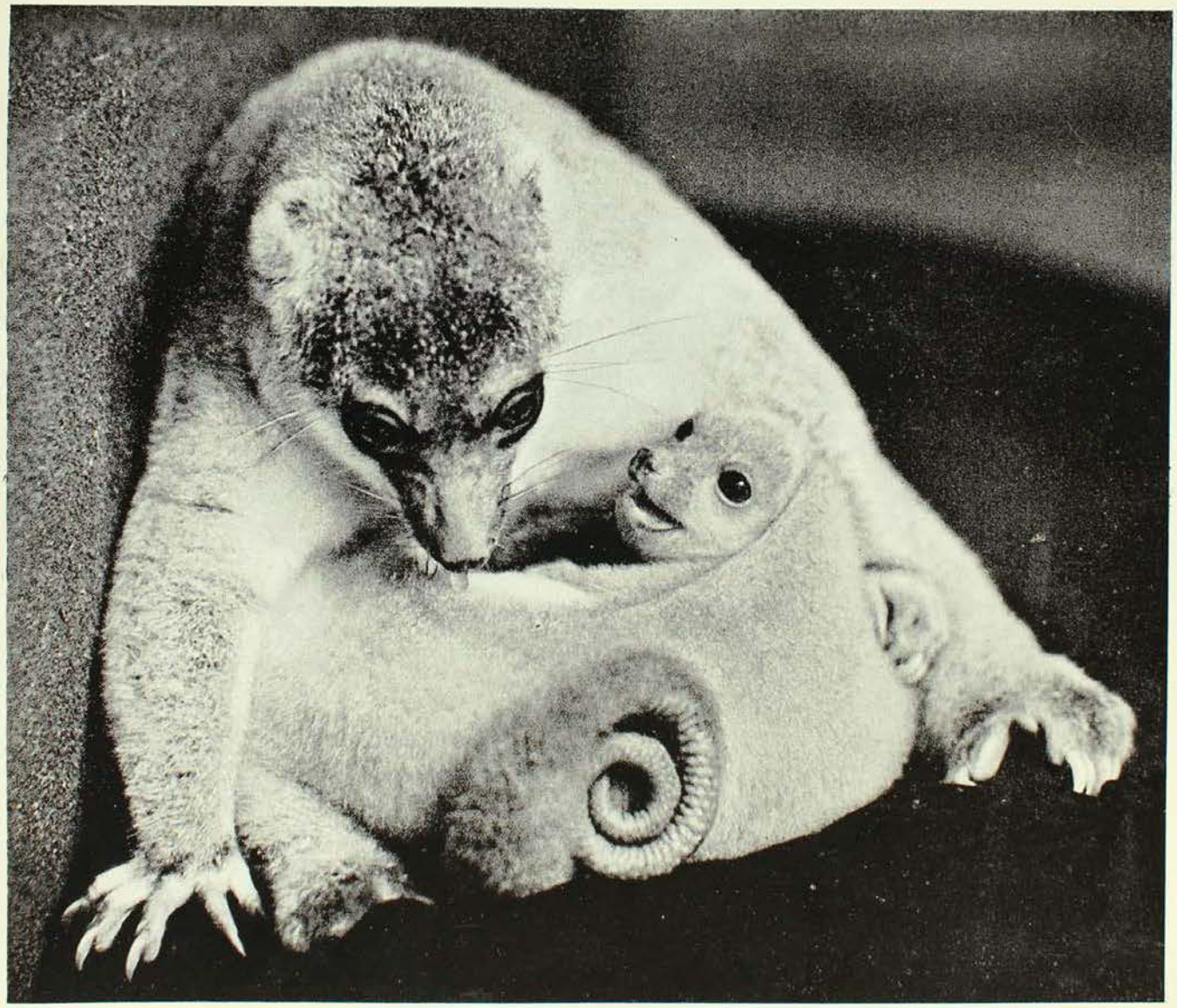
The AUSTRALIAN MUSEUM MAGAZINE

VOL. XII, No. 5 Price—TWO SHILLINGS



The Cuscus or Phalanger-Possum represents the largest members of the family of Australian possums. They inhabit Cape York Peninsula and New Guinea.

Registered at the General Post Office, Sydney, for transmission as a periodical

THE AUSTRALIAN MUSEUM

HYDE PARK, SYDNEY

BOARD OF TRUSTEES

PRESIDENT :
H. B. MATHEWS, B.A.

CROWN TRUSTEE :
H. B. MATHEWS, B.A.

OFFICIAL TRUSTEES:
THE HON. THE CHIEF JUSTICE.
THE HON. THE PRESIDENT OF THE LEGISLATIVE COUNCIL.
THE HON. THE COLONIAL SECRETARY.
THE HON. THE ATTORNEY GENERAL.
THE HON. THE COLONIAL TREASURER.
THE HON. THE SECRETARY FOR PUBLIC WORKS.
THE HON. THE MINISTER OF EDUCATION.
THE AUDITOR-GENERAL.
THE PRESIDENT OF THE NEW SOUTH WALES MEDICAL BOARD.
THE SURVEYOR-GENERAL AND CHIEF SURVEYOR.
THE CROWN SOLICITOR.

ELECTIVE TRUSTEES :

PROF. A. N. St. G. BURKITT, M.B., B.Sc.
FRANK B. SPENCER.
O. G. VICKERY, B.E., M.I.E. (Aust.).
WALLACE C. WURTH, C.M.G., LL.B.
PROF. A. P. ELKIN, M.A., Ph.D.
F. McDOWELL.
R. J. NOBLE, M.Sc., B.Sc.Agr., Ph.D.
E. J. KENNY, M.Aust. I.M.M.
F. L. S. BELL, M.A., F.R.A.I.
FRANK W. HILL.
G. A. JOHNSON.
PROF. P. D. F. MURRAY, M.A., D.Sc.

DIRECTOR :
J. W. EVANS, Sc.D.

ASSISTANT TO THE DIRECTOR :
H. O. FLETCHER.

SCIENTIFIC STAFF :

Birds, Reptiles and Amphibians: J. A. KEAST, M.A., M.Sc., Ph.D., Acting Curator.
Mammals and Skeletons : E. Le G. TROUGHTON, F.R.Z.S., C.M.Z.S., Curator.
Fishes : G. P. WHITLEY, F.R.Z.S., Curator.
Insects and Arachnids : A. MUSGRAVE, F.R.Z.S., F.R.E.S., Curator ; D. K. McALPINE, B.Sc., Assistant Curator.
Molluscs: D. F. McMICHAEL, M.A., Ph.D., Acting Curator.
Crustacea and Other Groups : F. A. McNEILL, Curator ; ELIZABETH C. POPE, M.Sc., F.R.Z.S., C.M.Z.S., Assistant Curator.
Minerals and Rocks : R. O. CHALMERS, A.S.T.C., Curator.
Fossils : H. O. FLETCHER, Curator.
Anthropology: F. D. McCARTHY, D.p.Anthrop., Curator.

EDITORIAL ASSISTANT AND PUBLIC RELATIONS OFFICER:
MARGARET W. FRASER.

EDUCATION OFFICER :
PATRICIA M. McDONALD, B.Sc., Dip. Ed.

LIBRARIAN:
JUDITH GOODWIN, B.A.

DEPARTMENT OF PREPARATION:
H. HUGHES, A.R.P.S.

DEPARTMENT OF ART & DESIGN:
F. J. BEEMAN.

HONORARY SCIENTIFIC STAFF :

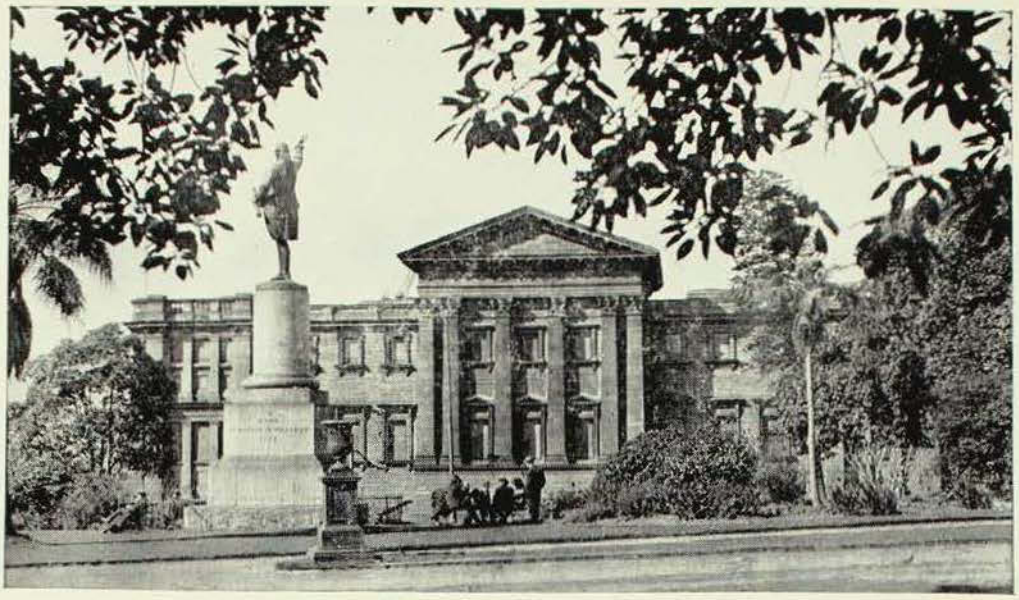
Zoologists.
E. A. BRIGGS, D.Sc.
H. LEIGHTON KESTEVEN, D.Sc., M.D.
MELBOURNE WARD, F.R.Z.S., F.Z.S.
TOM IREDALE.
A. J. MARSHALL, D.Sc., D.Phil.
JOYCE ALLAN, F.R.Z.S.
S. J. COPLAND, M.Sc.

Ornithologist.
K. A. HINDWOOD, C.F.A.O.U., F.R.Z.S.

Archaeologist.
Prof. J. L. SHELLSHEAR, M.B., Ch.M.

Numismatist.
G. C. HEYDE, A.S.T.C., F.R.N.S.

Philatelist.
FRANK W. HILL.



THE AUSTRALIAN MUSEUM MAGAZINE

(Photography, unless otherwise stated, is by Howard Hughes, A.R.P.S.)

OUR FRONT COVER.—This Cuscus was bred in captivity at Cairns. It represents one of the two species inhabiting Cape York Peninsula. Several brightly coloured phalanger-possums inhabit New Guinea, where they are also known by the ative name "kapoule". Distinguished from ring-tail possums by having the outer half of the tail entirely surrounded with rasp-like skin, the general appearance has led to misleading reports of monkeys inhabiting Cape York. Food consists of foliage, native fruits, and smaller animals.

Photo.—H. Chargois, F.R.P.S.

Vol. XII, No. 5 MARCH 15, 1957

THE AUSTRALIAN MUSEUM MAGAZINE

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

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

VOLUME XII, NUMBER 5 MARCH 15, 1957

A Kennel of Frogfishes

By G. P. WHITLEY

FROGFISHES are so-called for obvious reasons; they are squat, rather tadpole-shaped, smooth-skinned fishes with frog-like heads and they can even croak like a frog. This noise is made by rapidly contracting and expanding the muscle of the swim-bladder and can be heard from a considerable distance. During World War II, when particular attention was paid to submarine noises, Frogfishes were found to be the noisiest animals in the sea, one American species giving out during the breeding season an intermittent low-pitched "boop" resembling a boat whistle, a shriller blast than its usual coarse grunts of warning and alarm.

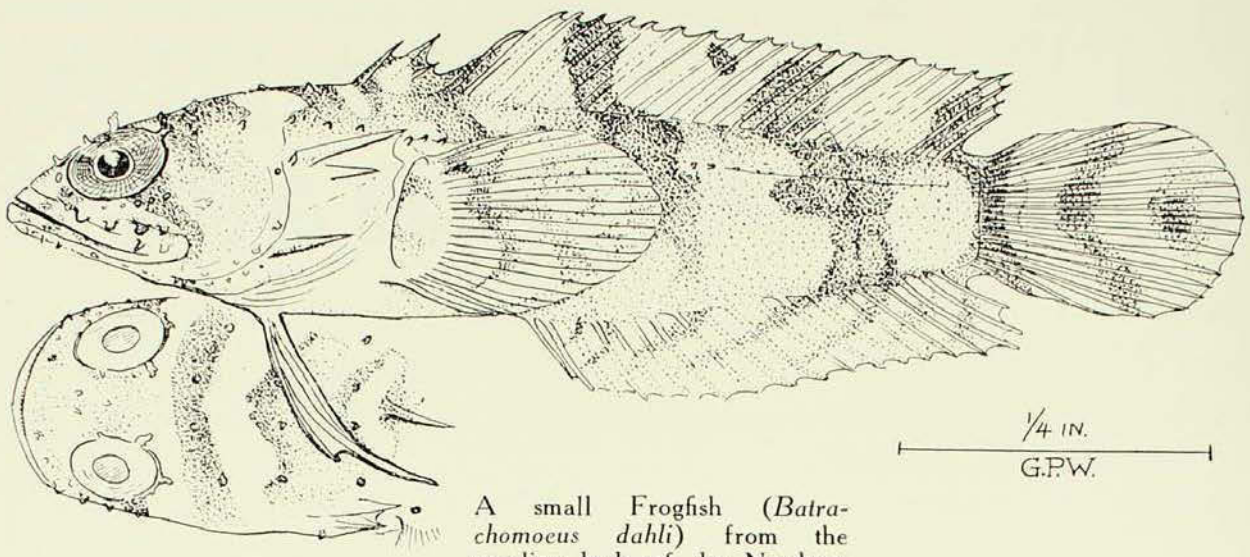
Lighthouse-keepers at Point Charles, near Darwin, reported a Frogfish (*Halophryne diemensis*) known to the Aborigines as Wirrarook: "The peculiarity of this fish is that it gets left by the tide under rocks with little water, and emits a cry like the roll of a kettle drum, which can be heard at a great distance."

Darwin fishermen regard Frogfishes as a bad omen as they take the baits when the snapper (*Lutjanus*) leave off biting, so, after removing the Frogfishes with pliers, the fishermen shift to another ground.

Frogfishes are found in all warm seas from the shoreline down to near the edge of the continental shelf. Sometimes they are left stranded, high, and almost dry, by the tide, when their grunting may betray them. Odd ones may thus be encountered in Sydney Harbour. John White in 1790 was the first to illustrate one of ours. He called it the "doubtfull Lophius" (*Lophius dubius*, nowadays *Batrachomoeus dubius*). The classic *Lophius* is the European Angler Fish or Fishing Frog, the *batrachos* of the Greeks, and the family to which our Frogfishes belong is called the Batrachoididae.

Other early illustrations of Frogfishes are those of Maregrave (1648) of an American one, and Renard's illustration of a "Fer a Gauffres" (waffle iron!) from the East Indies, published about 1718.

In captivity Frogfishes are more gregarious than they seem to be along the shoreline. They like to gather in rocky grottoes in an aquarium and lie with their heads poking out, like a dog in a kennel, and they sometimes lie in groups on top of one another, hence a "kennel" of frogfishes is an appropriate collective noun.



A small Frogfish (*Batrachomoeus dahli*) from the pearling beds of the Northern Territory.

What we call Frogfishes are known in the United States as Toadfishes. In the New York Aquarium an "unnatural natural habitat" has been provided for the toadfishes (*Opsanus tau*) which were given a pair of old shoes, a tin can, and a broken bottle in their tank to make them feel at home,[1] and they use these as kennels and for nests. Atz thought it safe to say that "the arrival in North America of the white man—with his crockery, his glass and metal ware, his building materials and all the other paraphernalia of his civilization—was the beginning of the greatest real estate boom in the history of the Toadfish tribe".

Frogfishes can creep along mud at low water with their stumpy ventral fins and John Gilbert[2] remarked of *H. diemensis*, "It is very difficult to capture, for on the slightest appearance of danger it plunges down instantaneously". Several old explorers of tropical Australia (Cook in 1770, P. P. King in 1821 and George Grey in 1838) mention fishes which progressed over mud, like amphibia, but their accounts seem to me to refer to Mud-skippers (Periophthalmidae) rather than to Frogfishes or *chironectes* as they called them.

Frogfishes are very slimy and the remarks of one old author[3] have a quaint sound now: "This mucous vesture facilitates their movements, when gliding amongst Gorgonia, or over the surface of rocks, and serves also to mitigate the effect of the concussions which they receive, when impelled against solid objects by the violence of the waves."

Sir Edward Hallstrom has informed me that a local Frogfish is exhibited at Taronga Park Aquarium, Sydney, where they have also had specimens of a more ornamental New Guinea species; but these fishes squirt out a liquid or slime which fouls the water and kills other fish. Some species have a pore in the pectoral axil or "armpit", the function of which is unknown, though it resembles the poison gland of catfishes. When annoyed, Frogfishes may erect spines on the side of the head and the three spines of the front dorsal fin. These spines are said to be venomous, so Frogfishes are sometimes called Bastard Stonefish and handled cautiously. The true Stonefish, however, has thirteen (not three) dorsal spines and is much more dangerous.

The colour of Frogfishes resembles the weedy rocks they inhabit, being brown, green or mottled and capable of some change to harmonize with their surroundings. The skin is thrown up into fronds and tentacles like weeds.

[1] According to James Atz, *Anim. Kingdom* 56, 1953, p. 73 & figs., including a cartoon from the *New Yorker Magazine*.

[2] In Richardson, Ann. Mag. Nat. Hist. xi, 1843, p. 352.

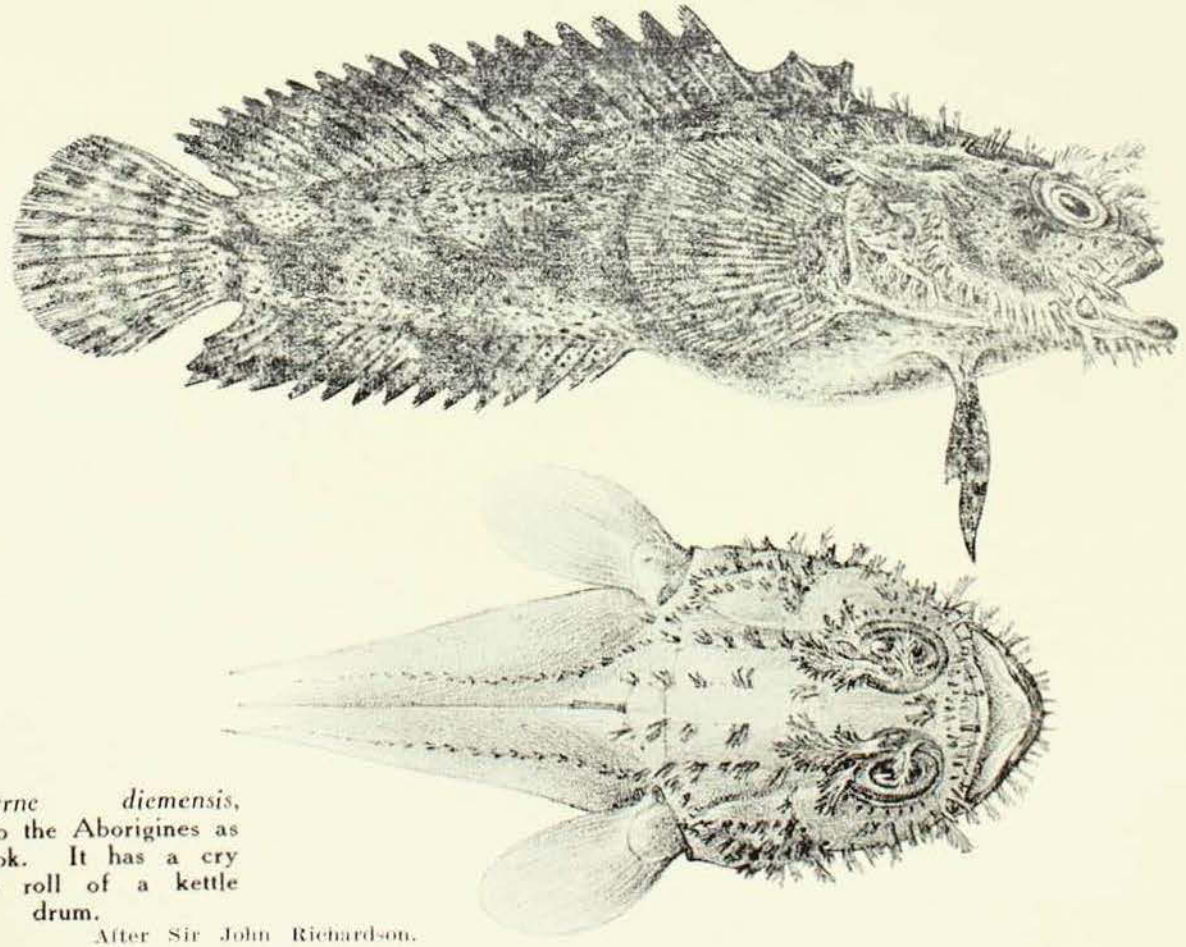
[3] Le Sueur, Journ. Acad. Nat. Sci. Philad. iii, 1823, p. 397.

There are five Australian species, the best-known being *Batrachomoeus dubius* from New South Wales, Queensland, Papua and Western Australia; the handsome *B. broadbenti* which has already been figured in this Magazine,[4] and the largest species (at least 11 inches long) from our tropical northern waters, *Halophryne diemensis*, whose specific name was originally given under the erroneous impression that it had come from Van Diemen's Land. A technical monograph on our kinds was written many years ago by Ogilby,[5] since when Scandinavian scientists have made known an additional species from our northern pearling-grounds. This species (*Batrachomoeus dahli*) is here illustrated for the first time. The fifth species, *B. striatus*, from Cape York, has not been recognized since it was first described in 1875. Important characters for classifying Frogfishes are the presence or absence of a pore in the pectoral "armpit", the nature of the teeth in the jaws, and the tentacles or fronds on the head and body, and the numbers of rays in the fins.

Frogfishes are carnivorous, darting out with unexpected speed on any small fish, crustacean, or mollusc which may come near them; at times they have been guilty of cannibalism. They are themselves good to eat. I have enjoyed fried fillets of their white flesh, although this plebeian fish is, according to an old-fashioned American author, "never admitted to the tables of the well-to-do, if by any persons. Nevertheless . . . its flesh is highly esteemed by many of the Gulf fishermen; these, it may be urged, are mostly ignorant blacks". I always suspected that I was bourgeois; my liking for Frogfish proves this.

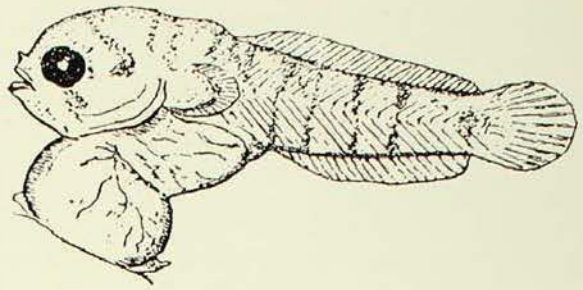
Frogfishes lay masses of rather large (for fish) eggs, which are attached to rocks, stones, the insides of bivalve shells or other objects. They have bred from time to time in Taronga Park Aquarium, but feeding the newly released young has so far proved an insuperable problem.

[4] Vol. x, no. 10, June 1952, p. 311, fig.
[5] Ogilby, Annals of the Queensland Museum, no. 9, 1908, pp. 39-57.



Halophryne diemensis, known to the Aborigines as Wirrarook. It has a cry like the roll of a kettle drum.
After Sir John Richardson.

The number of eggs in the female is not large, from 35 to 62 in either ovary having been counted in Australian species, which apparently breed in the later months of the year (September to December). The eggs are glued to their support by a small disc. The young do not attach themselves by a ventral disc which soon disappears, as has been supposed, but, after hatching, still remain attached by the adhesion of the yolk-sac to the inside of the egg membrane over the sticky disc-area until the yolk has been absorbed, a period of three or four weeks in an American species. The number of eggs in "clutches" is very variable, and ranges, according to the American authority, E. W. Gudger, from only 22 in a *Pinna* shell to more than 700 on a piece of board. One fish can hardly lay more than 100 eggs at one time, so that, like domestic fowls, Frogfishes must use a common nest. Indeed, one observer goes further and says, "When its young have been hatched, the older fish seems to guard them, and teach them the devices of securing food in much the same manner as a hen does her chickens". This guarding of the eggs is done by the father fish.



A newly-hatched American toadfish showing the large yolk-sac on which it feeds still attached by a sticky disc to the rock on which the egg from which it came was laid.

After Ida Mellen.

We have much to find out about the life-histories of our Australian Frogfishes, which show intelligence above the ordinary mass-monotony of the general run of fishes.

Nature Quiz

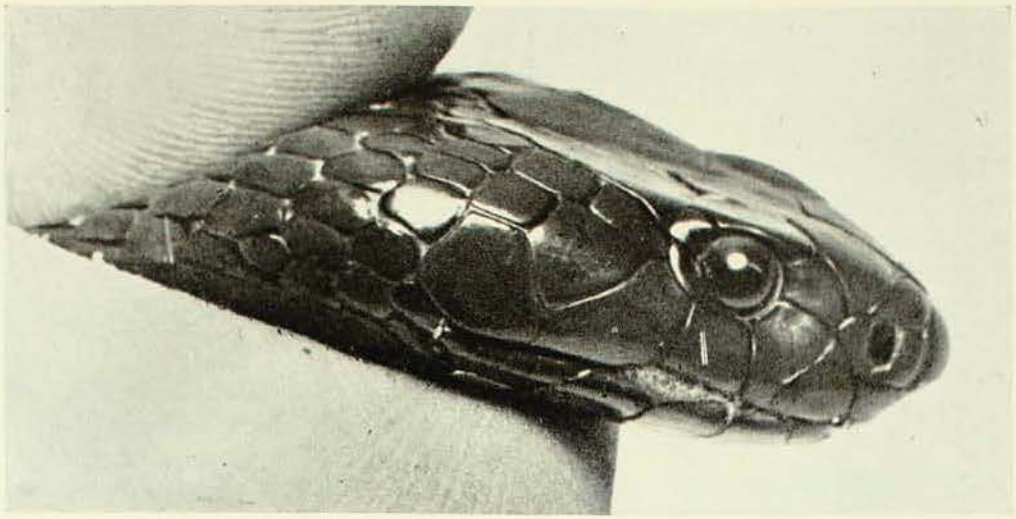
Q. Is the fish called Groper in New South Wales identical with the Queensland one of the same name?

A. There is a vast difference between these two fishes and the case demonstrates the insecurity of common or popular names. By habit both fish are certainly gropers over the sea floor but they belong to entirely different families. The Queensland Groper (giant of the two) grows to seven feet and more in length and can weigh hundreds of pounds. It is a member of what is recognised locally as the cod family, and related to the Black Rock Cod, the Wirrah, and the Coral Cod of our tropical reefs. On the other hand the New South Wales Groper is a member of a parrot fish family. It is sometimes more specifically named Blue Groper but even this is misleading. At times the colour is distinctly a reddish-brown and the two hues have been claimed to define the sexes. In contradiction to this, however, some individuals have a mottled pattern of both blue and reddish-brown. Large examples commonly weigh as much as 35 to 40 lb. and grow to a length of about four feet. The same species also occurs in Western Australia, where it is usually of a greyish colour.

Q. Is the famed call of the Whipbird of eastern Australia made only by the male of the species?

A. This vexing question is a perennial one, causing much conjecture and argument. It has, nevertheless, been completely answered by a number of competent observers who have made a life study of birds in the wild state. They have not only studied the bird calls at extremely close quarters but have seen both the male and female contributing their separate notes. The common practice is for the male to utter the loud explosive "crack", and the female the double terminal note, following in perfect synchronization. On occasions, however, the one bird (presumably the male) will utter the complete call.

As with other birds who forage amongst dense vegetation, the Whipbird call is used to signal whereabouts, so that pairs and others of the same species can keep in close proximity.



Head of the Black Snake, *Pseudechis guttatus*. This snake is a close relative of the Red-bellied Black Snake (*P. porphyriacus*). Contrary to popular belief the venom of Black Snakes is relatively mild, being only slightly neurotoxic, in contrast to the venoms of Tiger and Brown Snakes, the Death Adder and others.

An Apology for Snakes

By C. W. BRAZENOR
Assistant Director, National Museum of Victoria

MAN'S hatred of snakes dates from the earliest times and is recorded in the Bible and in myths and legends; it is still expressed in the strongest terms in contemporary writings. Nor is it confined to civilization, for the sight of a snake arouses in the wildest aborigine the same mental disturbance as occurs in the intellectual city-dweller. Civilized men no longer "know" nature, but as a rule the native races share their existence with animals and have more than a passing knowledge of animals' behaviour and habits. It is strange, in these circumstances, that seldom does the native distinguish between the harmful and the harmless snake; with fatalistic outlook he is as ready to die from a non-venomous bite as from a deadly one.

It is not my intention to suggest for one moment that snakes are pleasant playmates. They should be given a very wide berth and granted no liberties whatever. I do suggest, though, that much of the fear and hatred that is so universally shown for them is largely due to a misunderstanding of their physiology and habits.

Snakes are very specialized animals and their most notable external modifications are the complete loss of limbs and the great elongation of their bodies. Little is known about when and how this happened, for palaeontological evidence is meagre, but for the practical experience of living, these modifications place them under a number of very real disadvantages. Lack of legs, for instance, slows down snakes in their pursuit of prey, for contrary to widespread belief few snakes can reach a speed of four miles an hour. Then if one considers the important function that hands and feet play, amongst other vertebrates, in securing food, the disadvantages of footlessness become very evident. They are also cumulative, for not only must the prey be caught and immobilized by the unaided use of the snake's jaws, but in the absence of any means of dismemberment, it must be consumed whole. Following the swallowing of a complete animal, covered with a tough and fur- or feather-covered skin, very powerful and fast working digestive juices are called for in order to prevent the decay and fermentation of the body within the snake's alimentary canal. In fact, this sometimes occurs. Snakes feed only in warm weather and when a really cold change follows a meal, a snake's metabolic activity falls with the temperature. If the meal cannot be regurgitated the snake usually dies from food poisoning.

All these anatomical drawbacks are formidable but, on the other hand, nature is always fair. If she modifies in one direction she usually gives compensation in another; and so it is with venomous snakes. In this most specialized group not only are the gastric juices more powerful than those of other vertebrates, but one pair of salivary glands has assumed a very significant purpose. In other vertebrates these glands—called parotid and situated on each side of the throat—supply part of the saliva which lubricates the mouth. In venomous snakes they have attained large size and produce a powerful enzymic fluid, the venom, which serves several purposes. With the enlarged glands has developed a pair of enlarged teeth (fangs), situated on the maxillary bone, which are either grooved or canalized. The snake bites, and at the same time expresses this parotid fluid into the labial cavity. It reaches the base of the teeth and flows down the groove or canal to the deepest penetration of the tip, entering the blood stream of the bitten animal. So much for the mechanics of the system. The results are of great importance to the snake. In the first place the injection of venom quickly immobilizes the prey. Small mammals and lizards, which form the bulk of the food of venomous snakes, are usually immobile in a few seconds and dead in much less than a minute. The very toxic tiger snake usually bites and releases again, waiting till the prey is dead. Most of the other venomous species hold on, often receiving quite severe bites from mice and similar active prey. The brown snake bites and, with a corkscrew movement of its head and neck, constricts the prey for a short time in a series of coils, thus immobilizing it until the venom has taken effect. All species release the prey when dead and "nose" it until they get it into the right position for swallowing—head first.

Perhaps the most important function of venom lies in its strong digestive powers. Carried throughout the system of the bitten animal by the bloodstream, the venom commences the work of breaking down the walls of the blood vessels, laking the blood, and generally preparing the inner tissues of the prey for assimilation by the snake. In other words the venom immediately induces digestion from the inside before the gastric juices of the snake's stomach have penetrated the outer sheath of skin. In this way it speeds the process of assimilation.

The venoms of Australian snakes have four principal constituents, the quantum of each varying with the species. *Neurotoxin* is a nerve poison which has the curare-like effect of blocking the communication of nerve ends with muscle fibrils, thus causing muscular paralysis and asphyxia. This is the immobilising factor. *Haemorrhagin* attacks the walls of blood vessels, breaking down cells and causing internal haemorrhage. *Haemolycin* is responsible for the swelling and bursting of red blood corpuscles—called "laking" of blood. In conjunction with haemorrhagin it causes a serious lowering of blood pressure and heart dilation. These are the enzymic factors. *Thrombase*, a blood coagulant, is not, in Australian snakes, as important as the other constituents and some have little or none in their venom.

To return to the theme from which we started, there is, in nature, a reason for most things. The particular reason for the development of venom and a specialized biting apparatus in snakes is quite plain. It is not a sinister "horror creation" for the harassing of man, or, in fact, any of the larger animals, though it is toxic enough to be deadly, if somewhat slower, even for them. Rather is it a part of the snake's everyday need, created to overcome the disabilities of its peculiar form. Once in a long while a snake bites a man. So does a horse kick and a dog bite. In either case there would probably be no trouble were the animal unmolested and given a chance to retreat.

C. W. BRAZENOR joined the staff of the National Museum of Victoria, Melbourne, in London in 1924, and has been consecutively Articulator, Mammalogist, and since 1954, Assistant Director. He is the author of the Handbook "Mammals of Victoria" (1950) and his scientific papers on mammals and reptiles have been published in Australia and overseas.

An Archaeologist in Western New South Wales

By FREDERICK D. McCARTHY

THE north-western portion of New South Wales, west of the Darling River, is a vast area of country whose impression upon a visitor is apt to vary according to the kindness or otherwise of the weather. In rainy years the flat plains and rolling hills become an illimitable garden of yellow and white daisies, purple pea and red "hops", against the prevailing grey background of the trees and grasses, but in the dry years red sand and bare claypans (and in the north-western corner gibber plains), dominate the countryside as far as the eye can see. Mulga, gidgee and other acacias are dominant amongst the trees, but huge gums, with their roots sunk deeply into the sandy beds, form sinuous lines defining the numerous and mostly dry creeks. Low ranges and rocky hills, fresh and salt water lakes of varying sizes, also serve to break the monotony of scenery in which the rich purples and reds of early morning and late afternoon are striking features. The whole of this country is now occupied by sheep and cattle stations.

It is an intensely interesting and profitable region for the archaeologist because generations of Aborigines, belonging to some two dozen tribes, who lived and died in it have left behind many relics of their occupation. Most of these tribes possessed fairly large territories because of the comparatively barren nature of the environment, and each tribe's territory was further sub-divided into a dozen or so smaller areas each occupied by a local group or horde consisting of a man and his brothers and their sons, their wives and families, about thirty persons in all. The members of the local group lived together as masters of their own territory, and attended ceremonies with other local groups of the tribe when necessary. These tribes were organized into two moieties of two sections each, and a man or woman of one section married a spouse from a specified section in the opposite moiety. The wife always joined her husband's local group.

The river tribes had an abundant food supply in the cod, perch, bony bream, eels, tortoises and mussels in the river, and in the game and plant foods abounding along the shores. The bird life of the lakes also provided a valuable source of food to local Aborigines. The groups living in areas away from the rivers and lakes had a more difficult search for food in their drier terrain; they relied mainly upon the results of hunting by the men and on seeds (for dampers) and other plant foods collected by the women.

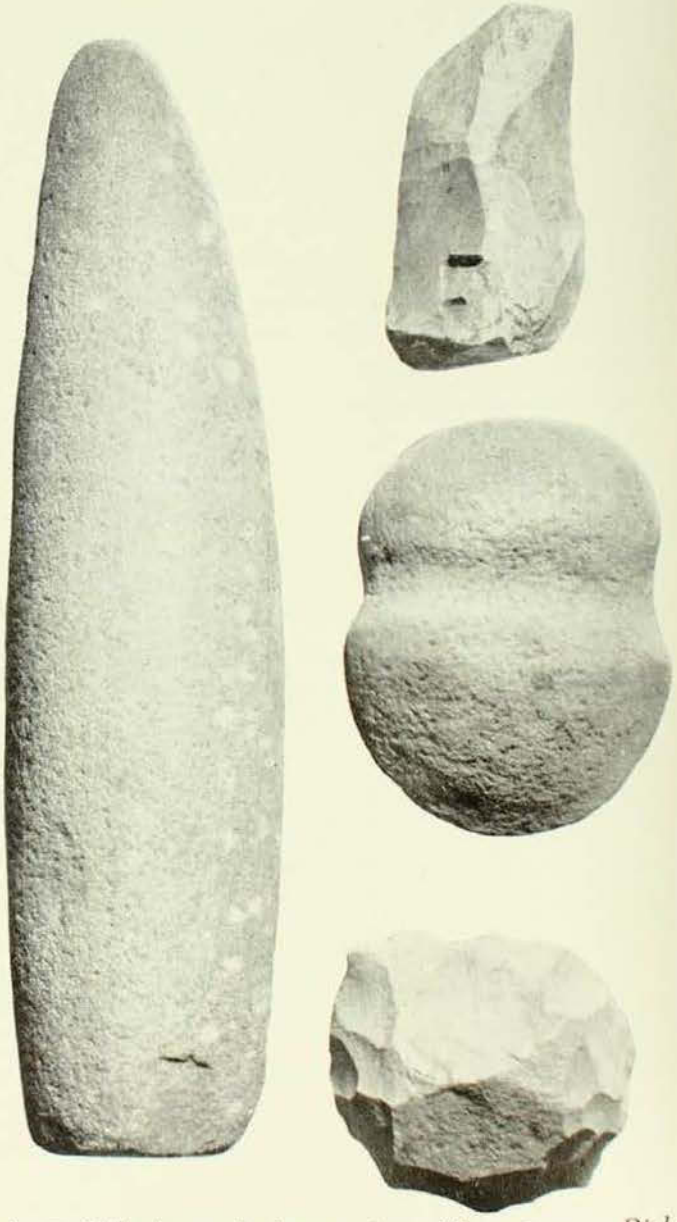
Throughout this region are to be seen the camp sites of these people, marked as a rule by heaps of burnt stones and lumps of ant-hill which formed the fireplaces. In cooking the kangaroos, emus and larger game, the stones and lumps were heated. Some were put into the body cavity of the animal and others were strewn over the body amid the ashes and hot sand for a few hours until it was cooked; it was cooked well if the people were not too impatient to eat, but underdone if they were very hungry. Fish and small animals were roasted on the hot ashes or baked under them, as were the dampers and yams. In the evenings the glowing camp fires formed gathering places for the separate families after the day's outing. Each family cooked its meals after the meat from a kangaroo, or the fish caught by the group, had been shared within the local group according to kinship rules. It is with a feeling of remorse that one visits these campsites which, to an anthropologist, are still permeated with the spirit of the former inhabitants who are now reduced to small groups living on the outskirts of townships such as Wilcannia and Tibooburra, and on the sheep stations.

The remains of aboriginal fireplaces in the far west are indicated by heaps of stones and lumps of burnt clay or ant heap. The Aborigines cooked animal and plant foods in their fireplaces and slept near them for warmth.

Photo.—Author.

On the old campsites an archaeologist may make a rich haul of stone implements, though axes are rarely found as they are easily recognised and most have been picked up years ago by drovers and station men. Many of the people now living in this part of the State have never seen a stone axe on their properties. The western axes are well made, commonly out of a buff coloured quartzite. Many of them bear a deep groove for hafting, and this kind is perhaps the most attractive axe type found in the west.

Cores and chipped flakes form the most numerous class of implements found on the campsites. They are not easy to recognise but after some guidance and experience their collection becomes a fascinating task. Most of them are made out of a white-to-cream stone called Greybilly, which forms a capping on the table-top hills and ridges in this region. This stone varies in texture from a smooth, fine quality chalcedony and chert to a hard quartzite. Implements of Greybilly occur on every campsite in this western region and the stone must have formed an important article of trade from localities in which it outcropped. Pebbles and lumps of stone, flaked to a working edge, were used to chop through saplings and branches and to cut out blocks of wood for a weapon, utensil, or ceremonial object. Flakes and blades to be fashioned into scrapers, adzes, knives, awls, saws, and spear-points were struck off larger pieces



Left: Cylindro-conical stone from Mootwingee. *Right (top to bottom):* End scraper, grooved axe, and a nucleus from which were knapped flakes to form knives, scrapers and other implements.

In western New South Wales rock engravings are mostly of small figures, their surfaces formed by a series of small pits which the Aborigines made with a stone hammer or other implement. This series at Mootwingee was chalked for photographic purposes.

Photo.—Author.

known as nuclei or cores. The adzes, which were usually made from the best pieces amongst these flakes, have the distal end chipped to a rounded shape. They are called *tula*, and were mounted in gum on the end of a stick and used as a chisel, adze and knife in fashioning wooden objects. As the edge wore away it was re-chipped until only a portion or slug remained, and this was discarded when it was of no further use. Flakes chipped along the end or lateral edges served as scrapers and knives. Some flakes have a point shaped on them for making grooves in wood and for other purposes. A rare type has a series of carefully fashioned teeth on one or more margins to form a saw-like working edge. There are also leaf-shaped points called *pirri* which were used long ago as spear points, and burins are occasionally found.

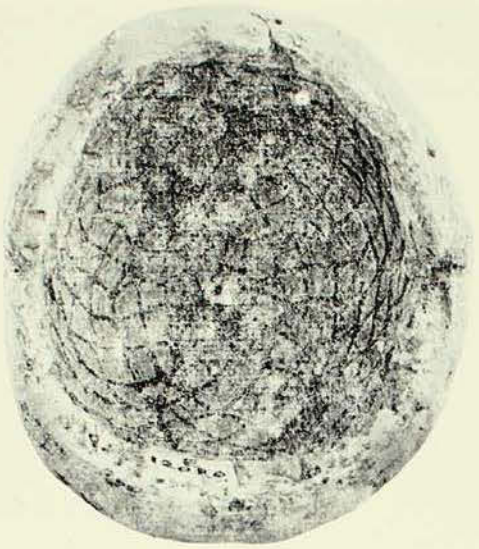
Other implements found on these campsites include the mortars and pestles used for breaking up hard seeds and bones, and the millstones and mullers used for grinding seeds into flour. It is not uncommon nowadays to see a shed floor or a path on a station paved with the large flat millstones, or garden beds flanked with them. Another interesting implement which occurs in this region is a large conical one known as a cylcon. One variety is straight and the other curved, and they are from about 6 to over 30 inches long. Many of them bear incised lines, including kangaroo and emu tracks, and they would appear to be the product of the same mythology as the rock engravings and paintings. Cylcons are also becoming scarce on the campsites but now and again the shifting sands reveal specimens.

On some of the graves are to be seen oval-shaped pieces of kopi, a white clay made from gypsum, and also the well known widows' caps, made of the same material, which were worn by widows during the mourning period for their dead husbands and then placed on the graves.

The Australian Museum possesses collections of implements from many campsites in the far west. Nearly 3,000 were collected last year during a trip (financed by Morley Johnson Ltd.) between Broken Hill, Mootwingee and the Queensland border. The late Mr. C. C. Towle bequeathed a fine collection from the Wilcannia district.[1]

On the whole, the implements in the far west represent some thousands of years' occupation by the Aborigines. It is known that there was a higher rainfall and better climate in the interior of Australia in the late Pleistocene period, when the Aborigines probably entered it between 10,000 and 20,000 years ago. It is interesting to mention here that the South Australian Museum has collected stone implements associated with extinct marsupial bones in

[1] My intention is to publish a description of the implements from this region, but several more trips will have to be made to obtain representative collections from a number of areas not yet visited.



When her husband died the aboriginal widow along the Darling Valley built up on her head a cap of white gypsum. When the mourning period ended the cap was placed on the grave. The impression of the net worn over the hair may be seen inside this cap.

Photo.—H. Barnes, Jnr.

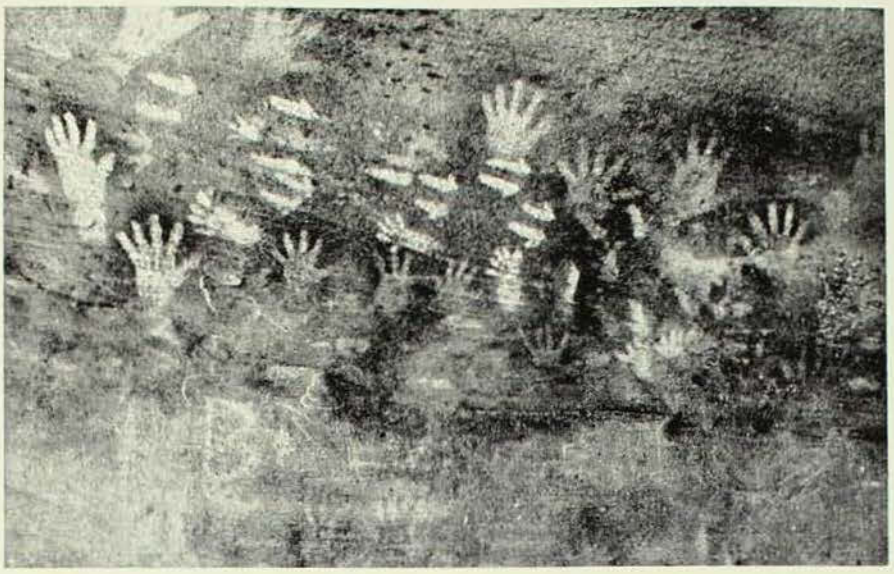
the Menindie district. This museum has also established four culture periods among these implements by excavating campsites at Tartanga and Devon Downs, on the lower Murray River, where the same range occurred as in the far west of New South Wales, a range which, in fact, extends into Western Queensland, the Northern Territory, and across the continent into Western Australia.

There are many other relics for the archaeologist to examine and record in the far west. For certain ceremonial purposes connected with their spirit beliefs and with initiation ceremonies the Aborigines constructed cairns and heaps of stones, and also elaborate patterns of boulders in rows, circles, and other designs. These are to be seen on the hills and claypans, and about a dozen sites are known.

About two dozen rock-shelters containing aboriginal paintings have been located in the far west, the majority of them being east of the Darling River between Menindie, Cobar and Bourke, and there is a fine series of paintings in about a dozen caves at Mootwingee. Stencils of the human hand are the only subject at some sites, but stencils of hands (mostly), feet, lizards, and bark dishes are to be seen at Mootwingee. The walls of the Gundabooka, Wiltagoona and Winbar shelters are covered with overlaid paintings which include the goanna, tortoise, lizard, emu and tracks, kangaroo and tracks, and a few fish. At Gundabooka one warrior is shown holding a long barbed spear, a favourite subject among the engravings at Mootwingee. Kangaroo and emu hunts are a feature of these cave paintings, some of which show the tracks only of the hunter and game, others the hunters and kangaroos themselves. There are numerous little men and women in conventional postures, often delicately portrayed in animated poses, dancing in sets of four or more, fighting duels, or standing armed with clubs or spears. A red kangaroo 4 feet high is painted at Winbar, a yellow duck and its egg at Campbell's Gallery, interesting line mazes at Wiltagoona and Gundabooka, concentric circles and diamonds at Winbar and Gundabooka. There is a huge serpent 28 feet long in red at Mootwingee, where boomerangs, animals and their tracks, lizards and other figures form the biggest concentration of paintings in the region. These paintings are in red, black, white or yellow, portrayed in linear and silhouette styles.

Perhaps the most striking relics left by the Aborigines are the extensive galleries of rock engravings at Sturt's Meadows, Mootwingee, Euriowie, and other places in the far west. They are all situated in outcrops of rock near permanent waterholes or places which would yield water for a long period in drought years. The engravings consist of thousands of small figures. Men and women, snakes, kangaroos (up to 3 feet 6 inches long), lizards, emus, implements, ornaments and weapons, and hunting incidents are portrayed among circular and other geometrical designs too numerous to describe. They are engraved as linear designs or in a thick intaglio band, and many of them are complete intaglios, the surface of the intaglio area being hammered all over to a depth of from 1/16th to $\frac{3}{8}$th of an inch.

It is generally surmised that the galleries had a ritual or mythological significance, as totem centres for one or more clans and as a record of the lives of spiritual ancestors in the Dreamtime. The

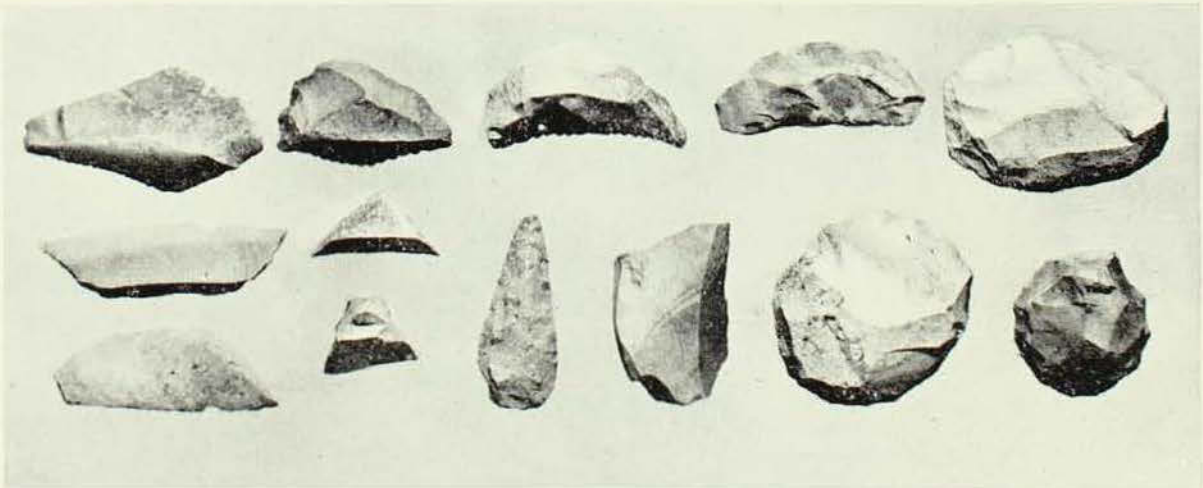


Cave paintings of stencilled human hands, and of human feet and kangaroo tracks, in white, in the main cave at Mootwingee. The initials below have been scrawled by a vandal.

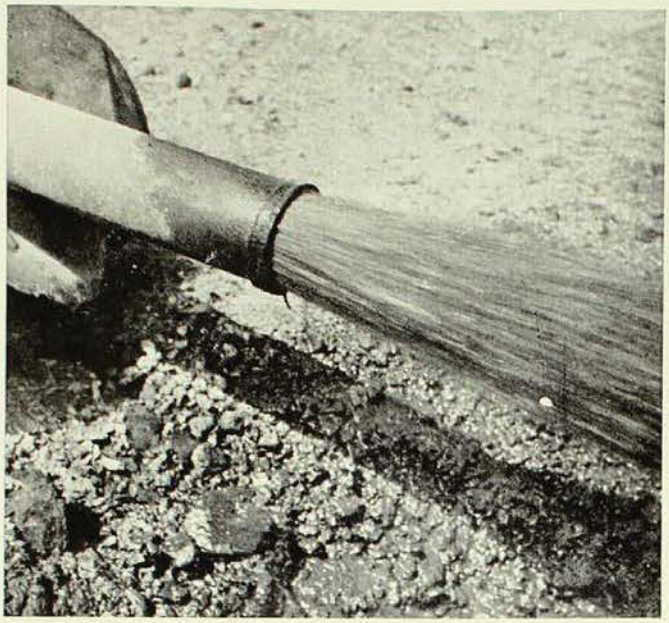
Photo.—Author.

appearance of the engravings and their situations in remote places are apt to give an impression of great antiquity, but a close examination reveals that many of them are not patinated and are quite recent in origin; others are so weathered that they are undoubtedly centuries or thousands of years old. Some of the subjects are the same among the paintings and engravings and it would appear that both are expressions of the one mythology, as are the cylcons, and that they were in ceremonial use from the early occupation of the country by the Aborigines to the time of white occupation.

I was able to make a preliminary study of the Mootwingee paintings and engravings during last year's trip, and another visit is planned to make a detailed record of these extremely interesting sites.



Typical knapped flake and blade implements from far western New South Wales. *Top, left to right:* Three dentated-edge saws (Tero Tank and Wangalilla); remnant or slug of a *tula* adze flake (Tongo); *tula* adze (Lake Peery); *Bottom:* Four geometrical microliths (Bundara, Purnanga and Tero Tank); *Pirri* spear point (Salisbury); scaled burin (Tero Tank); *tula* adze flake (Tongo); pyramidal scraper (Lake Peery). The saws and burin are rare types but occur throughout the western region.



Oil in Australia

By L. OWEN

THE existence of crude petroleum, as such, probably dates back to the first appearance of life on this planet for—in common with other complex carbon compounds—the substances which comprise "mineral oil" are a direct (or very nearly direct) product of living organisms. It is now generally accepted that some types of plant life produce, naturally, a small percentage of hydrocarbons which are identical with those found in crude oil. It is also generally accepted that quite recent muds (for example, in the Gulf of Mexico and in the Caspian Sea) contain detectable and measurable amounts of petroleum substances.

The problem in petroleum finding, therefore, is not the discovery of conditions under which crude oil can occur—these are almost ubiquitous as far as sedimentary strata are concerned—but to define the environments under which it can be segregated and preserved in worth-while quantity.

It is probable that primitive man, guided by the animals he hunted, soon found out that crude oil seeping from the ground was an effective agent for the destruction of pernicious parasites, such as ticks; it was only a matter of time for him to realise that the liquid possessed medicinal properties as well: "*And Nehemiah called this thing Nephthar, which is as much as to say, a cleansing*".

The first craftsmen to use petroleum are likely to have been the inhabitants of the Mesopotamian river plains, who, for lack of suitable timber, fabricated serviceable boats from reeds and asphalt (the latter is itself a naturally inspissated crude oil). A further step was the caulking of larger boats made of timber (cf., Noah's Ark). Later, asphalt, or bitumen, was used extensively as a building cement (*e.g.*, the tower of Babel) and in the fabrication of ornaments by Elamites, Chaldeans, Akkadians, Sumerians and Assyrians. Bitumen was mined in bulk at several localities of the region now known as Iraq, notably at Hit (originally called Ihidakira or "bitumen spring").

Both in Persia and in the Caucasus the existence of springs of oil and gas (eternal fires) has been known from the earliest times. The Persians not only worshipped fire at burning altars fed by seeps of natural gas, but also used crude oil for the first-recorded "flame-thrower": at the siege of Athens, in 480 B.C., they employed incendiary arrows with war-heads of oil-soaked tow.

Deposits of crude petroleum have, almost always, been associated with salt or brine and the translators of both the Old Testament and the New confused the script used for "salt" with that for "nitre" and "bitumen". It is interesting to note, therefore, that the modern technique employed in drilling for oil is a development of the methods used for sinking brine wells.

In the United States crude oil was skimmed from pools by the Indians, for medicinal purposes, long before the advent of the white man, and it was sold by the latter, in the natural or partly refined

state, at least as far back as 1830, under the name of "Seneca Oil" which was claimed to be a cure-all. The partly refined oil was also adapted for burning in lamps, thus replacing the then commonly-employed spermaceti oil, and as a lubricant.

Most of the wells sunk for brine west of the Alleghanies produced some oil, which was regarded as a nuisance, and a contamination. One of these brine wells, drilled with a percussion rig about 1806, produced 30 to 60 gallons of oil with large quantities of gas from a depth of 475 feet every two or three days.

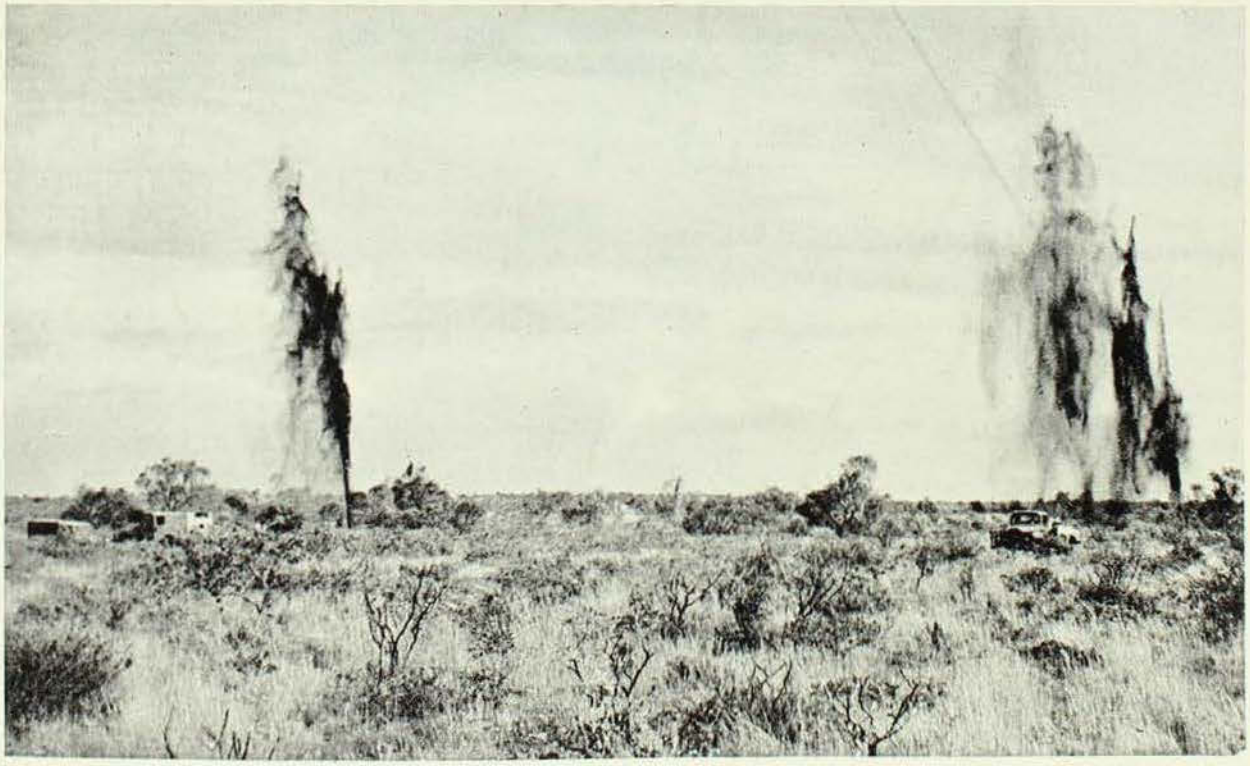
The first well drilled specifically with the object of producing petroleum, which by that time had attained a commercial value, was put down by Drake in 1859; from it, at 69 feet, 2000 barrels of crude oil were obtained before the end of the year. With an ever-increasing demand for kerosene, and later for petrol and lubricants, the oil industry became very important not only in the United States but in many other countries. The total world production of petroleum amounted to about 500 metric tonnes in 1859; in 1955, it exceeded 763,000,000 tonnes annually.

It is rather remarkable that the Middle East, which may be regarded as the birthplace of the widespread application of petroleum to the needs of man, did not attain commercial production (in the modern sense) until 1908, when the Masjid-i-Sulaiman oilfield was opened up.

Drilling for Oil in Australia

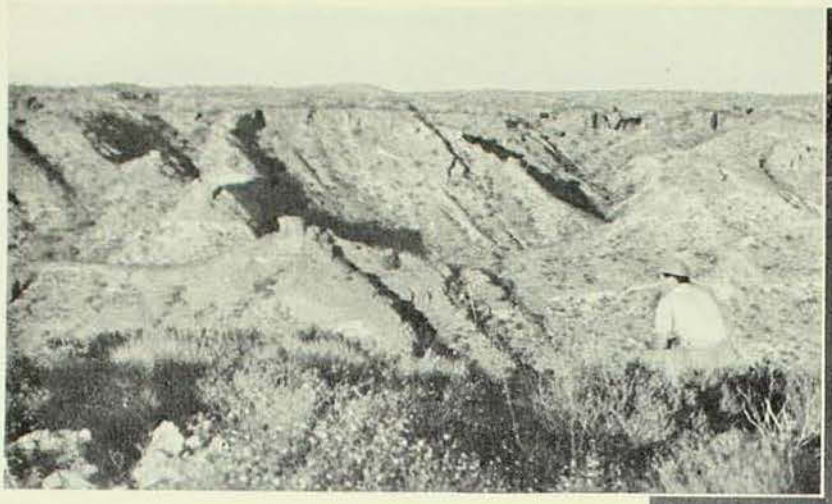
Although, by the end of the nineteenth century, several instances had been reported (and some verified) of the striking of natural gas and oil-shows in wells sunk for water on the Australian mainland, petroleum prospecting, during that period, and its attempted development were carried out by inadequately small syndicates, advised by quacks, diviners and folk with "hunches", lacking sorely in any knowledge or experience of the oil game.

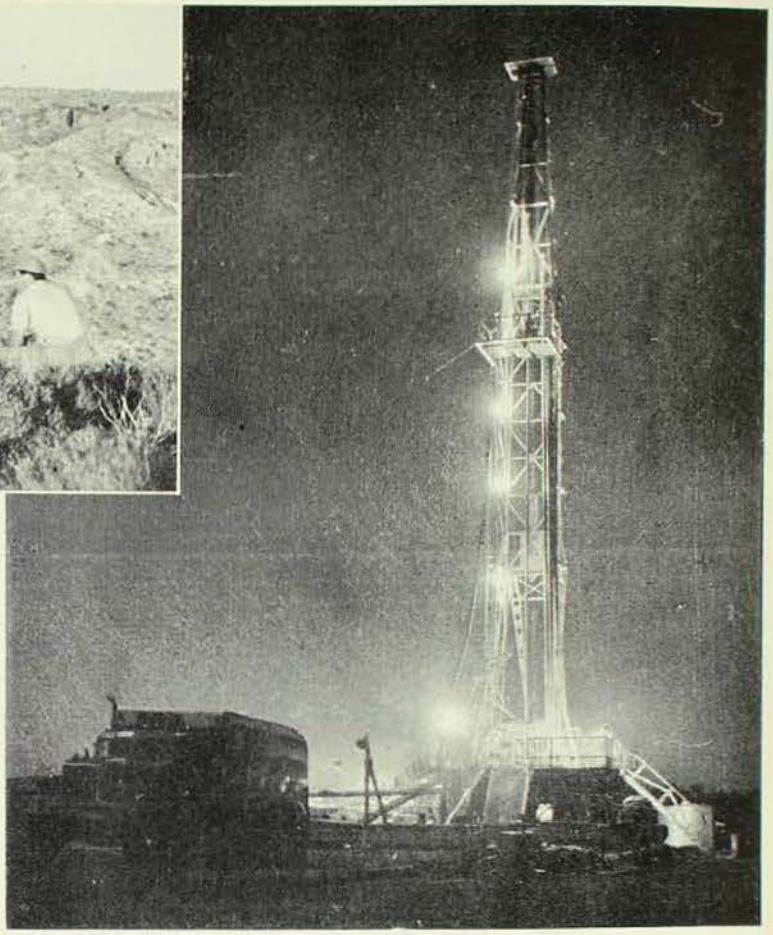
The first well in Australia to strike a sizeable flow of gas was sunk on Hospital Hill, Roma, Queensland, in search of artesian water in 1900. From a depth of 3683 feet, it produced an ephemeral supply which is stated to have reached a maximum flow of 70,000 cubic feet a day. Since then, more than forty wells have been drilled in



Surface explosions at Exmouth Gulf, W.A. Such explosions create shock waves which experts can measure on seismometers and thus obtain a picture of rock formations below.

Photo.—Ampol Exploration.





The type of country encountered by drillers seeking oil at Cape Range, Exmouth Gulf, W.A., and a rig operating at night in the same area.

Photo.—Ampol Exploration.

A snapshot of the author in Arab dress. Since the end of World War I Mr. Owen has been actively connected with exploration for, and exploitation of, petroleum in nine countries, including Saudi Arabia, Colombia, Venezuela and Papua.

search of oil near Roma, both by Government and private interests, without discovering anything of commercial value. To date, nearly 300 wells have been sunk all over the Commonwealth with benefit only to company promoters and gamblers in oil shares.

The depth of the wells has varied from quite shallow holes in the ground to over 15,000 feet which, by the way, is a record for the Southern Hemisphere.

Oil-Shows in Australia

The Australian mainland is unique, among all areas of comparable size in the world, for the fact that only one surface manifestation of petroleum, throughout its vast extent, has been verified by competent experts. Even this solitary indication is found in an environment which allows of little hope of commercial production as it occurs in vesicular basalt underlying limestone of Cambrian age in the East Kimberley district.

In view of the fact that some 5,500 artesian water bores have been sunk to as deep as 7,000 feet, and that the number of recorded sub-artesian bores and shallow wells is in excess of 200,000, it is not surprising that shows of oil and gas have been noted in a few cases; in fact, it is astonishing that the number of such manifestations has been so small.

Wells sunk expressly in a search for oil on the mainland now number about 300, but measurable (non-commercial) shows of oil and gas have been found in only about 30. All samples of crude petroleum derived from Australian wells to date possess one property in common: they contain evidence of having undergone extensive migration during which nearly all of them have suffered chemical and physical changes.

Roma can be quoted as an example of an oil which has been micro-filtered through tight (and sometimes chemically active) channels, in part, possibly, in the gaseous form, thus losing its heavier constituents.

Lakes Entrance (Victoria) has undergone change through passage along water sands, and inspissation. The more recent discovery at Rough Range was first micro-filtered and then inspissated when it reached the pre-Cretaceous land surface, later to have its remnants preserved in a pocket (and possibly pockets) of basal Cretaceous sandstone. Both Wilkatana (South Australia) and Woodside (Victoria) wells have yielded small amounts of typical micro-filtered petroleums, and some horizons show signs of subsequent inspissation.

CONCLUSION

The record of the search for oil in Australia can not be described as inspiring, although the fact that it is now being undertaken by major companies backed by years of experience gives hope for the future. Unfortunately, problems arising from the geological history of the mainland make essential, for hope of success, procedures not employed on "normal" fields and the use of techniques not commonly dealt with in text-books.

Certain oil-bearing regions, however—notably in South America—produce oils which have chemical and physical characteristics resembling those of the Australian samples. In addition, the geological histories of some of these areas parallel that of the Australian mainland. It is to be regretted that most of the records of field work done on the South American fields and data obtained lie buried in the files of private companies.

It is to men who have gained experience on such oilfields that Australia must look for the solution of its many problems in this tantalising search. Until a few years ago, with one or two notable exceptions, most of the exploratory work for petroleum in Australia has had to depend on geologists whose experience did not extend beyond "normal" oilfields. Often, unfortunately, the field work was carried out by persons without adequate oilfield experience of any kind and, in many cases, with only a rudimentary knowledge of the geology of petroleum.

The best augury for the future is the fact that it is now being recognised that the problems of Australian geological history —while not being unique—are very special ones, particularly with reference to oil finding.

Casting a Fish in Plaster

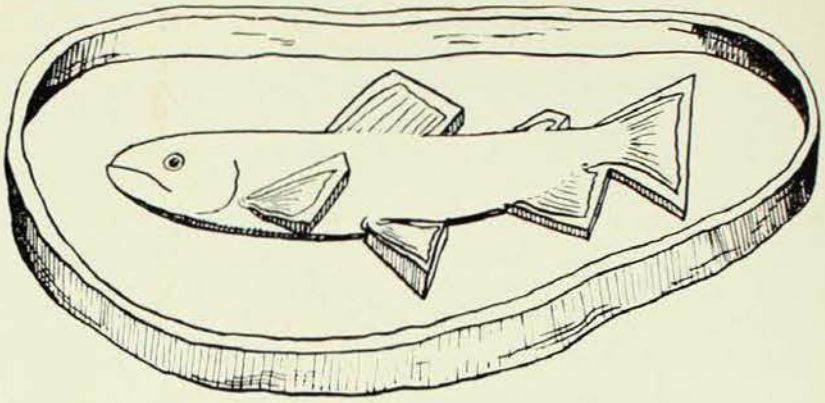
By ROY D. MACKAY

MANY an angler has caught what he considers a prize fish, or even a record-size fish, and has tried to record it for all time by photographing it or by word of mouth of witnesses. But when it comes to fish sizes no one will believe stories about "extra big ones" caught many years ago. Here is a method which will preserve a much-prized catch for posterity—after the fish has been eaten! It is a simplified way of casting, but it must be carried out without loss of time; therefore all the necessary materials must be at hand before the fish arrives.

Materials required: Good quality plaster of Paris; two bowls (one large, one small; enamel or aluminium is best); clay; a separating medium such as paraffin wax dissolved in kerosene, or candle wax dissolved in olive oil or peanut oil (substitutes will usually cover the detail of the scales); pins; string; a flat board (or sheet of glass) well oiled with the separating medium; ammonia or methylated spirits; a cheap knife or old table knife.

Before starting on the mould, the fish must be cleaned of any dirt or mucus adhering to the scales. This is done by wiping the fish over with water to which a few drops of either ammonia or methylated spirits have been added. Mucus exuded by the fish will affect the plaster if not wiped off, and the small amount of ammonia or methylated spirits used will certainly not

Fig. 1. Clay supports the fins in position and a clay wall surrounds the fish ready for the first layer of plaster.



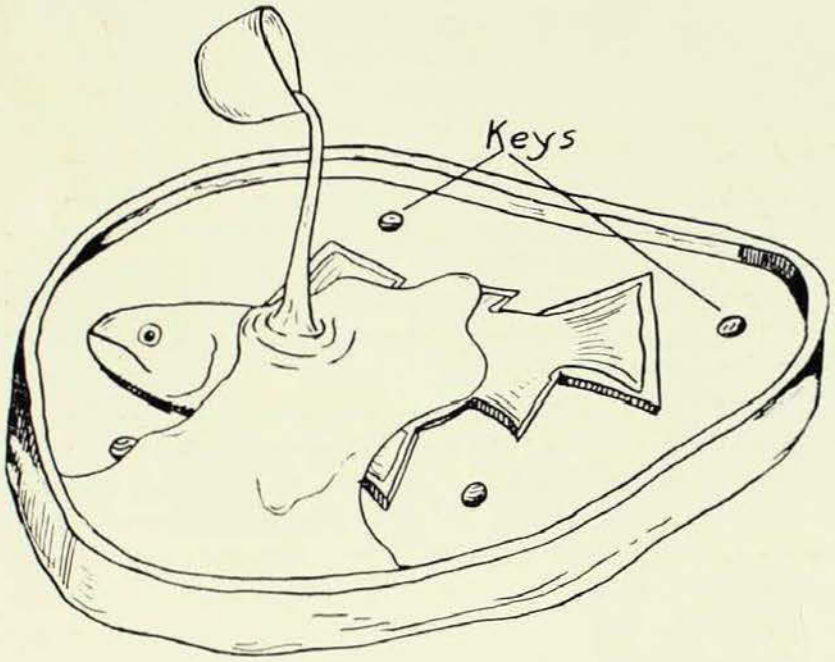
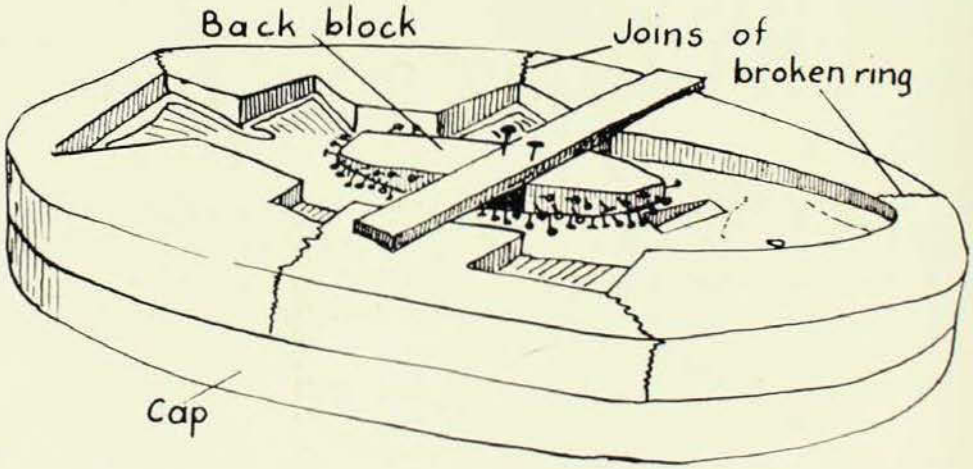


Fig. 2. The first layer of plaster has been poured and "keys" scooped out. The top or cap is now being poured.

Fig. 3. All parts of the mould are assembled and the back block is in position ready for the pouring of the cast.



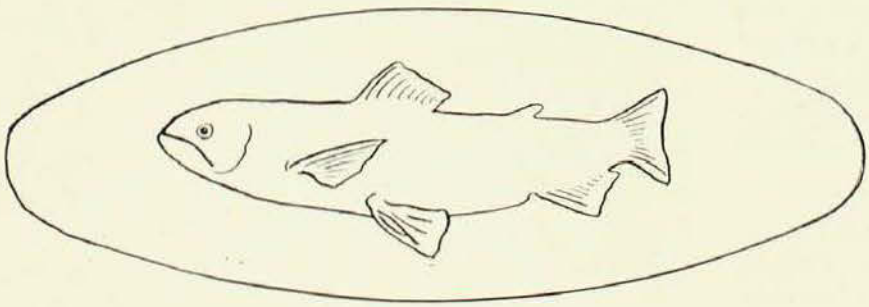


Fig. 4. The finished product trimmed and screwed to a plaque.

affect the fish for eating. Next, lay the fish on the board or glass and spread out the fins on flat sheets of clay. Cut the clay close to the outline of the fins (but not touching) as in Figure 1. Build a clay wall around the fish allowing a space of at least three-quarters of an inch between the fish and the clay wall.

Now mix a sufficient quantity of plaster to pour into the enclosure until it reaches the midline of the fish, *i.e.*, the level of the dorsal fin (Figure 2). When this plaster has set, scoop out a few "keys" in the exposed surface of the plaster with the end of a spoon, or a knife blade. Paint over the exposed surface of the plaster with a thin film of separator. The top layer of the mould may now be mixed and poured to about three-quarters of an inch thickness, forming a cap. When this has set hard the mould (and the clay, for which there is no further use) may be removed and the fish cleaned for the frying pan. Plaster, when setting, generates heat and, a short while after, cools down. It is at this stage that the plaster mould can be removed. The ring of plaster around the fish should be broken into several pieces to allow easy removal from the finished cast.

Each part of the mould is then given two or three coats of thin shellac or a plaster sealer. These coats should not be thick enough to obscure any of the detail in the mould. A piece of soft wood is then cut so that it will fit into the back of the fish with plenty of thickness of plaster around it (Figure 3). A number of nails should be hit into the surface of the wood to be enveloped by plaster, leaving about one-quarter of an inch protruding. This procedure allows the plaster to grip. This block should be given several coats of shellac or other wood sealer to prevent the water from the setting plaster swelling the wood and so splitting the cast.

Casting can now proceed. Firstly, give all surfaces of the mould with fish detail, all the surfaces with keys, and the joins of the broken plaster ring, a thin coat of separator. Place all parts of the mould together with the cap resting on the board or table. The wooden block should be attached to a slat which rests across the mould in such a way that no part of the block or nails touches the mould (Figure 3). A weight may be needed to keep the slat in place when the plaster is poured. Mix the plaster and pour into the mould up to the top level of the mould and back block and allow to set for twenty-four hours before removing from the mould. Large fish will need severals bowls of plaster or even buckets-full. The cast can now be extracted from the mould and put in a warm place to dry—not in the sun as the cast may crack. When dry, the cast may be trimmed of spare plaster and should be given one or two thin coats of shellac or sealer.

Then it can be painted to the natural colours of the fish. It is advisable to have the tinting done by a competent artist.

The cast can now be screwed to a shield or wall plaque (Figure 4) and hung—a constant reminder of pleasant times spent "wetting a line".

Research Fellowship in Pacific Science

The Museum's Acting Curator of Molluscs, Dr. D. F. McMichael, has been awarded a Research Fellowship in Pacific Science under the joint Fellowship Programme of Yale University and the Bernice P. Bishop Museum of Hawaii. The Fellowship is being used to finance field work in New Guinea where Dr. McMichael hopes to be able to make comprehensive collections of land and freshwater shells from both Dutch New Guinea and the Australian Territories and also from the numerous islands adjacent to the New Guinea coast. Australian scientists have a special responsibility in New Guinea, which remains one of the last regions of the earth to be studied zoologically. The Australian Museum collection already contains many of the shells collected by Charles Hedley, John Brazier, and other early shell collectors in Papua, and it is hoped that the collections made by Dr. McMichael, who has already made one trip to the Territory, will give the Australian Museum the most representative collection of New Guinea land shells ever assembled.

The Museum

ALTHOUGH at least a quarter of a million people visit the Australian Museum each year, many are ignorant of the full activities of the Museum and the way in which its work contributes to an understanding of the natural history of the Australian Continent and the Pacific Islands and also adds to the sum of human knowledge. The wealth of natural history material in the Museum is immense; its value cannot be measured in terms of money and many of the unique specimens are priceless.

Australia has one of the most interesting and important faunas in the world. Approximately 100 million years ago the continent was isolated from the rest of the world when land bridges linking it with other continents were covered by the sea. Our animals were thus removed from competition with the more highly evolved ones which subsequently developed in other parts of the world and from the menace of predatory carnivores. Marsupials are not the only Australian animals of importance; others of equal interest exist in almost every group, including such creatures as insects, shrimps and worms. There is an urgent need to safeguard this striking and unique fauna and by continual research to make it better known. The Museum is concerned both with conservation and research. An important duty is also to create and make known public interest in the natural history of the continent and to bring home to Australians an understanding of the interest and importance of their heritage.

The white man on arrival in this continent found a dark-skinned people, physically and culturally distinct from other peoples of the world; a people moreover whose art, material culture, economic life, social organisation, religion and magic are of great interest and offer important fields of study to the scientist. The layman also finds the customs and ways of life of these early inhabitants of the country a subject of never ending interest. By research in the field and with its collections, the Museum further helps our knowledge of the Aborigines and their culture and makes the results of this work available in its publications. Interest in aboriginal art has been promoted by the publication of a booklet on Australian Aboriginal Decorative Art.

For more than a century the Museum collections have been constantly increasing. Treasures have poured in from all parts of the continent and are housed in their thousands. There are, for instance, more than half a million shells alone in the Museum collections. Thousands of birds, rock and mineral specimens and fossils from all geological ages fill row after row of cabinets. There is possibly a quarter of a million insects in the entomological collection. Store rooms are filled with fishes, reptiles and marine animals of all sorts and also with specimens depicting the life of the fast disappearing Aborigines and of other peoples of the Pacific Region.

The Museum exchanges specimens with other museums in Australia and abroad to fill gaps and enrich its collections generally. Members of the public make good use

of the collections, and not only as casual visitors: architects and interior decorators, for example, consult the aboriginal material in the course of their professional duties, and art students regularly visit the galleries on sketching expeditions.

Behind the Museum collections are many stories of adventure. Specimens have been sought and obtained from all parts of Australia, from deserts, rain-forests and the Great Barrier Reef. They have been collected in New Guinea and other islands, from the great ice-covered continent of Antarctica and from dredgings in seas extending from the tropics to sub-Antarctica and even off the Antarctic Continent itself.

Specimens brought in by members of the public are often of great interest and importance and many rare ones have been added to the collections in this way; also many new species have been described which bear the latinised version of the donor's name.

Information is always appreciated by the Museum authorities on any finds of natural interest. In the past, investigations resulting from various sources of information have yielded startling results, such as the most perfect specimens of ancient armoured fishes ever found in Australia. These extinct fishes, more than 350 million years old, were found during road excavations near Canowindra. Information from Berowra Waters, near Sydney, resulted in a trail of footprints, made by an extinct reptile about 200 million years ago, being added to the collection. In several cases, aboriginal stone implements found in the country have proved to be unique.

Every specimen in the collections is registered, labelled and catalogued. It is difficult for the casual visitor as he strolls through the Museum galleries to appreciate the tremendous work involved. Some of the card catalogues of parts of the collections have taken years to complete and work still proceeds on others. Nevertheless any particular specimen can usually be produced for examination at short notice.

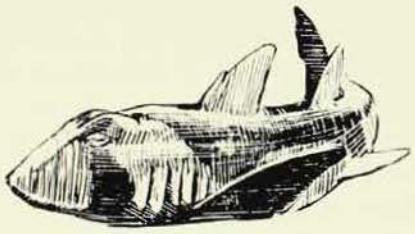
Although the exhibits in the galleries are only a small part of the material stored in the Museum their display and arrangement is one of the most important functions of the Museum. This is because the gallery exhibits provide the chief means of communicating a knowledge of natural history to the general public in a readily understood way. Rearrangement of the galleries is constantly taking place and attractive, well illustrated "story" exhibits, using a limited number of carefully selected specimens, are now taking the place of the "row-upon-row" system in the older exhibits. Thus the Museum galleries when rearranged will provide a clear picture, not only of the animals and Aborigines that live in this country, of the fossil remains of animals which have passed away, but also of many of the more interesting facts of the biological, geological and anthropological sciences.

The Museum is a live and not a dead place. It is alive with the spirit of exploration and the excitement of research and because of the great interest in the natural wonders of the Australian Continent the work done in this Museum is perhaps more fascinating than in any other.

As a centre of research the Australian Museum is visited by scientists from all parts of the world who study the zoological, geological and anthropological collections. The scientific staff of the Museum is constantly engaged in research. Comparative work with world-wide faunas is undertaken and many interesting and important discoveries are made. New animals are constantly being discovered and made known to science. Some of the results of these researches are published in the "Records" and the "Memoirs" of the Australian Museum and these are distributed to scientific institutions all over the world.

Many suppose that the Museum is concerned only with matters which bear little practical relation to every-day life. This, however, is not the position as the following few examples will show.

The marine zoologist in collaboration with the Maritime Services Board and the Queensland Forestry Services has carried out research into the destruction of timber by marine organisms. This provided data on which wholly successful remedies have been based. Investigations have been carried out in regard to the stomach contents of birds thought to be harmful to agriculture and fisheries; poisonous snakes and spiders are studied and harmful insects are identified; information has been supplied enabling fishing companies to commercially exploit new regions; a geologist has made known the qualities of building stones in New South Wales and has helped a great deal in the gemstone industry; the study of fossils and its application to stratigraphy has assisted field geologists and mining companies.



The list of these economic activities could continue. They are not small things but are of real value to the nation and the community generally.

The prevention of indiscriminate killing of the wild-life of Australia is of vital concern to the Museum. A State Fauna Panel, on which two Museum scientists serve, now deals with this problem which is one of great urgency as many species have already become extinct within the history of white man in Australia.

Equally important is the protection of aboriginal relics, such as rock engravings and paintings, arrangements of stones, carved trees and burial grounds throughout the State. The Museum has had a number of these relics reserved as national monuments, and it has for many years been pressing the Government to enact legislation and to set up a panel of interested people to deal with the problem of their conservation generally.

The library of the Museum, with over 31,000 bound volumes, is one of the largest and most comprehensive natural history libraries in Australia. It is used not only by the Museum staff but also by many scientific workers in museums, universities and other institutions in the Commonwealth and New Zealand.

The Australian Museum Magazine is published for the benefit of all persons interested in the natural history, geology and anthropology of Australia and the Pacific Islands. The articles are written in a popular manner and are well illustrated. The Australian Museum Magazine is published quarterly. The annual subscription is only 9/-, including postage.

Most officers of the Australian Museum spend portion of their time in the field and have in the past been selected as members of important scientific expeditions. In this way natural history specimens are collected and the habits of our native fauna and the environment in which they live are studied.

The wealth of natural history material housed in the Museum allows a realistic approach to the study of the Australian fauna in our schools.

Many school classes make regular visits to the Museum as an integral part of their Natural Science or Social Studies courses. These visits are arranged through an Education Officer, who is a trained teacher. The lessons of the classes are illustrated with films and the actual handling of specimens by the pupils, followed by a guided visit to the appropriate gallery exhibit. For those classes too far away to come to the Museum, a comprehensive loan collection of specimens and photographs is being assembled. Leaflets on Australian mammals, snakes, spiders, the Great Barrier Reef, Australian Abori-

gines etc., are sent to children when requested.

For the year ended 30th June, 1950, 2,187 school children visited the Museum to attend the natural history classes. This number has now increased and for the year ended June, 1956, 10,301 children attended the classes.

During school holidays a programme of films is shown at the Museum for children. These have proved extremely popular to the 40,000 children who have viewed the films since the series started a few years ago.

A series of twelve free "Popular Science Lectures" is delivered each year, each one being illustrated by lantern slides or films. Discussion is encouraged at the conclusion of the talks.

A large mail reaches the Museum daily from lay and scientific persons seeking knowledge of matters on which Museum staff members can give authoritative information. Many people make their inquiries in person. The Museum staff numbers 50 and comprises Curators and Assistant Curators, a Librarian, an Education Officer, Preparators, Clerical Officers, Technical Assistants, Artificers, and Attendants.

It is possible that some visitors, especially those from overseas, may suppose that the Museum, because of its name, is a Commonwealth institution. There is as yet, however, no Australia-wide natural history museum. The Australian Museum is maintained from State Government funds though its activities are by no means confined to the State of New South Wales. It takes pride in its name, to which it lays claim by virtue of being the oldest and greatest natural history museum in the Commonwealth.

Frequent visitors to the Museum may consider that changes in the exhibition galleries take place over-slowly. The reason for this is that such changes take much planning, both from the scientific and design angles, and also a great deal of preparatory work before they can be put into effect. They are also costly.

In many countries patrons of museums finance alterations, ranging from the reconstruction of a whole gallery to the provision of a single exhibition unit. The Australian Museum has in the past received some help of this nature and is always anxious for future benefits. There can be few more fitting ways in which a public-spirited citizen who takes pride in our heritage can express his appreciation to his fellow citizens.

Gold and telluride minerals from Kalgoorlie, W.A.

Mr. G. Spencer Compton, formerly Chief Lecturer in Geology, Kalgoorlie School of Mines, visited Sydney recently and brought with him a fine collection of the gold and silver telluride minerals, calaverite, sylvanite and krennerite. Kalgoorlie is one of the few localities in the world where these minerals occur and the specimens were outstanding. It is likely that no better examples had ever been displayed in Sydney. Also included in the collection were some fine gold specimens. It was not possible to display them publicly but they were left in the care of the Curator of Minerals for a few days and were viewed by interested people including members of the staff, and students, of the School of Mining Engineering and Applied Geology, N.S.W. University of Technology.

Book for Colombo Plan Countries

The book *Furred Animals of Australia*, by the Australian Museum's Curator of Mammals (Ellis Troughton), was recently selected by the Commonwealth Government as one of three representative educational works for distribution in countries embraced by the Colombo Plan. This selection of one thousand copies of the book, which first appeared in November, 1947, is regarded as a quite exceptional order by the publishers (Angus and Robertson). As a result, publication of the Seventh (Revised) Edition has been planned for early this year. An American Edition was published by Charles Scribner's Sons of New York in 1947.

Sea Mats and Sea Mosses

Since the resignation of Mr. A. A. Livingstone, the Museum has lacked the advantage of a worker on Bryozoa (Sea Mats and Sea Mosses). Recently the Department of Invertebrates has had the voluntary help of Mr. L. Thomas, a student of this group.

Adaptive Radiation of Trapdoor Spiders

By BARBARA MAIN

IT is often observed that the related forms of a group of animals may occupy distinctly different situations and each is specially adapted to its own particular environment. Such adaptive diversity of various animal groups attracts the attention and study of biologists. Some years ago I was prompted to investigate the adaptations of the Western Australian representatives of a particular group of trapdoor spiders (of the tribe Aganippini). The following article is a summary of the findings of this study.

The spiders of the tribe Aganippini show a striking sequence of adaptation to habitats ranging from moist forest situations to desert environments. Before discussing the spiders themselves a few points must be noted about the country in which they occur. The general environment of southern Western Australia ranges from a forest environment through woodland to acacia-scrub (mulga) and saltbush steppe (Nullarbor Plain). This corresponds with a decrease in the rainfall from the coast to the north-east and east where the country becomes progressively drier. In fact the mulga and saltbush steppe are technically deserts. These vegetation zones provide the following major habitats:—

(1) The forest and woodland zones provide:—

(a) moist situations of litter formed from the wide flat leaves of such trees as eucalypts and banksias (such a habitat I call 'spatulate-litter');

(b) relatively moist habitats (creek banks and clay-pans);

(c) dry habitats around the bases of casuarinas (she-oaks) and acacias (jam trees) the 'leaves' of which provide a ground cover of needle-shaped litter fragments (such a habitat I term 'linear-litter').

(2) The mulga scrub provides only one type of habitat, the litter area at the butts of the trees (again 'linear-litter').

(3) Finally, one habitat predominates on the saltbush flats of the Nullarbor Plain, *i.e.*, the bare ground of the clay-pans.

The aganippinid spiders show a sequence of adaptation, represented by three dominant levels corresponding with a change from a moist to dry environment. The relationships between the adaptive levels and the environments occupied are shown in Figure 1. Associated with the change in habitat the spiders exhibit two main lines of adaptation. The first is associated with the reduction of water loss through the skin (cuticle) of the animal and the second is directed towards a more efficient feeding method when the food supply is sparse.

A thick abdominal cuticle, possessed by certain species, prevents loss of moisture from the body. For instance *Idiosoma nigrum* has a tough, spiny, sclerotised abdomen in contrast to the soft, hairy abdomen of *Aganippe latior*.

Animals which live in habitats having an abundant food-supply, such as the spatulate-litter of *Eucalypt-Banksia* associations, and which have the burrow opening amongst the litter, seize their prey from within reach of the burrow entrance but without emerging. Similarly animals occupying creek banks and claypans, seize

Fig. 1. (*opposite page*): Three dominant "adaptive levels" exhibited by aganippinid trapdoor spiders in their adaptive trend from moist to dry environment. Note association of habitat, behaviour and morphology.

ASSOCIATION OF HABITAT, BURROW STRUCTURE, BEHAVIOUR AND MORPHOLOGY IN AGANIPPINID TRAPDOOR SPIDERS

HABITAT | BURROW STRUCTURE | BEHAVIOUR | MORPHOLOGY

DIRECTION OF ADAPTIVE TREND

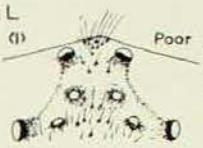
'PRIMITIVE' ADAPTIVE LEVEL

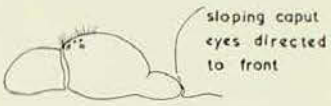
Dense spatulate litter (Eucalypt-Banksia association) of forest floor. Moist situation

Burrow with fragile litter door opening amongst litter.

Animals feed at burrow entrance amongst litter, never vacate burrow.

(1) Poor eyesight small widespread eyes





sloping caput eyes directed to front

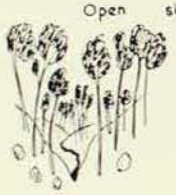
(2) Short stout legs

(3)

Soft hairy abdominal cuticle

'INTERMEDIATE' ADAPTIVE LEVEL

Open situations, relatively moist environment creek banks of forests

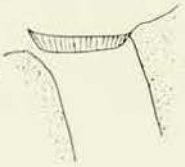


Flap like soil door

(creek banks)

OR

claypans of woodlands



Cork like soil door

(clay pans)

Animals seize prey within reach of burrow, do not completely emerge

(1) Moderately efficient eyesight

moderately enlarged approximated eyes

slightly depressed caput eyes directed partly to side

(2) Slightly elongated legs

(3) Slightly sclerotised abdominal cuticle

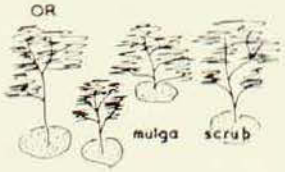
'ADVANCED' ADAPTIVE LEVEL

Linear litter, dry habitats. shrubby groves of forests

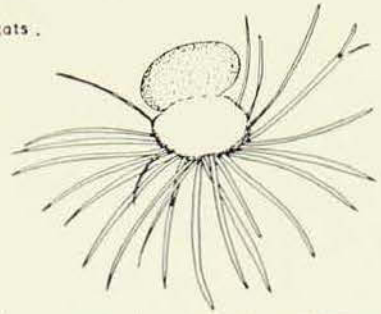
OR

shrubby or 'jam' groves of woodlands

OR



mulga scrub



Light litter door, waferlike; twigs attached to burrow rim

Animals feed by detecting prey on twiglines then running out of burrow in pursuit of prey

(1) Efficient eyesight

grossly enlarged approximated eyes

depressed caput, eyes look in all directions

(2) Long thin legs

(3) Hard spiny corrugated abdominal cuticle

Fig. 2. Burrow in "linear-litter" type of habitat, of the trap-door spider (*Caius villosus* Rainbow), showing twig wafer-type door and attached twig-lines which are used as feeling-lines for prey detection.

Photo.—V. N. Serventy.

prey within reach of the burrow. However animals in dry environments (that is, linear-litter at the butts of casuarinas or acacias) have a very different technique of prey capture. These animals have been seen to collect twigs and attach them singly, with silk, in radial arrangement, to the rim of the burrow (Figure 2 illustrates this type of burrow). These twigs are then used as "feeling-lines" for detection of prey. Spiders have been observed sitting in the burrow with the tips of the legs on the rim-ends of the twigs. Movements of insects on the twigs stimulates these spiders to run out of the burrow along the twigs in pursuit for perhaps several inches. In this way the spider greatly increases the area from which it can obtain prey, which is of obvious advantage if the prey is sparse.

Looking again at Figure 1 we note that associated with the different methods of feeding, that is with the behaviour, which varies in the distinct habitats, there are certain types of structure of the animals which represent three distinct adaptive levels. We find that the spatulate-litter dwellers have the head (caput) raised and sloping in such a way that the small, wide-spread eyes are directed only to the front. The poor eyesight of these animals is associated with the fact that in the litter these animals would in any case be unable to see prey at any distance. Also since these animals do not vacate the burrow there has been no selection for eyes being directed any way other than anteriorly. Such animals also have short stout legs, adapted for supporting the thickset body within the burrow.

Next it is noted that the spiders inhabiting bare ground situations (creek banks and claypans) have moderately enlarged eyes, which is associated with seeing their prey in the open. The legs of these spiders are also slightly longer and thinner, which is advantageous for quick movement *partly* outside the burrow.

Finally, the twig-lining animals have a flattened carapace enabling the eyes, which are grossly enlarged and approximated, to see in all directions. This is of great advantage when pursuing prey for some distance from the burrow. Similarly the legs are long and slender, adapted for running quickly on the flat surface outside the burrow.

By further reference to Figure 1 it is apparent that not only is the behaviour (feeding method) and body structure (morphology) of the animals modified in adaptation to the different habitats, but they construct also different and characteristic types of doors to the burrows.

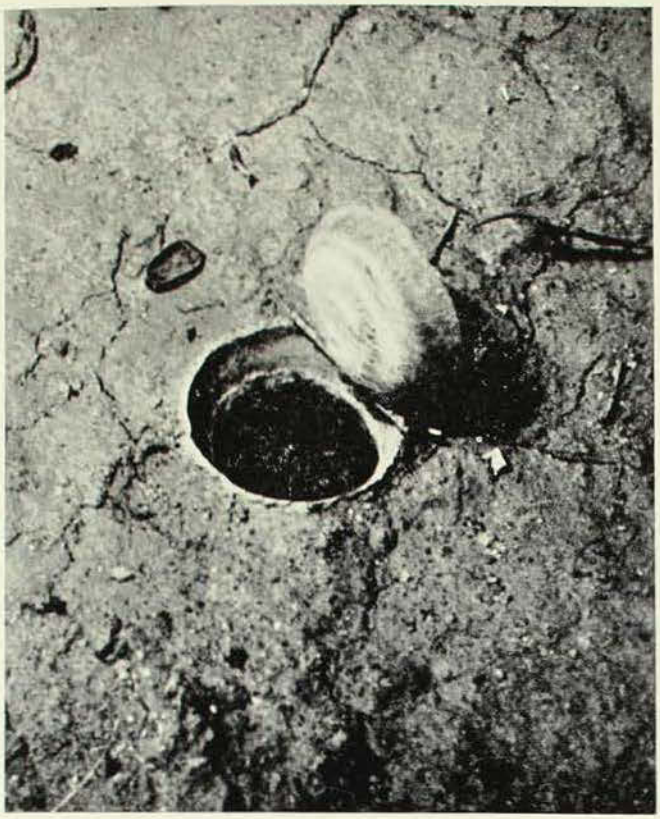


Fig. 3. Burrow in "clay-pan" type of habitat, of the trapdoor spider (*Aganippe occidentalis Hogg*), showing heavy cork-like soil door which prevents flooding of burrow.

Photo.—Author.

Dwellers in spatulate-litter have thin, fragile doors made of silk-bound litter fragments. Those in open situations have soil doors; if in creek banks then doors are thin and flaplike, while in claypans doors are thick and corklike (see Figure 3). Such a corklike plug effectively prevents the burrow being flooded when the bare ground is inundated after rain. Finally, the twig-lining animals which run out of their burrows to catch prey, construct thin, wafer-like doors of litter fragments, that are very light in weight and stand open unsupported when flung up as the animal pursues its prey.

Thus it is found that, associated with different habitats, there are particular behaviour patterns, burrow types and structural complexes (see again Figure 1). And it is significant that the various species, representing the different adaptive levels, have apparently been derived from a common ancestor by its expansion into several types of habitat where genetic recombination and natural selection have operated to produce forms which are modified, behaviourally and structurally. This selection continued until some forms are now completely adapted to the special demands of each type of situation occupied. At the same time, over a wide geographic range, the animals have become partially isolated into locally adapted populations, some of which are now reproductively isolated and represent a related group of species. It is this adaptive expansion, resulting in an array of related species, that biologists call a radiation.

A Research Fellow in the Zoology Department, University of Western Australia, BARBARA MAIN has been working for the past five years on field biology of Mygalomorphae (trapdoor spiders), principally in Western Australia.

Exploring Between Tidemarks

IV. Some Animal Communities of Rocky Shores

By ELIZABETH C. POPE and PATRICIA M. McDONALD

THE inter-relationships of all the animals on a well-populated rocky shore are so extremely complex that it would take more than a lifetime to work them out properly. In order to learn something about the pattern of part of such an animal community from a local rocky shore the authors selected the oyster band in Middle Harbour, Sydney. The oyster community was chosen because it is a well-defined association in which most of the habits of the animals are known owing to their economic importance to the oyster farmer.* Another important factor influencing our choice of locality to work was the fact that in Middle Harbour the oyster band forms a natural community (cultivation of oysters is forbidden owing to possible pollution of the waters by street drainage from surrounding suburbs). Because the oysters cannot be sold, the area is left largely untouched by humans.

THE OYSTER COMMUNITY

The oyster (*Crassostrea commercialis*) covers the rock between the levels of high and low neap tides to the apparent exclusion of almost all other species and the authors counted up to 400 live oysters per square foot. Some were young, as a new settlement of oysters had taken place fairly recently, but always the oysters in this band are small and stunted owing to overcrowding. Where oysters are grown commercially, some of the spat that settle are removed by the oyster farmer so that fewer and bigger oysters are produced in a given area.

In making this count of oysters the specimens were removed from the rock and kept in a bucket for later checking. All the creatures which were attached to them or sheltering among them were also gathered up for later sorting and counting. There were many more animals present than one would ever imagine could be found in so small an area. For instance among the 400 oysters in that one square foot were about 370 young *Bembicium* periwinkles, 170 tiny limpets, 44 barnacles, 60 small red-clawed crabs, about 30 tiny bivalve shells, 16 slater-like Pillbugs and 20 rugged *Venerupis* bivalves, 16 tiny corrugated Ellobiid gastropods, 16 mussels, several oyster-boring molluses and numerous amphipods skipping about like fleas, plus a few ribbon worms and bristle-footed worms. These were the low water inhabitants, but during high tide fishes and other oyster predators like the mangrove crab and the larger carnivorous molluses (Hairy Oyster Borer) would move in over the oyster zone.

FOOD WEB IN THE OYSTER COMMUNITY

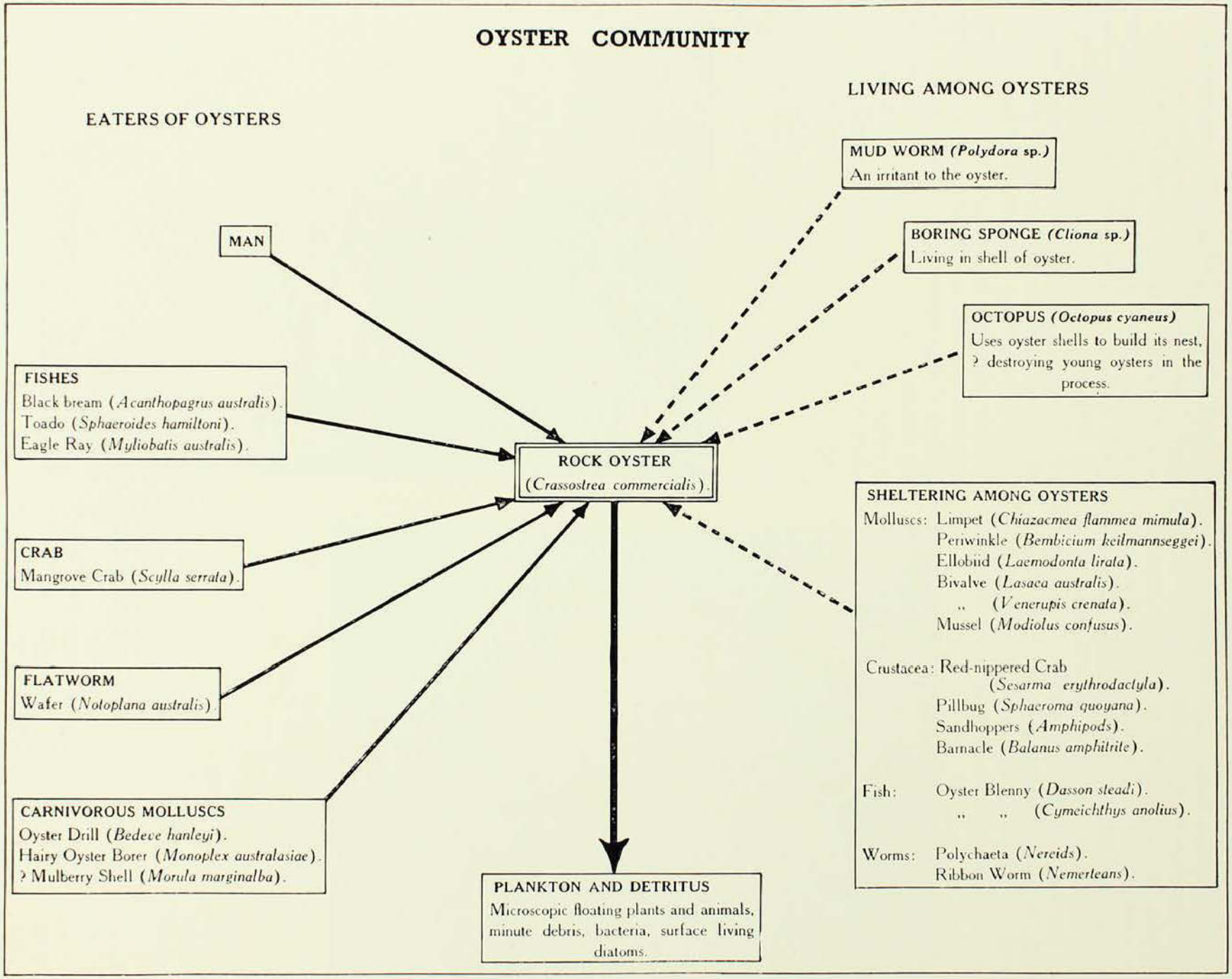
The oyster, which is the dominant animal in the community, derives its nourishment from plankton and probably also detritus floating in the water. Now the basic link in any food chain is always of a vegetable nature and in the case of plankton this final link is provided by the diatoms. So if we envisage the food chain of one of the carnivores preying on the oyster we would find a relationship like this:

Black Bream *eats* oyster *eats* plankton and detritus.

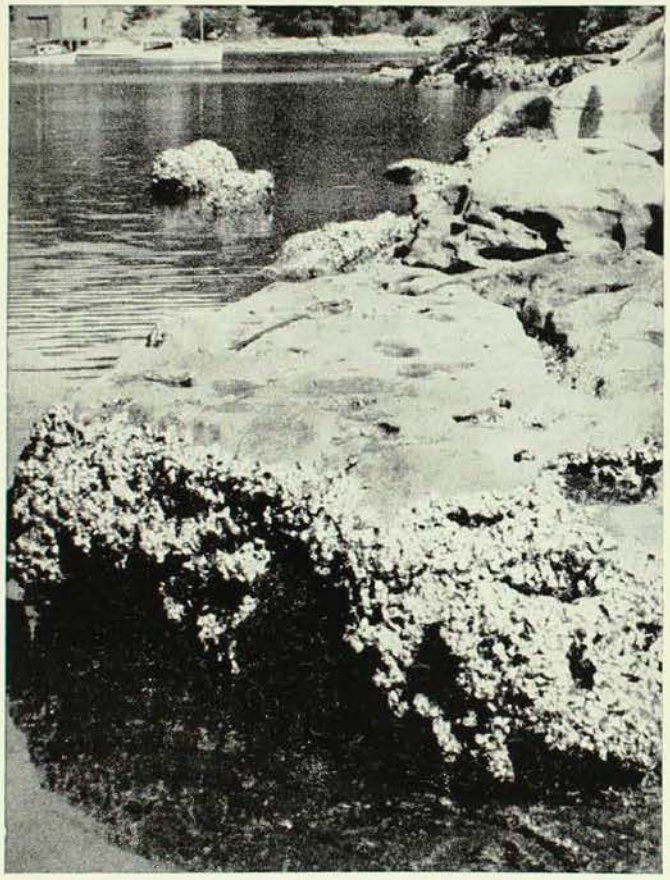
When one considers, however, all the inhabitants in this community and their food relationships, it is obvious that something much more involved than a series of

* Ref. T. C. Roughley's articles, THIS MAGAZINE, II. (5-8).

THE OYSTER COMMUNITY (*see diagram opposite*): Dark arrows point from eater to eaten. Broken arrows indicate some relationship other than eating.


OYSTER COMMUNITY
EATERS OF OYSTERS
LIVING AMONG OYSTERS
MAN
FISHES
Black bream (Acanthopagrus australis).
Toado (Sphaeroides hamiltoni).
Eagle Ray (Myliobatis australis).
CRAB
Mangrove Crab (Scylla serrata).
FLATWORM
Wafer (Notoplana australis).
CARNIVOROUS MOLLUSCS
Oyster Drill (Bedeve hanleyi).
Hairy Oyster Borer (Monoplex australasiae).
? Mulberry Shell (Morula marginalba).
ROCK OYSTER
(Crassostrea commercialis).
PLANKTON AND DETRITUS
Microscopic floating plants and animals, minute debris, bacteria, surface living diatoms.
MUD WORM (Polydora sp.)
An irritant to the oyster.
BORING SPONGE (Cliona sp.)
Living in shell of oyster.
OCTOPUS (Octopus cyaneus)
Uses oyster shells to build its nest, ? destroying young oysters in the process.
SHELTERING AMONG OYSTERS
Molluscs: Limpet (Chiazacmea flammea mimula).
Periwinkle (Bembicium keilmannseggei).
Ellobiid (Laemodonta lirata).
Bivalve (Lasaca australis).
,, (Venerupis crenata).
Mussel (Modiolus confusus).
Crustacea: Red-nippered Crab (Sesarma erythrodactyla).
Pillbug (Sphaeroma quoyana).
Sandhoppers (Amphipods).
Barnacle (Balanus amphitrite).
Fish: Oyster Blenny (Dasson steadi).
,, ,, (Cymeichthys anolius).
Worms: Polychaeta (Nereids).
Ribbon Worm (Nemerteans).

food chains exists. This complex is called a food web. Thus, to take a simple case, if the food chain mentioned is placed in its correct relationship to some of the other organisms in its environment, a jig-saw-like pattern is disclosed. The Black Bream eats oysters, which in turn feed on plankton and detritus, but the mussel sheltering among the oysters also feeds on plankton and detritus while the carnivorous oyster drill may feed on either the oyster or the mussel. The Black Bream also eats the



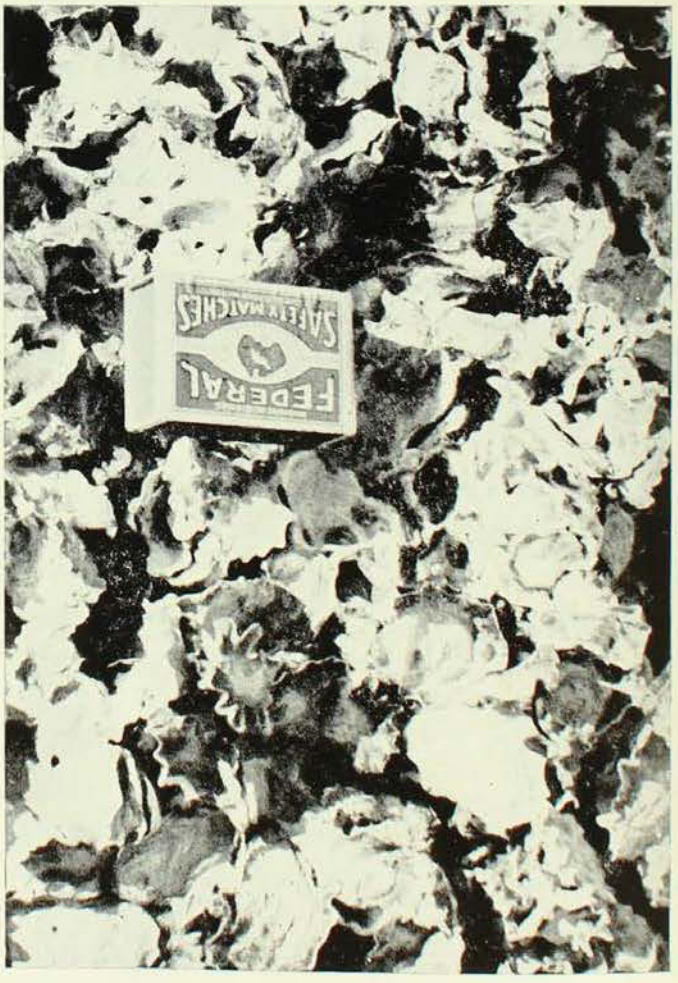
A well-developed oyster band at Sailor's Bay, Middle Harbour, Sydney.

mussels. This interlocking of filter-feeders, predator and prey, scavengers, etc., is typical of any shore animal community. Thus it is evident that no animal can live solely unto itself. It is merely part of that complicated meshwork which is called the food web of its community.

Pyramid of Numbers

As has been described, plankton consists of a multitude of different kinds of plants and animals, many of them microscopic in size, and literally millions of them may live in a single pint of seawater. The oysters feeding on this abundance of plankton are much fewer in numbers and there would certainly be only a few Black Bream feeding in any one cove lined by an oyster band. Thus the planktonic plants forming the first link in this food chain must of necessity greatly outnumber the oysters, while these in turn are far more numerous than the ultimate link, the Black Bream. This relationship of numbers in an animal community has been aptly called the pyramid of numbers, the plankton occupying the base and the Bream the apex of the pyramid. This relationship of numbers holds true for food chains generally.

Not only are the animals nearer the base of the pyramid greater in numbers than those nearer the apex but they are usually much smaller in size and less well adapted



Close-up of the oysters; limpets, periwinkles and other animals live among them.

Photos.—E. C. Pope.

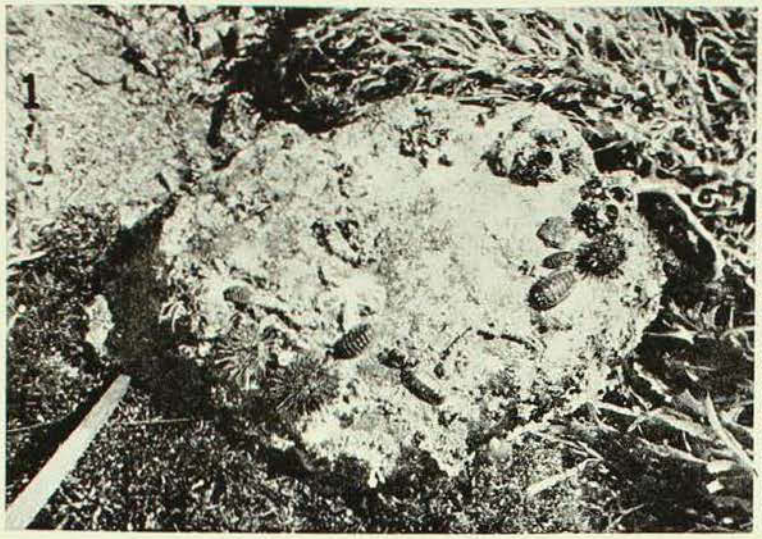
to protect themselves from their enemies. Applying this to our example we notice that the animal plankton are microscopic in size and can only float passively about. They are consequently at the mercy of any larger and stronger swimming predators. The oyster which feeds on this plankton may be larger in size, but it is fixed to the rocks and might seem to be an exception to the above generalizations. However, food is brought to the oyster by its own efforts—the beating of cilia on its gills creates water currents which suck food through the straining mechanisms whence it is conveyed to the mouth. As large volumes of seawater can be filtered by an oyster it has no trouble in catching plenty of food. Its shell protects it very well from most enemies but the larger Black Bream has teeth adapted for smashing open the shells of oysters and mussels. The Bream's swimming habits enable it to seek out and break off food from rocks and wharf piles. It relies on speed and eyesight and other senses to outwit its enemies.

Hidden or Cryptic Faunas

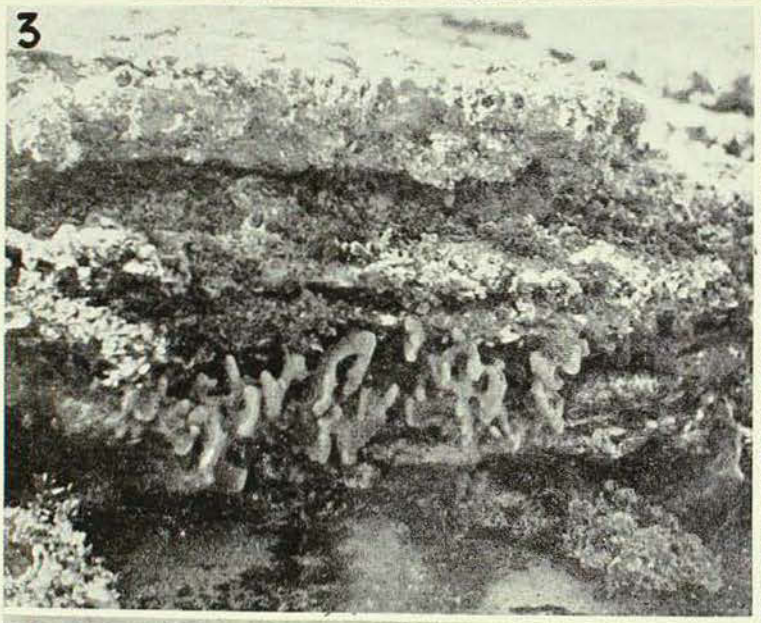
There are a number of animal communities just as intriguing as that of the oyster band and any one of them is worth investigating to make a census of the animals found in the group and to work out their biotic relationships and food webs. One well-defined community is that of the crusty growths of Galeolaria worms which, when carefully broken up and searched, reveal a whole world of little animals—the sheltering or cryptic species of worms, crustaceans and molluses—living in the spaces between the limy worm tubes, finding there a safe haven from breaking surf and from larger marauding enemies.

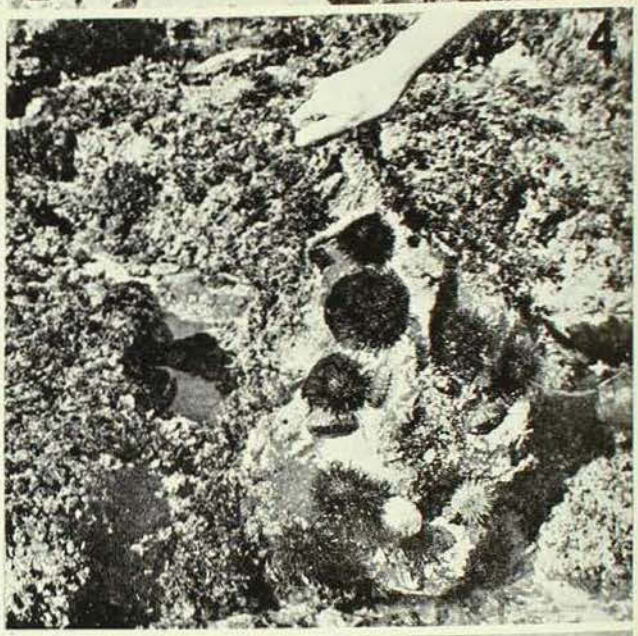
Other communities worthy of investigation are (i) a bed of mussels (or clumps of mussels on a wharf pile) or (ii) the fauna of the short turf-like mats of seaweed which grow on some of the outer edges of some rocky headlands. In fact, it is only when one investigates closely the cryptic species that hide away so effectively during low tides that the wonderful diversity of rock-dwelling animals is fully realised. The numbers of different kinds of animals to be seen in the average zoological gardens would be insignificant by comparison with the numbers of different genera and species (even of the highest group like Phyla) to be found during one low spring tide on rocky reefs at Bottle and Glass Rocks near Vaucluse, Sydney; Shellharbour, or Angowrie Point, to mention three well-tried collecting places in New South Wales. For this reason the seashore is a favourite area for training students in field studies in zoology and ecology—so much can be seen in a comparatively small area.

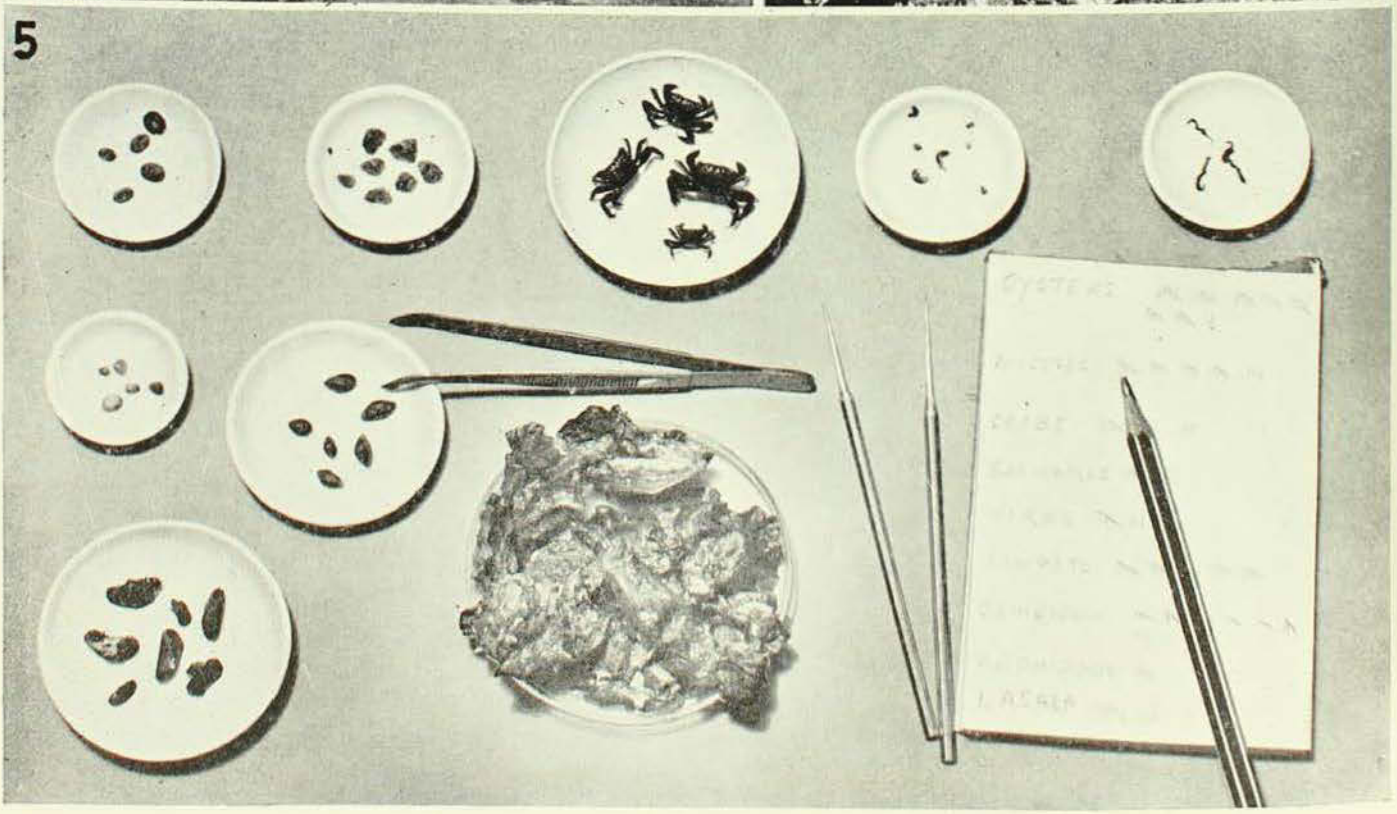
So far our explorations have dealt only with animals living on the upper surfaces of rocks and nothing has been said of animals under rocks. By doing so the authors have kept to the last what they believe will prove to be the most interesting animal communities for the newly-fledged explorer. The late Professor Wood-Jones likened the turning over of a drab coral boulder on the reef at Cocos-Keeling Islands to the opening of a jewel case—so many beautifully shaped and rarely coloured animals were disclosed. The same is true of our own ocean rocky reefs. If you can find a shore where reasonably sized boulders lie near low water level in a place not dangerous to work, by turning over the rocks you will discover this zoological treasure-trove for yourself. Sea urchins of four or five different species shelter there, highly coloured sponges and anemones, worms of at least twenty different kinds, prawns, small perky reef fishes such as Clingfishes, Tommyfish and Gobies will be seen. Hermit crabs and ordinary crabs of several kinds may scuttle for shelter as the boulder is turned or alternatively sham dead to escape notice. Many brittle stars and lots of molluses will be uncovered ranging from rarer cowries and small bivalves to large black Elephant snails and the many beautifully coloured and sculptured chitons. Some of the latter will roll themselves up like armadillos and bowl down the rock to safety on the sea floor. In such a short account as this no attempt can be made to list even the most common creatures that will be seen. Many of the


1


2


3


4


5

animals, however, can be identified by looking through back numbers of this Magazine or by reference to books like *Australian Seashores*, *Australian Shells*, and *Nature-craft in Australia*.†

Conservation of Fauna Under Rocks

At this stage, however, it must be urged upon the explorer of the tidelands that wanton destruction is at all costs to be avoided, and that wholesale turning of rocks and leaving them bottom up is as destructive to wild life as the careless cutting down of trees on the land, or other crimes against flora and fauna. So as soon as you have examined the fauna below a rock, *turn back the rock to its original position*. By doing so the balance of nature can return to normal much more quickly than if you leave the rocks so that all the former dwellers on the dark, sheltered underside are exposed to the light of the blazing sun and the drying winds of low tide. The cryptic fauna is not adapted for such conditions. Conversely the dwellers on the upper sides of the rock fare just as badly. Especially would we urge this matter of conservation on those European immigrants from Mediterranean shores who love to collect sea urchins along the rocks and eat their delicious roes. So many of them leave a trail of overturned boulders to mark their path. After such treatment some of these rocks will not have normal faunas for 2 to 3 years. So prolific is the rate of breeding of most shore animals that one season will ensure recolonization of the rocks *provided the boulders are turned back to their original positions*. As mentioned in another place all shore animals are adapted to their niches and there are few more highly adapted groups than the under-rock fauna.

† Published by Angus and Robertson (Sydney and London), and Georgian House, Melbourne.

Rare Beauty in Cryptic Fauna

Immediately one is struck by the fact that both in colour and in the structure of the body or shell, members of the cryptic fauna tend to be respectively brighter and more delicate than their relatives from the upper surfaces of the rocks. Comparison of the chitons, the molluscs, and the tube worms from the two habitats will at once show this clearly and much of the delight of shore collecting is provided by finds of rare beauty among the cryptic animals. Should it be possible and not dangerous, a visit to a boulder reef during a low tide on a late summer evening or after dark will be very rewarding to the shore fossicker, for many of the crepuscular, under-rock species come out and wander freely over the rocks in suitably moist surroundings. With a headlight on (to leave both hands free for notetaking) much can be recorded of the habits of these shyer species during such excursions; fun may also be had taking flashlight photographs to record the habits of these dwellers in dark places. Extra care must be taken to watch the sea for any danger and one should never go alone on such an expedition in case of accidents.

Some Peculiar Associations—Parasites and Commensals

The seashore has its share of animals which parasitize one another and perhaps the most peculiar one is the barnacle *Sacculina* which parasitizes crabs, attaching itself just underneath the tail. Entering the tissues of its host it changes the physiology of male crabs so drastically that they change sex and become female. The authors have seen males of the crab *Heteropanope serratifrons* from sandy mud flats affected in this way. Other notable parasites that may be found are the tiny white *Chryseulima* gastropod snails boring

Illustrated opposite: 1. An overturned boulder near low tide mark reveals numerous chitons and sea urchins. 2. A brittle star slithers down a rock to safety. 3. Purple sponges living under an overhanging rock ledge. 4. Sea urchins have mined holes in this rock as an added protection. 5. A sample of the animals of the oyster community photographed during sorting and counting.

Four top photos.—E. C. Pope.

into the arms of the prickly seastar, *Coscinasterias calamaria*, or the sponge *Cliona* which bores in the shells of molluscs, notably oysters.

Where two animals live together but neither seems to harm the other, and one or possibly both derive some benefit from the association, they are called commensals. Some notable commensals on our shores are the sponge crab, *Hyastenus diacanthus*, which carries on its back a complete covering of growing sponge. The crab is camouflaged and protected while the sponge is safely anchored and yet is transported about by the crab and can thus enjoy "good fishing" in a variety of places rather than in one fixed spot. A red commensal amphipod (sand flea) may be found living inside the bodies of Cunjevoi ascidians and a classic example of commensalism is the case of the *Chaetopterus* worm and the crab *Polyonyx* which live together in the Chaetopterus's U-shaped tube.‡

In this article it is impossible to do more than merely hint at the fascinating examples of the animal inter-relationships to be seen on our shores. There is only one thing to do about it. Go out yourself and have a look.

Next issue: Hints for Shore Explorers.

‡ Ref. E. Pope's article, THIS MAGAZINE, IX. (3); *Chaetopterus—a Strange and Beautiful Worm*.

Book Reviews

COWRY SHELLS OF WORLD SEAS: By Joyce Allan, F.R.Z.S. Georgian House, Melbourne pp. i-x, 1-170, pls. 1-15 (6 coloured). Illustrated by the author. Price, £3/3/0.

Miss Joyce Allan is well known to readers of THIS MAGAZINE, for her series of excellent articles on shells which have appeared over the years. Several years ago, Miss Allan's first book, *Australian Shells*, was published and met with an enthusiastic reception from the many shell collectors who, till then, had been without a general work on the subject.

Now, as a crowning achievement to Miss Allan's career, a companion volume has appeared, dealing with the shells which are the perennial favourites of all collectors—the Cowries. This book is a first-class account of one of the most difficult groups of shells (from the point of view of classification) and should prove of value to both professional malacologists and amateur collectors.

Practically every known, living species of cowry is described and the other closely related groups (the Trivias, Calpurnas and Eratos, etc.) are included. Many are figured, the coloured plates being especially beautiful, and the species can be easily identified. There are very few typographical errors and some of the omissions of the earlier volume have been remedied. Thus there is a full scientific index as well as a comprehensive list of the more important references. A useful list of the species which occur in Australian waters is appended.

Scientifically, the treatment represents a compromise between the taxonomic splitting of the Schilders and Iredale, and the "lumping" of conservative malacologists. Such an approach is probably closer to the truth than either of the extremes and will appeal to the majority of students of this group. Miss Allan has been most successful in correlating the work of Iredale and the Schilders, and in interpreting their views in a manner which will be fully understood by amateur shell collectors.

It is to be hoped that Miss Allan will continue her fine work, producing still more volumes on shells, in which scientific information is presented with a minimum of technicality, yet with infinite detail.

D. F. McM.

AN ATLAS OF ANIMAL ANATOMY: By W. Ellenberger, H. Baum, H. Dittrich. Revised edition; 288 illustrations, including additional plates by Stubbs, Cuvier, Laurrillard, Straus-Durckheim. Dover Publications Inc., New York. Price $6.00.

Achieving a new standard in anatomy illustration, this book is beautifully produced to give an explanation of the external appearances of such representative groups of animals as the horse, dog, lion, cow and bull, stag, roe and goat. In nearly all cases the skeleton, musculature, and the relationship of these to the surface configurations are shown from three aspects. These and the numerous details and cross-sections, make this an invaluable book of reference for the artist.

J. B.