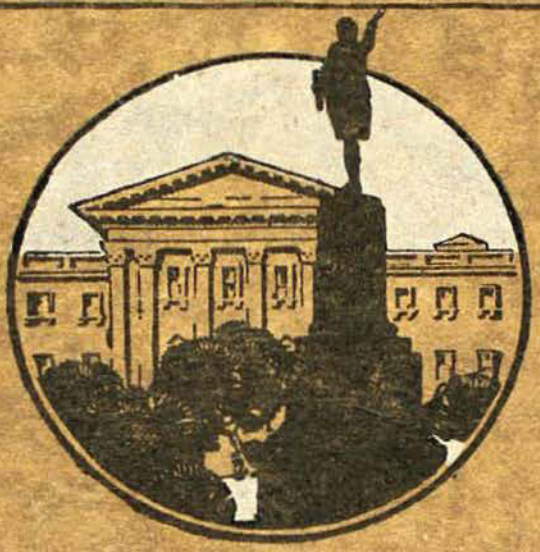
The AUSTRALIAN MUSEUM MAGAZINE

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



Save Australia	*The Editor*
The Horse and its Ancestors	*W. S. Dun*
The Story of the Freshwater Eel	*H. K. Anderson and G. P. Whitley*
Primitive Initiation	*W. W. Thorpe*
Observations on the Yabbie	*Herbert M. Hale*
The Perils of an Oyster	*T. C. Roughley*
Life on the Tidal Flats	

PROFUSELY ILLUSTRATED.

Vol. II. No. 8. OCT.-DEC., 1925. Price—ONE SHILLING.

PUBLISHED QUARTERLY.

THE AUSTRALIAN MUSEUM

COLLEGE STREET, SYDNEY

BOARD OF TRUSTEES:

President:

T. Storie Dixson, M.B., Ch.M., Knight of Grace of the Order of St. John.

Crown Trustee:

James McKern.

Official Trustees:

His Honour 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 and Minister for Railways
The Hon. the Minister of Public Instruction.
The Auditor-General.
The President of the N.S.Wales Medical Board (T. Storie Dixson, M.B., Ch.M.).
The Surveyor-General and Chief Surveyor.
The Crown Solicitor.

Elective Trustees:

J. R. M. Robertson, M.D., C.M.
Ernest Wunderlich, F.R.A.S.
G. H. Abbott, B.A., M.B., Ch.M.
J. J. Fletcher, M.A., B.Sc.
Sir William Vicars, C.B.E.
Maj.-Gen. Sir Charles Rosenthal, K.C.B., C.M.G., D.S.O., V.D.
Prof. L. Harrison, B.A., B.Sc.
E. C. Andrews, B.A., F.G.S.
Octavius C. Beale, F.R.H.S.
R. H. Cambage, C.B.E., F.L.S.
Gorrie M. Blair.
C. Gordon MacLeod, M.A., M.D., Ch.M.

Director:

Charles Anderson, M.A., D.Sc.

Secretary:

W. T. Wells, A.I.A.V.

Scientific Staff:

William W. Thorpe, *Ethnologist.*
J. Roy Kinghorn, *Zoologist, in charge of Birds, Reptiles, and Amphibians.*
Ellis le G. Troughton, *Zoologist, in charge of Mammals and Skeletons.*
Anthony Musgrave, *Entomologist.*
F. A. McNeill, *Zoologist, in charge of Lower Invertebrates.*
T. Hodge Smith, *Mineralogist and Petrologist.*
Tom Iredale, *Conchologist.*

Librarian:

W. A. Rainbow.

THE AUSTRALIAN MUSEUM MAGAZINE

VOL. II., No. 8. October-December, 1925

CONTENTS

A NEW GUINEA PIG-TOTEM TABLET FROM THE KERAM RIVER, A TRIBUTARY OF THE SEPIK RIVER *Frontispiece*

EDITORIAL—SAVE AUSTRALIA 257

NOTES AND NEWS 259

THE HORSE AND ITS ANCESTORS 260

THE STORY OF THE FRESHWATER EEL—*H. K. Anderson and G. P. Whitley* 266

PRIMITIVE INITIATION—*W. W. Thorpe* 270

OBSERVATIONS ON THE YABBIE (*Parachaeraps bicarinatus*) —*Herbert M. Hale* 271

OBITUARIES 275

THE PERILS OF AN OYSTER—*T. C. Roughley* 277

LIFE ON THE TIDAL FLATS 285

Published Quarterly by the Trustees of the Australian Museum, College Street, Sydney, in the months of January, April, July, and October. Subscription 4/4, including postage.

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

A New Guinea pig-totem tablet containing a skull of a man who belonged to that clan. This was collected from the Keram River, a tributary of the Sepik River, in the Mandated Territory of New Guinea. (See page 270).

Photo.—*G. C. Clutton.*

THE AUSTRALIAN MUSEUM MAGAZINE

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

Editor: C. ANDERSON, M.A., D.Sc. **Annual Subscription, Post Free, 4/4.**

VOL. II., NO. 8. OCTOBER-DECEMBER, 1925

Editorial.

Save Australia.

ON various occasions we have discussed the theme of the Australian fauna, and laid stress on the necessity for adequate protection of the many interesting animals which inhabit this continent. We welcome, therefore, the appearance of *Save Australia*, which deals with the question in considerable detail.

In his introduction Sir James Barrett discusses the flora and fauna of Australia, and points out their distinctiveness and importance from the scientific viewpoint and also their economic value if rightly used. He deplores the inroads which have been made into the ranks of our indigenous mammals by the insatiable demands of the fur trade, to satisfy which nearly six million marsupials were sacrificed during the period 1919-1921. In the opinion of Professor H. F. Osborn and Mr. H. E. Anthony, of the American Museum of Natural History, in no continent has the devastation been more rapid than in Australia.

As to the causes of the undoubted depletion of our indigenous animals, Sir James stresses the spread of settlement and the consequent destruction of forests, the skin trade, and the ravages and competition of imported animals such as the fox and the rabbit. The remedies he proposes are forest conservation and the planting of indigenous trees, the setting apart of reservations, " zoological islands, "properly protected and patrolled.

It is satisfactory to know that a strong feeling now exists both in the governmental departments specially concerned with the protection of our indigenous animals and plants, and among Australians generally, that we ought to feel a pride in our natural heritage, our monotremes, marsupials, birds, and plants, and that we should make every effort to preserve them and transmit them to posterity. But there can be no doubt that the protective laws are often successfully evaded, and that much remains to be done in educating the people, and particularly the young, to the interest, the beauty, and the usefulness of the mammals and birds of Australia, and the imminent danger which threatens the existence of many species.

Contributors from the various States deal ably with various aspects of the " Save Australia " problem, but we must take objection to some of the statements made by Mr. W. Catton Grasby in his article " Preservation of Flora and Fauna in Western Australia." Respecting the scientific collec-

tor he says: "a collector from the eastern states, after spending a few weeks here, reported that the Honey Mouse, or long-snouted Phalanger (*Tarsipes spenserae*) was confined to an area of a few square miles. Possibly it is well that he thought so, because the 'scientific' (?) collector is the worst enemy our animals have."

The number of animals collected in Australia for scientific purposes is so small that as an exterminating influence the scientific collector is a negligible factor. As a matter of fact the collector from the eastern states did not himself obtain a single Honey Mouse, but received several from a resident, all of which had been captured by a domestic cat. There are many cases of mammals and birds that have become extinct in comparatively recent times, and in no case are these largely, or even adequately, represented in scientific collections; we would instance the Dodo, the Great Auk, the Kangaroo Island Emu, and the Quagga. The White Gallinule of Lord Howe Island was once abundant, but now all that is left is a tingle skin in the Vienna Museum. Was it exterminated by scientific collectors ?

In his fine work on the mammals of South Australia Professor Wood Jones discusses the reasons for the rapid decrease in numbers of the Bilby (*Thalacomys*) and says: "Their pelts have been marketed in the skin sales in Adelaide in very large numbers; and they have been more wantonly killed for sport. Large numbers have been killed or maimed in steel traps set for rabbits, and possibly many have fallen victim to poison baits. As with all the more defenceless marsupials the introduced fox has probably played its sinister part." The Bilby, like the Dodo, the Great Auk, and the others, is poorly represented in collections, and in its destruction the scientific collector has played an infinitesimal part; indeed of one species a single specimen is preserved.

Of the Tufted-tailed Rat Kangaroo (*Bettongia penicillata*) Professor Wood Jones says: "Only a few years ago this animal was extremely common over the greater part of South Australia. Twenty years ago the dealers in Adelaide did a great trade in selling them by the dozen at about ninepence a head for coursing on Sunday afternoons. It may surprise people who remember these days to know that there is not a preserved specimen, not even a skin of the animal, available for scientific study in South Australia to-day. In the same way it will one day surprise the rising generation when they realise that the few native animals they are now familiar with are gone forever."

The scientific collector deplores the serious diminution in the numbers of our indigenous animals as much as anyone, but nevertheless he feels justified in securing for the national collections the comparatively few specimens which are necessary for study and for preservation, so that future generations may know what the various forms were like.

Save Australia: A Plea for the Right Use of our Flora and Fauna, by various authors: edited by Sir James Barrett. MacMillan and Co., Ltd., 1925: Angus and Robertson, Ltd. Price, 8/6.

On various occasions parties of boy immigrants have been brought to the Museum by Mr. Thomas Hawkins, Immigration and Welfare Officer, Y.M.C.A. These new Australians are always much interested in the strange animals and the beautiful birds of their adopted country.

One of our subscribers, Mr. E. Howard, Young, writes:—

"I enclose my cheque as an additional donation to the Magazine Fund. I am so pleased with your most interesting and instructive publication, at such a small cost, that I wish to show my appreciation of its value to me personally as a relaxation from business, and as a help to me in natural history and nature study in which I take a keen interest that I am delighted to help your publication by this small contribution."

Notes and News.

Among recent visitors to the Museum may be mentioned Dr. A. Hrdlicka, anthropologist, of the U. S. National Museum, Washington, who examined and made notes on our collection of aboriginal skulls: Dr. C. Holtzclaw, Chatanooga, Tennessee who is specially interested in the monotremes: Mr. E. F. Williams, Assistant Government Anthropologist, Papua; Mr. James Hornell, F.L.S.,F.R.A.I.,Director (retired)of Fisheries, Madras, who took much interest in our collection of outrigger canoes and string figures; Mr. A. F. Grimble, Lands Commissioner, Gilbert Group; Professor K. Ide, Mining Engineer, of the Imperial University, Kioto, Japan.

The Ravi, or Papuan community house exhibit, has been on view for some months without adequate casing, exposed to dust and other evils. The funds at the disposal of the Board of Trustees would not permit of this highly necessary work being put in hand, but thanks to the generosity of Messrs. T. E. Rofe, O. Phillips, Sir Arthur Rickards, Sir Hugh Denison and Sir Samuel Hordern, this highly necessary work will shortly be completed. These gentlemen are defraying the cost, £120, and the community's thanks are due to them for their public spirited action.

At a special meeting of the Board of Trustees held on July 3rd Dr. G. Gordon MacLeod, M.A. and Mr. G. M. Blair were unanimously elected Trustees of the Australian Museum. At the ordinary meeting on August 8th, they, in company with Mr. R. H. Cambage, C.B.E., F.L.S., also recently elected a Trustee, were welcomed by Dr. T. Storie Dixson and formally introduced to the members of the Board.

His Excellency the Governor, Sir Dudley de Chair, and the Executive Council have approved the appointment as Trustee of the Hon. M. M. Flannery, Secretary for Public Works and Minister for Railways, in place of the Hon. R. T. Ball.

Fortnightly demonstrations to deaf, dumb and blind pupils have now become a regular feature of the Museum's activities, and the officers who take part are much impressed by the intelligence and quick perception displayed by these welcome visitors.

Among recently delivered outside lectures were the following:—

"Ancient Egypt," by Mr. W. W. Thorpe, to the Millions Club, on 9th June.

"Lord Howe Island," by Mr. A. Musgrave, at the Royal Colonial Institute, on 16th June.

"Snakes and Snake Venom," by Mr. J. R. Kinghorn, to the Sydney University Science Society, on 11th August.

"Economic Value of Australian Mammals and Birds," by Mr. J. R. Kinghorn, to the Royal Society for the Prevention of Cruelty to Animals on 20th August.

The following popular science lectures will be delivered in the Australian Museum lecture hall on the respective dates shown at 8 p.m., and to which there will be no charge for admission. These lectures are illustrated by exhibits from the Museum collections and by lantern slides.

Oct. 8th—"The Importance of Certain Animals in the Causation of Disease in Man and Stock," Dr. Burton Bradley.

Oct. 22nd—"The Romance of Ocean Depths," Tom Iredale.

Nov. 12th —"Australian Marsupials and Egg-laying Mammals," E. Le G. Troughton.

Nov. 26th—"Engines of the Human Body," E. A. Briggs, M. Sc.

Besides these lectures on the regular syllabus there will be an additional one on October 1st at 8 p.m. by Dr. T. Storie Dixson, President on "Captain James Cook, R.N., relics and mementoes associated with him in the Australian Museum." The collections of the Museum will be extensively drawn upon to illustrate the lecturer's remarks, in addition to a number of lantern slides, which have been specially prepared and coloured for the occasion.

The Horse and Its Ancestors.

[The following article contains the substance of a lecture delivered in the Australian Museum by Mr. W. S. Dun on June 11th, 1925.—*Editor.*]

"Said the little Eohippus:
I'm going to be a horse
And on my middle finger-nails
To run my earthly course;
I'm going to have a flowing tail,
I'm going to have a mane
I'm going to stand fourteen hands high,
On the psychozoic plain"
The Coryphodont was horrified,
The Dinoceras shocked;
And they chased young Eohippus,
But he skipped away and mocked.

—*Mrs. Charlotte P. Gilman.*

THE horse, so familiar to all of us, is in many ways a most interesting animal. It has been man's friend and servant since the dawn of history, and but for its aid man's progress towards civilization would have been a much slower and more laborious process. Whether the horse was domesticated in prehistoric times is uncertain; though, from the fact that a drawing of the Stone Age depicts a horse with bridle-like markings on its head, it has been conjectured that even in Palaeolithic times it was employed in the service of man. It was certainly used extensively as food by our ancestors; a remarkable prehistoric encampment in France was enclosed on one side by a wall consisting almost entirely of the bones of horses to the number of about 80,000.

To the naturalist the horse is interesting from several points of view. It offers a wonderful example of adaptation to environment, and its geological history affords a classic instance of the evolution of a race. Through millions of years the ancestors of the horse were becoming adapted for swift running over boundless plains, until the race culminated in the modern horse, which is the finest racing machine in the animal kingdom. The history of this adaptation is what is meant by the evolution of the horse, and the various stages are revealed to us by the abundant remains of fossil horse-like animals which have been found during the last eighty years or so, buried in old river deposits or embedded and preserved in successive strata of the earth's crust.

LIFE AND ROCK.

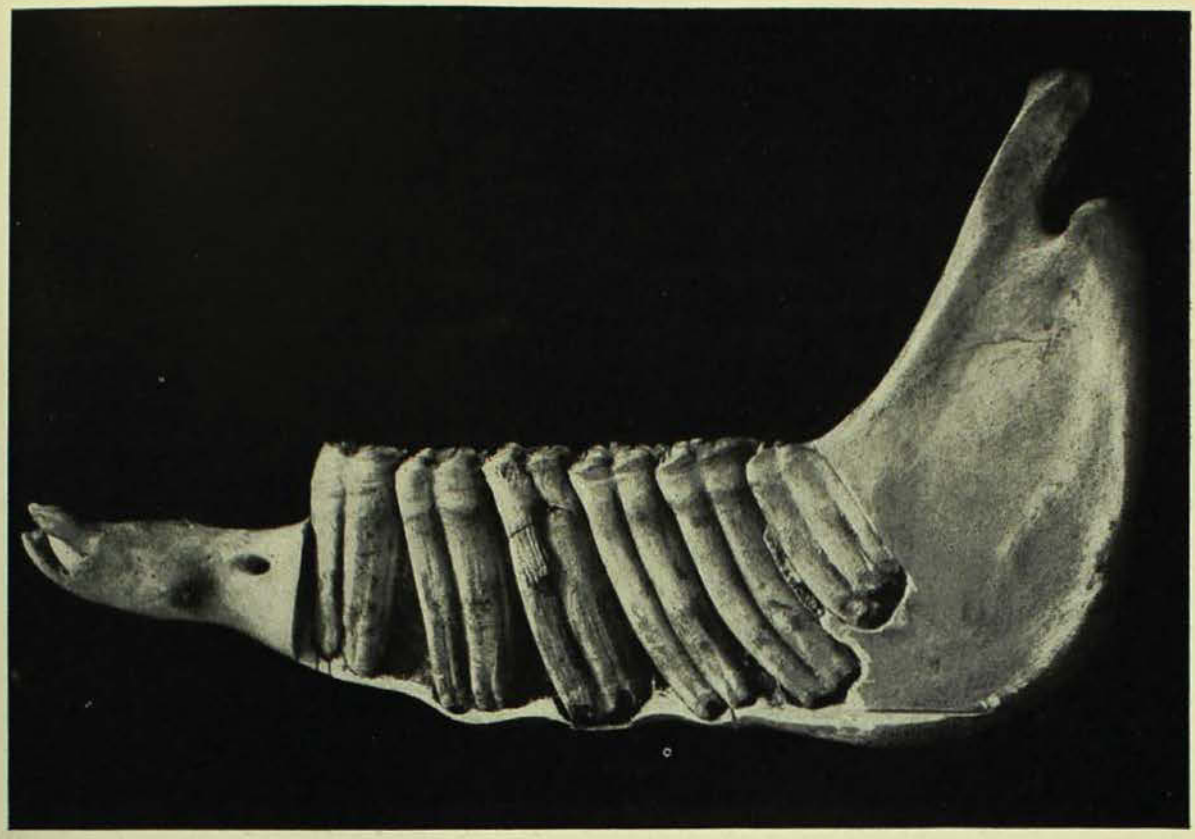
Stratified rocks, which are the hardened sediments of bygone geological periods, can be classified chronologically on the basis of their contained fossils, for it is clear that the lowest beds are the oldest, and the life forms found therein are therefore older than those contained in higher beds. Geologists have thus been able to divide the earth's history into volumes and these volumes into chapters. The earliest volume, containing the story of life's beginning, is the Palaeozoic. That was followed by the Mesozoic or Age of Reptiles,* which gave place to the Cainozoic or Tertiary, the period of modern life. The Tertiary is divided into four chapters, which in order of decreasing age are termed Eocene, Oligocene, Miocene, Pliocene. These were followed by the Pleistocene or Glacial period which immediately preceded our own epoch. The oldest known horse ancestors were found in rocks of Eocene age, and throughout this immense period of time, extending over millions of years, we can trace the rise and development of the horse family from primitive animals no larger than a fox terrier, and presenting but few of the features which render the horse and its allies such a distinctive group.

STRUCTURE OF THE HORSE.

Before examining its pedigree we may discuss some of the special features which are presented by the organisation of the horse, for it is these that, in the long course of its history, have been evolved in response to the demands of environment. No part of an animal's structure reacts so readily to environment and mode of life as the teeth and the limbs, and we shall see that it is these features which in the horse present the greatest degree of specialization.

In its bodily contour it is distinguished by smooth flowing lines, so that a racing horse offers as little resistance as possible to the air.

*See "A Dinosaur Exhibit," *Austr. Mus. Mag.*, Vol. I., No. 10, 1923, pp. 314-9.

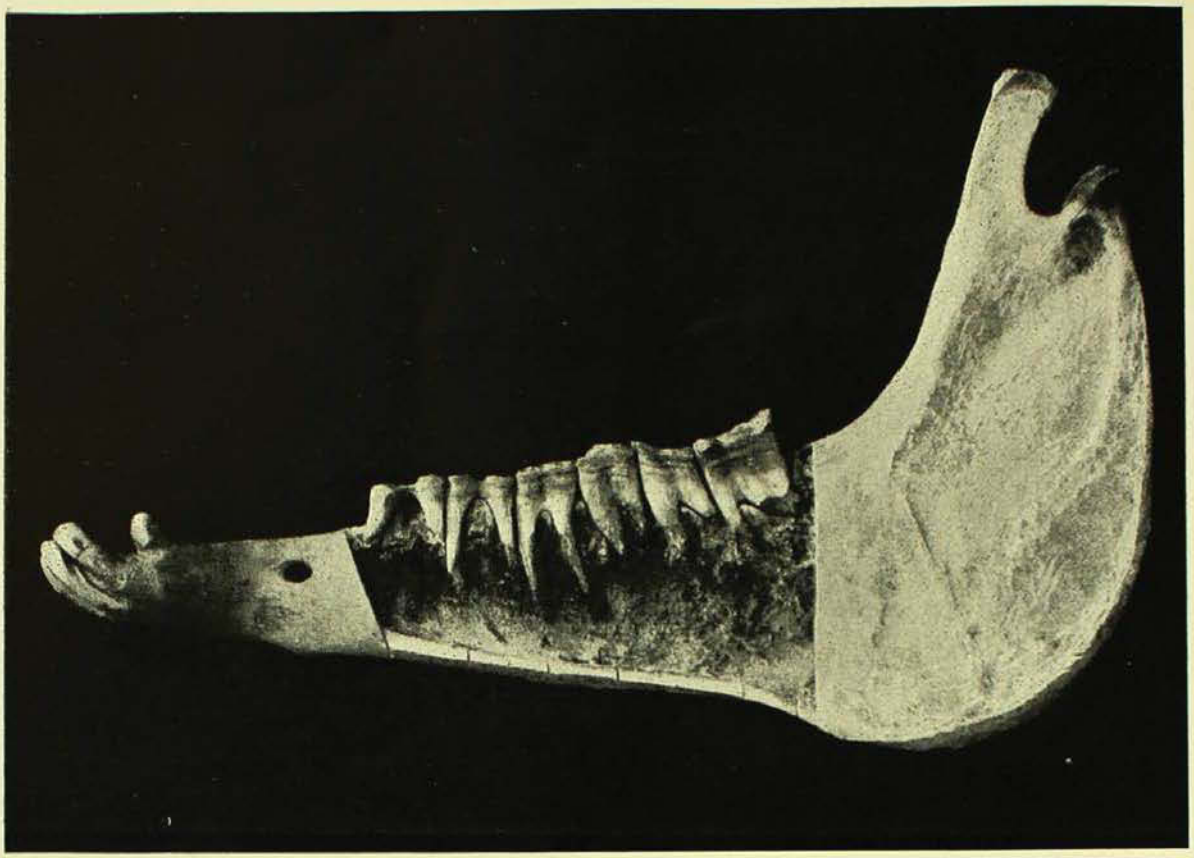


The lower jaw of a modern horse (Equus caballus) about four years old, the bone cut away to show the embedded parts of the grinding teeth. The teeth are still open below as the roots are as yet unformed. The long pillar-like teeth mostly extend for the full depth of the jaw, which shows slight protuberances where the lower ends of the teeth press on the bone. The third permanent tooth has not yet replaced its " milk " predecessor, and the last molar is just erupting. Australian Museum specimen.

[Photo.—*G. C. Clutton.*

Its legs are long and the lower part is slender, the great muscles being concentrated high up near the body. Its limbs terminate in a single digit (finger or toe), which corresponds to the middle digit of an animal such as man with the normal number of five digits. The middle finger of the human hand consists of three bones jointed together and known as phalanges. These are joined to the bones of the wrist by a longer bone called the metacarpal, which with the metacarpals of the other four fingers forms the palm. The corresponding bones of the foot are called phalanges and metatarsals. Now the hoof of the horse corresponds to the human nail or the claw of a cat, but it is broadened to form a firm support, and the " frog " or cushion underneath acts as a shock absorber and prevents injury to the limb when the animal is speeding over hard ground. The terminal or third phalange is enclosed in the hoof and is succeeded by the second and first phalanges, the latter articulating with the lower end of the metacarpal or metatarsal bone, which is often called the cannon-bone. On each side of the cannon-bone is a long slender " splint," terminating below in a slight knob. These splint bones are exceedingly interesting, for they indicate quite clearly that the horse formerly had three toes; they are the rudiments of the metacarpals of the second and fourth digit. The horse then walks on the tips of the nails of its third finger and third toe, but the splint-bones found on each side of the cannon-bone in both fore and hind limb show that it had an ancestor with at least three toes. It will be noticed that the heel or hock of the horse is high above the ground and what is called the knee corresponds to our wrist.

The long neck and head of the horse are correlated with its length of limb, for otherwise the animal would not be able to graze in comfort. The face is long so as to allow room for the row of long pillar-like grinding teeth, the " marvellous dental battery," which is one of the most striking features in the skeleton of the horse. This length of face also raises the level of the eye, so that a



Lower jaw of a horse over thirty years of age. The teeth have moved upwards to compensate for wear, and only short stumps remain. The teeth now have long fangs and the roots are fully formed. Australian Museum specimen.

[Photo.—*G. C. Clutton.*

grazing horse has a wide view over the landscape and can detect an approaching enemy in good time.

DENTITION.

The teeth of the horse are remarkable for their great length. They are high-crowned, to use the language of comparative anatomy. The front teeth or incisors are adapted for cropping the herbage, and are so formed and placed that with the aid of the sensitive flexible lips they can grasp the shortest blades of grass, cutting them off as neatly as one could with a pair of scissors. There is a pit like depression in the grinding face of the incisors. This is called the mark, and, as it wears away with use, it is of importance as an indication of age. The canine tooth is poorly developed in the horse. It is always present in an adult male but is only occasionally seen in the female. Between the front and the back teeth of the horse is a wide gap or diastema, which is an important feature from man's point of view, for it permits the insertion of the bit, one of the main instruments in the subjugation of this noble animal.

The back teeth of the horse, the grinders or molars as they are called, are worthy of special notice. They are high crowned and columnar, and the grinding surface shows an intricate pattern consisting of enamel, dentine, and cement, three materials which differ markedly in hardness, so that differential wear produces wavy ridges of the harder enamel and a very efficient triturating surface is maintained. For some time the teeth remain open below and continue to grow, extending deeper and deeper into the jaw and also moving outward to compensate for wear. At about five or six years of age the limit of growth is attained, for no further growth is possible without actual perforation of the jawbone; the roots are then formed and the tooth is complete. But the outward movement continues, and to maintain this the whole tooth moves towards the surface, the socket being filled by a growth of spongy bone. Finally, should the animal live to reach its thirties, which is extreme old age in a horse, the magnificent, long, prismatic teeth of its glorious youth are reduced to mere stumps, which are finally shed. In

nature the processes of growth and wear are nicely balanced, so that the teeth last out the normal life of a horse, which is about thirty-four years.

MENTAL QUALITIES.

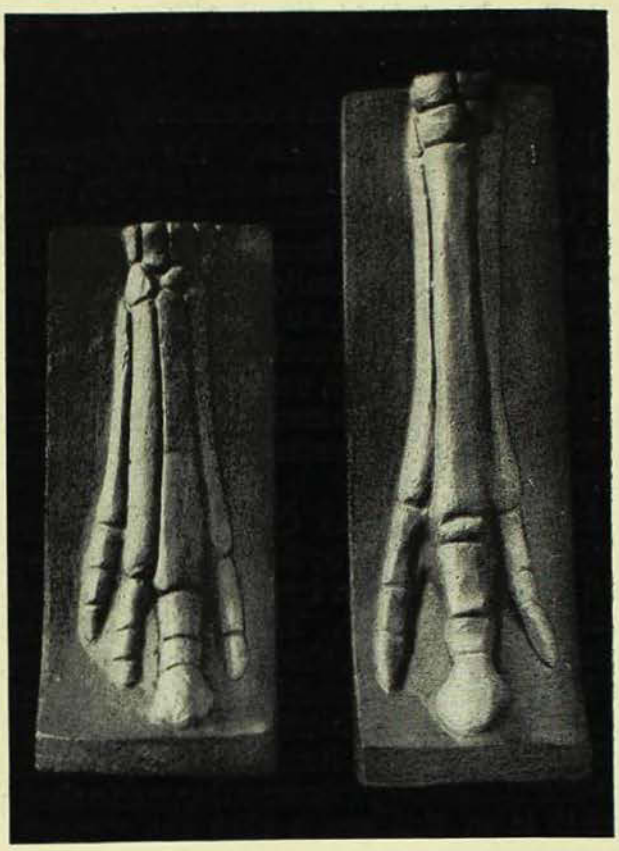
The brain is large and well developed, and the intelligence of the horse is proverbial. It is a nervous highly-strung animal, and when alarmed it instinctively takes refuge in flight. A bolting horse is but obeying a primal instinct, which, though it is often fraught with serious consequences to itself, its owner, and the innocent bystander, must have been of great advantage to its wild ancestors, for their safety lay in instant flight when need arose.

ANCESTORS OF THE HORSE.

The most primitive horse-like creature known is *Hyracotherium* of the London Clay, which is of Eocene age. Only the skull of this animal is known, but its teeth already foreshadow the complexity which characterises the dentition of the horse family. Of about the same age is *Eohippus*, the Dawn Horse, found in the Lower Eocene rocks of western North America. These two forms, the oldest known ancestors of the horse, were apparently very similar, and by some zoologists they have been regarded as generically identical. They were succeeded on both sides of the Atlantic by a long series of primitive horses, although the series is more continuous in America, whence it has been conjectured that America was the real centre of evolution and dispersion, the European forms being the result of migrations which took place at intervals when barriers were removed.

EOCENE HORSES.

Eohippus was about twelve inches in height and in general proportions it was more like a dog than a horse. Its fore foot had four complete digits, each with a hoof-like nail, the hind foot had but three, although a splint-like vestige of a fourth and, in one case, of a fifth, indicate that *Eohippus* had started on the line of digital reduction. There can be no doubt that it was descended from a five-toed ancestor, though, so far, this ancestral form has not been discovered.



Fore (left) and hind foot (right) of Eohippus venticolus the oldest known ancestor of the horse, from the Eocene of Wyoming. It was about as large as a terrier, and had four toes on the fore and three on the hind foot.
Australian Museum Specimens (Casts).
[Photo.—*G. C. Clutton.*

During the Eocene period the climate was warm and moist, and much of the land surface of the globe was covered with forests, though doubtless there were also extensive marshy stretches and spreading grassy plains. *Eohippus* was probably a forest dweller, and its spreading feet were adapted to carry it over the surface of soft boggy ground. Its teeth were much less complicated than those of modern horses, but, like those of *Hyracotherium*, they showed the promise of future complexity. It was evidently a browsing animal, living mainly on the foliage of shrubs and small trees.

THE MOUNTAIN HORSE.

Orohippus the Mountain Horse, also an Eocene form but later in age than *Eohippus*, shows an advance over its predecessor in the total loss of the splint of the fifth digit in the hind limb, the shortening of the outer finger, and the increase in tooth complexity.

Several genera of Eocene horses have been discovered but *Eohippus* and *Orohippus* are best known.

HORSES OF THE OLIGOCENE.

Following the Eocene, the Oligocene was characterised by increasing aridity, which led to a decrease of streams and lakes, forest and marsh, and an increase in prairie-like country. This diversity of environment—forest-land, meadow, and prairie—led to the development of several branches of the evolving horse family, some of which became extinct in the Oligocene, while others survived and were the ancestors of the Miocene horses.

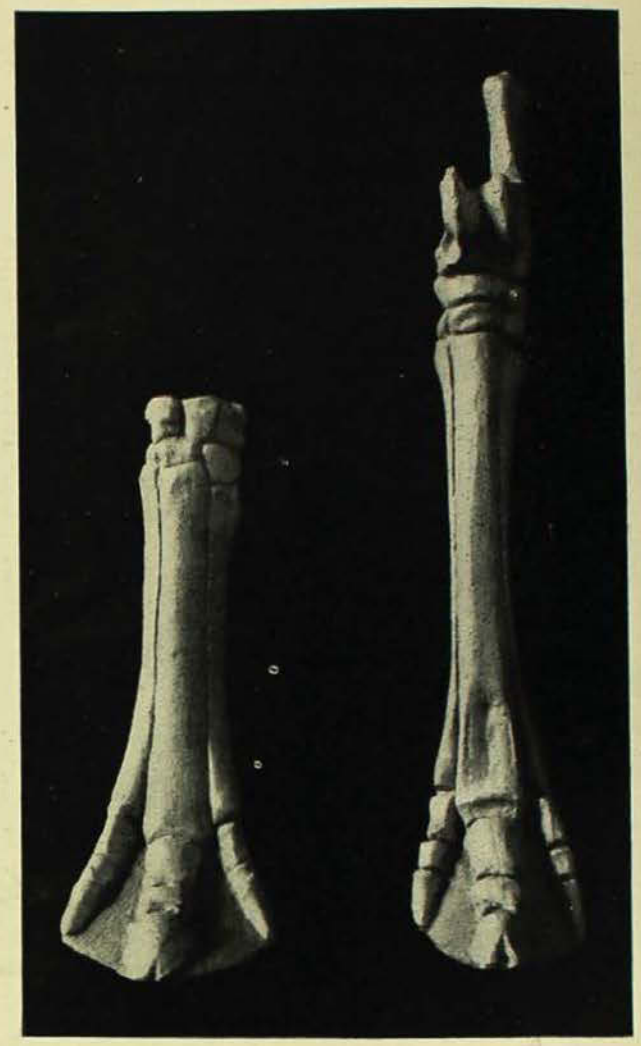
Mesohippus of the Oligocene had three functional digits on both fore and hind foot, and on the fore leg a long splint bone represented the fifth finger. The middle toe in each was much the largest, showing that the second and fourth were becoming less important; *Mesohippus* was definitely on the road which led to the one-toed horse of to-day. Some species of *Mesohippus* were as large as a sheep, and it is in this genus that the "mark," an enamel-lined pit in the incisors, makes its first appearance.

MIOCENE HORSES.

In the succeeding Miocene period the forest area was further diminished, and many browsing types of animals were unable to maintain themselves and became extinct, but the grazing forms adapted themselves readily to the new conditions and gradually became the dominant mammals. There were several Miocene horses. *Merychippus* is an important type, as it shows the beginnings of the transition from horses with short-crowned teeth without cement to those with long cemented molars specially adapted for cropping the hard dry grass of the prairie. It was three-toed with vestiges of the first and fifth finger, but the lateral toes were short and did not reach the ground, so that functionally it was a one-toed animal.

Hipparion, another Miocene horse, was a graceful creature, apparently very fleet of foot and adapted for life in semi-desert country. It was three-toed and ranged widely, for its remains have been found in Europe, Asia, and America.

Hypohippus became extinct early in the Miocene. It was an unprogressive forest dweller, its teeth fitted only for browsing on soft herbage. It had three toes, which spread widely, and the lateral hoofs were well developed. It was as large as a small pony, but, being unable to accommodate itself to changing environment, it perished.

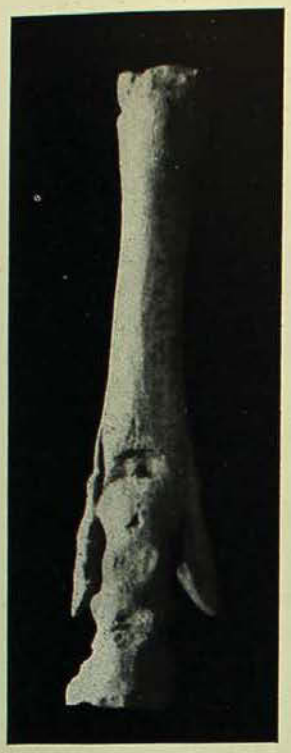


Fore (left) and hind foot (right) of Mesohippus bairdi, from the Oligocene of Dakota. It had three digits on each foot, but the middle one was much the largest. It was about as large as a Newfoundland dog. Australian Museum Specimens (Casts)
[Photo.—*G. C. Clutton.*

Pliohippus of the Upper Miocene was the first one-toed horse; it reached a shoulder height of ten hands (about forty inches).

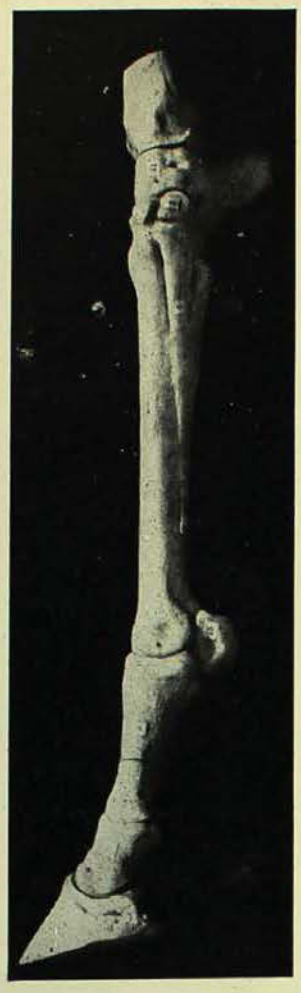
THE PLIOCENE.

In the Pliocene the climate became colder, many new land bridges were formed, and the faunas of countries previously separated by sea became intermingled. Now for the first time we find horses in South America, which had previously been isolated by the existence of an ocean stretch where the isthmus of Panama now joins the two Americas. The



Fore foot of Hipparion gracile, from the Miocene of Pikermi, Greece. This horse ancestor had three digits, but the second and fourth did not reach the ground.

[Photos.—*G. C. Clutton.*



Right fore foot of modern horse from inside, consisting of the middle finger and metacarpal (cannon bone). The " splint " on the side of the cannon bone is the much reduced metacarpal of the vanished second toe. Another splint on the outside of the cannon bone is the remnant of the fourth metacarpal. Australian Museum specimens.

earliest known South American horse is *Hippidion*, with short, stout, one-toed feet. It was succeeded by *Onohippidion*, which probably lingered on into the human period, though it was extinct before America was discovered by Europeans.

The modern horse, *Equus*, first appeared in the Upper Pliocene of Europe and Asia.

PLEISTOCENE HORSES.

In the early Pleistocene there were several species of horses in Europe, Asia, Africa and America, but they became extinct in North America, so that the present race of horses (including asses and zebras) is descended from old-world forms. In America the horse survived the first onset of glacial conditions but succumbed shortly afterwards. Apparently European horses also became extinct during the Pleistocene, but the family survived in Asia and Africa. Why European and American horses should have perished utterly in the Pleistocene is more or less a mystery. Glacial conditions alone do not account for their disappearance, and it has been suggested that they were carried off by some insect-borne disease.

MODERN HORSES.

Several species of the horse family still exist in the wild state in Asia and Africa. The Tarpan, or Prejvalski horse, which inhabits the Gobi Desert of central Asia and the neighbouring regions, is the only true wild horse now extant. This steppe type resembles a big-headed pony, with a short erect mane and of a general dun colour. The Kiang of central Mongolia and Turkestan comes close to the true horses, though it is very ass-like in appearance. The zebras are exclusively African and two species are recognized, while a third, the quagga, is recently extinct. The wild ass still lives in the tropics of Africa, there being two varieties, the Nubian Ass and the Somali Ass, The ass has been domesticated since the earliest times, and as a beast of burden is second only to the horse, though it is inferior in this respect to the mule, which is a hybrid between the horse and the ass.

Domestic breeds of horses have been derived from several wild types which have since become extinct as wild species. It is fairly well established that three types of horses are represented in our domestic breeds. One is the Celtic pony, or plateau type, found from Iceland to western Norway; it is buff coloured or mouse gray, with a short face, slender legs, and small hoofs. The Norse yellow dun is evidently related to the Mongolian horse, but it is a larger animal. It is the main stock from which the domestic horses of north-western Europe have been derived, The third type is the Arab or barb, *Equus africanus*, usually bay or chestnut in colour, with small head and graceful limbs; it is a swift high-spirited animal, and from it has descended the modern thoroughbred.

The Story of the Freshwater Eel.

By H. K. Anderson and G. P. Whitley.

ONE of the most romantic of Dame Nature's secrets, and one which she has been particularly slow in revealing, is the mystery of the life story of freshwater eels (*Anguilla*). Their method of propagation has, until quite recently, been a great puzzle to naturalists, because no eels have been observed breeding in fresh water.

HISTORICAL.

Long ago, Aristotle, the father of natural history, noted that eels could crawl on dry ground, that they made their way down from marshes and rivers to the sea, and that they were neither male nor female, having no eggs at all. He thought that eels arose from the " entrails of the earth," *i.e.* worms. Curious worms known as *Gordius* are sometimes found in ponds and streams ; they are like long tangled black threads, and live, when young, as parasites in insects. On the death of their hosts they make their way into water where they lay their eggs. Observing these aquatic worms, the ancients came to believe that horsehairs, if soaked in water, would eventually give rise to eels, a belief which is still prevalent in some of the obscurer rural districts of Europe.

Large eels were assumed to be females, although the inconspicuous ovaries with their minute contents were not discovered until 1707. The males, however, were not recognised as such until Dr. Syrski, an Italian naturalist, identified them in 1873.

THE " TADPOLE " OF THE EEL.

It has long been known that eel fry, about 2½ inches long, termed elvers, make their way from the sea into the mouths of rivers, which they ascend at certain seasons in great numbers, forming what is known as an eel-fare, but, for a long time, no earlier stage in their life-history was known.

At intervals, however, curious, transparent leaf-shaped fishes, called " glass eels " or *Leptocephali*, were obtained in the Mediterranean Sea, and, whilst evidently related to eels, were regarded by some naturalists as freakish little monsters whose development had in some way been arrested. Some forty years ago, however, a French zoologist, Yves Delage, kept a glass eel in an aquarium, and was surprised to find that it shrunk in size, lost its transparency, and eventually developed into a little conger. Later, two Italians, Grassi and Calandruccio, had a similar experience with another species of *Leptocephalus*, which became a typical elver. Thus was discovered what Sir Ray Lankester has called the " tadpole " of the freshwater eel.

Since all the glass eels obtained up to the end of the nineteenth century were collected from the Mediterranean, it was supposed that the European eel spawned there, and at that time such an hypothesis was quite feasible. But in 1904, two were captured in the Atlantic Ocean, and an unexpected complexity confronted those who thought that an answer to the " eel question " had been found.

LIFE OF THE EUROPEAN EEL.

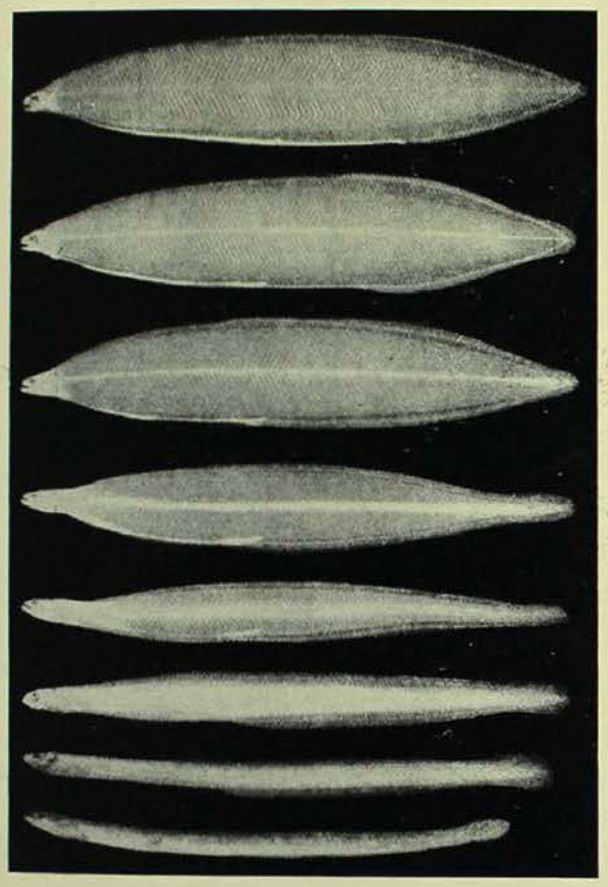
As eel fisheries are of great importance in Denmark, the Danish Government selected Dr. Johs. Schmidt of the Carlsberg Laboratory, Copenhagen, to investigate the problem in detail. This he has accomplished, after many years of patient and difficult work.

Briefly stated, the following is the life-history of the common eel of Europe (*Anguilla vulgaris*), as traced by Dr. Schmidt.

The eels, having attained a large size in fresh water, seize the first opportunity to migrate to sea, and, guided by instinct, make their way to a locality, hundreds of miles from their home streams, situated in the western Atlantic Ocean, north-east of the West Indies. Here the eggs are evidently deposited (it is claimed that a six pound eel produces nine million eggs), but there is no record of the survival of the parents, which, having fulfilled their destiny, are seen no more.

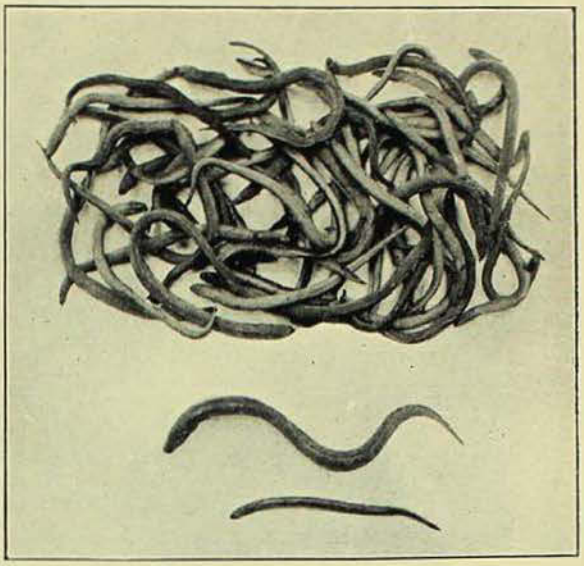
The newly-hatched glass eels, one-quarter to half an inch long, live for a few months at depths of about 650 to 950 feet. After growing to a length of about one inch, they come to the surface and commence their

long journey to the coasts of Europe. At the end of a year, the little travellers are about two inches long, and most of them have reached the central Atlantic. Thousands are devoured by fishes and other animals on the way, but, a year later, the survivors, still retaining their transparency and leaf-like shape, are nearly three inches in length, and have almost reached their destination. Next, they actually decrease in length and height, assume the elver form, and make for the mouths of rivers.



The topmost figure shows a full-grown Glass Eel or Leptocephalus from the Atlantic; the two lower ones are Elvers. The intermediate stages in the transformation of the larvae are clearly shown in this series. About three-quarters natural size.
[After *Dr. Johs. Schmidt.*

The males stay in freshes, and rarely grow longer than 18 inches. The females, however, ascend even the smallest steams, penetrating hundred of miles inland, stocking rivers and water-courses *en route*. Arrived at a suitable place, they feed and grow as "yellow" eels for a number of years, which varies according to conditions. When nearing maturity, they become fat and silvery and, the migratory instinct asserting itself, make their way seawards once more, travelling, nobody knows for how long, to the far-away waters of the western Atlantic, there to lay their eggs, and there to die.



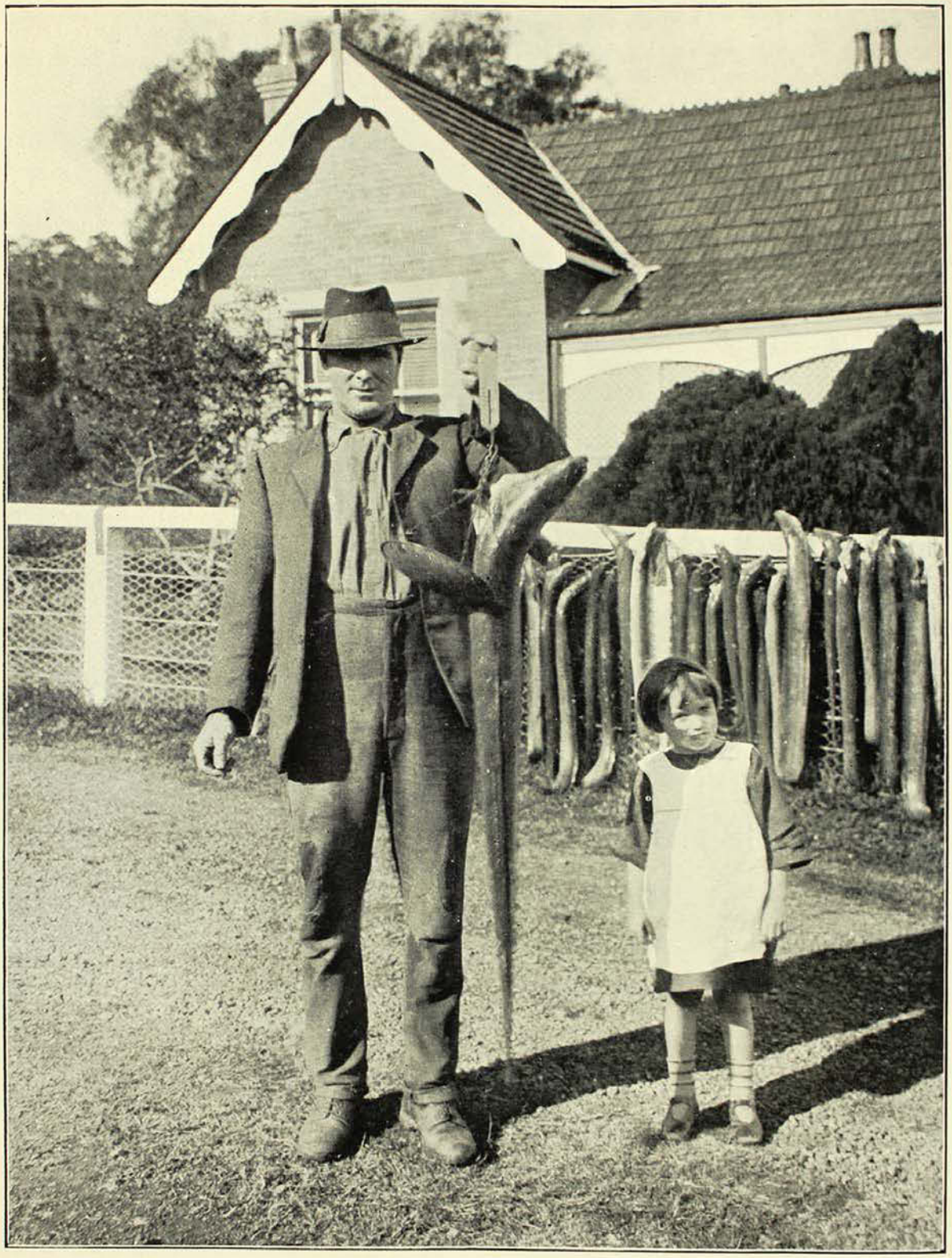
Young Eels, which have ascended freshwater as far as Prospect, New South Wales. These have passed the elver stage, and are four to six inches long.
[Photo.—*G. C. Clutton.*

The American freshwater eel (*A. rostrata*) has a similar life-history. Its breeding place is a little to the south-west of that of the European eel, but the larvae of the two species intermingle in some parts. The glass eels of the American species have not nearly so far to travel as those of the European, so that they take only about a year to attain the elver stage.

AUSTRALIAN FRESHWATER EELS.

There are several species of freshwater eels known from Australia, the commonest being the Long-finned Eel (*A. reinhardtii*) and the Short-finned Eel (*A. australis*). With the exception of a few eels caught at Roebuck Bay, Western Australia, and others introduced into the Swan and Avon Rivers, freshwater eels are known in Australia only on the eastern slopes from Cape York to Victoria and Tasmania, a few trespassing over the south-eastern boundary of South Australia. Eels have been caught at Bourke and Wilcannia, western New South Wales, but they probably travelled by land and water from the coast.

Many seaward migrations of eels from Prospect Reservoir have occurred. At comparatively long intervals, when abnormal rainfalls have filled the reservoirs to overflowing, countless numbers of eels, up to fully fifteen pounds in weight, escape over the



During an overflow of Prospect Reservoir last June, large numbers of Long-finned Eels made their way towards the sea in order to lay their eggs. Many were captured, and a few of them are shown here. The one on the scales weighs fifteen pounds. Our freshwater eels are good food-fish, and the study of their life-histories is not only of great scientific interest, but is also of economic importance.

[Photo.—*J. W. Morris.*

by-wash at Prospect Dam and make their way down the creek to George's River and thence, probably, to Botany Bay. Some idea of the magnitude of these migrations is conveyed by the fact that many cartloads of eels are collected from shallow pools along the creek, their weights ranging from three pounds upwards. As a rule, the overflow is of short duration; the last occurred on 25th June, 1925, and lasted only a few hours, but eels weighing approximately half a ton were then collected for Dr. Schmidt, who has been investigating Australia's freshwater eels for the last two years. Further specimens are, however, needed, and would be welcomed at the Museum.

GLASS EELS AND ELVERS IN NEW SOUTH WALES.

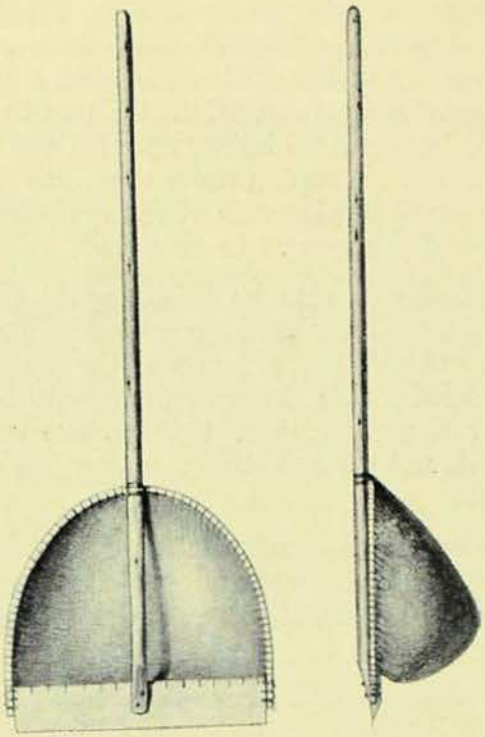
At various times, glass eels have been washed upon our beaches; practically nothing is known concerning them at present, but some of them are doubtless the young of marine eels.

Mr. F. A. McNeill of the Australian Museum is apparently the only person who has collected elvers in New South Wales and preserved them for scientific use, but it is hoped that this example will soon be followed by others. He found them under flat stones between tide-marks at Coogee Bay in March 1922, not far from the outlet of a storm-water pipe which opens onto the beach. Though no water was running at the time, the elvers perhaps detected faint traces of fresh water which had percolated through the sand, and were evidently waiting for an opportunity to leave the sea for inland waters.

It is recorded that hundreds of small eels, about the size and thickness of a lead pencil, were observed during the 1917 Christmas holidays climbing up the concrete face of the Goulburn water supply weir, whilst a similar occurrence was witnessed in 1912 at Moonee Moonee Creek, Hawkesbury River, where large numbers of small eels climbed the slippery face of the rocky fall which prevents further inland encroachment by sea-water. Elvers have also been observed travelling up a stream which enters the sea at Maroubra.

HOW YOU CAN HELP.

Before anything definite can be pronounced concerning the life histories of our freshwater



An approved type of net for catching elvers. The close-meshed netting is attached to a wooden frame-work, the base-board of which is thirty inches long.

eels, it is very necessary that large numbers of specimens of all sizes and species be secured for detailed investigation. That elvers visit our shores in early summer is fairly certain, so that there is no time like the present for trying to secure them. Dr. Schmidt has kindly supplied us with the following instructions, drawn up by Captain G. Hansen, of the Research Steamer "Dana."

"Elvers can be caught with a shrimp net in the following manner. Hold the net pointing downwards as for shrimping, with the straight, front side pressed well down, following the bottom so closely as always to bring up some of the sand or other material, as the elvers bury themselves some way down in the bottom.

"The net must also be pushed along at a pretty good pace, so that the water flows through the meshes briskly. After walking a little way in this manner, lift the net *smartly* out of the water, otherwise the elvers will escape.

"In order to use the shrimping net, the bottom must be fairly level, whether it be sand or grass.

"Elvers can also be caught in other ways, by lifting stones that are settled fairly deep

in the sand. The stone must be lifted away with a quick movement, and there may at times be a number of elvers in such a spot, so that quickness is essential. Where there are many, they can be bailed up with the hands, for instance, scooping them over into the net, which must be placed in readiness beforehand close to the stone to be removed.

" They can also be taken with tweezers before they have again burrowed down into the sand or gravel where the stone was embedded ; this, however, can only be done where there are few ; if there are many, it is better to scoop them up by hand into the net.

"Where small waterfalls occur, one may often find elvers crawling up the stones at the side of the fall, where the water splashes over ; in such cases, it is best to take them with tweezers.

" Elvers are found as a rule at the outlet of all fresh water channels flowing out into the sea, also far up in little streams and ditches."

Elvers evidently pass up the streams only for a few days in each year, and if any of our readers should secure a hundred or so and send them, packed in moist rags, in tins or bottles, to the Director of the Australian Museum, they will materially assist scientific investigation. From such specimens, valuable data may be gleaned, and a further stage forward will be reached in the unravelling of the life-history of a fish which is not only of interest scientifically, but which may, in the future, be more highly esteemed as food.

Primitive Initiation.

By W. W. Thorpe.

INITIATION ceremonies, having for their object the elevation of young men or boys to the status of manhood, play an important role in the lives of almost all primitive peoples.

The institution of " men's houses " is intimately connected with these ceremonies. Women or uninitiated men are not allowed to enter or approach these buildings and various adjuncts, such as bull-roarers, masks, carved figures and other totemic symbols, are used to awe and warn off intruders, and to enhance the solemnity of the sacred precincts.

The object illustrated in our frontispiece is one of the devices for impressing the neophyte, and also serves to perpetuate the memory of a deceased tribesman. It formed part of the furniture of a " tamborang " or ceremony house on the Keram, a tributary of the Sepik River in the Mandated Territory of New Guinea. The most important part of this curious object is a human skull, which, except for the frontal region, is covered by a mass of resinous material. The nose is produced into a proboscis resembling the snout of a pig, and for eyes it has perforated plates of nautilus shell. On the crown of the head are sections of this shell and several pig tusks. The whole is supported on a plaited cane background, which is covered with a thick coating of the resinous substance, in which are embedded pig tusks, seeds, and shells. The object has a fringe of cassowary feathers and fibre.

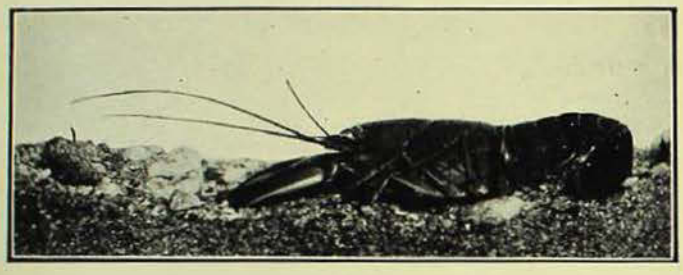
During initiation ceremonies the boys are instructed in tribal history, the tactics of war and the chase. They are taught respect for their elders, obedience to authority, and the etiquette of social observance, especially as regards marriage laws. In the Pacific a young man's fancy must not turn lightly to any charmer, for the tribal laws circumscribe his choice and decree that he can marry only into certain groups.

Often the candidates for initiation are isolated for a considerable period, and fasting also forms part of the ritual, the object of which is to impress on the youth the importance of the step he is about to take. So in the days of chivalry the new knight had to submit to fasting and bathing, and to hold a midnight vigil in the church. The young men are encouraged to believe that the elders who conduct and stage manage the ceremonies are in constant association with spirits, which belief has a powerful influence in lending authority and permanent effect to their teaching.

Observations on the Yabbie (*Parachaeraps bicarinatus*)

By Herbert M. Hale.

MOST boys, at one time or another, have experienced the joys of fishing for Yabbies—the procedure is almost too well known to need description, A piece of meat on a string is lowered into a creek in which the crustaceans are known to reside ; after a time it is gently raised to near the surface and a net is slipped beneath the

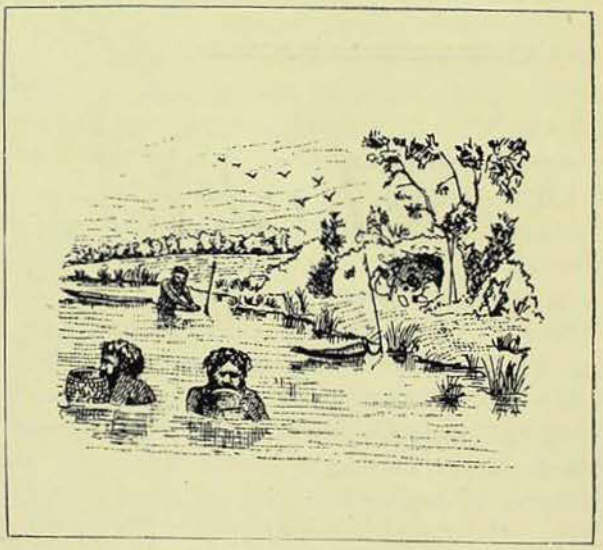


The Yabbie in an aquarium.

[Photo.—*H. M. Hale.*

clinging crayfish, depriving them of meat and liberty at the same time. The Yabbie is also known popularly as the " Crawlie " or "Yabber," and is one of the most commonly occurring, and certainly the best known, of the crustacea inhabiting the fresh-waters of Australia. It is, in fact, the most widely distributed of our fresh-water crayfishes but, while found nearly all over the continent, it does not occur in Tasmania ; it lives in the interior and also in coastal streams and pools in which the water is often brackish. The one-time extensive lagoons and backwaters of the River Murray in South Australia harboured the species in considerable number, but, since the comparatively recent reclamation of Murray lands, it is rare over certain areas. It was, for a time, plentiful in the irrigation drains there, and was a source of annoyance and expense owing to its persistent habit of burrowing into the banks and sides of the earth barriers. The River Murray aborigine found the yabbie palatable, and T. Worsnop, in his book *The Aborigines of Australia* illustrates the method of capture adopted by the native. This writer remarks : " The fisher puts between his teeth an ordinary rush bag, to hold the crayfish, which he first dislodges with his toes and then catches them with his hands, bagging them rapidly." This mode of operation would doubtless appeal more to the aborigine than to the more tender-footed white man. The European Perch has been introduced into some of the South Australian rivers and has therein destroyed great quantities of the endemic yabbie ; fishermen, knowing the partiality of the perch for this food, use small examples as bait, and these are eagerly taken when the fish are feeding.

The colouration of the adult yabbie varies very considerably ; some examples recently received alive from Broken Hill are of a remarkable pale pink shade, others are almost black. The soil in this locality presents a good range of colour, and a resident, Mr. F. W. Shepherd, writes that the colour of the yabbies is always similar to that of the situation in which they are taken. Thus, in Stephen's Creek they are dark blue, in the Tramway Dam delicate pink, in the Imperial Dam pale brown, and in the Redan Dams reddish-yellow. A backwash of the Imperial Dam is full of black, decaying vegetable matter, and here black specimens are found.

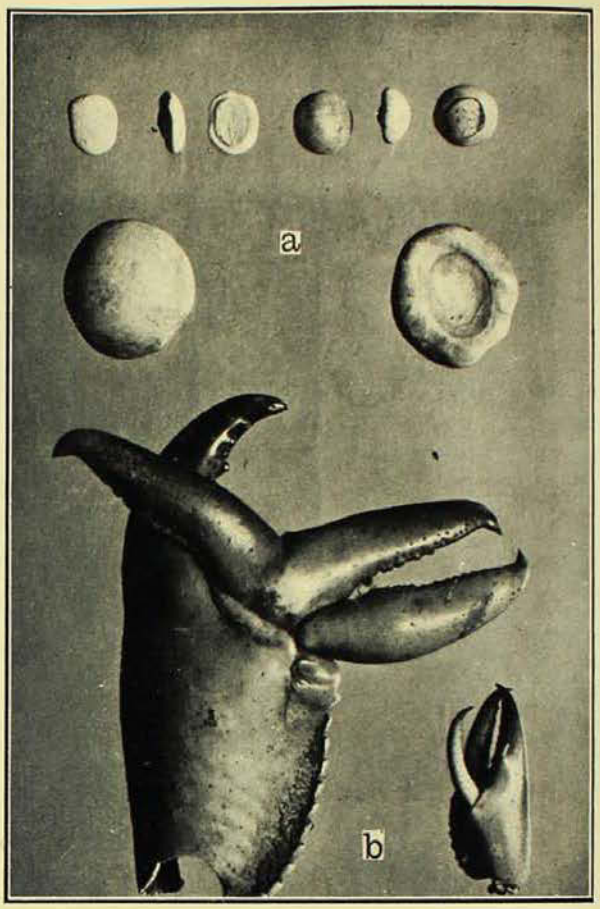


Natives of the Murray River fishing for Yabbies.

[After *Worsnop.*

The exoskeleton or " shell " of the yabbie, like that of other crustacea, is never perceptibly elastic after it has hardened, nor does it increase in size ; to allow for growth the animal has therefore to periodically cast off its old covering and form a new, and larger, shell. Moulting is frequent in the young stages, but it is probable that as the maximum size is approached the act is seldom performed. Before a moult is undergone the flesh becomes very flabby, so that the muscles of the legs and other appendages may be withdrawn from their sheaths. The yabbie draws itself out of the shell through a comparatively small split, the discarded exoskeleton being surprisingly complete. After the moult the animal is without any adequate means of protection, for the large claws have the consistency of wet paper, and the new covering, which was previously formed beneath the now abandoned shell, is weak and thin. At this stage water is absorbed and the crustacean quickly increases in size ; then the covering is gradually hardened by the deposition of calcium carbonate and other salts of lime. In the fresh-water crayfishes several discoidal nodules of limy matter are formed a little time before a moult takes place ; these are stored in the cavity of the stomach and after moulting are broken up and dissolved, apparently to supply some of the calcareous material necessary for the strengthening of the new integument. These limy masses or " gastroliths " have a characteristic appearance, but have often proved puzzling to persons who have encountered the objects under circumstances giving no clue as to their identity. For instance, some years ago a man found a number of gastroliths of yabbies in the excrement of shags, and quite recently two large gastroliths, which are in the possession of Dr. A. Chenery, were taken from the stomach of a Murray Cod captured in the River Darling (see photograph). Considering the size of these nodules as compared to those of the yabbie it seems almost certain that they were formed by a Murray Lobster (*Astacopsis serratus*) which was probably devoured by the fish soon after the crustacean had undergone a moult ; the undigested gastroliths would, in such case, constitute the only " identification discs " of the crayfish.

Gastroliths were noted in the European crayfish a very long time ago ; they were popularly known as " crab's eyes " or " crab's stones " and were at one time used in medicine for absorbent and antiacid purposes. Two centuries ago the illustrious French naturalist Reaumur observed that the crayfish when ready to moult has always two stony substances in the stomach, which appear destined to furnish at least part of the matter of which the new shell is formed, for, if the animal is opened the day after its moult, when the shell is only half hardened, these substances are found only half diminished, and if opened later they are proportionately smaller.



(*a*) Gastroliths, or " stomach-stones " of Australian fresh-water crayfishes ; the six small nodules were taken from Yabbies, and the two large examples probably came from a Murray Lobster. (*b*) Malformed claws of two Yabbies. All slightly more than half natural size.

[Photo.—*H. M. Hale.*

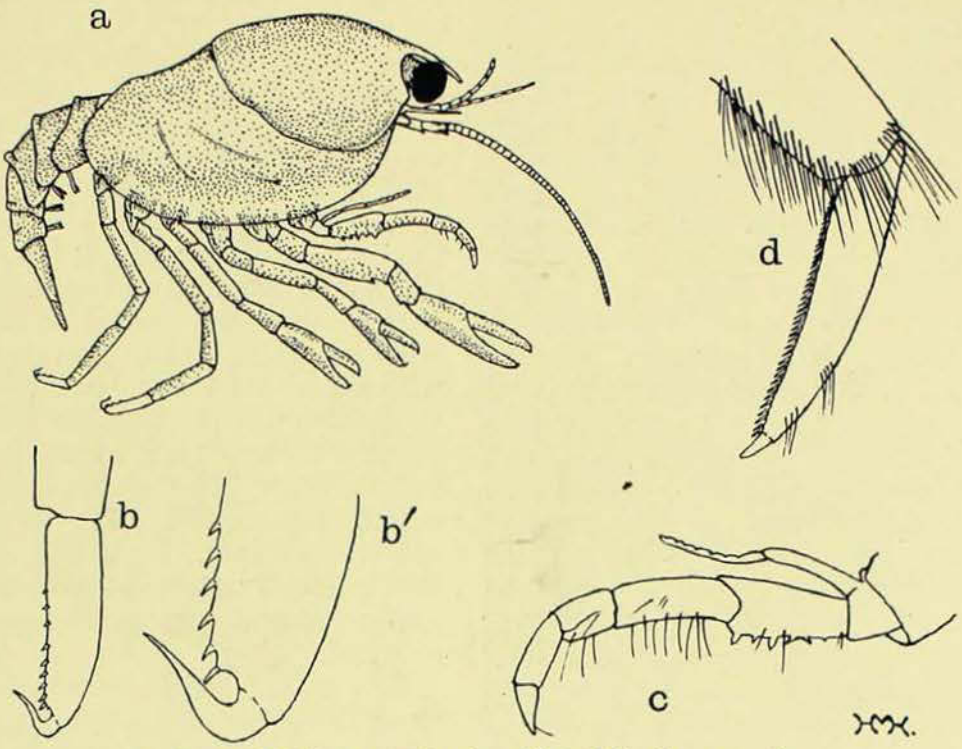
It is a well known fact that if some crustaceans are grasped by one of the larger legs, or if such a limb is injured, the animals are able to cast off the affected appendage at the smallest segmental connection. If one of the large limbs is injured it is automatically disconnected at the weakest point by a reflex contraction of the muscles—otherwise the crustacean may bleed to death. The smaller area thus ruptured quickly heals over and,

normally, the lost part is gradually reproduced, increasing in size at each moult and eventually attaining its proper character and proportions. Occasionally, however, under circumstances not altogether understood, the process of regeneration may go wrong and various malformations and abnormalities result. It is said that deformities are usually due to injury received soon ofter a moult, while the exoskeleton is in a soft state. A deformity may be perpetuated, notwithstanding further moults, and so become a permanent character of the individual concerned.

The accompanying photograph shows the result of injury to one of the large chelipeds or nippers of two yabbies. The larger claw is that of a very large specimen. In this the movable finger is tridactylate or composed of three branches ; the three components or fingers are soldily fused towards their inner ends, and their common base is so connected with the much enlarged and distorted articular opening as to allow slight movement. This nipper is useless, as the inner member of the deformed portion obliquely crosses the thumb or immovable finger ; the two outer fingers are in apposition, but are, of course, inoperative. The smaller nipper appears to have been injured at the base of the movable finger ; from this point has grown a narrow scythe-shaped, movable, but quite useless finger, which is not of characteristic form. A sharp curved spine, not present in typical examples, springs from near the base of the thumb and, owing to slight distortion of the lower part of the hand, the tips of the normal finger and thumb are crossed.

The young of the fresh-water crayfishes, when first hatched, have much the form of the adults, whereas the related marine lobsters commence active life as tiny pelagic creatures which bear little or no resemblance to their parents. The young crayfishes are moderately inactive and cling beneath the abdomen or " tail " of the mother until they have moulted for the first time since emerging from the eggs. Female yabbies with eggs attached to the underside of the abdomen are commonly taken on baits, but those with young, so far as I am aware, are seldom taken thus. Mr. Shepherd kindly sent me a preserved female yabbie from Broken Hill with the young attached to the abdominal appendages or swimmerets ; Mr. Shepherd writes : " During many years sojourn on the Barrier I have, with various parties, visited most of the dams and water-holes within a twenty-five mile radius of Broken Hill for the purpose of obtaining yabbies. Whenever we want a female with young we go out in March, or at latest April, and search under stones in the water or in yabbie holes, and this is where these females are to be found. On no occasion have I caught in a net a yabbie with the young attached to the swimmerets, but have often captured females with eggs. At this time of the year (March or April) most of the large males are about to cast their outer covering." The female forwarded is three and one half inches in length, and more than forty youngsters, each about five mm. in length, are attached to the hairs of the swimmerets, these immature specimens offer some interesting features.

The young of the European fresh-water crayfish (*Astacus fluviatilis*) has hooked tips on the three pairs of nippers, by means of which the young animal clings securely to the abdominal swimming appendages of the mother. After a time it moults, and the nippers lose their hooked tips. In the case of the young of our yabbie the nippers are not hooked but are merely slightly inturned as in the adult. Each little yabbie is, however, strongly attached by a special modification of the last two slender pairs of limbs, which in the adult are walking legs. In the young the last joint (dactylus) of each of these four legs has on the inner margin several spines, and terminates in a curved claw which, in conjuction with one of the spines, forms a veritable snap-hook, which clips to the hairs of the swimmerets of the mother and so securely anchors the little creature ; the marginal spines above the claw are downwardly bent, and doubtless serve to guide the hair or hairs into the hook. Thus, instead of clinging to its parent with its hands as does the European crayfish, our young yabbie hangs from the maternal life-line by its heels. In the adult the dactyli or terminal joints of the last limbs are very different, ending in relatively tiny, stout and straight claws. The mouth parts of the young are much as in the older stages, but certain of them (maxillipeds) lack the dense, plume-like feeding-hairs, which appear after the moult. The carapace is greatly distended owing to the fact that the body is crammed with



(*a*) Young Yabbie soon after hatching (12½ diams.). (*b*) Dactylus of walking leg, showing prehensile terminal claw (50 diams.) (*b'*) Terminal part of same dactylus (125½ diams.). (*c*) third maxilliped (25 diams.). (*d*) Dactylus of walking leg of small adult Yabbie (12½ diams.)

[*H. M. Hale, del.*

reddish-yellow food-yolk, and it would seem that, as the youngster is thus provided with food to maintain it until the first moult, the immature mouth parts are not used during this stage. The antennae or feelers are shorter and composed of a lesser number of joints, the first pair of nippers are relatively weaker, and the second and third pairs stouter, than in the adult. The penultimate segment of the abdomen has no outer plates or uropods, which with the shield-shaped terminal abdominal segment form the tail-fan of the adult. The uropods evidently appear after the first moult, for, on clearing and mounting the abdomen of the young, the tail-fan, complete with uropods, can be seen inside the exoskeleton of the last segment.

Fifty years ago it was pointed out that the young of a New Zealand crayfish do not cling to the mother with the large claws, but are attached by a prehensile hook on each of the walking legs—an arrangement similar to that obtaining in our yabbie. It would be interesting to ascertain if this modification occurs in the young of the other Australian and New Zealand species.

The unsightly corrugated iron sheds facing William and Boomerang streets have called forth comment from the Town Planning Association of N.S. Wales, and rightly so too. Reference to previous issues of this Magazine will show that the Trustees of this institution are at one with the Association in this matter. The sheds are not only unsightly, but they are white ant eaten, they leak, and, generally speaking, have out-lived their usefulness. Much as the Trustees would like to see them replaced with additions long overdue they are powerless unless Parliament makes the necessary financial provision.

Obituaries.

ALLAN R. McCULLOCH.

BY the death of Allan Riverstone McCulloch, which took place at Honolulu on September 1st, this Museum loses a most valuable officer, systematic ichthyology one of its foremost exponents, and many of us a very dear friend.

He was born on June 20th, 1885, and his association with the Australian Museum began in July, 1898. For three years he worked as a volunteer, and even in these early days he was distinguished for his enthusiasm, his ability, and his determination to succeed. For some years he was assistant to Mr. Edgar R. Waite, now Director of the South Australian Museum, Adelaide, who encouraged and helped him in his scientific work and developed his artistic talent. When in 1906 Mr. Waite left the service of the Trustees to become Curator of the Canterbury Museum, Christchurch, New Zealand, McCulloch succeeded him as Assistant-in-charge of the Vertebrate section, though he was then not quite twenty-one. By that time he had definitely resolved to devote himself to the study of fishes, and that became his life work, though he was interested and skilled in all branches of natural history and was recognised as an authority on decapod crustacea. He had a rare gift, almost a genius for taxonomic work, and, largely as a result of his numerous contributions, the taxonomy of Australian fishes has been placed on a sound basis.

Although not of robust physique he was full of courage, and more than once he had risked his life in the pursuit of knowledge. He had made several trips to the Barrier Reef and to various Pacific islands, generally in company with Mr. Charles Hedley, formerly of this Museum, and now Scientific Director of the Barrier Reef Committee. He had donned a diver's outfit and descended into the dangerous waters of Torres Strait, and readers of this MAGAZINE will remember his cliff-climbing exploits at Lord Howe Island, and his adventurous journey in Papua with Captain Frank Hurley in 1922.

His versatility was striking, and in any work he undertook he was never satisfied with the second best. He was an expert photographer, an accomplished artist and musician, and a delightful lecturer. The various scenic and habitat groups now exhibited in the Museum were largely planned by him, and owe much to his artistic ability. He was a splendid organiser, and had taken an important part in training the younger members of the staff, most of whom had at one time or another served under him.

He was a great worker, and by his unremitting toil, often far into the night, he had seriously undermined his constitution. For two years his health had been in a very unsatisfactory state, and at the time of his lamented death he was on long leave, granted by the Trustees in the hope that his health would be restored. He left Sydney to attend the Second Pan-Pacific Food Conservation Conference, in response to frequent invitations, and all his friends hoped that the change would have a beneficial effect. This hope was not realised, and he passed away at the early age of forty, leaving a record of achievement rarely compassed in the full span of human life.

He was a member of the councils of the Linnean and the Royal Zoological Societies and his membership was so highly valued by his colleagues that they deferred acceptance of his resignation, tendered when he entered upon extended leave, hoping that the respite would enable him to return in invigorated health.

His was a bright and vivid personality and he was ever ready to help and cheer his comrades. He loved children and children loved him ; indeed his only relaxation seemed to be providing amusement for the little ones. Young and old who came into contact with him are left with happy memories of his charming companionship, and are immeasureably poorer by his passing.

At the monthly meeting of the Board of Trustees on September 4th, the Director. Dr. C. Anderson, feelingly expressed the loss suffered by the Museum in the death of Mr. McCulloch, whose scientific work he held in high admiration. The President, Dr. T. Storie Dixson, in endorsing these remarks, said that Mr. McCulloch suffered from an intense devotion to his work and was a martyr to his own enthusiam.

J. DOUGLAS OGILBY.

Mr. J. Douglas Ogilby, who had been seriously ill for the long period of five years, passed away on August 11th, at the age of 72. He was for many years recognised as an authority on Australian fishes and had contributed many papers on that subject to various scientific publications.

He was born at Belfast in 1853, and was the son of the well-known zoologist, William L. Ogilby, his mother being a Douglas of the Earl of Morton's family. He was educated at Winchester College and Trinity College, Dublin. For some time he was employed by the British Museum and later came to Australia, where in 1885 he became assistant in zoology in the Australian Museum. His most notable work while at the Australian Museum was his catalogue of Australian mammals published by the Trustees in 1892 and to this day regarded as being very valuable. He devoted his energies principally to ichthyology, and he had written a long series of papers on Australian fishes, which appeared in various scientific serials published in Sydney and Brisbane.

The last twenty years of his life were spent in Queensland, where for many years he acted as curator to the Amateur Fishermen's Association and was later appointed ichthyologist to the Queensland Museum.

Ogilby had a wide knowledge of the Australian fauna, and was gifted with a most retentive memory. His knowledge was always available to others, and many younger workers benefited largely by his experience and mature knowledge.

THOMAS STEEL.

Mr. Thomas Steel, F.L.S. who died on the 17th August, was an outstanding figure among Australian scientists. He was born at Glasgow in 1858 and was educated at the Greenock Academy and Collegiate School. He adopted the profession of Chemistry, and, after holding several appointments in Scotland, he came to Australia in 1882 and entered the service of the Colonial Sugar refining Company Limited, where he remained until his retirement in 1918.

Although he was a chemist by profession he was interested in many branches of science especially natural history, and was an ardent collector from his earliest years. He specially devoted himself to obscure and little-known groups and lines of investigation which had little attraction for most workers. He was recognised as an authority on planarian worms and *Peripatus* and had made a special study of fish *otoliths* of which he had amassed a large collection.

He took a prominent part in the activities of the various scientific societies of Sydney. He was for many years a member of the council of the Linnean Society of New South Wales of which he was president in 1905 and 1906. He was president of the Naturalists' Society in 1903 and editor of the *Australian Naturalist* since 1911.

Mr. Steel had been in indifferent health for some time and realising that his active and fruitful life was drawing to a close he recently transferred his extensive zoological and ethnological collection, the gatherings of many years, to the Australian Museum, together with a valuable series of books and reprints dealing with the subjects that had formed his special study. Only a few days before his death he wrote a long letter to the Director regretting that he would not be able to visit the Museum again, and giving the clearest and most detailed information and instructions regarding his collections, hoping they would be useful to some younger worker. For many years previously Mr. Steel had made various gifts to the Museum collections and his special knowledge of certain groups had always been freely placed at our disposal. In him the Museum loses a valuable contributor, and a very helpful friend. He was a most urbane and kindly gentleman, who was held in the highest esteem by all who knew him.

On 14th August a private screening of "The Lost World," the film version of Sir Arthur Conan Doyle's celebrated story, was conducted in the Museum Hall by arrangement with First National Pictures, Ltd. It was attended by Dr. T. Storie Dixson (President), Trustees, and an invited audience of about two hundred. The wonderful restorations of prehistoric monsters greatly impressed the audience.

The Perils of an Oyster.

By T. C. Roughley.

IT has been calculated that if all the eggs of oysters were to be fertilised and were to live and grow to maturity they would fill up an entire bay in a single season, while the fifth generation of descendants from a single female would make more than eight worlds as large as the earth, even if each female spawned but once.*

An oyster may, during each spawning season, eject several millions of eggs and of these probably not more than two develop into adults. The wastage that takes place during the development from the egg to the adult oyster is therefore enormous, and it is the purpose of this article to describe some of the factors contributing to the loss.

The early free-swimming stage of an oyster's life is its most hazardous period. We have seen in a recent issue of the Australian Museum Magazine that, when an oyster spawns, the eggs from the female and the sperms from the male are cast direct into the water after the manner of most fishes. They are at once at the mercy of wind and tide, they provide food for a host of other animals, and many adverse conditions may work for their destruction. Mullet (*Mugil spp.*) are often attracted to the region of the spawning oysters and the eggs and embryos are strained from the water and freely devoured. The number thus consumed, if allowed to develop to maturity, would probably have been sufficient to stock the whole river with a prolific crop. The survivors soon begin to swim but their movements are very feeble and they are carried about by currents which may take them out to sea or leave them stranded on the foreshores with each receding tide. Sudden changes of temperature and salinity kill off large numbers, and everywhere are the gaping mouths of molluscs, crustaceans, and numberless other animals waiting to absorb them. Daily their numbers diminish as the dwindling army battles on to that critical stage when the individuals must cease to roam, when they must either find some clean stable object in the water to which they may cement their shells or perish. They cannot swim powerfully enough to search for such objects but must trust to the fortunate course of the current to carry them to their vicinity. At this period the death rate must be very high ; large numbers settle on to mud or sand and are quickly smothered, others are carried backwards and forwards with the tide and never encounter any surface suitable for their future sedentary life.

The oyster cultivator now begins to take a hand. He cannot protect the swimming oyster from its numerous perils on account of its microscopic size, but by placing large quantities of suitable material in the water he does give many an opportunity to live in situations where they must have perished without his aid. Having once secured the fixed oyster, the cultivator can often assist it to evade its enemies or save it from destruction after it has been attacked.

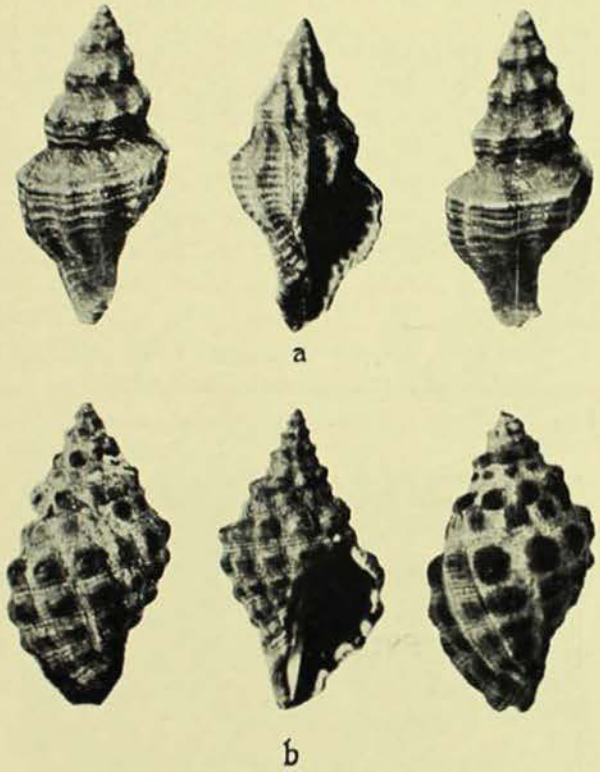
Oysters two months old destroyed by the Common Borer. Practically every oyster shows the small characteristic hole drilled by the borer's radula. Natural size.

[Photo.—*T. C. Roughley.*

*Brooks, "The Oyster," p. 50.

BORERS OR DRILLS.

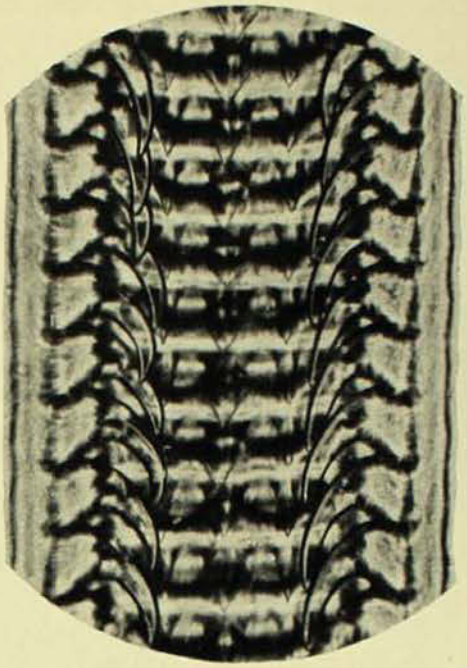
Probably the worst pest young oysters have to contend with is the boring whelk, a shell-fish provided with a tongue-like rasp, or radula, by means of which a hole is bored through the oyster's shell, the flesh then being extracted piecemeal through the opening. This radula is a wonderful adaptation of nature which allows quick and easy penetration of a shell, hard enough, one would imagine, to offer an effective resistance to the attacks of so small an animal. The mechanical drilling action is assisted by the secretion of sulphuric acid which converts the carbonate of lime of the oyster's shell into sulphate of lime and thereby greatly reduces its resistance. The hole made is clean-cut and circular in outline.



(*a*) The Common Borer (Xymene hanleyi). (*b*) The Black Borer (Drupa marginalba). These borers possess rasp-like tongues by means of which holes are drilled in the shells of oysters and the flesh is then extracted piecemeal through the openings. Natural size.

[Photo.—*T. C. Roughley.*

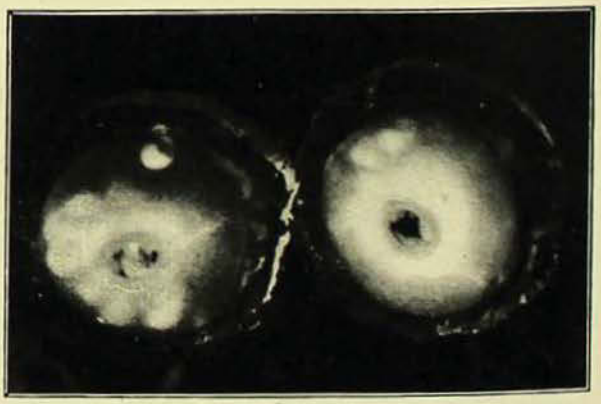
Oyster borers are most common where the salinity of the water is fairly high; they cannot withstand water of low salinity, and are therefore found in greatest numbers near the entrances of rivers or in those streams into which little fresh water flows. Fortunately, in such waters the crops of young oysters are usually very much greater than in those of lower salinity, for there is less



The radula of the Common Borer (Xymene hanleyi). By means of the minute horny teeth on this strap-like rasp, holes are bored through the shells of young oysters. Magnified 240 times.

[Microphotograph.—*T. C. Roughley.*

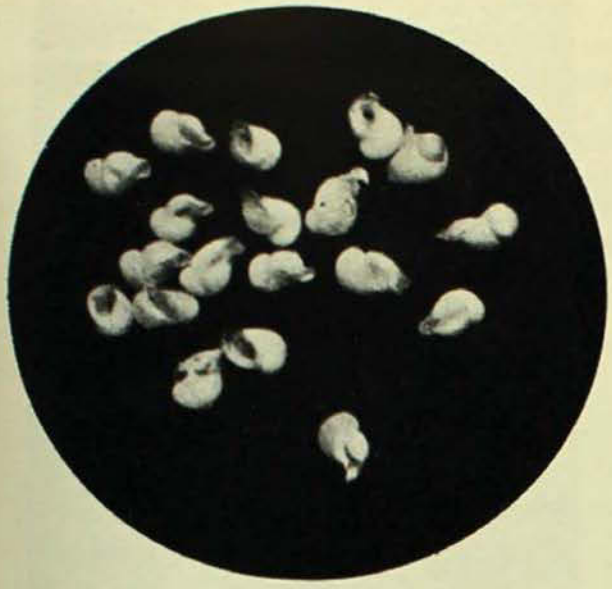
sediment in suspension, and the stones, sticks and other material which offer surfaces for attachment remain very much cleaner. It frequently happens that far greater numbers of oysters attach themselves than can ever grow to maturity owing to their overcrowded condition. The borers, however, quickly thin them out.



Egg-cases of the Common Borer (Xymene hanleyi). The eggs and developing larvae are protected by a semi-transparent membrane attached to shells and other objects in the water. Magnified 6 times.

[Photo.—*T. C. Roughley.*

An oyster cultivator can do little more than gather those borers he finds and destroy them by throwing them ashore well beyond high tide level or by dipping them into boiling water; the destruction of the eggs whenever found must also eventually result

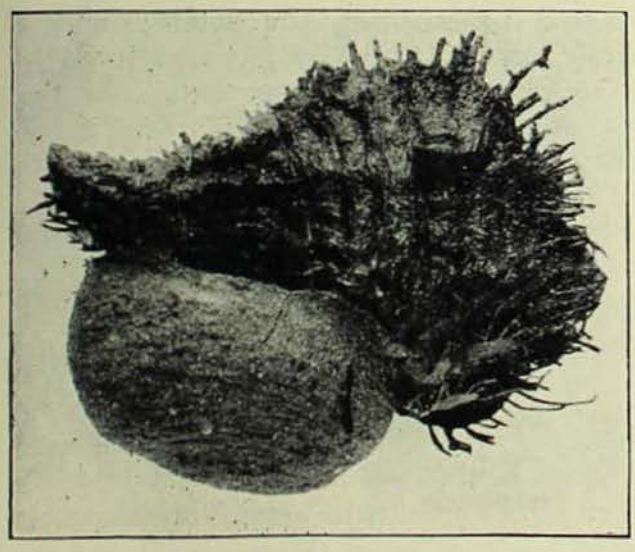


Larvae of the Common Borer (Xymene hanleyi). Upwards of a hundred larvae may be enclosed in each egg-case. Magnified 9 times.

[Photo.—*T. C. Roughley.*

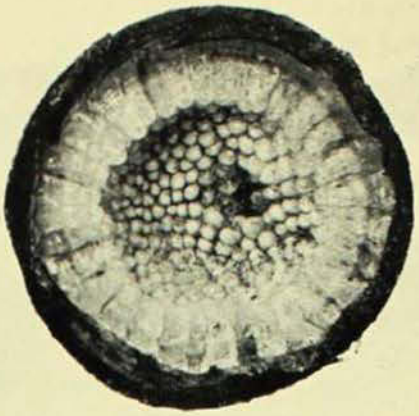
in a considerable reduction of their numbers. Heavy rain with resulting freshets either kills off the borers or drives them out to sea.

There are three species of boring whelks found on the coast of New South Wales: (1) the common borer (*Xymene hanleyi*), which grows to a length of about an inch, and deposits its eggs in dome-shaped capsules about one-eighth of an inch in diameter; these it attaches to the surfaces of oyster



The Hairy Borer (Cymatium parthenopeum) with egg-case attached. This borer makes a comparatively large hole and is capable of penetrating the shells of adult oysters. Two-thirds natural size.

[Photo.—*T. C. Roughley.*



The interior of the egg-case of the Hairy Borer. The eggs are contained in the conical semi-transparent capsules. Natural size.

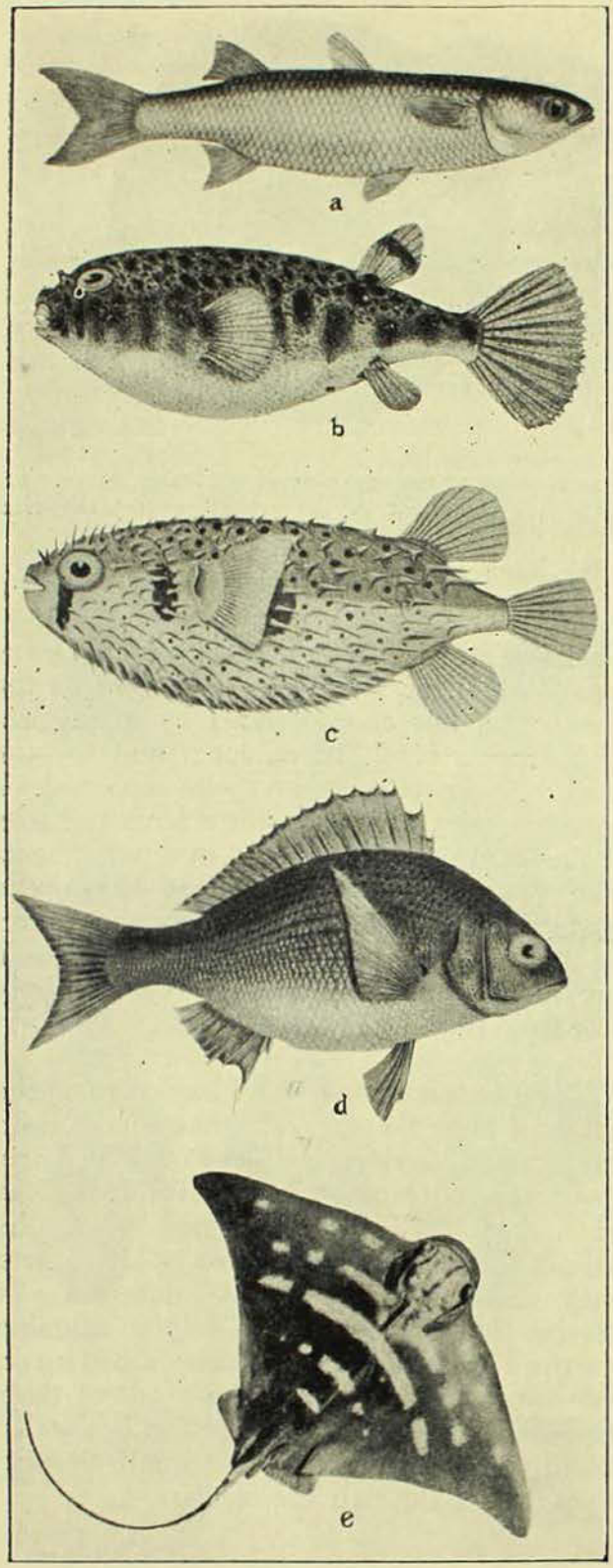
[Photo.—*T. C. Roughley.*

shells or stones; (2) the black borer (*Drupa marginalba*), of about the same size as the preceding, but characterised by blunt protuberances, black in colour; and (3) the hairy borer (*Cymatium parthenopeum*), a larger species which attains a length of four inches and deposits its eggs in a parchment-like case held firmly against the under surface of the shell. The common borer, as its name implies, is by far the most prevalent, and few, if any, rivers are entirely free from it.

The greatest destruction I have seen on the coast of New South Wales has occurred on the Brunswick river and at Port Macquarie near the entrance. The natural habitat of boring whelks is in the sea where the salinity of the water is always high; here they take toll of great numbers of marine shell-fish. One has only to examine the dead shells of such molluscs washed up on the ocean beaches to see the result of their depredations; a large proportion is usually found with the characteristic small circular holes drilled through the shells.

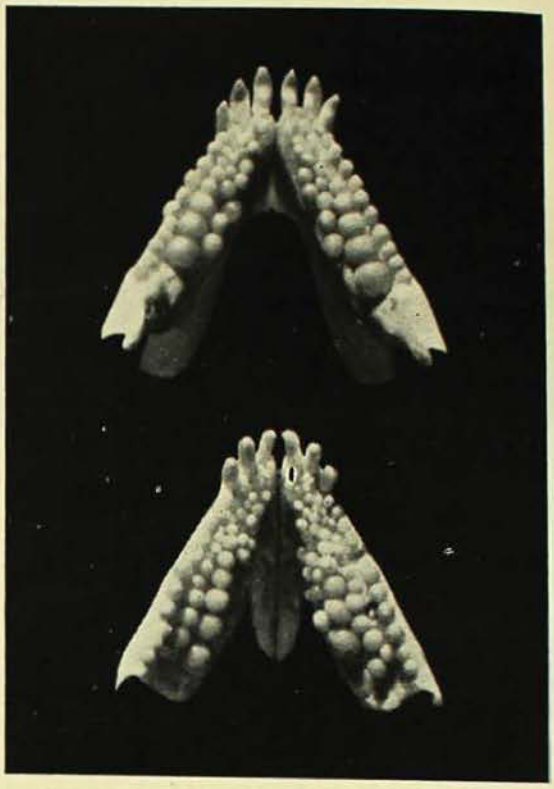
FISH PESTS.

In addition to the mullet, which, owing to the feeble development of its teeth, is capable of devouring the oyster only when it is a soft bodied creature of microscopic size, there are other types of fish whose teeth are well adapted to crushing the hard shells of attached oysters. Of these, the greatest pests are



Fish Pests of the Oyster. (*a*) **Mullet** (**Mugil sp.**). (*b*) **Toadfish** (**Spheroides hamiltoni**). (*c*) **Porcupine Fish** (**Allomycterus jaculiferus**). (*d*) **Bream** (**Sparus australis**) (*e*) **Eagle Ray** (**Myliobatis australis**).

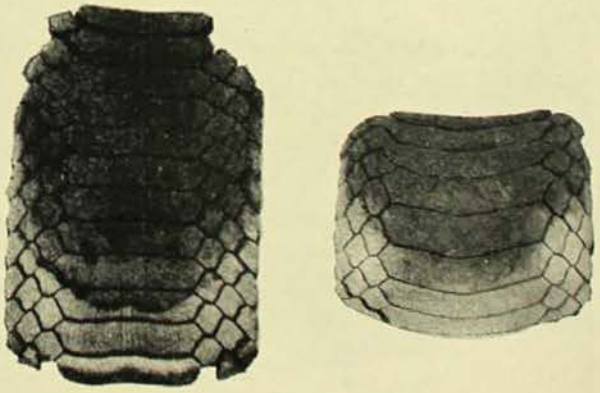
(1) the common toadfish or toado (*Spheroides hamiltoni*), which has the teeth modified into a kind of beak resembling that of a



Upper and lower jaws of the Bream (**Sparus australis**). **The canine teeth are used for wrenching oysters free and the molars for crushing the shells. Natural size.**

[Photo.—*T. C. Roughley.*

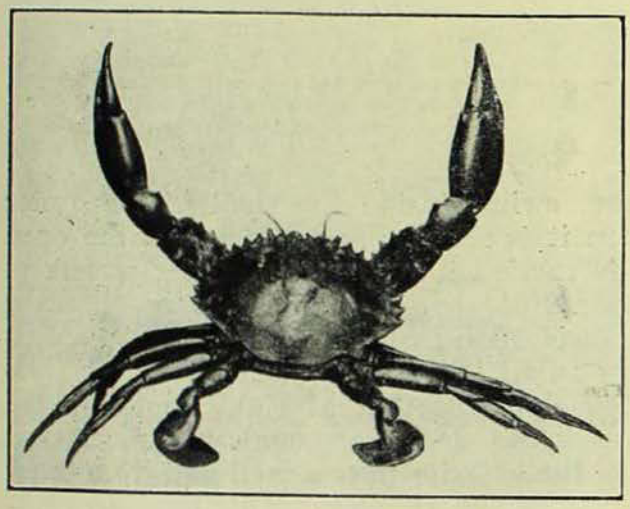
parrot; (2) the porcupine fish (*Allomycterus jaculiferus*), with jaws similar to that of the toado; (3) the bream (*Sparus australis*), with a set of canine teeth used for wrenching an oyster from its attachment and molars adapted to crushing the shells; and (4)



Upper and lower jaws of the Eagle Ray (**Myliobatis australis**). **The upper half of each plate is seen to be considerably worn through crushing oysters and other shellfish. One-half natural size.**

[Photo.—*T. C. Roughley.*

the eagle ray (*Myliobatis australis*), whose powerful jaws are provided with hard, pavement-like plates. The eagle ray may attain a width of four feet and is capable of crushing the shells of fully grown oysters. The damage done by these fishes is considerable, and the only means of protection afforded to the oyster cultivator is to fence off the leases with stakes or wire netting. The labour and expense involved are of course not warranted unless the destruction caused by the fishes is extensive.



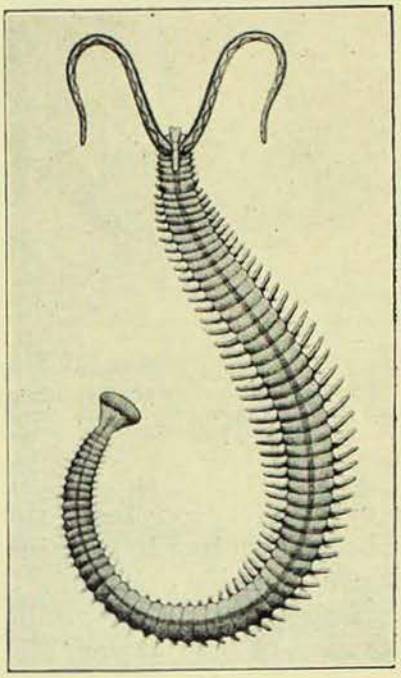
The Mangrove Crab (Scylla serrata). Oyster shells are crushed between the powerful nippers and the meat devoured. One-ninth natural size.

[Photo.—*T. C. Roughley.*

CRABS.

The oyster grower frequently suffers much loss from the onslaughts of the mangrove crab (*Scylla serrata*), a large species, deep greenish brown in colour, which may attain a width of two feet overall. The oysters are crushed between the powerful nippers, most of the damage being done at night. While the young oysters suffer most at the hands of this crab, fully grown specimens are by no means immune, particularly if their growth has been rapid and their shells not very thick and hard. The visits of the crabs are periodical, and, if concentrated in considerable numbers, a whole bed of oysters may be destroyed in a few days.

The mangrove crab is more common on the North than on the South Coast, the Macleay river probably suffering to a greater extent than any other. The only remedy so far devised is to improvise fences to keep them off the leases.



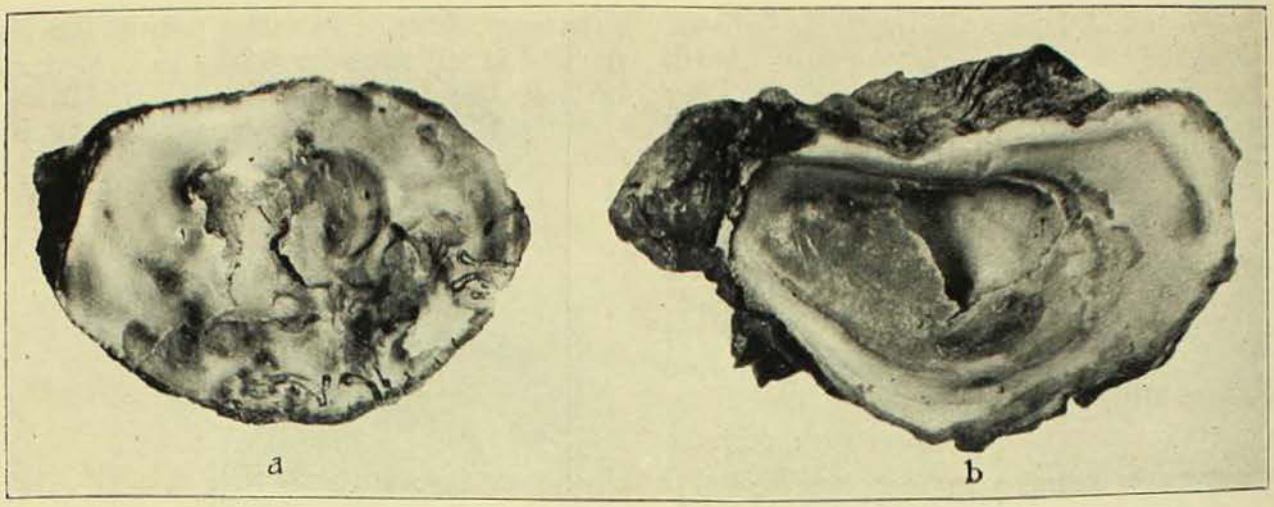
The Mud Worm (Polydora ciliata). This is the greatest pest of the oyster in Australian waters. It lives inside the shell where it accumulates a quantity of mud, eventually killing the oyster. Magnified 5 times.

[*T. C. Roughley, del.*

MUD WORM.

The greatest enemy the oyster has on the coast of New South Wales is the mud worm (*Polydora ciliata*). So great an influence has been exercised by this worm that it has altered the whole type of cultivation practised. The first extensive damage caused by it occurred in the Hunter river about the year 1870, but whether it was introduced there in oysters imported from New Zealand at that time, or whether it already occurred on the coast and some favourable conditions enabled it to increase enormously cannot at present be determined. Certain it is that in recent years it has played very great havoc with the oysters. Mr. Thos. Whitelegge, a well-known zoologist and then on the staff of the Australian Museum, investigated an outbreak at this locality in 1890.* From the Hunter it has spread to

*For the results of Mr. Whitelegge's investigations, see "Records of the Australian Museum." —Vol. I., 1890, p. 41.



(*a*) Upper (right) shell of an oyster showing the channels on the lower edge of the shell made by the mud worm. (*b*) A large "blister" in the lower (left) shell formed by the oyster secreting a deposit of shelly matter over the mud brought in by the worm. The mud has been washed out to show the extent of the cavity. Three-fourths natural size.

[Photo.—*T. C. Roughley.*

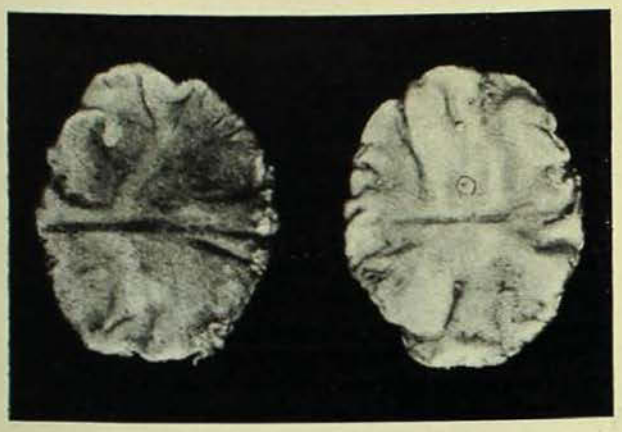
practically every river on the coast. The only oyster bearing waters to remain entirely free from it are Bonville creek and the Bellinger and Nambucca rivers, while in the Manning the damage done is very slight.

Prior to the outbreak on the Hunter, the market requirements were satisfied almost wholly by oysters grown on areas never bared by the tide, often at considerable depths, the term "dredge oysters" being generally applied to them because of the fact that a dredge had to be used to gather them. These beds were the first to suffer, and in a short time it was found to be practically impossible to raise an oyster to maturity in such situations. At the present time dredging is confined to a few rivers only on the coast, principally the Manning and the Bellinger. As the dredge beds were abandoned, cultivation along the foreshores was concentrated upon, and at the present time the bulk of the oysters marketed is the product of foreshore leases. The quality and size of the oysters has deteriorated somewhat in consequence, for those matured on dredge beds grow more quickly, attain a greater size and retain their condition for longer periods of the year. But for the mud worm it is questionable whether any cultivation at all would be carried on along the foreshores, for the natural beds below low tide level are probably more than sufficient to supply the requirements of the whole of Australia.

The worm is reddish-yellow in colour and rarely grows more than an inch long. It either swims inside the shell of the oyster when it is feeding and the valves are open or is carried in with the in-going stream of water. Entrance is gained usually when the worm is in the young or larval stage and is very small. Once inside it constructs two tubes close together at right angles to the edge of the shell and begins to collect mud from the exterior of the shell and from other objects in the vicinity. This mud accumulates on the inner surface and sets up irritation of the tissues in contact with it. The oyster proceeds to deposit a layer of shell over the mass, completely enclosing it in a separate chamber. Further attacks by worms gradually upset the normal economy of the oyster, its living space becomes restricted, it begins to weaken, and a stage is eventually reached when it is no longer capable of secreting shelly material over the mud and at last succumbs.

The worm thrives best in muddy situations but is by no means confined to them. It is most prevalent near or below low tide level. Oyster growers combat it by keeping material to which the oysters are attached well off the bottom by means of poles, wire netting supported on posts, etc., and if any beds are found to be badly infested the oysters are raised for a week or two to near high tide level where they are exposed to the heat of the sun for long periods and are covered by the tide for very brief intervals; by this means the worms are killed and the oysters suffer little or no injury.

In order to allay any fear on the part of the oyster consumer it should be pointed out that oysters whose shells are infected with worms are not by any means detrimental when eaten. The worms, except in rare cases, are completely isolated from the oyster's body, and there is little or no risk of any being partaken with the meat. It is not a parasite on the oyster but simply builds its mud home inside the shell for the protection afforded.



Upper and under surfaces of the Wafer (Leptoplana australis). This worm is suspected of killing large numbers of oysters.

[Photo.—*T. C. Roughley.*

WAFER.

The turbellarian worm known as the wafer (*Leptoplana australis*) is thought to cause much damage to oyster life, but in what manner it kills the oyster has not been definitely determined. It is commonly found feeding on the meats of recently dead oysters, and is of course blamed for their death, but it is difficult to see how entrance can be gained inside a live oyster. However its frequent association with dead oysters places it under grave suspicion, and it is therefore destroyed whenever found.

OCTOPUS.

The octopus (*Polypus cyaneus*) does not prey on the oysters directly but uses them to build its cone-shaped nest. Crawling over beds on which loose oysters lie, it attaches its suckers to several of them and carries them to its appointed home. Piling them in a circle round it, the octopus soon gathers a heap of oysters up to two feet high and hides in the hollow in the middle. Because of the weight of the oysters above them and the accumulation of sediment, many of the lower ones are smothered. It is not an uncommon sight to see numbers of such nests on a flat below low tide, and where the octopus is prevalent a careful watch must be kept for their nests and the animals speared. The octopus has a decided preference for water of high salinity, and quickly makes for sea at the approach of a freshet.

FRESHETS.

Freshets, caused by flood waters pouring down from the source and tributaries of a river, must be accounted amongst the major enemies of oyster life. Very great damage is periodically caused by them, particularly on several rivers on the north coast of New South Wales. Extensive areas of oyster-bearing grounds may be covered with water of very low salinity, in some cases with water fresh enough to drink, for such long periods that the bulk of the oysters succumb. Even greater damage may be caused by the sediment brought down by the fresh water, which may accumulate on the beds to a depth of several inches, resulting in the death of every oyster beneath it. On the Richmond, Clarence, and Macleay rivers practically all the oysters, with the exception of those grown in the estuaries, have at intervals been exterminated by these causes. A certain amount of fresh water is decidedly beneficial to oysters; those growing in the salter water of the estuaries in normal seasons rarely thrive so rapidly as do those situated in the more brackish water upstream. It is the water of very low salinity and the sediment which are fatal to them.

TIMBER BORERS.

Timber borers such as *Limnoria*, *Sphaeroma* and the dreaded "cobra" (*Nausitoria*) not only limit the class of wood available for oyster culture but shorten the life of all timber used, and thus are classed by cultivators amongst the oyster pests. If it were not for the destruction caused by these animals, the available supply of sticks and logs suitable for oyster cultivation would be limitless, whereas now only three or four species of trees are sufficiently resistant to withstand their attacks long enough to enable the oysters to mature. Where logs are to be employed for

supporting stones with attached oysters, the most durable timbers are the prickly tea tree (*Melaleuca styphelioides*) and the turpentine (*Syncarpia laurifolia*). It is necessary that the bark of both species be left intact. In situations where the logs sink partially or wholly into the mud most timbers are but little affected by marine borers, for the coating of mud gives a certain amount of immunity from attack. The bark of these trees is unsuitable for the attachment of oysters; for this purpose the black mangrove (*Aegiceras majus*) is the ideal timber; it is strongly resistant to borers in even very small dimensions and the sticks of this tree have been used to a far greater extent in cultivation than those of any other species. The frames (mostly sawn hardwood) to which wire netting is attached as a support for maturing oysters do not last as a rule more than three years, the length of time depending on the type of timber employed and the prevalence of borers in the river, some waters being more seriously infested than others.

CONCLUSION.

There are a number of other pests which either continually do minor injury to the oysters or may periodically cause a heavy mortality in isolated rivers. Amongst these may be mentioned the red weed (*Falkenbergia*) which at intervals invades Port Macquarie in such quantities that it lies thick on the beds, where it rots and liberates gases which kill large numbers of oysters; the balloon weed, which grows on loose oysters and, becoming distended with gas, floats away with them; the boring sponge (*Cliona*), which honeycombs the shells of the older oysters; and mussels (*Mytilus*), which may grow on the beds in such dense clusters that the oysters remain poor and in some cases die. Space will not allow of a detailed description of these pests; sufficient has been written to show that the oyster's life is full of peril and that the cultivator has a busy and somewhat uncertain time waging warfare on its numerous enemies, in order that the initial crop may be given an opportunity to grow and fatten to provide a festival for the most cunning and relentless of all the oyster's enemies—man himself.

This is the final contribution from Mr. Roughley upon the oyster. Previous articles from him have been:—

"The Story of the Oyster" (Vol. II., No. 5, January-March, 1925).

"The Birth and Growth of the Oyster" (Vol. II., No. 6, April-June, 1925).

"The Cultivation of the Oyster" (Vol. II., No. 7, July-September, 1925.

The recent visit to Sydney of a division of the U.S. Battle Fleet brought many of our American friends to this institution. They were particularly interested in all things Australian, and our strange mammalian (marsupial) fauna evoked much interest, as did the collection of relics which belonged to, or were associated with Captain James Cook, R.N., the circumnavigator,

Mr. W. W. Thorpe, our ethnologist, at the request of Commander M. V. W. Witherspoon, U.S.N., addressed a section of the company on board the U.S.S. *Colorado* upon the Australian aborigines and their customs, an event which proved of considerable interest to our guests and a privilege equally enjoyed by the lecturer. Writing from Auckland Commander Witherspoon said: "We all appreciated your wonderful illustrated lecture last night. It was a revelation to us. I think we will go back to America with a better idea of the aboriginal than most men who come to Australia."

On numerous occasions we have been the recipients of appreciative letters from teachers regarding the school pupils' lectures scheme. The following opinion expressed by Mr. Hugh D. McLelland, B.A., Chief Inspector of Primary Schools is, therefore, of considerable interest: "I cannot remember whether I carried out an intention of mine to write to you expressing the satisfaction of this Department with the efforts of yourself and your staff to interest our city children in nature study. Personally I regard such a subject as second to none in educative value, and I can assure you that all the more thoughtful teachers appreciate fully the assistance now being given by the Museum to the schools. I hope that each year will add to the number of those to whom your lecturers are giving a bias toward some form of science study."

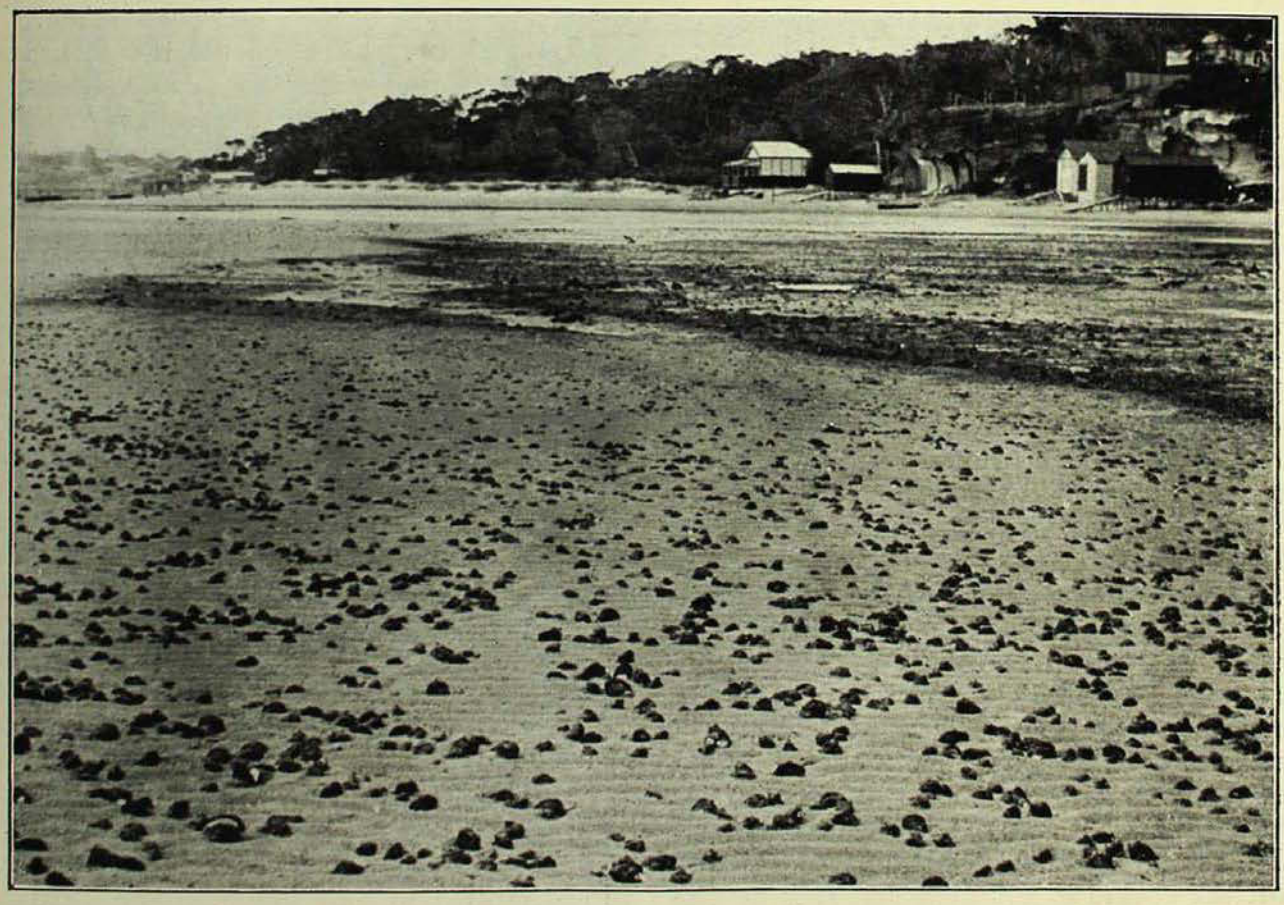
Life of the Tidal Flats.

[During the last two years the marine zoologists, Messrs. F. A. McNeill and T. Iredale, aided by assistants A. Livingstone, W. Boardman, G. P. Whitley and H. O. Fletcher, of the Australian Museum, have been conducting scientific investigations at Gunnamatta Bay, Port Hacking. Many interesting observations have been made, and in these pages will be published a series of articles, of which this is the first, describing some of the forms of life there met with.—*Editor.*]

FEW of the thousands of ferry passengers who daily cross the waters of Port Jackson ever pause to think of what lives in the element over which they are speeding. The secrets of marine life which dwells therein are not known to every one, but only to those whose occupation or inborn curiosity leads them to the quest.

When Phillip and his companions arrived here in 1788 Port Jackson was vastly different from what it is to-day. It was not a terminus of ocean highways, its waters were tranquil and unpolluted by the commerce and traffic of a busy port. Marine life enjoyed the conditions so essential to its existence, but to man-wrought changes much of it has since succumbed. One must, therefore, look elsewhere, and fortunately for Sydney residents there is no need to travel far. In Port Hacking, about sixteen miles to the south, one finds conditions similar to those which existed in Port Jackson a century ago.

Mr. Thomas Whitelegge, a veteran zoologist formerly attached to the Australian Museum, introduced us to Gunnamatta Bay, one of the many delightful havens of this undeveloped port which had been known to him for well over thirty years. Several collecting trips proved so successful that it was decided



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

[Photo.—*A. Musgrave.*

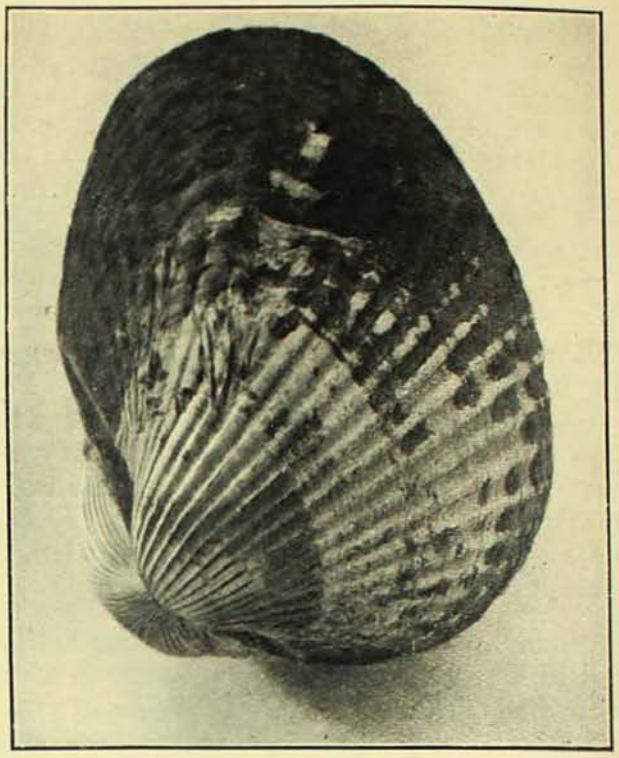
to make a more thorough investigation of the area, the results of which will be presented in a series of contributions.

When the tide is full Gunnamatta Bay presents a scene that would be hard to surpass. From our camp is seen an unbroken expanse of water sheltered in a wide shallow gully, the sombre green foliage on the opposing shore being interrupted here and there by a splash of colour where some watersider, anxious to escape the "madding crowd," has made his home. The even colour of the water suggests no shallows, yet in an hour or so shoals have appeared, and very shortly afterwards an unbroken area of sand, some six or eight acres in extent, comes into view.

With the tide on the ebb preparations are made for collecting—bathing suits are donned, and, equipped with buckets and a few glass tubes for rarities, we begin our investigations. Leaving the shore one has to wade carefully through a muddy span covered with shallow water; carefully, because the bottom is a mass of shells, some having bumpy surfaces, others knifelike edges which may inflict a severe gash.

THE SYDNEY COCKLE.

It is in this muddy expanse that the Sydney Cockle (*Barbatia trapezia*) lives. This mollusc formed one of the principal items in the aborigines' bill of fare, and around the foreshores of the inlets of Port Hacking may be seen numerous kitchen middens, which are accumulations of shells, principally cockles, the animals of which were eaten by the aborigines in the years gone by. The cockle spends its life half buried in the mud, but the shell is so swollen that it does not sink altogether; usually a tuft of seagrass grows on the exposed portion of the shell and to a certain extent acts as a float. As the tide is receding from the cockle banks an interesting sight is presented. Innumerable small jets of water can be seen playing like fountains. This is part of the process by which the cockle gathers its food and oxygen; water is drawn in through an inhalant siphon and, after this has supplied these necessities to the animal, it is ejected through an exhalant siphon. This operation is continued until the cockle is left high and dry by the tide, when it tightly closes its valves and awaits the flow.



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

[Photo.—*G. C. Clutton.*

Though known as the cockle, this shell must not be confused with the totally dissimilar shell of the northern hemisphere, once a favourite item of food amongst the poorer classes. Our cockle belongs to the group popularly know as the "Arks" by reason of its resemblance to the Noah's Ark which amused our childhood. Probably it received its name from Captain Cook, who, in his journal, under date Botany Bay, May 6th, 1770, wrote: "On the sand and Mud banks are Oysters, Muscles, Cockles, etc., which I believe are the chief support of the inhabitants, who go into Shoald Water with their little canoes and peck them out of the sand and mud with their hands, and sometimes roast them and Eat in the Canoe, having often a fire for that purpose, as I suppose, for I know no other it can be for." In Japan the Arks are extensively cultivated for food; they are considered highly nutritious and are valued as a food for invalids.

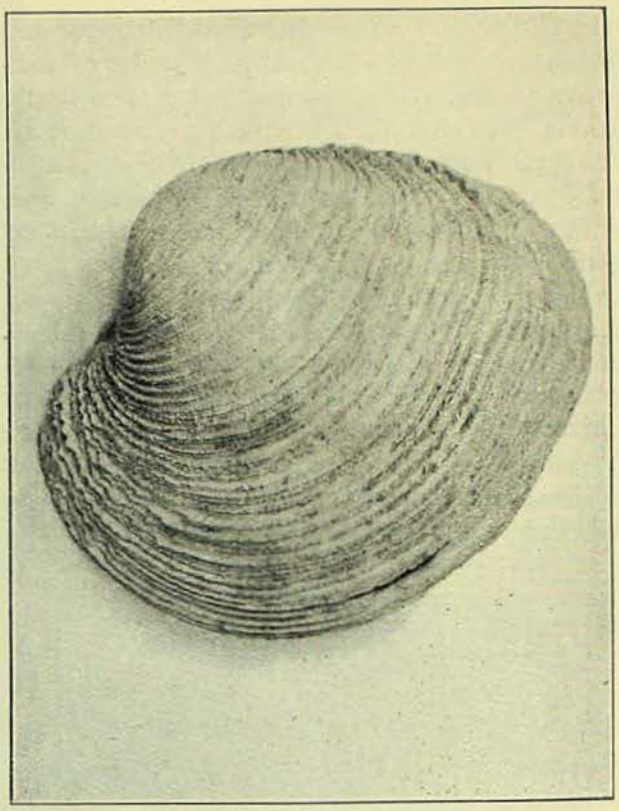
TAPESTRY SHELLS AND MOTHER COCKLES.

Associated with the cockles are the larger, more handsome, but less common Tapestry shells (*Paphia turgida*) and Mother Cockles (*Antigona laqueata*). The former are beau-

tifully variegated and derive their name from a resemblance they bear to a tapestry pattern. In the Mediterranean countries they are considered a delicacy, and, though the local variety has not been tried as an article of food, it is possible that it would prove no less dainty.

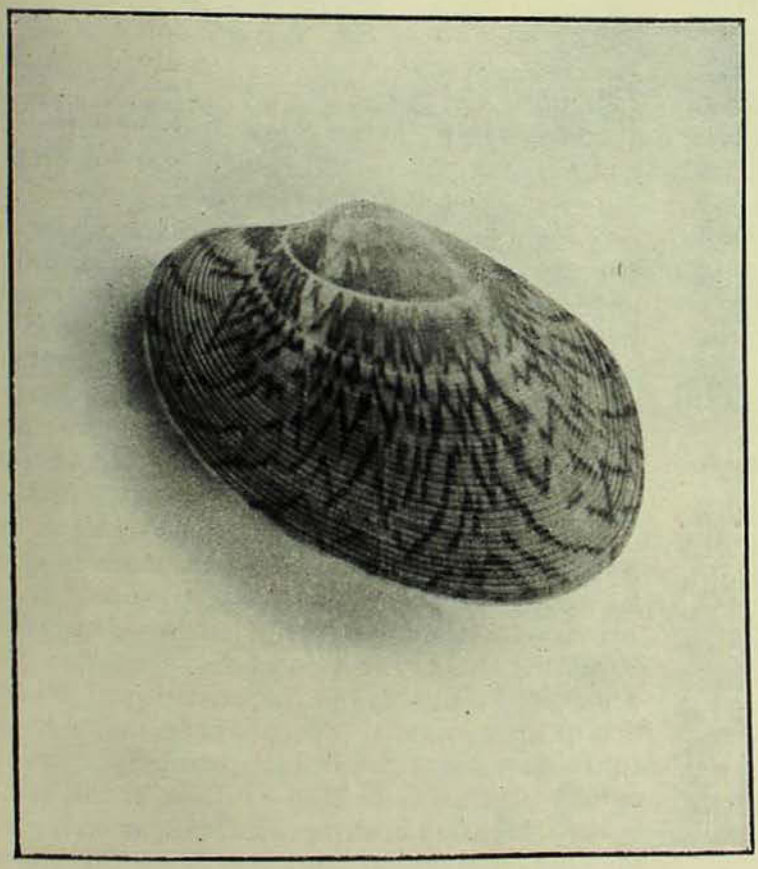
The Mother Cockles are less common than the tapestry shells. They are also known as Venus shells, for legend associates the rising of the goddess Venus from the sea with a variety of this shell occurring in the Mediterranean. The American Indians used Mother Cockles for the manufacture of wampum, a medium of exchange, made by stringing fragments of them upon a thong.

In nature the life of one thing is dependent upon the life of another, and whilst these inoffensive bivalves are devouring tiny animalculae from the surrounding water other members of the same class are intent upon their destruction. Nevertheless, as far as can be seen, the cockles have almost mastered the secret of an undisturbed existence. It is possible that, with the exception of the wily cuttlefish, of which more anon, their only effective enemy is disease. It may be mentioned here that shellfish is the chief food of many of the deep water fishes, but none of these occur in the shallows of Gunnamatta Bay. Nevertheless, small whelk like molluscs (*Nassarius spp.*) make attempts to bore through the shelly armour of our cockle, but these are not specialised enough to cause any serious discomfort to the inmate, and are forced to revert to smaller prey for their livelihood. Occasionally, however, certain large whelks(*Cymatium parthenopeum*)* are found on the flats which would be quite equal to the task, but these are few in number, and having wandered in from the deeper waters of the sea are out of their usual environment.



The Mother Cockle (Antigona laqueata), is less swollen and more circular than the Sydney Cockle, and grows to a larger size. (About two-thirds natural size.)

[Photo.—*G. C. Clutton.*

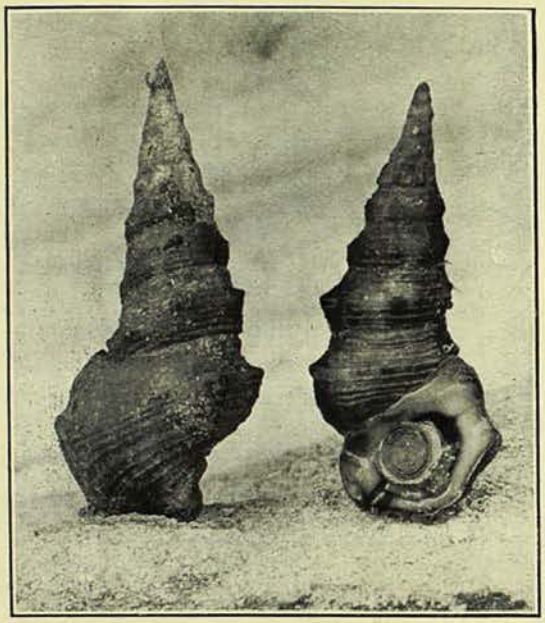


The Tapestry Shell (Paphia turgida). A fine example exhibiting the delicately traced pattern whence its vernacular name has originated. (Natural size.) [Photo.—*G. C. Clutton.*

* See illustration on Page 279

THE SYDNEY WHELK.

On the areas where the cockles occur are small communities of Sydney Whelks (*Pyrazus herculeus*). The application of the name "whelk" to this shell is another instance of our forefathers delight in attaching "home-land" names to Australian objects; the Sydney Whelk has neither relationship or likeness to the English variety, which is a large carnivorous mollusc and in no way comparable to our meek herbivorous beast. The Sydney Whelk was first met with by Captain Cook at Botany Bay and it is of historical interest for the reason that it was the first shell from New South Wales to be illustrated in scientific literature. The specimens taken home by Banks and Solander



The Hercules Club Shell or "Sydney Whelk" (Pyrazus herculeus, about two-thirds natural size, showing the solid structure of the shell, and its nodular character.

[Photo.—*A. Musgrave.*

were eagerly sought after by shell collectors. It appeared in early catalogues under the name of "Hercules Club Shell of New South Wales." This name is much more appropriate than the above, and is derived from a resemblance the shell bears to the club said to have been possessed by Hercules, with which he slew the Lernæan Hydra; it has the form of an elongated cone, and its outer surface is liberally supplied with irregularly disposed nodules.

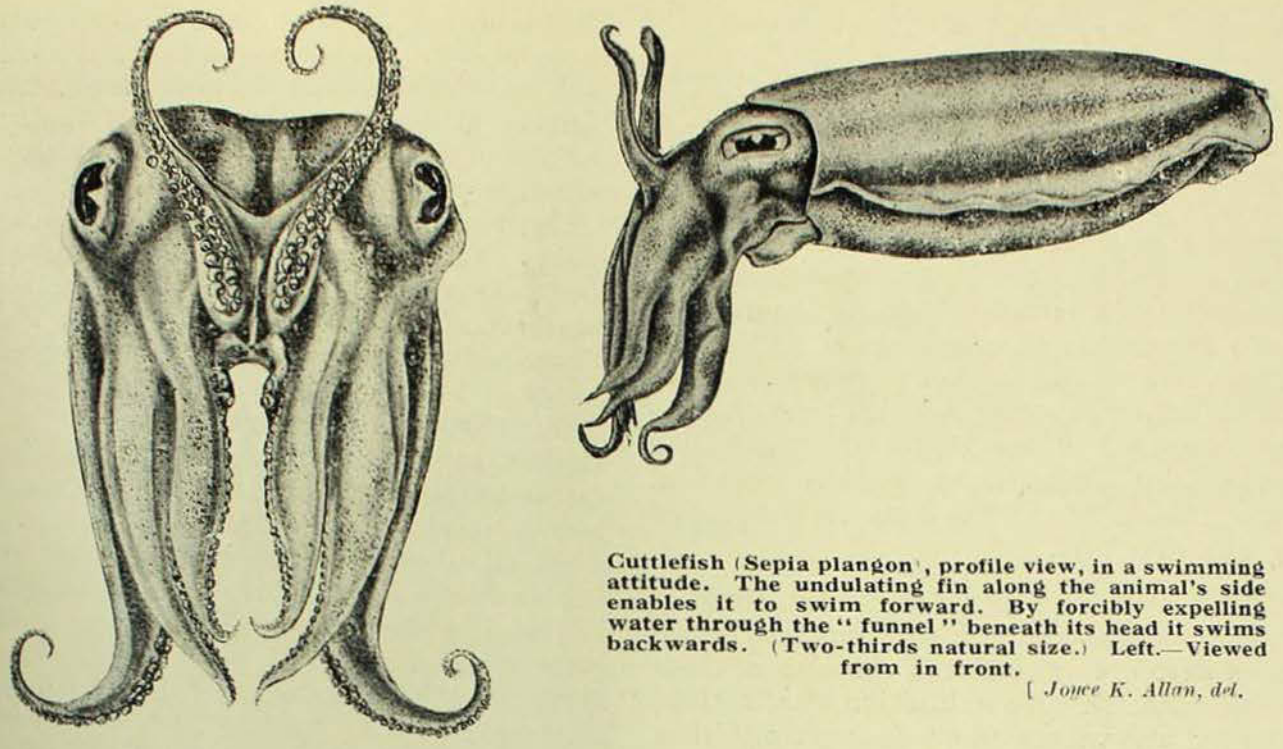
Living in association with the Hercules Club Shell is a smaller nodulated variety of this so-called whelk (*Pyrazus australis*), which at first sight may be thought to be the young of the larger kind. Both of the above species belong to a family with numerous representatives, most of which are slowly but surely adapting themselves to a terrestrial existence. In the tropics they frequent mangrove flats and are exposed many hours daily, while some varieties even climb into the foliage of the trees, and live almost entirely out of the water.

The English Whelk (Buccinum undatum), which has little or no resemblance to the stout and almost unbreakable "Sydney Whelk." (Natural size.)

[After *Jeffreys.*

CUTTLEFISHES.

Swimming about in the shallow water as the tide recedes is to be found a weird and extraordinarily coloured little animal with horn and trunk-like appendages. Such a combination is bizarre in the extreme, and if peered at intently through the water the creature will be seen to change colour in order to harmonise with its surroundings. This is a cuttlefish (*Sepia plangon*), which is allied to and grouped with the octopus in natural classification. The creature is oval in shape and possesses eight short arms provided with suckers on their inner surfaces. When in the water two of these appendages are raised aloft like horns, whilst the others droop downwards. Two extra and longer tentacular arms are hidden from sight, being curled up in sheath-like cavities in the creatures' sides. These appendages are capable of great extension and are the cuttlefish's main food-gathering apparatus, which can be launched forth unexpectedly at an unwary



Cuttlefish (Sepia plangon), profile view, in a swimming attitude. The undulating fin along the animal's side enables it to swim forward. By forcibly expelling water through the "funnel" beneath its head it swims backwards. (Two-thirds natural size.) Left.—Viewed from in front.

[Joyce K. Allan, del.

prey. Beneath the skin of its back is situated a protecting shell, familiarly known to us as the "cuttlebone" which we collect on the beaches for our aviaries, and use as an abrasive in tooth powders and fine polishes. The cuttlefish's chameleon-like faculty of being able to change colour at will is of equal value in the procuring of food and in escaping from enemies. Some interesting observations on this colour changing were made, and it was discovered that the cuttlefishes not only took on a different hue, but were capable of effecting a change of pattern.

According to Huxley this phenomenon is due to cells embedded in the skin, termed "chromatophores, which are sacs with elastic walls, full of pigment, and provided with radiating muscles, by which they may be drawn out to a size many times greater than that which they occupy in their contracted state. In their dilated condition, the colour proper to the contained pigment becomes plainly visible, while in their contracted state they appear as mere dark specks. It is to the successive expansion and contraction of these chromatophores that the cephalopoda [cuttlefishes and octopi, etc.] owe the peculiar play of 'shot' colours, which pass like blushes over their surface in the living state. These blushes of colour are especially well displayed by young cephalopoda just freed from the egg."

When closely pursued our cuttlefishes often became panic-stricken, and seemed incapable of properly controlling their many colour changes. As the creatures were chased hither and thither some were seen to be striped with dark blue and grey in a zebra-like fashion, while others were of a green mottled colour, which could be instantly changed to a pallid, uniform tint. Again another sudden change would present a dark line along the centre of the body, on each side of which would appear a dark spot resembling an eye. Many made good their escape by darting into water over extensive sandy patches, where they changed to a uniform yellowish hue exactly resembling that of the sand. Though so highly protected in this manner, cuttlefishes are stupid creatures when opposed to man. Their rapid backward darts were as often as not ill-directed under stress of excitement, and resulted in untimely capture. When sudden grabs were made at individuals herded into shallow water, they often shot backwards so quickly that they became stranded on the dry sand.

Another and perhaps more widely known method of protection for cuttlefishes is the possession of an ink-sac similar to that found in the octopus. This is filled with a thick substance which is used solely to create a dark cloud in the water, under the cloak of which the cuttlefish can extricate itself from a tight

corner; this substance constituted the famed "sepia" colouring of the mediaeval artists, but is now replaced by inferior artificial dyes. When a cuttlefish is placed in a can of water immediately after capture, it ejects a great quantity of "ink." If the aperture or funnel on the underside of the body happens to be facing uppermost when the captive is darting about, it is advisable to exercise great care in keeping well out of range of that dusky stream. On one occasion whilst gazing intently into the can, an unwary member of the party had his vision temporarily obscured by a slimy mass of "ink"; fortunately this was not attended by any ill effects.

The cuttlefishes were constantly encountered in pairs, and what was assumed to be the males were only two-thirds the size of their female consorts. No exhibition of affection, however, was witnessed on the part of either animal. In Mediterranean countries for centuries past the cuttlefish has been highly prized as an article of diet, and the surest way of catching it is said to be by the aid of a female. The fisher places a captive female back in the water, when the male will appear from hiding and put his arms protectingly around her. In this position he suffers himself to be drawn from the water and martyred on the altar of constancy. This display of affection was a favourite theme for the old Grecian poets.

The little cuttlefishes secured by the Museum party were only five to seven inches long, but very much larger ones exist in the deeper waters off the coast of New South Wales. Some big specimens in the Museum collection measure as much as three feet in length, but some closely allied forms are amongst the largest known denizens of the sea. These latter are known to inhabit the Tasman Sea, but none have yet been stranded on the Australian coast. Several huge specimens however, are recorded from Cook Strait, New Zealand, with bodies varying from seven to eleven feet long, and possessing tentacular arms reaching the extraordinary length of fifty feet.

Cuttlefishes have a horny beak like that of a parrot, but operating in the reverse direction, the long hooked mandible being lowermost. Through ignoring this fact, and despising the size of our small captives, one of the party received a bite which drew blood.

A collection of representative fossils has been presented to the Broken Hill Museum by the Trustees of the Australian Museum. This collection will be particularly valuable for class instruction purposes.

Messrs. G. P. Whitley and W. Boardman, of the Australian Museum, accompanied the steam trawler "Bar-ea-Mul" on one of its recent cruises along the fishing grounds off our coast. Material of great value was collected and the courtesy of the proprietor, Mr. D. Hann, and the master, Captain H. Johnston, is much appreciated for the facilities afforded.

On 11th July a party of senior zoology students from the University, in charge of Miss E. E. Chase, B.Sc., visited the Museum and were shown round the mammal, bird, and reptile collections by Messrs. E. Le G. Troughton and J. R. Kinghorn.

In connection with the centenary of the work of the Church Missionary Society of Australia and Tasmania, an exhibition was held in the Sydney Town Hall from 8th to 11th September. At the request of the Society, the Trustees showed a number of exhibits from the Northern Territory, Ceylon, and China.