it is not unmusical, and the varying lengths of the tongues give different notes. The Kaffirs seem very fond of it, and sit for hours twanging away.

The xylophone is constructed of various pieces of resonant wood, with gourds or calabashes placed behind them, to act as resonators. It is played by striking the various notes with two wooden hammers, exactly as is done with the ordinary instrument so beloved by the modern jazz drummer.

Maggots.

By G. H. Hardy.

Walter and Eliza Hall Fellow in Economic Biology, Queensland University, Brisbane.

IN 1857, Frank Buckland wrote: " Pray what is there to be found in a horse-pond except mud, dead dogs and cats, and duckweed ?" That notable naturalist then proceeded to answer his own question in such an entertaining fashion that the book containing the question ran through no less than five editions in three years.

Although my subject may be as distasteful to you as the horse-pond was to the public of Buckland's day—at least to the adult public of that day—yet it is not without its compensations. The maggots I refer to are those of the blowflies and of these four genera concern us, *Neopollenia*, *Lucilia*, *Sarcophaga*, and *Chrysomyia*.

The first of these contains the two largest common species, one a black and brown shaggy fly, the other smoother and with a blue stripe down its yellow-brown abdomen, The maggots of these, as also those of *Lucilia*, the common green blowfly, are quite typical of their kind ; the body tapers to the head where two deeply imbedded black hooks can be easily seen through the translucent skin, whilst the thick end terminates abruptly and here are to be found a pair of brownish spiracles through which the creature breathes. Flies of the genus *Sarcophaga* are all greyish with three black stripes down the thorax and with a tessellated abdomen ; the maggots of these are similar to the last, but the rear portion is overgrown by a thick fleshy growth that hides the spiracles. *Chrysomyia* contains two forms of maggots, one known as the " hairy maggot," because its body is covered with tubercles, which really do not resemble hairs at all, the other has the usual smooth skin.

The maggots belonging to the first three genera are well behaved, quietly disposed individuals, but not so those of the genus *Chrysomyia*. The hairy maggots are pugnacious and feed upon those of the other genera, whilst the smooth ones of the kind, although not known to be cannibalistic, act as if they too were expecting to be charged with murder. When first I met with these in quantities, I thought they were *Lucilia* maggots breeding, and, when they left the meat on which they had been feeding, I was very surprised to see several hundreds of them shivering. The quivery-quaky motion was so very rapid that, with these hundreds in a mass performing in this manner, it gave almost a blurred effect.

Another maggot that feeds on meat, but one that does not belong to the blowfly group, is able to jump. This is a small fellow that catches the hooks of the mouth into the rear portion near the spiracles, and by straining in this doubled-up manner and releasing itself suddenly, leaps away perhaps a foot or more. It repeats this action many times in succession without losing power, but, its manœuvring to get into the hooked position is a rather slow process.

Not many human visitors come to my insectarium ; the researches in progress are not inviting ones and most of those who are interested enough to face the ordeal of a visit there soon retreat to my office. Indeed I do not stay in that oversized meat-safe myself more than I can help. Other visitors are plentiful, however ; about fifteen species of flies settle and buzz around endeavouring to get at the sheep's hearts within. A cranky fan-tail and other insectivorous birds visit there during the mornings, making a meal of these flies. Beetles that feed on carrion are plentiful, and a beautifully compact metallic blue one of the family Histeridae frequents the spot too. This last deposits eggs on carrion where blowflies are breeding, and the grubs that hatch prey upon the maggots of flies and also upon the puparia inside which these fly maggots undergo miraculous changes that finally yield the flies themselves. The damage one of these predaceous grubs can do amongst maggots and puparia is prodigious so they have to be rigorously excluded. Then there are parasites of these blowflies, some four species in all, two of which deposit their eggs in the maggots before they pupate and two that accomplish the same in the puparia. I have often wondered what would happen if all four of these parasitic wasps were to deposit their eggs in the same unfortunate individual. The information is not at all as easily secured as you might think, but I have got part of the way to answer the query and perhaps when I have found out I will tell you all about it.

Has it ever occurred to you that a maggot is thick at the rear and tapers down to a minute head, whilst the fly is big at the head and tapers to the rear ? The metamorphosis that includes such an abrupt reversion of direction is carried out in the puparium, and there the first three or perhaps four segments that were the head end of the maggot contain within them the germinal buds of the developing head of the fly. Out of that which was the mouth of the maggot emerges this developing head, so virtually the head of the maggot becomes the neck of the fly. This interpretation gives a logical idea of what apparently happens in this metamorphosis, but should you probe further you would probably find that the head of the maggot entirely disappears. Other wonderful changes also take place but they are not so easily explained as is this discrepancy in the sizes of the heads.

Over three years ago, when I was asked if I would like to carry out some needed research work on the biology of blowflies, I said I would. But, alas, that was not strictly accurate, for I had a deeply rooted objection to the work, the reason for which can be easily guessed at. When I was leaving Sydney to take up my duties, the editor requested an article on the subject for this MAGAZINE but the ubiquitous blowfly was not an appealing subject. Two years passed ; the first three months of that period were pleasant enough, then the insectarium was completed and six months of agony came when almost nightly I would go home with a sick headache ; there followed an easier time again when I became immune to the aromas of the maggot's food, It is the habit of specialists and such like. whether their thoughts dwell on mice or monkeys, music or money, to work up an enthusiasm and fondness for their subject. Perhaps this is what a certain lady had in mind when about this time she remarked to her husband "That man does love his blowflies."

The Animal Life of the Nepean River.

By Anthony Musgrave.

Sandy Cave, the rock shelter in which we usually camp, and the home of the Fairy Martin.
[Photo.—*A. Musgrave.*

THE diversity of scenery on the Nepean River between Penrith and Norton's Basin, has a corresponding effect on the animal life of the district. The stream flowing sometimes between reedy banks or rocky boulders provides abundant security to many water loving forms. The rugged cliffs shelter many interesting species, while thickets of castor oil plants afford ideal lurking places for those which delight in such situations. To enumerate all the animals of the thirteen mile expanse of river would be far beyond the scope of this article, and even if we restricted the list to include only the animals seen in the vicinity of our cave it would still be too colossal an undertaking. We are therefore compelled to deal merely with the more conspicuous forms.

MAMMALS.

The non-marsupial animals of the district are represented by rabbits, foxes, rats, bats, and the dingo. Rabbits are abundant in the

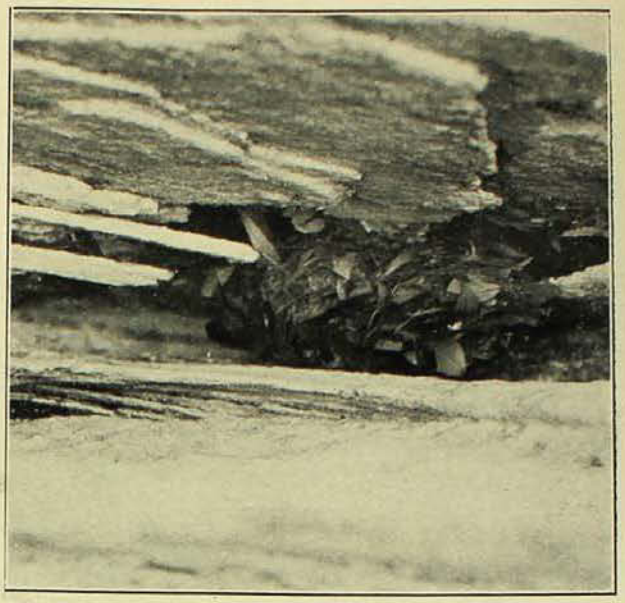
gullies leading to paddocks or clear patches of grass, and a small colony has been established for some time in a gully near the junction of the Warragamba and the Nepean Rivers.

Foxes have been observed by us on occasions, and doubtless do a great deal of destruction among the ground frequenting birds.

Though Sandy Cave, the rock shelter in which we usually camp, is about three miles from the nearest house, the traps which my friend Mr. Troughton set in its vicinity caught only the common English Black rat or ship rat, *Rattus rattus*. This species has been distributed all over the world through the agency of shipping. It is said to have been introduced into England by the Crusaders and it arrived in Australia at a very early date so that we hear of rat plagues so far back as 1864. The animals Troughton hoped to catch were native rats, which may be distinguished from the introduced species by their soft fur, that of the foreign species being coarse and bristly.

We have been informed by other campers that dingoes occur on the river, and despite an assertion by a resident of the district that he had seen them "trailing along the tops of the cliffs like ants," we have never had the fortune to see one.

Bats, attracted by the insects holding their revels round the flame of our acetylene lamp, skim swiftly from one end of the cave to the other, reaping *en route* a rich harvest. These bats proved extremely difficult to secure, as they appeared only for a fraction of a second in the circle of light thrown by our lamp, the overhanging ledges of rock making shooting almost impossible. Our mammalogist, Mr. Troughton, conceived the idea of catching them in a butterfly net, but after many fruitless swipes he abandoned the project. To those of us who watched him it seemed that it would be almost as simple to catch a lightning flash as to secure thus these tiny demons of the dusk. Next evening we hit on the more practical method of shooting them from the boat in midstream, the creatures being clearly outlined against the afterglow of the sunset. Several were thus shot, and as their bodies fell into the water there was a wild fumbling of oars to reach them before they sank.



A nest of the Yellow-footed Pouched Mouse, in a sandstone cave.
[Photo.—*A. Musgrave.*

Upon examination they proved to be *Nyctonomus norfolkensis*, a widely distributed species. The body of this bat measures only two inches in length. Other bats doubtless occur along the river, and we once saw a Flying fox, *Pteropus poliocephalus*, suspended in a river oak.

THE MARSUPIALS.

In former times the Brush-tailed Rock Wallaby, *Petrogale penicillata*, occurred abundantly along the banks of the river, but they have been so reduced in numbers by sportsmen that now they are but rarely seen, and it is only a matter of time before the species entirely disappears from the district. Rock Wallabies are able to travel with great speed up the rocky cliffs and gullies, bounding from rock to rock with the utmost facility, but their ability to run does not ensure them complete protection from the sportsman, who usually waits near some gully down which they come to drink at the river, and only too often they fall victims to his rifle. During the day the animals hide in rock shelters and come out at night to feed, and it is during the dusk or early morning that the sportsman lies in wait for them. In the Australian Museum are specimens of rocks which have been polished by the feet of successive generations of wallabies while visitors to the Jenolan Caves may see

The Yellow-footed Pouched Mice, Phascogale flavipes.
[Photo.—*G. C. Clutton.*

such rocks *in situ* as well as the wallabies themselves, for here the laws are rigidly enforced and the visitor is rewarded with the sight of many of these animals. Rock Wallabies differ from other wallabies in certain special modifications which enable them to frequent their rocky haunts. The tail at the base is not thick and is not used to support the weight of the body to the extent that it is in other wallabies, but is used rather in balancing the body when jumping. The tail ends in a brush of long hairs from which the animal derives its specific name of *penicillata*. The under surfaces of the feet are very rough and covered with little tubercles which probably save the animal from slipping when going at full speed over the sandstone rocks. The animal itself stands about twenty-nine inches high. Besides the Rock Wallaby the Scrub Wallaby (*Macropus ualabatus*) also occurs and we found the remains of one near Norton's Basin not long ago.

In a crevice of the sandstone rocks near Norton's Basin we found a nest of the Yellow-footed Pouched Mouse (*Phascogale flavipes*). The crevice was situated about eight feet from the ground and the nest was placed about two feet from the opening of the cavity. This consisted of gum leaves rolled up into a ball in the middle of which were three young ones. The task of collecting the leaves and carrying them up the steep, almost vertical face of rock must have been a very arduous undertaking for this small marsupial, which measures only five inches in length. Phascogales are related to the Native Cats, from which they differ by their smaller size and the absence of spots, while they may easily be distinguished from the true rats by the fact that there is no toothless gap between the front incisor teeth and the back (molar) teeth, as in the rats.

Phascogales are carnivorous, unlike the true rats, which, though omnivorous, seem to prefer a vegetable diet. When I was collecting in the Upper Chichester Valley some years ago, this tiny animal was frequently caught with a meat bait, while the rats I secured were attracted by a raisin bait. About nine species of Phascogales have been recorded from Australia, and the yellow-footed species ranges from Papua through Eastern Australia to South Australia.

In addition, flying phalangers and opossums also occur in the eucalyptus trees along the river.

BIRDS.

To the ornithologist the Nepean presents a particular fascination, for in addition to such aquatic birds as darters, cormorants, coots, and reed-warblers, terrestrial birds of all kinds such as lyre birds, coach-whip birds, and black-backed magpies or tallawongs occur in the gullies and ravines, and in the early morning campers are treated to an avian symphony.

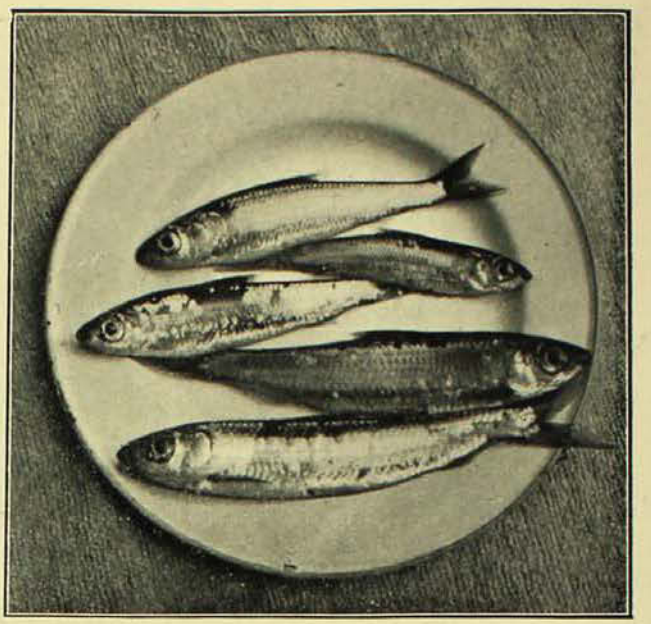
The cormorants or shags are frequently seen on the trees along the banks. From their elevated positions they crane their necks at us until our boat draws near when they wing their way up or down stream or else take to the water, where they are secure from molestation. They are wonderful swimmers, and can swim under water and keep ahead of a boat as we proved on one occasion when we pursued a wounded bird for some distance. About five species haunt the river, the Black Shag, the Little Black Shag, and three white-breasted forms. These species occur abundantly in the estuaries

and rivers in other parts of the State. The white-breasted forms formerly occurred in immense flocks in the trees, or could be seen fishing in the river, where they would systematically work a section, catching all fish that came their way ; now they occur only in very small numbers.

Under overhanging ledges of rock, sometimes only a few feet above the water, sometimes a considerable distance above it, the Fairy Martin or Bottle-necked Swallow (*Petrochelidon ariel*) constructs its nest. In Sandy Cave the nests are common, often crowded together, and from early morn till dewy eve these dainty little birds skim twittering in and out of the cave. The nest of the fairy martin is flask shaped and made of pellets of mud lined with feathers and grass. One summer during the week that we occupied the cave there was a steady drizzle of fragments of the nests of these birds with an occasional nestling to relieve the monotony. The bird itself is black on the back, the breast is white while the head and back of the neck is reddish. It occurs all over Australia and may be distinguished from the Welcome Swallow by its smaller size and colouration. In the Australian Bird Gallery of this Museum is a small, but extremely beautiful group, showing these birds and their nests in a typical haunt. This exhibit forms the subject of the frontispiece of this issue.

FISH.

The river has long been the haunt of fishermen who find the perch fishing attractive, the numerous sandstone caves along the banks serving as ideal camps from which to make their forays. Despite the fact that the Isaak Waltons of our party ply many an angle while on our trips, they rarely catch any perch, but they nearly always seem able to catch the ubiquitous and comparatively insignificant Freshwater Herring (*Potamalosa novae-hollandiae*). On the river, towards dusk, the water suddenly becomes covered with little circles as though drops of rain were falling, as hundreds of these tiny fish rise to the surface. This is the time to catch them. They are good eating, particularly the smaller ones, the larger forms being too bony to be enjoyable, but it takes quite a number of them to make a square meal.



The Fresh-water Herring, Potamalosa novae-hollandiae, which occurs abundantly in the Nepean.
[Photo.—*A. Musgrave.*

Eels also occur in the river, and a line set one evening yielded next morning a magnificent specimen of *Anguilla australis* which later bulked large in the menu, and was considered quite a pleasant departure from our usual bill of fare.

REPTILES.

One of the most familiar sights of the river is the Eastern Water Dragon (*Physignathus lesuri*), a large lizard which may measure three feet in length. This fellow usually sits sunning himself on a rock or log near the river, and if disturbed at once jumps into the water with a loud plomp or else scurries away into the bush making a rustling noise among the leaves. It is quite as much at home in the water as on the land, and may be seen swimming in most of the creeks and rivers from Queensland to Victoria. The crests of spines on the neck and back and the yellow cheek-pouches render it readily distinguishable from any other species.

The great abundance of water and the amount of cover affords ideal conditions for snakes. In fact the large beds of reed grass and the thickets of castor-oil plants may be aptly described as "snaky," but though I have had nearly twenty trips to the locality I have seen

The Eastern Water Dragon, Physignathus lesuri, may often be seen on the rocks or logs near the river, enjoying a sunbath.
[Photo.—*A. Musgrave.*

very few snakes. Those which have come most under our notice are the Green Tree Snake (*Dendrophis punctulatus*) and the Black Snake (*Pseudechis porphyriacus*). We have encountered both species swimming across the river, and on two occasions had quite exhilarating times trying to kill black snakes. Once a small black snake was injudicious enough to swim into the reeds at the end of our cave, and for a while caused great excitement until I had the good fortune to shoot it. But the most exciting time we have yet experienced was when a Museum party while rowing up the river came upon a large Diamond Snake (*Python spilotes*) asleep on the bank. Endeavouring to find out if it could swim they levered it into the water with an oar, and the next minute were full of information as to its swimming ability, for it proved not only quite at home in the water but also extremely resentful of their conduct, promptly trying to climb up an oar into the boat. They immediately pushed him off and left hurriedly, not because they were afraid, but because they had suddenly tired of scientific investigation.

FROGS.

Often as we lie in our bunks at night we hear a curious little tinkling rattle from the grass along the river's edge. At one time this used to cause much controversy as to its origin, when it was finally settled by the late Dene Fry who formerly had charge of the reptiles and amphibians in this Museum. Fry solved the problem by the simple expedient of taking a lantern and looking for the originator of the noise. The culprit proved to be a frog (*Hyla latopalmata*), which might well be called the "stone-in-the-jam-tin frog," since that is the nearest I can get to describing his call.

The frog, which measures about two inches in length, is brown in colour

"The Stone-in-the Jam-tin-Grog," Hylalatopalmata whose tinkling note is a pleasant feature of the river.
[Photo.—*A. Musgrave.*

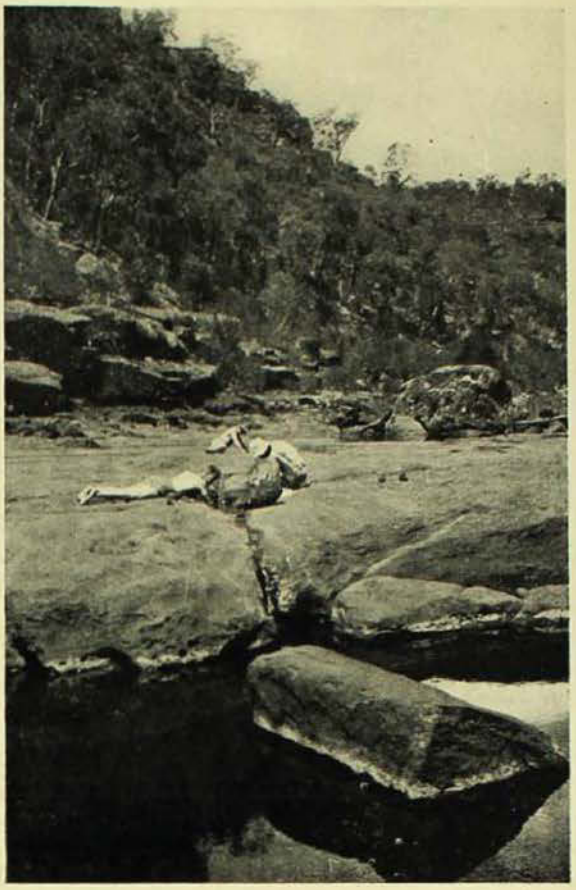
with two black marks on the side of the head. It is also found in Queensland and South and West Australia.

THE FRESH-WATER SHRIMP.

But the most interesting of our discoveries was the finding of a new fresh-water shrimp (*Atya striolata*), which was described by my friends McCulloch and McNeill from specimens

collected on one of our holiday trips to this locality[1]. The genus *Atya* previous to our finding it at Norton's Basin, was not known from Australia, but had been recorded from the West Indies, Africa, Indo-Malaysia and the Pacific Islands. These shrimps occur only in running water and in localities where there are stones for them to hide under. They seem to have an aversion to any but clean water and the majority of our specimens were taken by stirring up the sediment at the bottom of a small pot-hole from which we had removed the stones. We had previously stretched a cheese cloth barrier across the only outlet from the pool and, as each shrimp endeavoured to leave the disturbed water, it was trapped and secured with a hand net together with small fish, and specimens of *Paratya australiensis*, an allied species. Though we tried the same tactics at adjacent pools we were unsuccessful, and all the specimens of this rare crustacean came from the one little pot-hole.

Besides being exclusive in its haunts, this shrimp has some very remarkable habits. It is able to swim forward through the water with an even movement, and it is only in matters of extreme emergency that it jerks itself backwards by flexing the abdomen in the usual manner of shrimps. As they left freely a shallow dish of water by crawling over its side one is led to believe that this habit is associated with their migration from one pool to another when drought conditions cut off the running water.

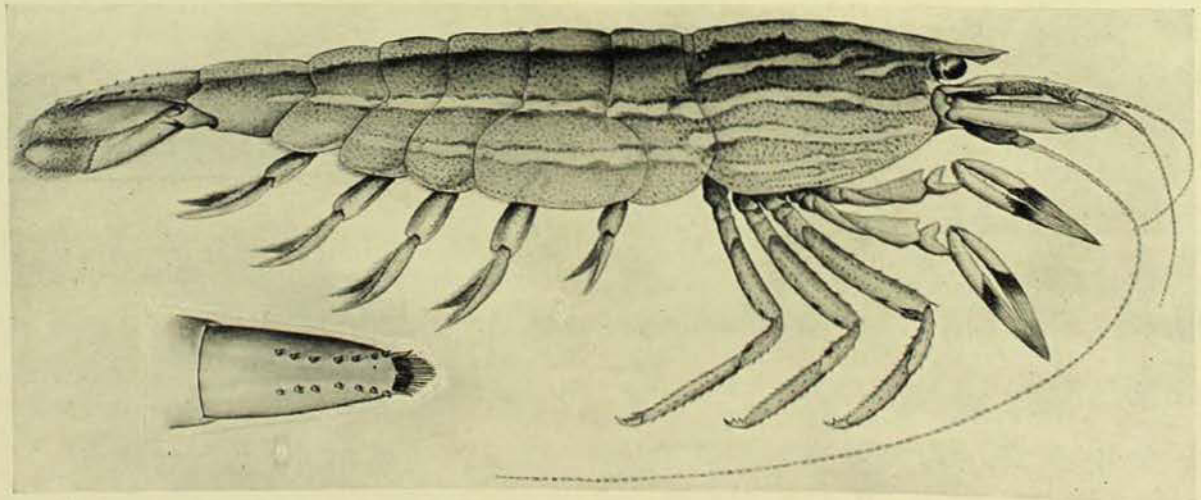


Messrs. Troughton and McNeill collecting Fresh-water Shrimps near Norton's Basin, the pot-hole into which they are looking was the only one in which the Atya occurred.

[Photo.—*A. Musgrave.*

An interesting feature about the members of this genus is the structure of the pincers

[1] McCulloch and McNeill—*Rec. Austr. Mus.*, Vol. XIV., No. 1, 1923, pp. 55–57.



The Fresh-water Shrimp, Atya striolata, known only from specimens collected by us at Norton's Basin, Nepean River. The front pair of legs show the pincers closed and the long hairs grouped into a pointed brush.

[*A. R. McCulloch*, del.

(or chelae) on the first and second legs. These are provided with thick tufts of hair which, when the pincers are closed, are like a wet camel's-hair brush from which surplus water has been pressed out to leave a pointed tip. An American naturalist, Dr R. P. Cowles has given a very entertaining account of the manner in which these pincers are used. He noticed that the species of *Atya* that occur in the Philippines had a preference for running water like our own species, but he also noticed that it always clung to some object and then arranged its body to point upstream, and with the first and second pairs of legs thrust out. Then the pincers were opened and the hairs of the tufts spread out so as to make a funnel-shaped strainer with the wide opening directed towards the stream. Each pincer has two strainers or eight for the entire animal. When a pair of strainers has collected a sufficient quantity of food, the pincer is closed and the hairs grouped together into a single brush. " Then the chela turns backwards on its basal end, and finally the brush of hairs is applied to the mouth where the food is extracted." This action of passing the food into the mouth is performed with great rapidity occupying less than half a second, " and when it is completed the chela returns to its former position and opens, and the strainer begins to perform its function again."

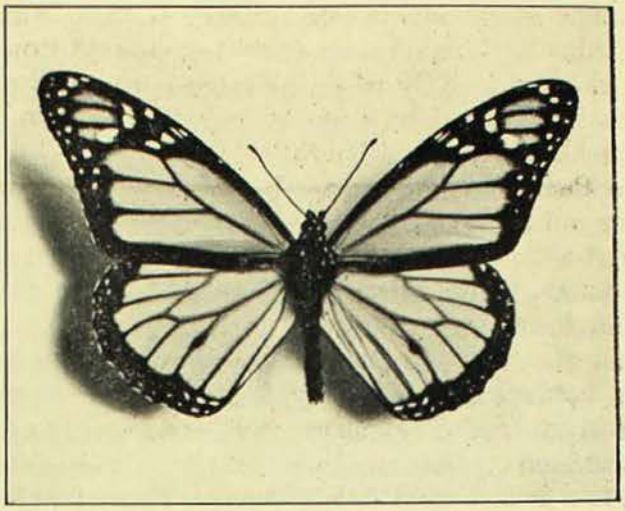
And thus the clever shrimplet sits with widely
gaping claws,
A-snaring little animiles within its hairy paws.

THE INSECT LIFE.

The wooded hills and tranquil waters make the river an entomologist's elysium. Among the cotton weeds on the bank opposite Sandy Cave, numbers of the Wanderer Butterfly (*Danaida archippus*), may often be seen lazily flying overhead or clinging to and depositing their eggs on the leaves. On the Leptospermum bushes near Norton's Basin, many insects attracted by the honey in the flowers have been secured by us, and some have proved to be new species, while in the river itself occur many interesting forms or their larvae.

It is only natural that such water-loving insects as may-flies should visit our camp.

One evening while we were having our meal we were suddenly plagued by numbers of these insects, which came flying out of the

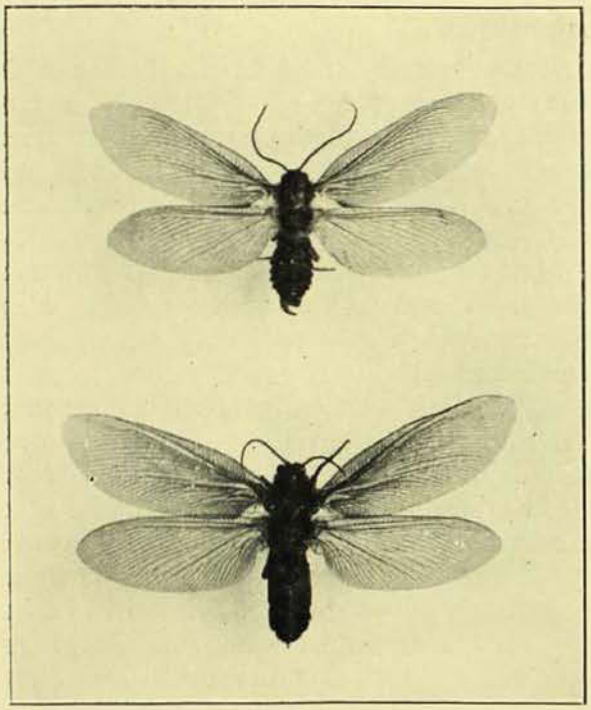


The Wanderer Butterfly, Danaida archippus, an American species which, in recent times, has circumnavigated the globe.
[Photo.—*A. Musgrave.*

night into the little ring of light thrown by our acetylene lamp and candles, to dash themselves against the glass of the lamp or to be burnt or become enveloped in stalactites of candle grease. With them came moths, beetles, and flying ants, and, to my great delight, a few specimens of the Moth-Lacewing, (*Ithone fusca*). This was the first occasion of our meeting with this comparatively rare insect, which hitherto had been recorded from the sandy regions bordering the coast, such as one finds at Woy Woy. It has, however, been found by Mr. Luke Gallard at Epping near Sydney breeding in hard soil, and specimens are in the Museum from Coogee secured by Mr. McNeill of our staff. This insect has only recently fluttered into the limelight of scientific study, and its habits and life history have been made known through the investigations of Dr. Tillyard of the Cawthron Institute of New Zealand[1], but as this information is, for the most part, known only to the student of entomology, a few facts about this interesting insect may be appreciated. The female moth-lacewing lays from 200 to 300 eggs in the soil which she digs up by means of a plough-like organ at the end of her body. When nearly a month has elapsed the larvae emerge from the eggs, and are ready to hunt for the beetle larvae on which they feed. The *Ithone* grubs so closely resemble the white grubs of the beetles upon which they live that Dr. Tillyard on digging them out of the ground

[1] Tillyard—*Bull. Ent. Res.*, XIII., pt. 2, Aug., 1922 pp. 205 223.

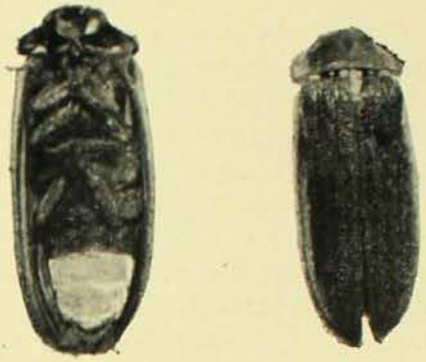
threw them away, not knowing they were the larvae of the insect that he was looking for. It was only when he later succeeded in rearing from the eggs a number of these scarabaeid-like grubs that he realised what he had done some years before. The *Ithone* grubs can be distinguished by the odour of citronella they emit ; the beetle grubs being without any odour. The *Ithone* larvae remain in the grub stage for nearly two years, and at the end of this time they are ready to form cocoons in which to pass their pupal stage. The cocoon is very similar in appearance to that made by many wasps and in it the insect spends six weeks, three in the larval stage and three in the pupal.



The Moth-Lacewing, Ithone fusca, a visitor of the twilight, whose life story has only recently been told.
[Photo.—*A. Musgrave*

Dr. Tillyard has stated that the adults emerge "just about sundown, during the fortnight from the end of October to the middle of November," but our specimens were secured in December.

After the sun has set, the moth-lacewings become very agitated and finally take flight, the females flying about for a while and then settling on tree trunks while "the males dash hither and thither," and according to Dr. Tillyard assemble in swarms around the females. We did not see the *Ithones* in any numbers on the Nepean and we possess only three specimens from this locality, two females and a male. Dr. Tillyard's observations were made chiefly at Woy Woy.



The Fire-fly Beetles of the Nepean (much enlarged). The beetle on the left shows the under-surface with the luminous organs at the hind end of the body.
[Photo—*A. Musgrave.*

FIRE FLIES.

One of the most charming sights witnessed on any of our trips to the river occurred one November evening while we were returning cave-wards from the Warragamba River. At the junction of the Nepean with the Warragamba a number of fire-flies were flitting about, the dark scrub behind showing up the beauty of their fairy-lights. The light from the luminous organs of these tiny beetles appeared to be intermittent, resembling in miniature the revolving lights familiar to mariners. This glittering effect was apparently due to their disappearing behind trees or bushes, as specimens caught showed the light to be continuous. Some flew down the river bank, where one unfortunate fell into the stream, his little luminous organ betraying his whereabouts as he bobbed up and down on the surface of the water. Not having any collecting gear with us we rowed to our camp and secured a net and tubes, but on returning half an hour later only a few individuals were to be seen flying about, the majority having taken refuge among the grass. I scrambled up the steep bank, and after some searching with the aid of a torch, succeeded in capturing four specimens, which proved to be a species of *Atyphella*.

By the time I had secured my last victim, the moon was well above the hill, the long shadows cast by the casuarinas were growing shorter and as "the lightnin' bugs in dew was all squenched away," we dipped our oars and returned to the cave.

Raining Fishes.

By A. R. McCulloch.

"RAINING cats and dogs" is merely an exaggerated phrase in common use to describe particularly heavy downfalls, and would mislead nobody into the expectation of finding numbers of these animals lying around loose, even after a cloud burst. And so conservative are most of us that information to the effect that it was raining shrimps and little fishes would leave us wholly unconvinced. Add to this a suggestion that a few frogs had likewise descended from the clouds and all but the most gullible would gladly put the dog on to one's informant. Which is why I am somewhat diffident in suggesting that under certain conditions, shrimps, fish, and frogs may be showered upon us, and that such occurrences may be more common than one might at first suppose.

The following letter recently forwarded to the Director of the Museum, together with some of the fishes referred to, sheds some light upon the subject :—

"Gulargambone,
N. S. Wales.

"Dear Sir,

"I am forwarding by to-day's mail, a bottle containing three small fish which were found in the gutters and on the streets here, with hundreds of others after recent heavy rain. Will you be good enough to let me know to what species they belong, whether they are salt or fresh water fish, and your opinion as to their origin.

Yours faithfully,
F. Richards."

An examination of the specimens forwarded by Mr. Richards, shows them to be small fresh water gudgeons (*Carassiops klunzingeri*), which species is very common in streams and waterholes in western New South Wales, and southern Queensland. A very closely related species, *Carassiops galii*, which is common around Brisbane and known to boys as the "Fire Tail" has also been recorded as participating in aerial escapades. In March 1906, the celebrated ichthyologist, Mr. J. D. Ogilby, exhibited specimens of this little gudgeon which were said to have come down during a heavy thunder storm in large numbers on Mildura Farm at Cooper's Plains. One of them not only survived its perilous journey through the air, but was alive and kicking even after spending twelve hours, corked up in a small medicine bottle in its captor's pocket. Again, in August, 1901, Mr. E. G. W. Palmer, exhibited before the Linnean Society of N.S.W. still another gudgeon, *Philypnodon grandiceps*, which had fallen in a shower of rain at Warwick, Queensland.

So much for showers of fish. Now for a little shrimping. In the issue of 1st August, 1918, *The Sydney Morning Herald*, published an account of a downfall of large numbers of shrimps near Singleton, New South Wales, during a prolonged shower of rain. Some of these were later submitted to us for identification, and were found to be *Paratya compressa*, a very common inhabitant of almost all fresh waters in New South Wales.

It must be confessed that severe frog-storms have not been recorded in Australia so far, though obviously, the conditions which render aerial transportation of fishes and shrimps possible will serve equally well to give small batrachians, or at least their tadpoles, a fly. In a splendid article appearing in a recent number of the *Journal of the American Museum of Natural History*, Mr. E. W. Gudger has collected accounts from many sources which tell of the descent of fishes and even frogs after heavy downpours. Further, he shows that these extraordinary happenings may take place anywhere, and that even marine fishes have been dropped from the skies in other parts of the world.

What is the explanation of such extraordinary occurrences? The authorities quoted in Mr. Gudger's article almost unanimously believed that the fish were caught up by whirlwinds or even waterspouts, and after being carried some distance, were dropped upon the ground. A well known ichthyologist, Count de Castlenau, was fortunate enough to be in the centre of a fish-storm at Singapore, during the year 1861, and he published some very illuminating facts concerning it. To discountenance suggestions that the fish had merely been left upon the ground by

overflow waters of some flooded stream, he wrote "As they lay in my courtyard, which is surrounded by a wall, they could not have been brought in by the overflow of a torrent, nor is there any considerable one in the neighbourhood."

In the issue of the *Herald* quoted above, there is appended a statement by Mr. D. J. Mares, Divisional Commonwealth Meteorological Officer, who said it was quite possible under unstable atmospheric conditions for local whirlwinds to develop which might lift portions of a water surface in which they moved. He thought also that it was quite likely that small fish or any other small animals could be thus transported from one district to another, and he added that the Weather Bureau had received reports of another shower of small fish which had fallen at Quirindi.

Though one is naturally reluctant to accept too readily tales of fish, frogs and shrimps being lifted out of their homes in some billabong or shallow stream for transportation by whirlwinds to some neighbouring flat, there seems to be abundant evidence to prove that this is actually what happens. The power of willy-willies in the western districts is well known, and those familiar with their severities will have less difficulty in accepting the explanation than easterners who are accustomed to less boisterous breezes. It is probable, however, that they hustle some of the smaller inhabitants of the inland plains quite a lot, and are probably largely responsible for the dispersal of various fresh-water animals over the greater part of Australia, west of the divide. Unless they be wind-borne, it is difficult to understand how such fishes as the Banded Grunter (*Therapon percoides*), and the fresh-water Hardyhead (*Craterocephalus fluviatilis*), can have crossed the innumerable interspaces of desert separating the various water-systems they are known to inhabit. Assume that they have been unwilling passengers, however, travelling by way of a brief aerial route across some otherwise impassible barrier, and the mystery of their distribution disappears. Obviously only a small proportion of those forced to make such a perilous journey can hope to descend unharmed, and at the same time sufficiently near a watercourse to re-enter their element. But a few fortunate ones which survive and manage to establish themselves in a stream or lagoon not previously inhabited by any of their kind, inadvertently become as frontiermen or pioneers of their race, extending, as they do, their activities into fresh streams and waters new.

An event of importance to biologists and nature lovers took place at the National Park on Saturday, March 21st, when in the presence of a distinguished gathering the Hon. C. W. Oakes, Chief Secretary, formally handed over to the Royal Zoological Society of New South Wales a cabin and cottage which are to be used as bases for a biological survey of the Park. Dr. G. A. Waterhouse, President of the Royal Zoological Society, in accepting the cottage said that this biological station was the first of its kind in Australia and he and Professor Launcelot Harrison, who is in charge of the survey, spoke hopefully of the work which will be accomplished. The members of the National Park Trust, and especially their chairman Mr. Frank Farnell, have earned the thanks of all who are interested in biological research and are to be congratulated on the fine public spirit they have shown in providing a home for those who wish to observe and study the animals and plants of the National Park, which is an exceptionally interesting area from a zoological and botanical point of view.