The AUSTRALIAN MUSEUM MAGAZINE

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

Cowries - - - - - - - - - - - *Joyce K. Allan*

Our Coastal Sponges - - - - - - *W. Boardman*

The Eye and Eyesight - - - - - - - - - - - - - - *R. Granville Waddy, M.B., Ch.M.*

The Life of a Dragonfly - - - - *R. J. Tillyard, D.Sc., F.R.S., etc.*

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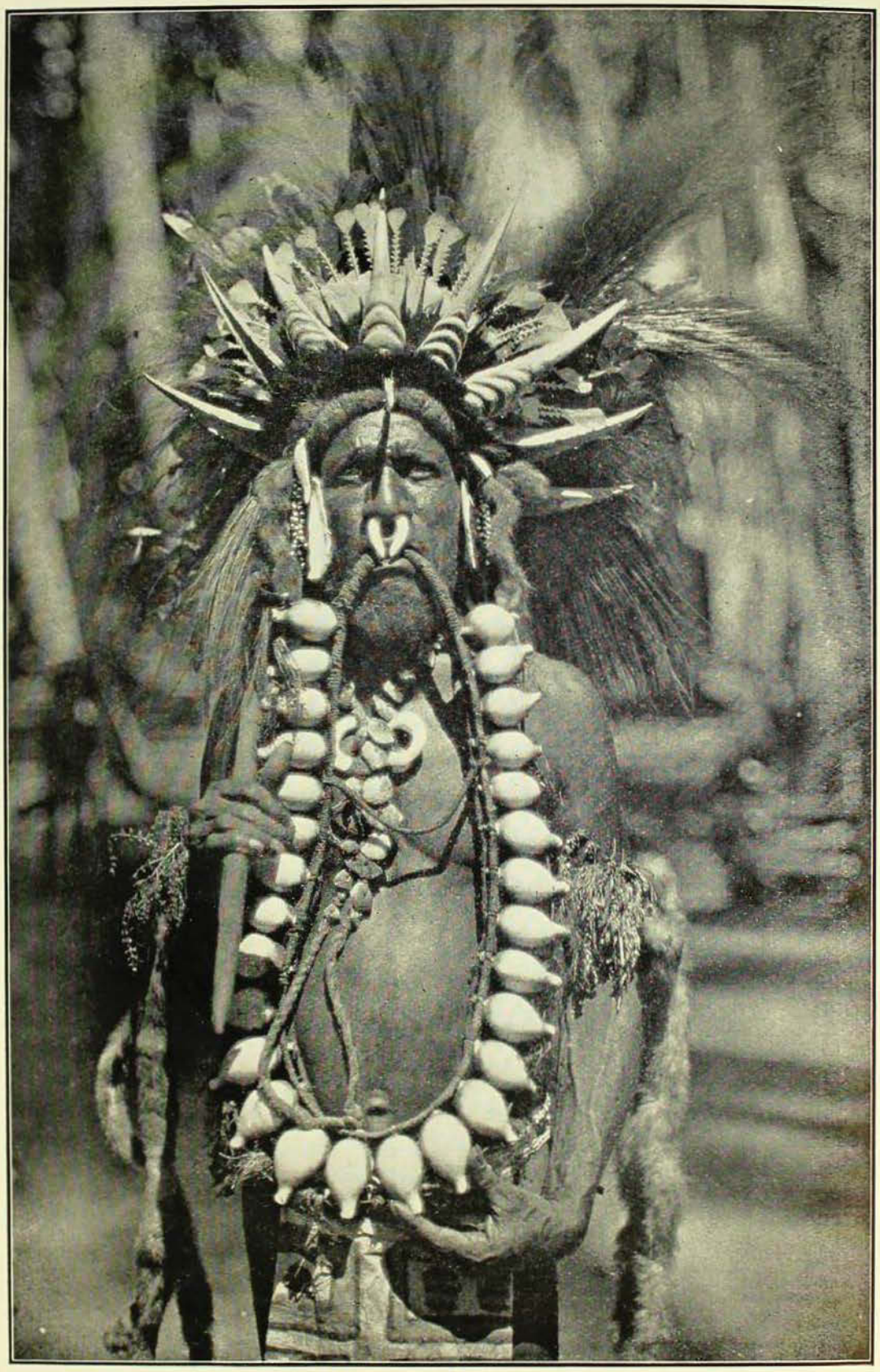

A Papuan Chief in his official regalia. The large White Egg Cowry (Ovulum ovum) is a prominent feature of his garb. Eroro village, Oro Bay, North-Eastern Division, Papua.

[Photo.—*Captain Frank Hurley.*

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VOL. IV, No. 9. January-March, 1932.

Cowries

By Joyce K. Allan.

Shake one, and it awakens, then apply
Its polished lip to your attentive ear,
And it remembers its august abode
And murmurs as the ocean murmurs there.

—Walter Savage Landor.

THE Cowries, or Gowries as they were sometimes called, are a large family of beautiful and well-known shells. On account of their rich brilliant colouring and remarkable polish, they are easily the first to attract the attention of collectors, to whom they become objects of the greatest delight. The word "Cowry" is derived from a Greek word meaning "a little pig," the hunched back with uptilted ends of the shell probably suggesting the name. The earlier name for these shells, *Porcellana*, had the same meaning. The Romans termed them *porci* or *porculi*, while the French of today give them the uncomplimentary title "*pou de mer*."[1] The word porcelain, applied to the beautiful earthenware which originally came from China and Japan, owes its derivation to the cowries. In the olden days, when people first saw the rich glaze on this wonderful china, they remarked how closely it resembled the polish on the *porculi*. Later, the idea became reversed, and the polish on the cowries was likened to the glaze on the porcelain, but porcelain really received its name from its likeness to the sheen on the cowries.

Their beauty of form suggested their scientific name *Cypræa*. The shell was known in the olden days as the "concha venerea," the shell of Venus, the goddess of love and beauty, whose worship principally centred round the island of Cyprus. This name usurped the earlier one of *Porcellana* towards the beginning of the eighteenth century.

FORM AND GROWTH.

Though they vary considerably in colour and design, the cowries closely resemble each other in shape. The shell really consists of one big whorl, with sometimes a suggestion of earlier whorls

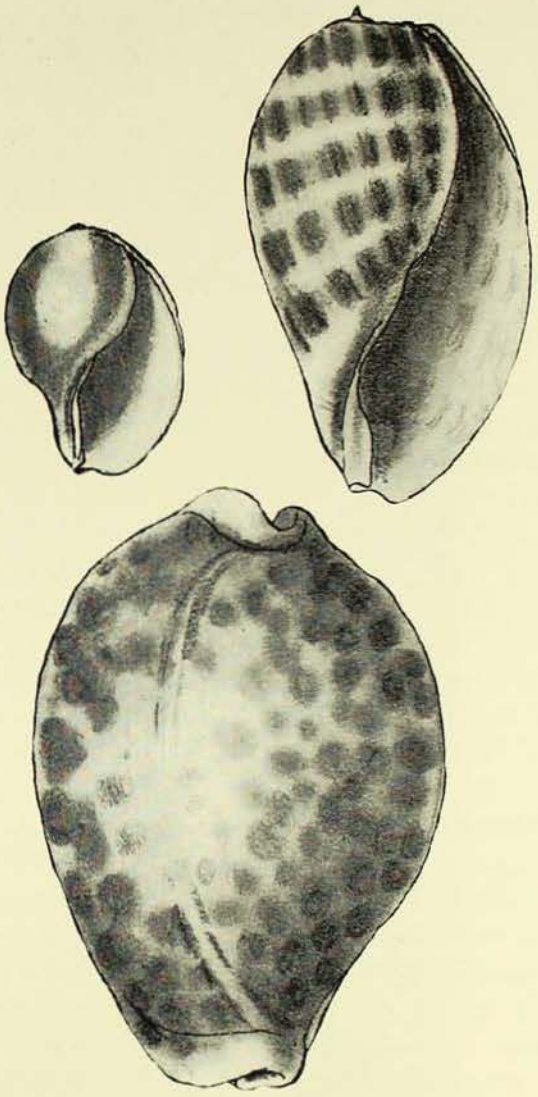
[1] Sea-louse.

in the form of a small spire at the anterior end. The mouth in the adult shell is narrow, so narrow, in fact, that it is difficult to believe that an animal can appear and disappear through so slight an opening.

Commencing life as a thin bulla-shaped shell, with its colouring dispersed in faint bands, and a wide thin-edged mouth, it resembles in no way the beautiful matured specimen. As the shell grows to adult form it becomes more solid, the edges of the mouth come together, and teeth begin to develop on them. Then follows the rich colouring, and finally the laying over the whole surface of the brilliant polish, the last constructive action of the animal in the making of its shell.

It is naturally to be expected that such beautiful shells should house similarly beautiful animals, and in some cases the animals are not only as handsome as, but even surpass in beauty, the homes they inhabit. The animal itself is very striking, with a bright coloured broad foot, truncated in front, for crawling. A large mantle of variable colours forms expansive lobes on either side, and these are usually extensively and elaborately ornamented with tentacular filaments. These are dotted in the middle and on the base with small eyes. The mantle lobes, capable of covering the shell, play an important part in its manufacture by depositing that final high polish, which no other shell can boast, upon it. Down the centre of the back of a cowry may be seen a fainter band of colour, known as the dorsal line; this is where the two edges of the mantle lobes meet over the shell.

Much discussion has arisen at different times concerning the development of the cowry shell. Many naturalists believe that the animal is able to dissolve its shell away when it becomes too small to hold it, and secretes a new one to accommodate the enlarging animal. This hypothesis has developed from the discovery that series of shells of well-known species are by no means uniform in size. One naturalist, Lieutenant Hankey, of the Royal Navy, wrote in 1844 that he had seen more than one cowry crawl away to a sheltered hollow, where the shell, which is made of carbonate of lime, became thinner and dull in colour, finally



Three stages in the growth of a typical cowry. The complete shell develops from a small thin bulla-shaped one.

[J. K. Allan, *del.*

cracked and was dissolved away by an acid secretion. The naked mollusc thus left soon began again the task of building a new, thin, transparent shell, which gradually became more solid and more suitable for the animal. Several authorities disagreed with this statement; some partly believed it, but it is generally accepted that the animal has the power of dissolving the interior of the shell as

the exterior is added to, and thus room is made for the growing animal.

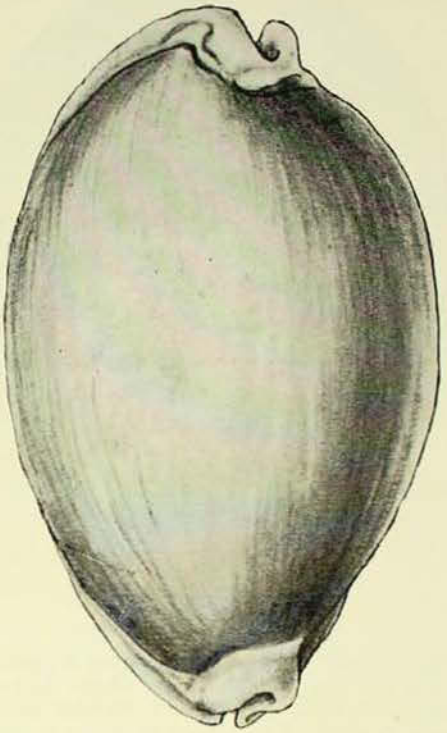
The cowries, as is so often the case with other brilliantly coloured groups, inhabit tropical and subtropical seas, except in a few cases. Whether shyly hiding away under stones, or slowly crawling over coral reefs in search of coral animals, their food, they always create the greatest interest and admiration.

RARE AND COSTLY SHELLS.

Their price and value vary considerably, and the most showy is not always the most valuable. One may be dear at a certain price, and at the same price a less conspicuous one would be cheap. Many of the rare cowries still retain much of their former high value, and would still fetch a good price on the market. With the arrival of the dredge, however, and the bountiful results of deep-sea dredgings, many which were almost unprocurable, and therefore brought high and often fanciful prices, are now easily obtained. Their prices have fallen considerably as a result, in spite of many attempts by dealers to keep them up. Wanderers and captains returning from cruising in the South Seas have found a ready market and received princely prices for shells which are now worth only a few shillings.

An Orange Cowry (*Cypræa aurantia*), a famous and rather rare cowry, fetched the large sum of £30 in England, previous to the year 1881. Nearly four inches in length, these are very handsome, shiny, orange-coloured shells, with no other markings on their surface except a white base and bright orange teeth. It can be easily imagined what excitement was caused by the first one of these to reach home, and, although their price has lowered rapidly until they are now sold in England for about five shillings each, the interest in them has not waned and they are still a welcome addition to any collection. Early collectors had great difficulty in obtaining them, as they were considered a badge of the highest honour amongst natives of the Friendly Islands, and were kept by them for this purpose.

Some cowries are so rare that they are known to the greater number of people, even naturalists, by pictures alone. Two of these in particular, the Prince Cowry and the White-toothed Cowry, rank to-



Devoid of any contrasting markings, the Orange Cowry (C. aurantia) depends on its rich orange colour alone for its beauty. Permission to wear this as an ornament is granted by Friendly Islanders as a mark of the highest distinction.
[J. K. Allan, *del.*

gether in scarcity and value. The former shell, accidentally found for the first time in a private collection, was labelled "the Brindled Cowry of the Persian Gulf." For a long time this was the only known example of the species, and it is now in the British Museum. Whether it really come from the Persian Gulf, or was taken home from the South Seas or other locality, is not known. Later, the late Dr. J. C. Cox, of Sydney, for many years President and Crown Trustee of this Museum, secured a fine specimen of it from New Guinea, and there is, I believe, a specimen in America. It is a large, thin cowry with swollen sides and much elevated back. The ground colour is yellow, shading to pink, with a patch of brownish wavy lines on the centre of the back. On

each side of this is a squarish patch of dark brown. The two ends have several concentric dark lines on them, and the sides are spotted. Valued at about £60

The Brindled Cowry of the Persian Gulf (C. princeps). Only three specimens of this very rare cowry have been found. Very highly priced, and a rich reward awaits the finder of another specimen.
[J. K. Allan, *del.*

towards the end of the last century, it is still very rare, and is now worth about one-third that amount, so a fine reward awaits any collector fortunate enough to find one.

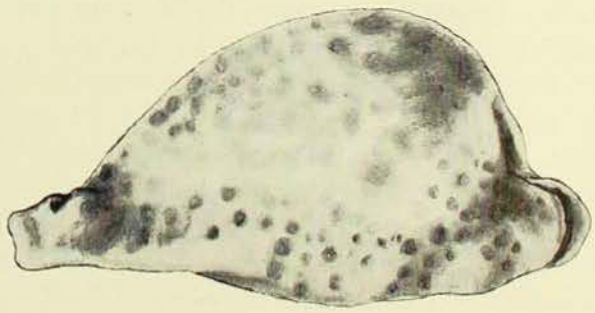
The White-toothed Cowry (*Cypræa leucodon* Brod.) is represented by a single specimen in the British Museum from an unknown locality, and was originally valued at £50.

Like the two previous species, the Spotted Cowry (*C. guttata*) is very rare, and has fetched from £12 to £45 for good specimens at different times. A few private collectors and some museums are fortunate enough to possess specimens of this. It is reddish-brown in colour, with white spots of varying size on the back, and large red, sometimes forked teeth, extending across the base, make it easily recognizable. Specimens have been found in the Red Sea, New Britain and on the coasts of New South Wales.

Many other species are more or less rare, or of pecuniary interest, and prices range from a few pence to shillings for good specimens of the commoner cowries.

THE WONDER COWRY.

The cowry to raise the most interest here, financially or scientifically, is the Wonder Cowry (*C. umbilicata*). It has a very interesting history, as, when the first one found its way to England, it was considered a monstrosity of either the Tiger Cowry or the Panther Cowry, and was practically ignored. In the year 1848, a specimen was sent to the British Museum, from a collection of cowries found in Bass Strait, which finally removed the stigma of monstrosity from it and made it a definite species. The demand for it instantly arose, and it immediately sprang into fame. Such a beautiful and large new cowry naturally brought a wonderful price, and £30 was paid for the second specimen sent home. Since then they have frequently been dredged in Bass Strait and in the last two decades extensively off the coast of New South Wales, but as they are deep water species, they are procurable only in this way, and therefore the ordinary collector finds difficulty in obtaining them. It is a large fawny-cream humped-back species with an orange tinge on the back and mottlings on the upper-surface. The most curious thing about it is the fact that it can live in such cold waters, away



The Wonder Cowry (C. umbilicata). Considered for some time only a monstrosity of another species, this beautiful cowry is dredged in large numbers off the coast of New South Wales. Unlike other cowries, it is able to live in cold waters.
[J. K. Allan, *del.*

from the tropical warmth most large cowries are used to.

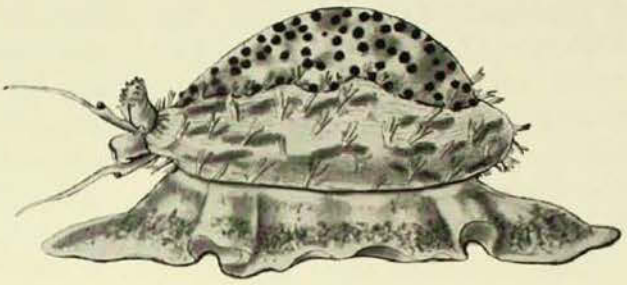
There is a scarcity in some cowries, however, which were hitherto quite common. A well-known shell dealer in New York remarked recently that where shells, especially cowries, once came to America from other places in case loads, sometimes as many as 3,000 to a case, they now come very sparingly, and he now never sees a case of one kind. This is probably due to the fact that dealers in the outlying parts where these cowries were found have gone out of business, and no one else has seriously taken on the job, so the shells are not collected and forwarded in anything like the same quantity as formerly.

It is a mistaken idea that the beauty and value of a cowry can be increased by removing the outer surface with an acid and inscribing texts or other things upon them. This is altogether wrong, and permanently ruins the shell for display or scientific purposes.

COWRIES IN SYDNEY HARBOUR.

Recently Mrs. M. J. Waterhouse presented to this Museum her well-known and wonderful collection of shells. The cream of this gift was the collection of cowries, the largest and finest that has even been presented to the Museum. Every specimen had been carefully chosen for its richness, size and perfection, and the result is a wonderful range of the finest specimens available, including all the well-known forms and many rare ones. Careful collecting, choosing, and purchasing combined to build up what is now a splendid exhibit for the Museum as well as an excellent reference collection for scientific workers.

Cowries are amongst the rarest shells found in Sydney Harbour, very few, even dead specimens, coming to light over long stretches of years. Owing to the extensive dredging activities in recent years, more specimens have been found than previously, but these have been dead shells of a tropical character. As far back as 1895, therefore, Mrs. Waterhouse and her sons were fortunate in finding alive in Port Jackson seventeen different species, one hundred specimens in all, of cowries. They were all found within a radius of about a hundred yards at extreme low tide, and this was the first and so far the only time so many had been found in that locality.



Side view of the animal of the Tiger Cowry (C. tigris). The shell can be seen partly swallowed up in the mottled and tufted mantle. The large foot is extended for crawling.

[J. K. Allan, *del.*

Included in this magnificent find were nine species which had never before been found in the harbour, and, although in recent years a few dead examples have turned up, they have not since been found alive here.

SOME BEAUTIFUL SPECIES.

Though not of such pecuniary value as some mentioned before, many cowries are valued or treasured because of their beautiful markings and general appearance. The best known and most frequently collected of these is the Tiger Cowry (*C. tigris*). The animal is even more brilliant than the shell, and, when found hiding from the sun's glare among coral masses, the shell is completely covered up by the large, richly mottled and heavily fringed mantle. They live in shallow water, and seem able to change the intensity of the colours on the mantle, which retracts into the shell when touched. The colouring in the various stages of growth in this cowry varies considerably. Commencing as a uniform brown colour, it then breaks up into bands composed of close set blotches of a darker shade. These are superseded by series of distant zigzag lines upon a white ground, hiding the

original colours. Teeth begin to form and layers of different coloured spots, black and brown, are put on the surface. The dorsal line becomes edged with red, and over each successive layer of spots a white layer of enamel is placed, until the final effect is reached.

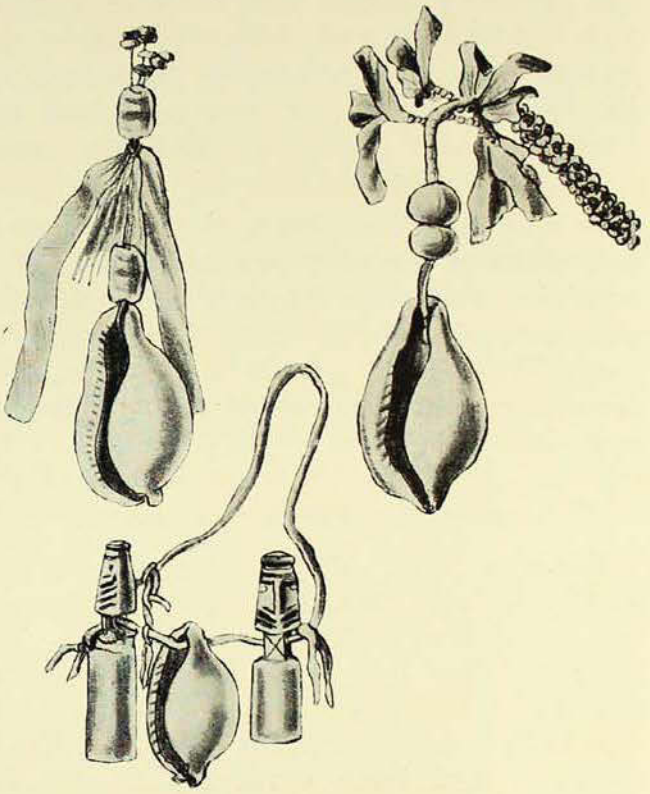
Closely rivalling the previous cowry as a cabinet favourite is the Mauritius Cowry (*C. mauritiana*). Quite the most solid and heaviest of the cowries, it is easily recognized by the hump-like elevation of the back, and the rich dark blackish-brown reticulations on its fulvous back.

The Tortoise-shell Cowry (*C. testudinaria* L.), is so unlike any other shell of the genus that it seems almost an outcast amongst so many species which resemble each other in colour or shape, if not in size. The biggest species of the lot, it reaches sometimes to a length of five and a half inches, and is remarkable for its long narrow form, peculiar rich dark tortoise-shell markings and the sprinkling of the finest white specks over the surface of the shell. These specks, although they only appear in the final layer of enamel, are observed embedded at different depths in it. The bright colour and individual characters of a cowry are reserved till just before the shell is full grown, but the Map Cowry (*C. mappa* L.) breaks away from this usual habit, and, while the animal is still immature, places a layer of its final pattern on the surface, particularly on the left side; then, when it reaches maturity, it places another richer but similar layer above it.

Numerous other cowries have attractive qualities, and are named according to some fancied resemblance to other animals, such as the Snake's head, Serpent head, Panther, and Leopard Cowry.

USE AS ORNAMENTS AND CURRENCY.

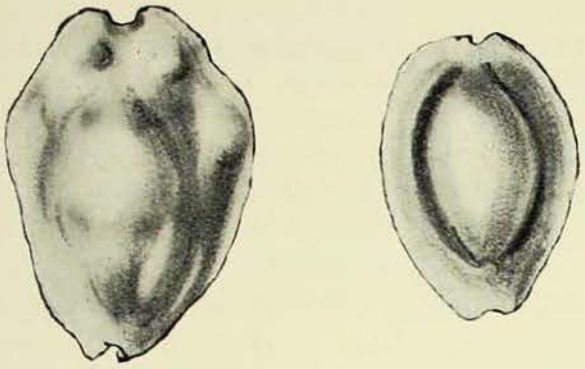
The uses of cowries are many and varied. For generations they have been extensively used by both civilized and uncivilized races. Amongst the former, they are fashioned into all manner of trinkets, such as sleeve-buttons, bracelets, brooches, and small charms; by the latter they are employed mostly as adornment or currency. When adorning their bodies or their masks, they are often used by the natives as charms to keep away evil spirits. Most noticeable, particularly amongst the Sea Sea islanders, is the frequent use of the big white Egg Cowry (*Ovulum ovum*). In the New Hebrides, New Caledonia, and elsewhere it is worn on the upper arm, knee, or below the knee by chiefs and their families as a badge of



Small White Egg Cowries with fibre and beads are used for the two body ornaments and the charm. They are worn by natives of Dutch New Guinea.
[J. K. Allan, *del.*

rank. The Orange Cowry, as mentioned before, is used for a similar purpose in the Friendly Islands and Fiji. In general, cowries are used for rattles, breast, arm, and forehead ornaments, for decorating canoes, and as charms and weights for fishing nets; they are commonly found amongst the sacred contents of the medicine bag. They are used as eyes in their idols, and as eyes in the sockets of their enemies' skulls. To insure a good harvest, the Murray Islanders arrange numerous egg cowries amongst feathers, seeds, and fibre on their extraordinary masks. Head-

hunters wear necklets and armlets containing as many cowries as the scalps they have to their credit. This is very important to them, because in many parts head-hunting is one of the necessary



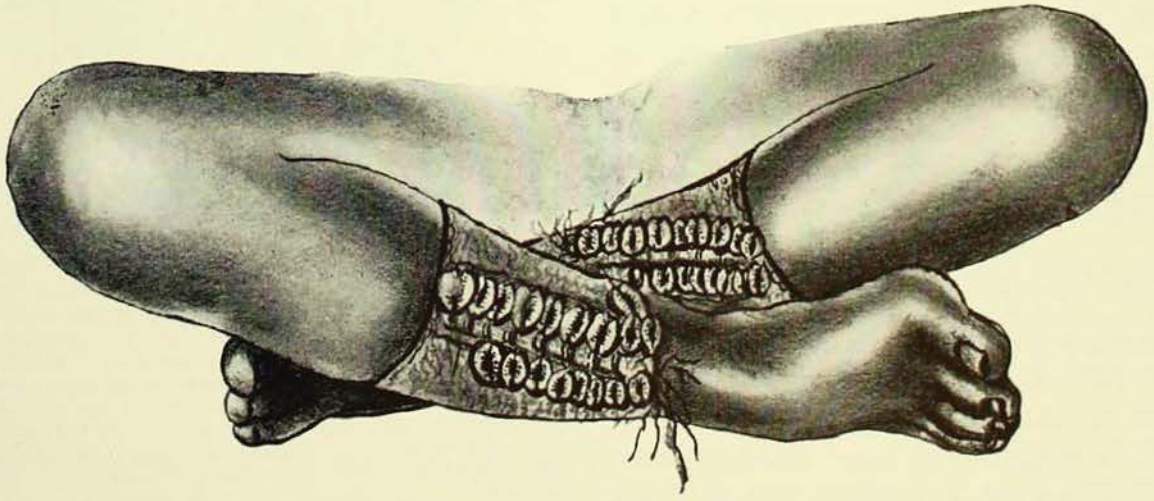
Money Cowries. Best known of all cowries, these two species (C. moneta and C. annulus) are most suitable for currency on account of their small size and solid structure. The former varies from deep yellow to white; the latter is encircled by a deep red or orange ring.

[J. K. Allan, *del.*

qualifications of marriage. The women firmly believe in their power as charms, as they were worn as armlets by the women of Pompeii to prevent sterility, and have been found in women's graves in France and the south of England. In India and Persia the trappings on horses and elephants are decorated with cowries to keep away evil spirits.

It is, however, as currency that the cowry has become most famous. The two most extensively used for this purpose are the Money Cowry (*C. moneta*) and the Ring Cowry (*C. annulus*). As these are both small, heavy species, they need no treatment and are easily manipulated as currency, being in common use in West Africa and parts of India.

This form of currency dates back to antiquity, and cowries were exported from all parts to these regions for this purpose. In West Africa it was first used in the slave traffic, but later ivory and palm-oils were exchanged for it. The money cowries vary in value according to the tribes which handle them, but in all cases the value is graded in a table-like manner. Roughly, two and a half strings, containing one hundred cowries (they are strung for the purpose of currency) are about equivalent to an English penny. A young wife can be bought for 60,000 to 100,000 cowries (about £4 to £8 sterling), an older one for less. A lively state of barter with cowries still exists, and in many parts these are still the only form of currency.



Anklets formed of a double row of Small Cowries fastened to woven bands, worn by a Papuan native.

[J. K. Allan, *del.*

Our Coastal Sponges

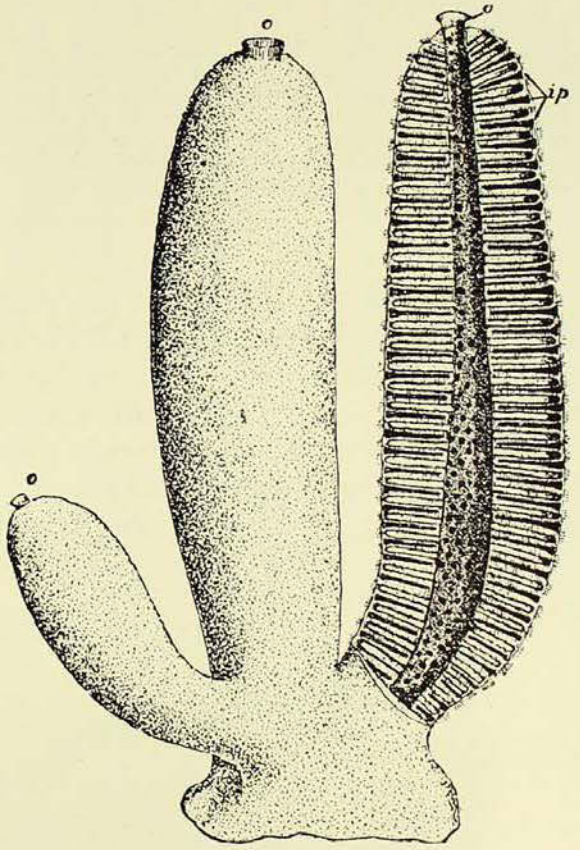
By W. BOARDMAN,
Department of Lower Invertebrates.

"There is found growing upon rockes near unto the sea a certaine matter wrought together of the foame or froth of the sea which we call Spunges. . . ."—Gerarde's *Herbal*, 1636.

THE keenly observant Aristotle shrewdly guessed that sponges were essentially animals and not plants, as their form and habit of permanent attachment would lead a casual observer to believe. The dust of many centuries, however, collected on his famous *Historia Animalium*, and the observations on sponges which he had recorded therein remained without elaboration till the latter half of the eighteenth century, when John Ellis's researches were published. Ellis commented on the fact that the pores on the surface of a sponge had been noticed, some discharging water from, some taking water into, the body, and he concluded that: "The Sponge is an animal whose mouths are so many holes or ends of branched tubes opening on its surface; . . . ." Robert Grant in 1825 made a more careful examination of a living sponge, confirming the earlier work of Ellis, and adding the important fact that the current passing into the body did so through small apertures on the surface, while the avenues of discharge were restricted to much larger and less numerous apertures.

FORM AND SIZE.

Sponges are to be found in a legion of different forms. Almost the whole of the members of the group are permanently attached to some solid base during their adult existence; a few deep sea species are known which are not attached, but lie loosely on the sea floor. Between tide-marks encrusting forms predominate, but in deeper water a more favourable environment permits a much greater diversity of shape, spherical, branched, fan-like, cup-like, and cylindrical growths being among some of the commoner types which may be collected. It is not unusual for the same species of sponge to assume several different forms under the governance, presumably, of varied factors in its environment.



A sketch of portion of a Finger Sponge (Sycon gelatinosum) with the right cylinder dissected to show the relative position of the central (paragastric) cavity, the flagellate, and the incurrent (shown by the black bands) canals. *ip* indicates three groups of inhalant pores at the outer ends of incurrent canals, *o* opening of the paragastric cavity. (Parker and Haswell, "Text-Book of Zoology.")

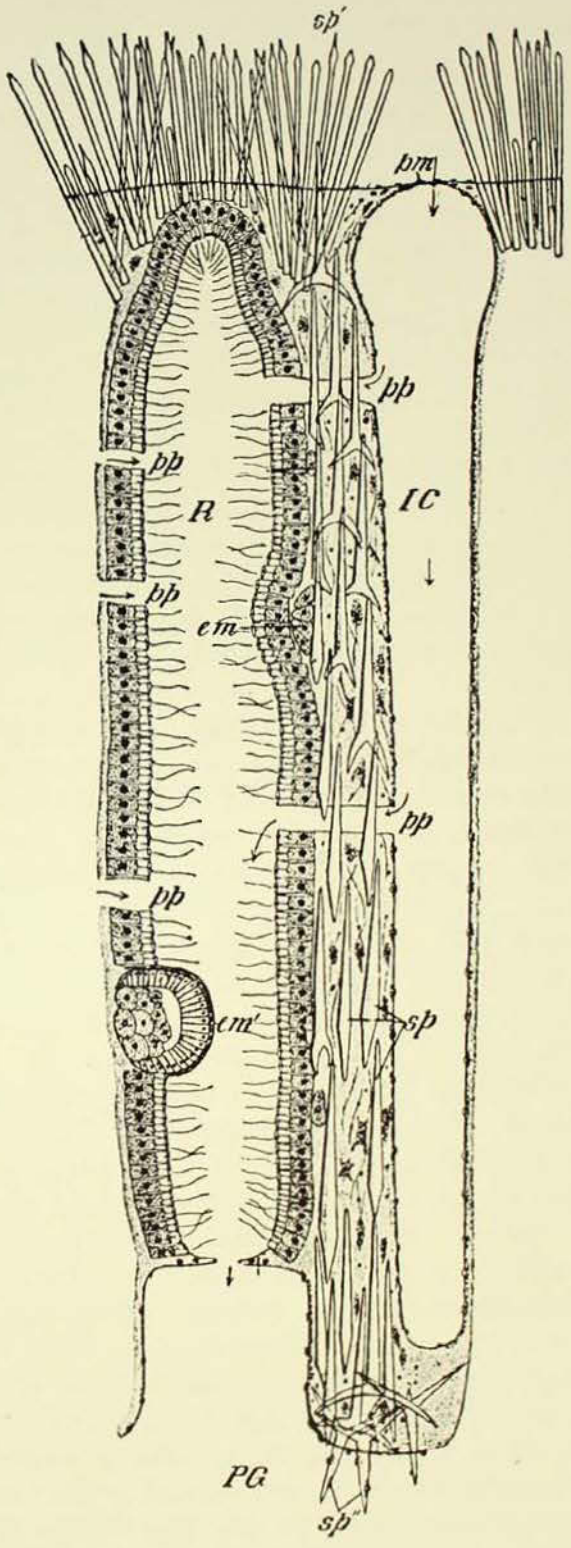
In size there is also much variation, with, at the one extreme, species no larger than a pea, and, at the other, great masses which, when freshly taken from the sea,

would defy the efforts of a man to lift. Every zone of the sea bottom, from the narrow band between tide-marks to the oozy plains of the most profound submarine deeps, supports a sponge fauna characteristic of that particular situation.

STRUCTURE.

An insight into the structure of sponges generally is best provided by the examination of an easily obtained local species, such as the Finger Sponge (*Sycon gelatinosum*), wherein there is not found the extreme simplicity of the most primitive members of the group, nor yet the complicated structure of the more highly developed forms, such as the well-known commercial varieties.

The Finger Sponge is a small tuft-like growth to be found between tide-marks on the New South Wales coast, the tufts composed of unbranched cylinders one to two inches long, united at their bases and usually grey in colour. It is noticeable that at the free end of each cylinder there is an aperture a twentieth of an inch or so in diameter surrounded by a delicate fringe. Let us bisect one of these cylinders longitudinally, and we easily perceive the aperture at the end to be the opening of a canal which runs down the centre of the branch to join in the basal part of the tuft the similar canals of its neighbouring cylinders. Scanning the walls of this canal (known as the paragastric cavity) with a fairly powerful pocket lens, we see that numerous pores, small and close together, are dotted along its extent. To appreciate the significance of the pores opening into the central canal, it is necessary to resort to transverse sectioning of the cylinder wall, which demonstrates that each pore leads into a tiny radially arranged canal extending almost to the outer surface and ending blindly. Then there is another series of radially arranged canals of similar size which, however, end blindly at their inner ends just below the wall of the central canal, and open on the outer surface through a membrane pierced by several exceedingly small apertures. The canals of one series



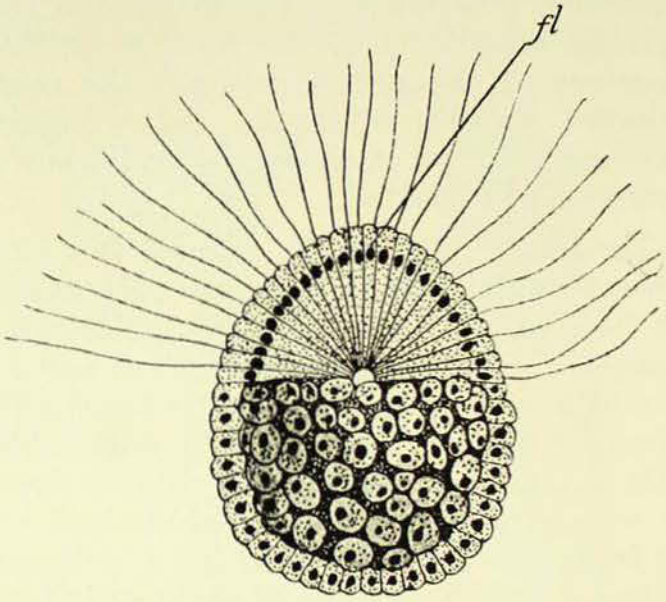
Transverse section through the wall of a cylinder of the Finger Sponge (Sycon gelatinosum) parallel with the canals, showing an incurrent (*IC*) and a flagellate (*R*) canal. *sp* spicules, *pm* pore-membrane, *pp* small connecting canals, *PG* central (paragastric) cavity, *em* early embryo, *em'* late embryo; the arrows indicate the course of the water current through the sponge. (Parker and Haswell, "Text-Book of Zoology.")

are in communication with those of the other by fine transverse pipes connecting neighbouring units.

Let us take a living example and examine it in a small aquarium; the flow of the water currents in and out of the sponge is much easier to see if fine particles of carmine powder are scattered in the water in its neighbourhood. As though drawn by a magnet, the grains are irresistibly attracted to the surface of the sponge and absorbed by it; they are being taken in through the pores in the membranes covering the ends of the second mentioned series of canals (incurrent). Shortly, one can observe carmine particles being ejected from the apertures at the ends of the cylinders, so that, knowing what we now do about sponge anatomy, it is obvious that the particles have entered the body, passed over from the incurrent canals through the slender connecting pipes to the series emptying into the central cavity, and so found themselves again in the open sea-water. How is this continuous circulation brought about? In examining sections of the cylinder wall under a high power of the microscope, we find that each of the cells lining the canals opening into the paragastric cavity has depending from it a tiny whip-like flagellum; it is the constant vibration of these numberless flagella, those of individual canals throbbing in unison, which urges the water out at the open end of the paragastric cavity and causes it to be drawn in from the exterior through the incurrent canals. Moreover, each cell has surrounding its flagellum a prolongation of the end of the cell in the form of a delicate transparent cup, a collar, as it were, and from this unusual modification the cells are called collared cells. Since it is only in the one series of canals that the collared cells are found, the term flagellate canals is used to designate them.

HOW SPONGES FEED.

The collared cells of sponges are very important, not only because they induce the current of water, but for two other reasons. Firstly, in a large number of sponges they are held to be the mouths, and perhaps in some measure the digestive units of the organism. Living specimens of some, usually simple, sponges which have been kept for a time in water containing suspended particles of carmine, and then killed and sectioned, have been found to have the substance of the collared cells gorged with minute particles of the colouring matter; in the same situation small animalculæ, such as are

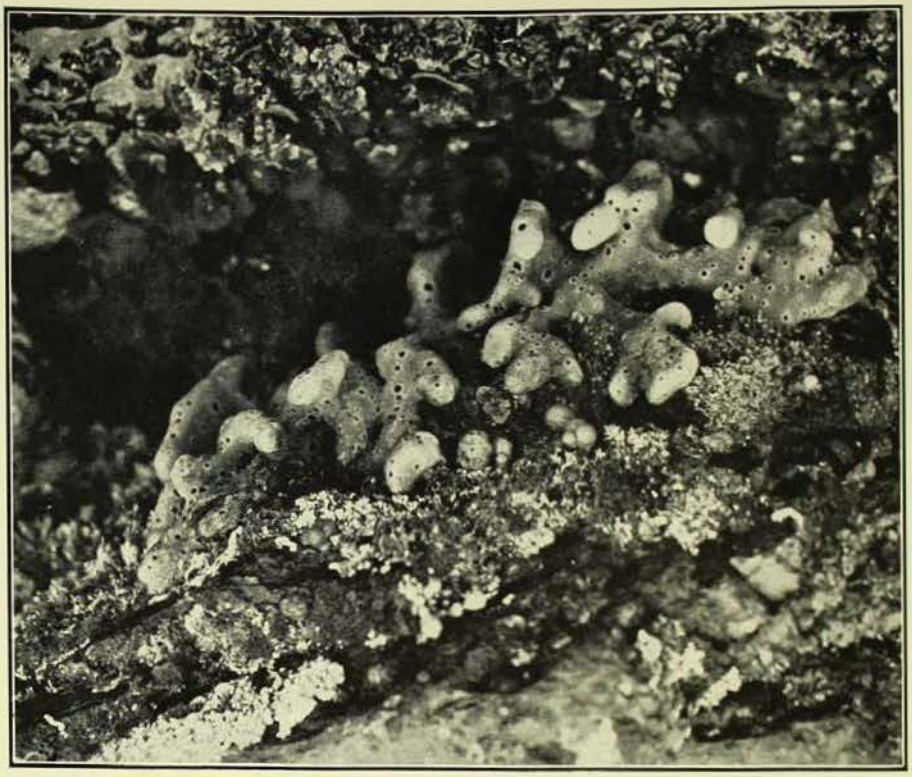


A newly born free-swimming sponge larva. The vibration of the flagella depending from the cells *fl* endows the tiny organism with independent motion. (MacBride, "Text-Book of Embryology.")

abundant in shallow and surface waters, are also found.

The more complicated the canal system of the sponge, the more evidence there is of alteration of the units entrusted with the capture of food, the collared cells being more or less superseded in this function by other peculiar cells, lacking both flagella and collars, which are found in the lining of the incurrent canals; in the more highly evolved sponges the collared cells are mainly concerned with the production of the current, the incurrent ones referred to looking after the capture and, maybe to a large extent, the digestion of the food. Thus the small edible bodies sucked in are absorbed and digested and the waste matter disposed of simply by being conveyed to the cellular

surface of the canals and discharged into the current. In the case of portions of food too large for attention by a single cell, the observation has been made that a number of cells have been detailed off, as it were, jointly to deal with that particular fragment. Some sponges at least have the power of absorbing nutriment in solution and display a keen sense of choice in that direction. The whole question, however, of sponge nutrition and excretion has for many years formed a vexed problem around which there has been no little controversy.



An encrusting sponge (Chalina sp.) photographed under a rock ledge at Long Reef, near Collaroy, N.S.W. This pretty heliotrope species is quite common in sheltered situations near low water mark.

[Photo.—*A. Musgrave.*

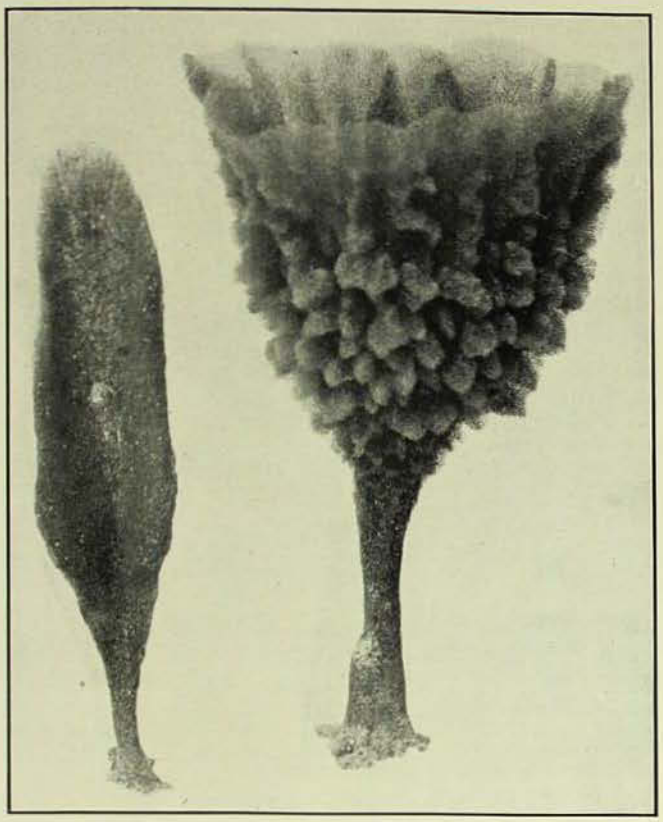
THE AFFINITIES OF SPONGES.

Another reason why the collared cells are so important is that they provide us with a clue to the affinities of the group. The animal kingdom is divided up into two great divisions—the Protozoa, which includes organisms consisting of a single cell only, and the Metazoa, in which the multicellular state is characteristic. The sponges are without doubt the most lowly of the Metazoa, but it is singular that they have no affinities with any other group of that great division. The collared cells are found only in sponges and a Protozoan group, the Choanoflagellata. One of the choanoflagellates has numerous individual collared cells embedded in a gelatinous matrix, and the hypothesis has been advanced that the sponges have branched off from the Choanoflagellata. The isolation of sponges (Porifera) in the Metazoa is so pronounced that a special division, the Parazoa, has been set aside for them.

THE SKELETON.

The Finger Sponge, in common with the majority of sponges, has a skeleton composed of spicules. A conception of the spicules and their arrangement is perhaps best obtained by reference to the illustration. Most of the spicules are three-rayed, and are so arranged as at once to support and protect the delicate parts of the body. There are also clusters of small needle-like spicules which protrude through the skin in areas which cover the blind ends of the flagellate canals and also form a fringe surrounding the entrance of the main paragastric cavities.

In the sponge we have a demonstration of Nature's attempt at the construction of a body. The Protozoa, which includes the Choanoflagellata, are characterized by the possession of a single cell which carries out all the functions necessary for existence. A body implies the differentiation of cells with a special function allocated to each kind. So in sponges there are collared cells, and in the inner jelly-like layer of the body wherein the spicules are embedded, there are found other kinds of cells having various duties to perform. Some of the wandering cells —cells which are able to move within the body, but which occur solitarily and do



Two sponges frequently found cast up on local beaches after heavy coastal weather. That on the left is the Tongue Sponge (Thorecta marginalis) and on the right a related species (Thorecta erecta).
[Photo.—*G. Clutton.*

not form a tissue—will eventually become male or female sex elements for instance. Other cells are engaged on the work of secreting spicules, each spicule being mostly secreted by a single cell only, but in some sponges three cells are required to manufacture a three-rayed spicule and sometimes even more to form a straight or monaxon spicule.

THE REPRODUCTION OF SPONGES.

All sponges reproduce by a sexual process, that is, by male cells or sperms bringing about the fertilization of female cells or ova. Ova and sperms are developed in the same individual, but at different times, in order that self-fertilization may not take place. The sperms are discharged into the canals and so to the open sea, where tides, ocean currents, and independent movement supplied by the lashing of their tiny tails combine to distribute them widely, so placing them in a position where they may enter other sponges, similar to that from which they emerged, per the inflowing current. Should this sponge contain ripe ova, fertilization takes place and then development commences. Eventually somewhat spherical embryos, one hemisphere of each of which is covered with vibrating hairs, are liberated to enjoy a brief spell of free-swimming existence.

A larva in settling down becomes attached, and rapidly assumes a cylindrical form, with a central canal and simple apertures in the side, through which the water currents pass; there is present also an armament of spicules. With growth, the various canals and cellular elements are formed, and in due course the mature state is reached. The larvæ of different sponges exhibit considerable variation, but, broadly speaking, follow the lines indicated above. The little boring sponge, *Cliona,* which burrows in the shells of oysters and other bivalves, is the only known species in which the early development does not take place within the body of the parent; in *Cliona* before segmentation commences the ova are extruded on to the outer surface, and in this position development to the liberation of the larva takes place.

CLASSIFICATION.

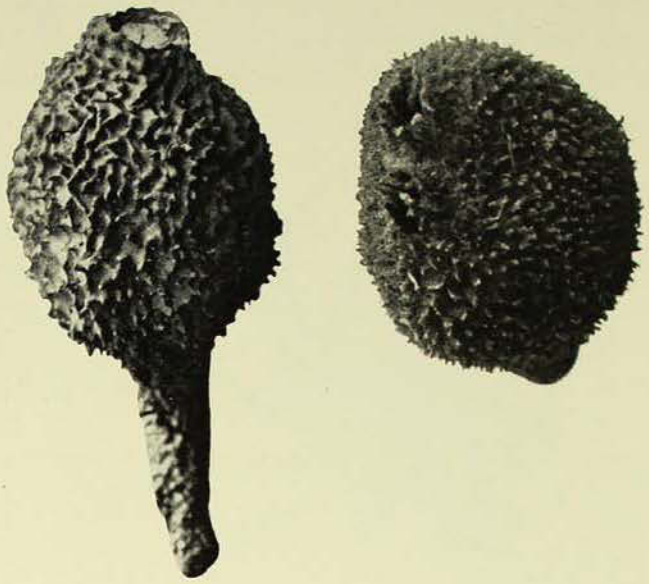
In endeavouring to formulate a scheme of classification for sponges (Porifera), research workers have had much difficulty in that the structure within the group is fundamentally rather uniform. However, three main groups are distinguished, *viz.*: the Calcarea, which have spicules made of lime and possess relatively large collared cells; the Hexactinellida, with six-rayed, siliceous spicules and simple canal system; and the Desmospongia, in which a skeleton may be absent, or, if a skeleton is present, it is composed of spongin fibres or a combination of spongin fibres and siliceous spicules. The type of skeleton, then, is the principal factor in the classification of sponges.

The best commercial sponges have a skeleton composed entirely of spongin,

which is a tough, fibrous, velvety substance, remarkable for the amount of iodine it contains; some tropical sponges have an iodine content of 14 *per cent.*, which is very high when one considers that seaweeds, regarded as being rich, contain no more than 1·6 *per cent.* Incidentally, it is only the skeleton from which all the flesh has been cleaned that is purchased as a "sponge" for domestic use.

A SPONGE MENAGERIE.

Sponges do not seem to be edible by many sea creatures, particularly by such higher forms as fish; some soft-bodied molluscs are almost the only organisms regarded as subsisting on a diet of sponge. Sponges, however, make up for deficiencies in palatableness by the abundant shelter they provide for a large range of small sea creatures. A few minutes' dissection of the cavities of a fair-sized sponge is generally repaid by a harvest of marine worms, crabs, small prawns, brittle sea-stars, sea-fleas, and what not. Indeed, the regular finding of this miniature menagerie led many of the early observers to fall into the erroneous belief that the growth had been constructed by the inhabitants, just as a bird builds its nest. Crabs not infrequently use sponges as a means of protection and concealment. The masked Spider Crab (*Hyastenus diacanthus*) lives in the shallow water of estuaries, and when captured (sometimes on fishing lines) is found to be covered with a dense growth of sponge attached to its back and limbs; singularly enough, the nippers are never so invested, being seemingly kept clear for action. The great advantage of such a covering must manifest itself in various ways, in the first place acting as a camouflage, at once serving to conceal from both enemies and prey, secondly, making the otherwise dainty crab morsel distasteful. On *Hyastenus*, the sponge is attached originally by means of a mucous secretion of the mouth, plus the anchoring effect of numerous tendril-like hairs on the back and limbs, both helping to hold in place the small fragments deliberately put there by the crab until they become attached in their own manner.

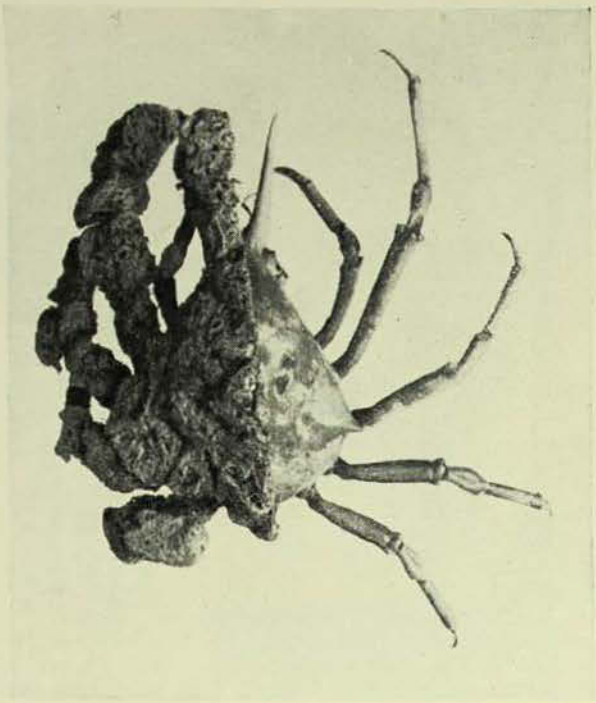


The Bulb Sponge (Stelospongia levis). A photograph of two specimens, the one on the left being "in the flesh," the other showing the skeleton after the flesh has decayed and been washed out.
[Photo.—*G. Clutton.*

Another little Sponge Crab (*Petalomera lateralis*), which is seen when stones are overturned between tide-marks in Port Jackson, also makes use of sponge growths, but in a different manner; it holds a fragment of sponge over its back by means of the specially modified hindmost limbs. Such a covering is considerably larger than the crab and completely hides it from view when observed from above, and is so controlled in growth that it possesses a concavity which exactly fits the hemispherical back of its bearer.

SPONGE FISHERIES.

From very ancient times sponges have been used as toilet accessories, the best examples for that purpose coming from the Adriatic and various parts of the Mediterranean. Of later years the fisheries of the West Indies and the Florida Keys have come into prominence by yielding excellent domestic sponges, little, if at all, inferior to the European article. The Australian coast line is rich in sponge life, but most of the species are valueless commercially and the conformation of the coast does not exhibit the extensive shallows where commercial sponges could



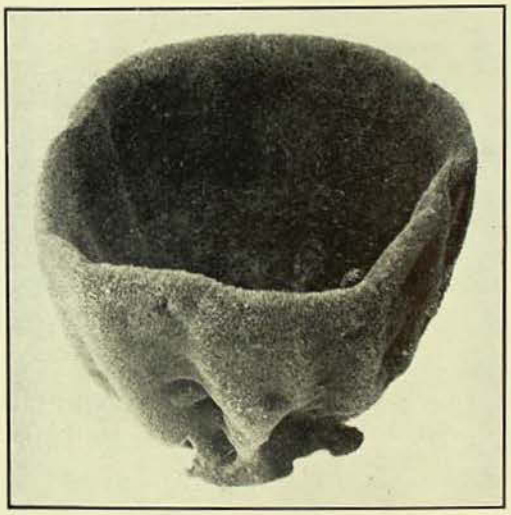
The Sponge Crab (Hyastenus diacanthus) showing half of its body denuded of sponge. The covering of sponge is an excellent camouflage and serves at once to conceal the crab from both enemies and prey.
[Photo.—*G. Clutton.*

at once flourish and be readily fished (the Great Barrier Reef region is, perhaps, exceptional). On the New South Wales coast sponges very closely related to the overseas varieties do occur, and are equal in quality to them, but payable beds in accessible situations have not so far been found.

SOME LOCAL COASTAL FORMS.

There is perhaps no better way of gaining an idea of the variety of form and appearance of our local coastal sponges than to spend an hour or so beachcombing after some heavy coastal weather, for the violence of the waves tears sponges and seaweeds from their anchorage, and strews and piles them on the shore. If one contemplates taking advantage of such a favourable opportunity, it is well not to delay, for the flesh of the sponge quickly decays. This accounts for the fact that most sponges picked up on the beaches are in the form of skeletons, and it is sometimes quite difficult to obtain a specimen of a particular sponge "in the flesh." Twenty or thirty species of sponge, represented, if needs be, by dozens of individuals, can thus easily be gathered and a few can be named on sight, but the determination of the majority is a matter of no little difficulty, requiring expert knowledge of the group and the microscopical examination of sections; the external form is not often of much help in classifying except along the broadest lines, and only then to a specialist. Some of the commonest forms, however, found washed up on the local beaches may be identified on the spot, and below a few of these are enumerated.

NEW SOUTH WALES BATH SPONGE (*Euspongia illawarra*).—Dried specimens resemble in shape, size, and colour the imported bath sponges, to the best of which the species is closely allied. The first specimens to be examined scientifically were taken at Lake Illawarra, New South Wales, hence the name; but the species has a much wider range along the coast, extending north at least as far as Tuggerah. This sponge does not seem



A beautiful example of the Cup Sponge (Thorecta tenuis).
[Photo.—*G. Clutton.*

to occur in any particularly constant shape, and is generally picked up in amorphous masses, often obviously torn from much larger growths; there is a tendency for growths to develop flabellate expansions. *Euspongia illawarra* is the best of our sponges from a commercial standpoint, but it has not been found in paying quantities. The late Mr. T. Whitelegge reported that it is ". . . quite equal, if not superior, to many of the kinds used for domestic purposes. The texture is soft, elastic, tough, and durable, and the main fibres are entirely free from

foreign bodies such as sand grains and spicule fragments. . . ." Clean dead specimens washed up on the shore are yellowish-brown in colour and quite soft and woolly to the touch.

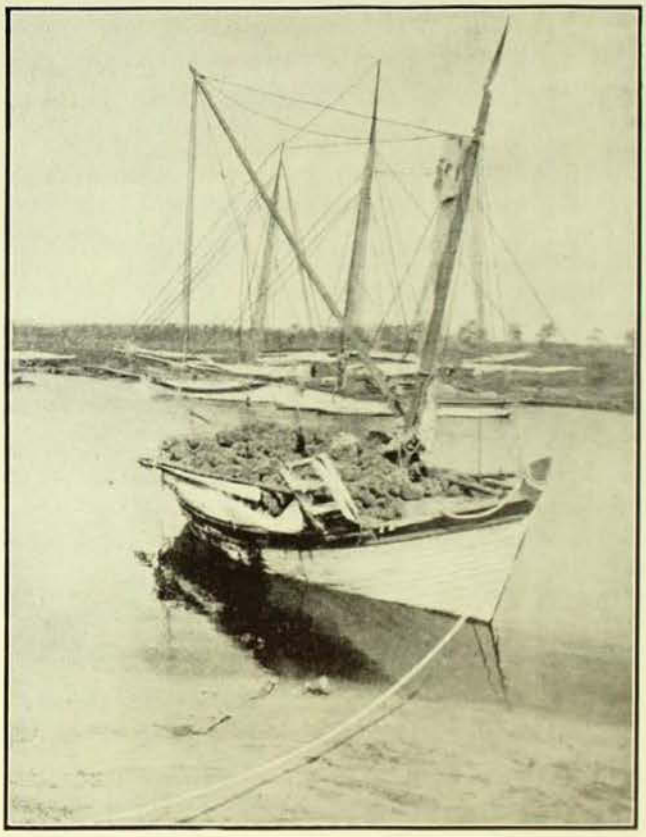
THE CUP SPONGE (*Thorecta tenuis*).—Although occurring in other forms, this sponge is most often collected in the shape of a cup. A large specimen would be about eight inches high, with a diameter across the lip of the cup slightly less. The living sponge is attached by a short very stout stalk. The outer surface has on it longitudinal ridges, strongly marked below, but fading away toward the upper margin. When found in the flesh, the exhalant pores are seen within the inside surface of the cup; they are quite large at the base, but get smaller as the margin is approached. Smaller inhalant pores are scattered over the outer surface. The skeleton has the form of a firm mat of fibres, of which the main ones, when examined microscopically, are perceived to have a core of sand grains. The general texture is so close and hard as totally to unfit it for domestic purposes.

The shapes this sponge may be found to assume have a wide range, varying from flabellate examples to the perfect cups. Usually it is the skeleton only which is discovered, and in that state it is brown in colour.

The related species *Thorecta erecta* also occurs in a range of forms, from erect lobose examples with flattened tops to hollow inverted cones and cup shapes, but with a more slender and much longer stalk than in *T. tenuis*.

THE TONGUE SPONGE (*Thorecta marginalis*).—Here again the form is not constant, but the commonest seems to be the tongue shape, when the total height of the sponge may be a foot or more, of which the lower quarter is a slender stalk. The large excurrent canal openings are not numerous, and are usually concentrated on one side.

THE BULB SPONGE (*Stelospongia levis*).—This is one of the commonest of the sponges washed ashore, and occurs in the form of bulbs having a vertical diameter of three or four inches, supported by a short stalk below and having at the top the opening of the main excurrent canal (osculum) situated on a small conical elevation; there is generally only one osculum, but two or more are sometimes found on the crown of the growth. The skeleton is chestnut brown and is very hard and coarse, the living examples being usually light violet brown.



Type of boat used in sponge fisheries, Florida. The ladder which the diver descends is shown triced up, and a cured catch may be seen on the boat itself.
[Photo.—*U.S. Fish Bureau.*

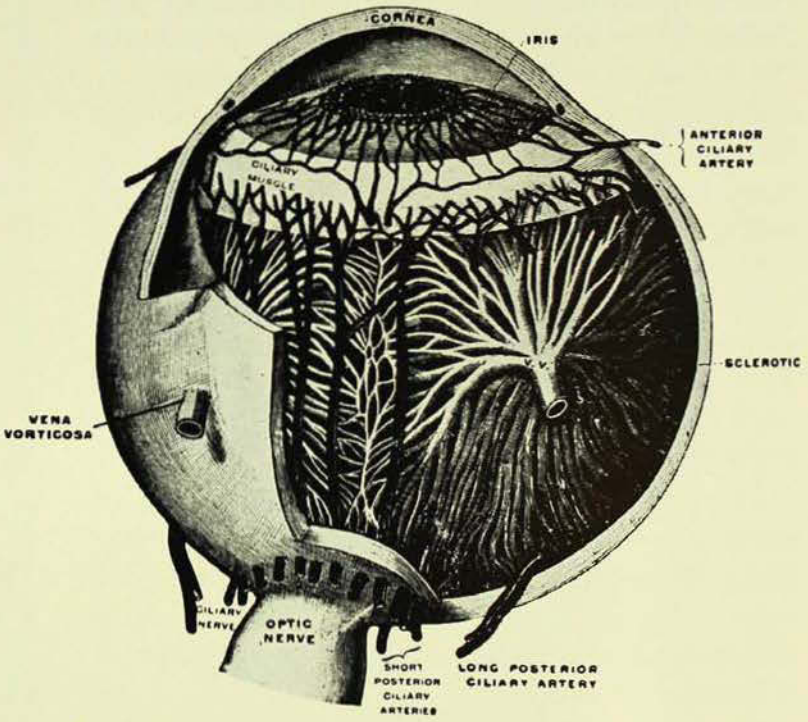
In addition to the sponges mentioned above, there are all sorts and sizes of other species to be collected. One of these, in particular, is not often washed ashore, but may be found plentifully beneath stones and under rock ledges between tide-marks. It is an encrusting type, does not grow very thick and shows a tendency to lobe on the upper surface. Large oscula are scattered over the surface, and the species displays the pretty heliotrope shade fairly general in the members of the genus *Chalina*, to which it belongs.

The Eye and Eyesight

BY R. GRANVILLE WADDY, M.B., Ch.M.

ANIMAL and vegetable matter consist of a mass of small separate elements, closely packed together to form the tissue structure, each individual element being known as a cell. Every living creature, composed of countless millions of cells, has originated from only two cells, the ovum and the sperm. After the union of these two microscopic elements a process of division rapidly goes on, the resultant mass growing in size as this ceaseless and rapid multiplication proceeds. Very soon the cells take on different shapes, functions and characters, become specialized, as it is called. There are organisms such as bacteria, germs, and the amœba, which are single celled, unicellular, throughout life, and these primitive forms of life possess a sensitivity to light over the whole cellular structure. In multicellular structures—often in botanical as well as in animal—sensitiveness to light becomes the special function of a group of cells partaking of a differentiated structure; usually this consists of a surface or epithelial cell connected to a nerve cell by a fibre of greater or lesser length, by medium of which the stimulus created by the action of light upon the protoplasm of the epithelial cell is conducted to the main or central nerve organ.

The eye of man and of the higher animals is essentially a similar type of apparatus, there being, in place of a single epithelial cell, a vast number, congregated together to form the sensitive retina. This layer of tissue is the vital or essential portion of the eye and its function, all other structures being there either for its protection or to facilitate its proper and efficient function. It, too, is of epithelial or surface cell origin, and develops as an outgrowth from the primitive brain of the embryo. The other parts of the eye develop at a later date and are designed to perform the functions of protection, nutrition, movement and optical purposes.



Vessels and nerves of the chorioid and iris, seen from above.

Let us consider the systems into which these characters may be classified.

PROTECTION.

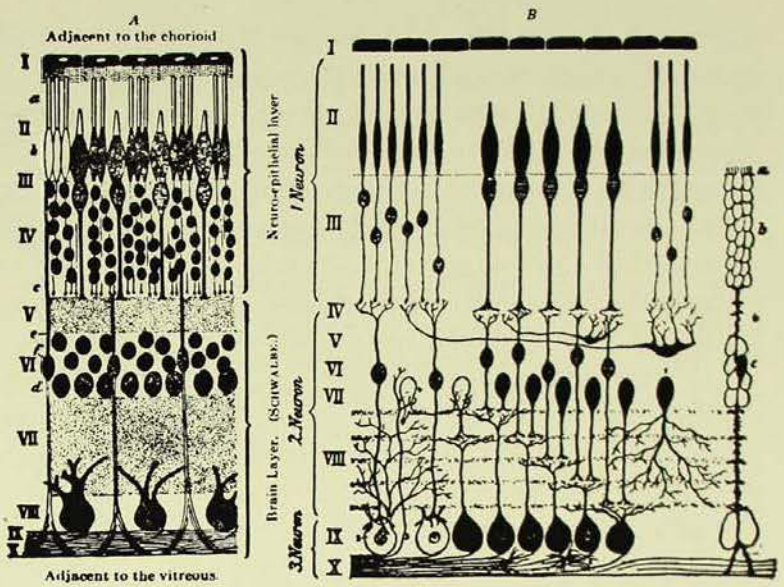
The eyeball lies in a bony cone, filled with soft fatty tissue; the rim or margin of this cone or recess overhangs sufficiently to protect the eyeball from many blows, except those of a stabbing nature from directly in front. A great many players of cricket and tennis, and boxers receive blows upon the face with the ball or fist and have the delicate eyeball saved by this overhanging bony margin. It is because of the small size, not the hard-

ness, of a golf ball that blows in the neighbourhood of the eye so often do permanent contusional damage to the eye.

The lids protect the globe from desiccating, and mechanically move off particles of dust and dirt. They also, by a rapid reflex action causing closure of the lids, save the globe from squirts of corrosive acids or other liquids, and protect in a hundred different ways.

The conjunctiva or lining membrane of the lids and the eyeball forms with the lids a sort of ball and socket joint which facilitates movement.

The lachrymal apparatus by supplying a watery secretion lubricates this joint, provides a solution which is deleterious to bacteria and germs, and keeps the cornea moist and polished.



Scheme of the structure of the human retina. (After Souter *in* Posey and Spiller.)

A. **Horizontal section, hæmatoxylin stain. I. Pigment epithelial layer. II. Layer of rods and cones: *a*, external; *b*, internal elements. III. External limiting membrane. IV. External molecular layer: *c*, fibre layer. V. External granular layer. VI. Internal molecular layer: *d*, spongioblasts; *e*, supporting fibres of Müller; *f*, nuclei of the same. VII. Internal granular layer. VIII. Layer of ganglion cells. IX. Nerve fibre layer. X. Internal limiting membrane.**

B. **Demonstration after the method of Golgi. I. Pigment epithelial layer. II. Layer of rods and cones. III. Molecular and visual cells. IV. External plexiform layer. V. Layer of horizontal cells. VI. Layer of bipolar cells. VII. Layer of amacrine cells. VIII. Internal plexiform layer (fibre layers). IX. Layer of ganglion cells. X. Nerve fibre layer: 1, diffuse amacrine cells; 2, diffuse ganglion cells; 3, centrifugal nerve fibres; 4, association-amacrine cells; 5, neuroglia cells; 6, supporting fibres of Müller.**

THE ORGANS AND FUNCTION OF SIGHT.

(*a*) *The Supporting System.*—As the eye has to move about in order to be directed upon objects at different angles in the field of vision, it has to possess some solidity, and this is provided by a tough, dense coating called the sclerotic. But were this a uniform globe, like a tennis ball, it would be opaque, and Nature has let in, as it were, a watch glass, the clear transparent cornea, through which rays of light pass from external objects to reach the retina and so stimulate it to pass on the stimulus to the brain. The structure of the cornea is shown in the accompanying micro-photograph.

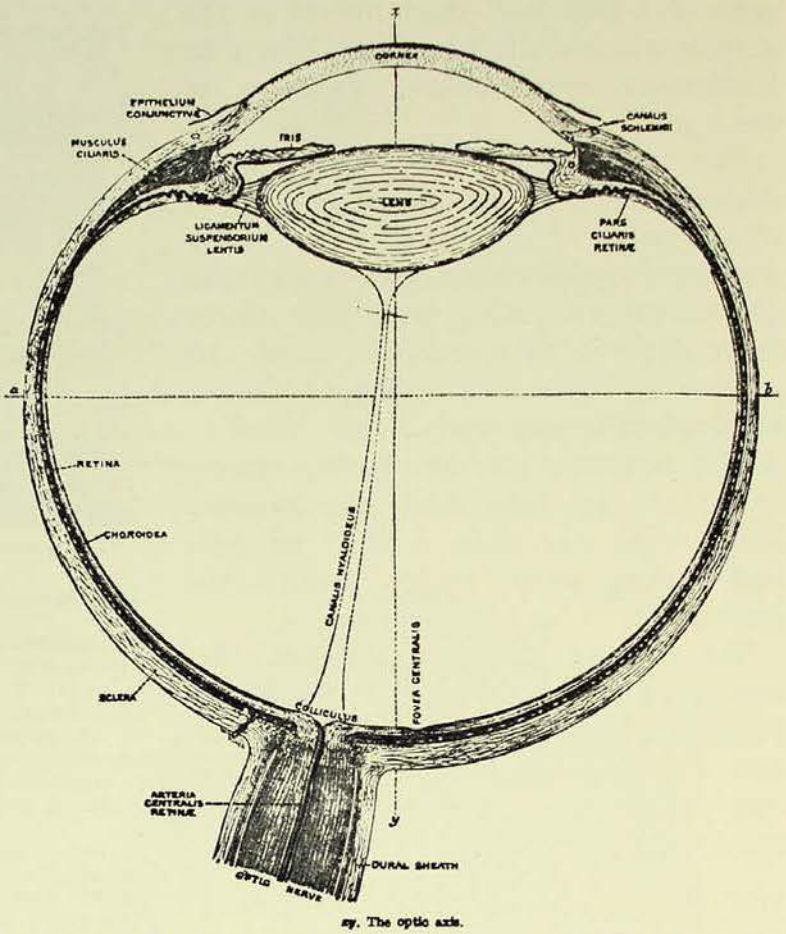
(*b*) *Vascular or Nutritive System.*—This comprises the arteries which convey oxygenated blood to all the cells, and the veins by which the used blood returns to the heart. The cornea is a type of tissue structure totally devoid of arteries and veins, and has the nutrition of its cells supplied by a fluid of blood plasma type which circulates from the periphery in channels called lymphatics, in which there circulates a fluid which has passed through the smaller arterial vessels.

One of the inner coats of the eye, lying against the protective, tough sclerotic, is the chorioid, consisting of a close meshwork of veins and arteries, really like a large nævus or "birth mark"; the function of the chorioid is to provide a fine system of vessels out of which lymph or blood plasma can transude in order to supply food and nourishment for portion of the delicate retina. Every man, woman and child has the same or nearly the same distribution of arteries and veins, there being very few departures from standard.

(*c*) *Sensory or Perceptive System.*—This system is the vital one of sight or vision. It may be divided into three portions:

(1) Ocular, in which the retina plays the chief function. And here it may be well to explain some of the details of the act of vision. Every object in an atmos-

phere of light reflects rays of light, some of which may be so directed as to pass through the pupil of an eye. They are so directed or focussed as to come to a point on the retina and there certain specialized cells are stimulated by some electrical or chemical reaction, and these cells hand on the created impulse to at least two other specialized cells in series; the latter of these has a long fibre attached to it, and the fibres gravitate towards a minute hole in the sclerotic at its back portion, pass out of the eyeball through minute perforations in the sclera, comparable to the holes in a collander, group together and become the optic nerve. A substance called rhodopsin, or visual purple, plays a very important part in the translation of the stimulus of the rays of light into the energy produced thereby upon the retinal cells. On, or in, the retina an upside down or inverted image of external objects is produced by the refracting or focussing apparatus.



xy. The optic axis.

Diagram of the right adult human eye, divided nearly horizontally through the middle.
[After *E. A. Schäfer.*

(2) The Conducting Portion.—This leads the stimulus effected by the rays of light from the eyeball *via* the optic nerve to the brain, by a somewhat long path. The optic nerves of the two eyes send half their fibres to a crossing arrangement at the optic chiasm, and thereafter the nerves are known anatomically as the optic tracts. These tracts, two in number, run into the lower portion of the brain and the long fibres, originating from the retina, end by wrapping their tentacles around a new group of cells, and at this stage hand on their stimulus to the new cells. A complicated arrangement of cells hereabouts eventually sends the stimulus to the grey matter of the brain in the occipital region; that is the portion just above the nape of the neck. It is in this visual cortex, as the area is named (it is present on each side of the brain), that the act of vision finally and actually takes place; this brain matter is essential to vision. Many a soldier has been shot through the back of the head, the bullet injuring these small visual cortex areas, and become stone blind, although his eyes have not been involved in the slightest damage or alteration. If we cogitate a moment, it will be realized that we see, not with our eyes, but with our brain.

(3) Motor System.—Some of the lower animals have fixed and immobile visual organs, and in these cases they are usually multiple. The next step in development was to reduce the number of eyes and make the fewer ones capable of being turned in varying directions. In the higher animals we have six muscles so attached to the eyeball as to be capable of moving it round a complete circle; the globe is, as it were, set in a ball and socket joint, capable of being pulled hither and thither by the muscles attached to it. These muscles are referred to as the extra-ocular.

In addition, there are two delicate intra-ocular muscles, one being a circular

ring, surrounding the area of the pupil and embedded in the iris tissue. The contraction of this muscle reduces the area of the pupil; in strong lights, glare *et cetera*, this muscle functions like the diaphragm of a camera, and so reduces the amount of light entering the pupil to reach the retina. The second of these muscles lies a little deeper in the eye, and is connected with the function of accommodation, or focussing of near objects. By its action the lens is permitted to alter its shape and become more convex, thus giving it a differing focal length.

(4) Refracting or Focussing System.—This is rather too complex to deal with at length. Suffice it to say that the normal, healthy eye when at rest is so arranged as an optical system as to focus parallel rays of light on to the rod and cone layer of the retina. The rays, from being parallel to one another, are "refracted" or bent towards one another as they pass into and out of the cornea, again as they pass through the convex lens, so that eventually, instead of being a parallel bundle, they unite in a pencil point. Objects nearer to the eye than twenty feet have divergent rays arising from them, and unless the convexity of the lens is altered, these diverging rays would fail to focus on the retina and the resulting image they create would be blurred, like a bad photo. The lens, through the agency of the ciliary muscle is, therefore, in a constant state of change to allow for the focussing of objects; this act is referred to as accommodation.

The abnormal eye is so constructed when at rest as not to focus parallel rays on to the retina, and this is the reason for the wearing of spectacles, the glasses of which are constructed so as to correct the inherent deficiency of the focussing system. Long sight, or hypermetropia, is such as to require convex spectacle lens; short sight, or myopia, needs concave lens. Astigmatism is a term used when two diameters of the cornea have different curves, instead of being equal as in a true spherical surface. A portion of a tennis ball has a uniform curve in every radiation, and this would possess no astigmatic error, whereas an ordinary spoon bowl has such an error in that the radius of the curve in the direction of the handle is larger than the radius of the curve at right angles to the handle.

The focussing or optical system of the eye is necessary to produce sharp definition of the outside world, but is not of itself the act of sight, which appertains to the retina and brain. In the condition known as cataract the lens develops blurs, smudges, or opacities which hinder its function, and eventually the lens becomes non-transparent or opaque, so that although the retina be healthy, impulses of rays from the objects cannot reach it owing to the opacity of the lens. It is rather like being inside a room with the blind drawn. Raise the blind, extract the cataract (requiring the most delicate operation in the whole of surgery), and the way is open for these rays to reach the retina. But the focussing power of the lens has been removed from the eye, so that the image is very indistinct, and the patient who has had a cataract operation has to replace the intra-ocular lens by an equally powerful lens worn as a spectacle glass, and, as the function of accommodation has been interfered with, the individual requires a different glass for focussing objects at varying distances.

(5) Pressure System.—It is obvious that a hollow cup or shell like the supporting system must need some packing to keep it from collapsing on itself. The eyeball has a normal pressure or tension of its own which must be maintained, otherwise diseases arise and the tissues undergo degeneration. Consider a football. Until the bladder has air blown into it, it is soft and useless, much like an eye which has had a puncture wound which has allowed the escape of intra-ocular fluid. The footballer knows by feel the proper tension or tightness to which the football should be inflated in order to make it most serviceable. So with the eye. Fluids, rather like a saline solution, are in constant circulation in-

side the eye, being secreted from blood vessels into areas devoid of tissues, there to circulate and undergo a continuous outward drainage through minute channels. Should access to these channels be hampered there is a tendency for the fluid to accumulate in the eyeball and thereby for the pressure or tension to be raised. If this raised tension be continued, either permanently or intermittently, the retina becomes squeezed and eventually blindness results. An increase of intra-ocular pressure goes by the medical name of glaucoma, one of the worst sight-destroying diseases to which the eye is subject.

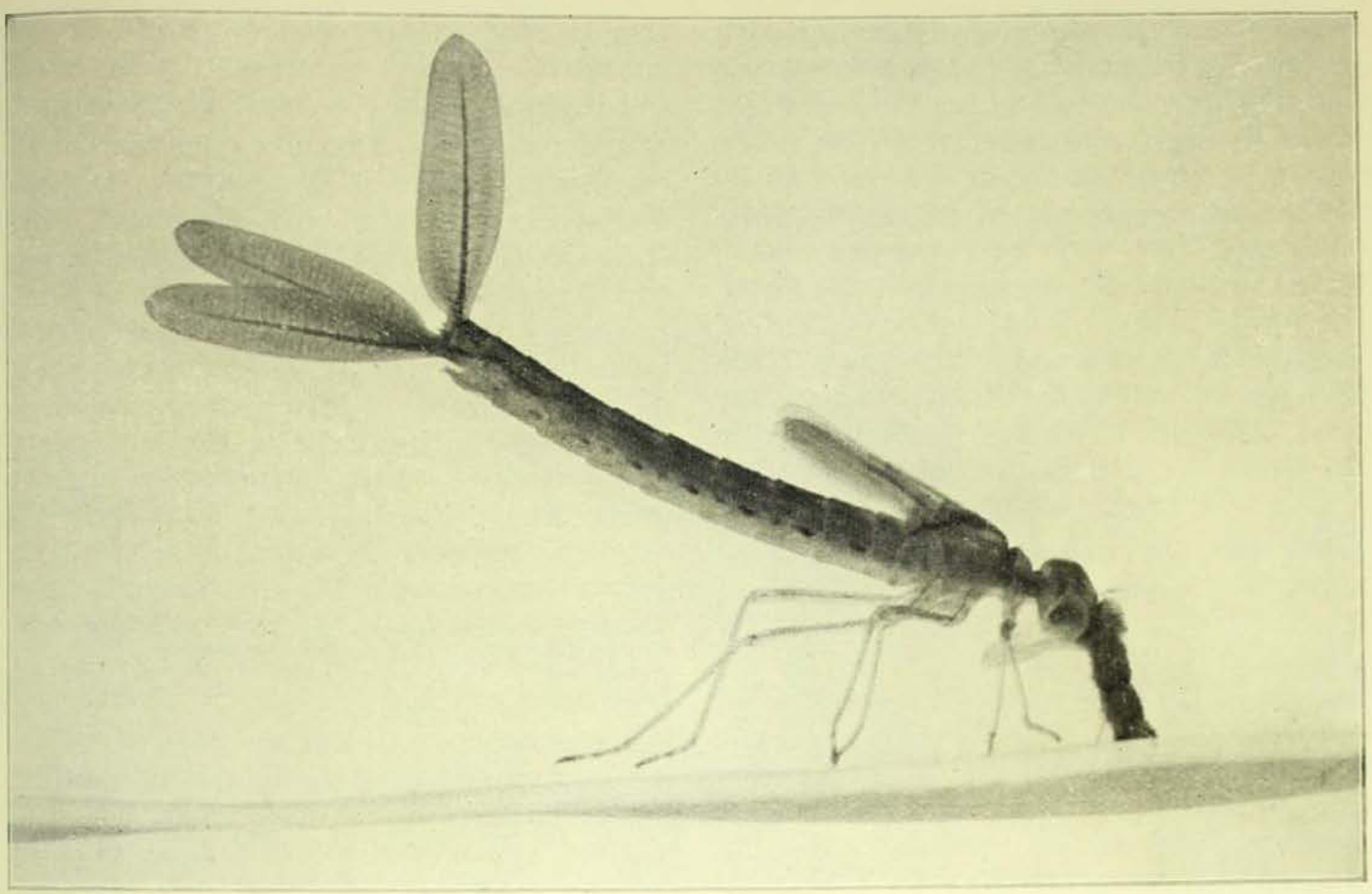
The Life of a Dragonfly

By R. J. TILLYARD, D.Sc., F.R.S., ETC.

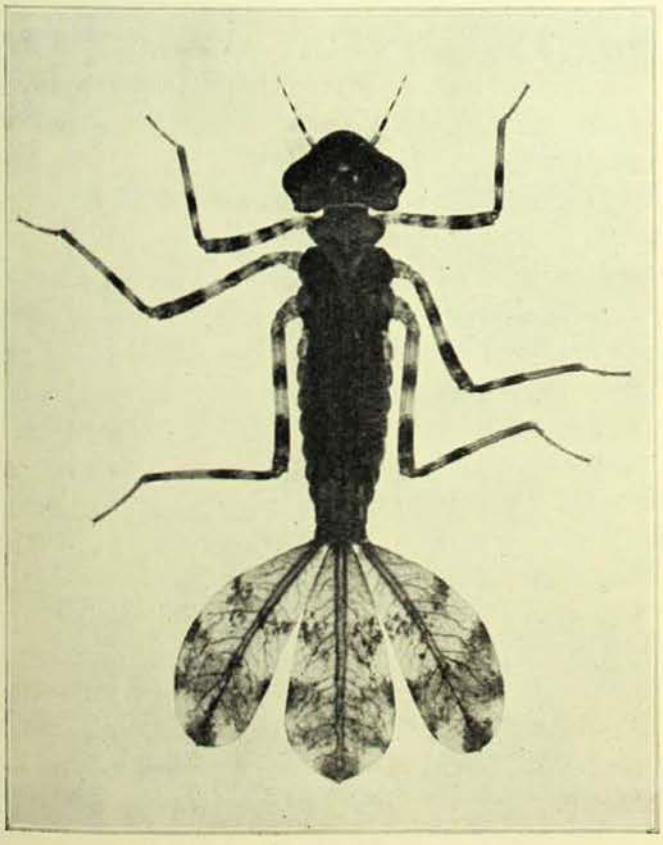
ON a calm, sunny morning of a week-end in early November, I am standing by the edge of a small pond in which grow many interesting aquatic plants, water-lilies, bull-rushes, myriophyllum and potamogeton. The bull-rushes form a tall edging to one side of the pond, a very convenient hiding-place from which to observe without being seen; the myriophyllum and potamogeton spread out in irregular masses; the water-lilies expand their clusters of leaves, floating flatly on the water, with here and there a freshly opened flower of exquisite beauty breaking the circular outlines of the leaves. There is scarcely a perceptible breath of air over the pond. There comes a whirr of wings, and a large Dragonfly (*Anax papuensis*) appears suddenly on the scene, flashes across the pond, rises in a graceful curve to capture a small unwary moth, and disappears as quickly as it came. A few minutes later I hear a click of wings, followed by a low drumming sound from the farther edge of the pond, and I see two of these same dragonflies apparently engaged in combat. It is, however, not a fight, but a friendly interlude between male and female before mating. Their evolutions together in the air are so rapid that one cannot quite see what is happening; but the result of a quick entanglement and disentanglement is that they now appear together, flying in good order, tandem-wise, the male in front of the female, holding her by the back of the neck with his anal claspers, and, as it were, solicitously asisting to explore the many likely places in the pond where her eggs might be laid.

It is here that the bull-rushes come in handy. One can gaze through the delicate screen of green uprights without disturbing the insects in their evolutions. The pair are now coming along the pond towards me, stopping here and there to explore the floating leaves. Soon they arrive at a fine clump of water-lily leaves situated only a few feet from where I am watching. The female alights on a broad, flat leaf, and moves backwards until she can feel the edge of it with the tip of her abdomen. Meanwhile the male, with wings whirring, remains poised almost vertically in front of her, evidently by this manœuvre assisting her to maintain her balance in a rather unstable position. Finally, she selects a suitable area on the underside of the leaf near its edge, and curves her body round it, rasping its soft tissues with her ovipositor and evidently laying several eggs one after another in them. A kind of intentness seems to settle down upon the pair; the male is tireless in his spinning energy as he keeps poised on quivering wings in front of the female. A period passes which appears to me to be fully five minutes, but is probably much less, during which the pair remain preoccupied with this business of egg-laying; then there is a sudden swoop from above, and a somewhat smaller but swifter dragonfly, the common species, *Hemicordulia tau*, tries by a sudden dart to interfere with the pair, and succeeds sufficiently to cause them to rise in the air and continue their explorations further down the pond.

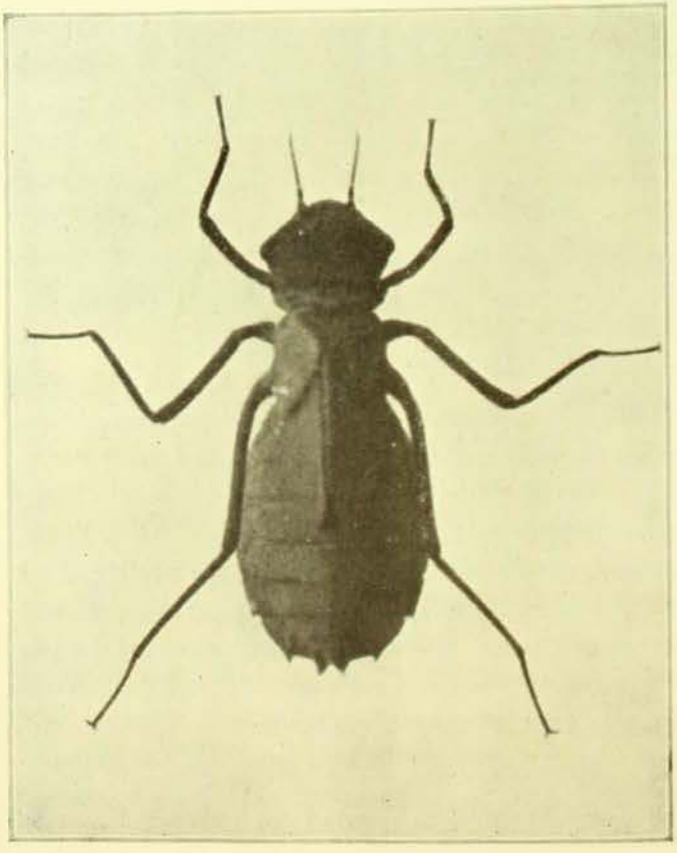
A little later, *Hemicordulia tau* itself, one of the fastest and best of fliers, dashes



Larva or nymph of Austrolestes analis Ramb., full-grown, in the act of devouring a Chironomid larva (× 3).



Larva or nymph of Argiolestes icteromelas Sel., full-grown (× 2½).



Larva or nymph of Hemicordulia tau Sel., full-grown (× 2).

[Photos.—*Dr. A. J. Nicholson and Miss A. G. Burns.*

rapidly past me engaged in pairing with its mate in the air. This pair, however, do not continue for long flying tandem-wise; instead, they disengage, and the male rises and circles high into the air, while the female, apparently with great trepidation, proceeds with rapid, jerky movements to wash off into the pond the fertilized eggs which are oozing in a kind of jelly from the end of her abdomen. This is done by repeatedly descending to the level of the pond and then quickly dipping the tip of her abdomen on the water, with a kind of brushing movement.

Further out on the pond there now appears a smaller dragonfly, bright red in colour, flying tandem-wise in front of a greyish-brown companion, which is the female of the same species, *Diplacodes bipunctata*. The female is doing almost exactly what the female *Hemicordulia* did, brushing off sticky masses of eggs from the end of her abdomen into the water; but she is assisted by the male, who accompanies her everywhere.

On a nearby reed, a foot above the water-level, a pair of small damselflies have just settled. These two are coupled tandem-wise. They are *Austrolestes leda*, the male a lovely blue and bronze, the female duller and with much less blue on her. They are exploring the reed-stem, moving slowly down it until the female reaches the water-level. Having descended halfway into the water, she starts slitting the stem with her ovipositor and inserting eggs into it.

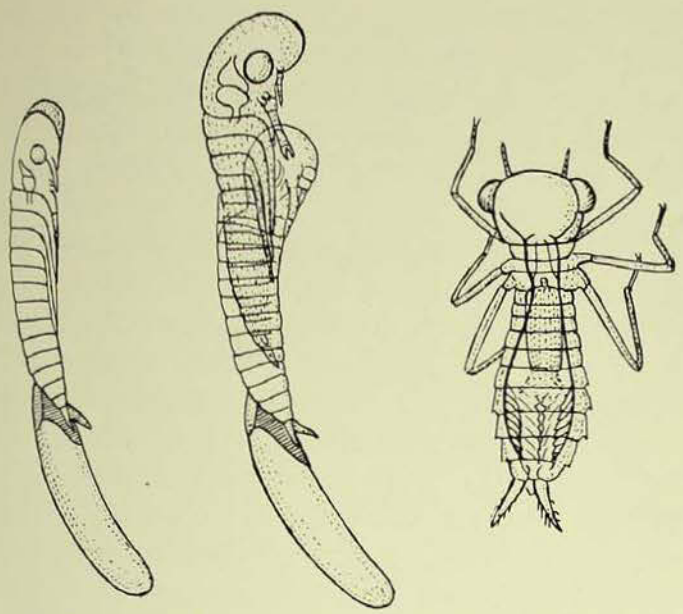
The little damselfly and the huge *Anax* agree closely in their methods of ovipositing. Both are accompanied by their males; both slit open the tissues of water-plants; and both insert their elongated eggs within the slits. Some of the floating leaves on the pond are seared with criss-cross markings where numerous dragonflies have rasped their tissues. If such a leaf be gathered and held up to the sunlight, the eggs can be seen clearly *in situ* within it.

On the other hand, the swift *Hemicordulia* and the darting *Diplacodes* dispense with the formality of slitting the tissues of water-weeds, and deposit rounded eggs in water merely by brushing them off from the end of the abdomen.

The fossil record shows us that, of all the living types of dragonflies, the little damselflies are the most ancient. All of these use the cumbersome method of laying their elongated eggs in splits in plant-tissues, and so also do the more ancient types amongst the true dragonflies. It is only the most highly evolved of these latter, as represented by the two genera *Hemicordulia* and *Diplacodes* already mentioned, which have simplified the original process by dispensing with the ovipositor and producing instead, direct from the abdomen, a more rounded type of egg which can be washed off straight into the water.

There are two different kinds of dragonfly larvæ. The little damselflies, which we have already stated are the most ancient types of the order, have, as might be expected, larvæ which are most like the corresponding adults. These are slender, gracefully built aquatic forms, of the types shown in the photographs of *Austrolestes analis* and *Argiolestes icteromelas*, and easily recognized by the possession of three conspicuous breathing-organs at the end of the body, called the caudal gills. On the other hand, the true dragonflies possess larvæ which differ greatly in form from the adult insect, being much stouter, like *Anas papuensis*, or else more spider-like, with a short, squat body and long legs like *Hemicordulia tau*. These types never have any caudal gills, but breathe by means of a complicated series of internal gills situated within the rectum. They make a fine bait for trout, and are known vernacularly as "mud-eyes," as most kinds live at the bottom of streams and ponds and are remarkable for the prominence of their large eyes.

Let us now follow out the individual life history of the big fellow, *Anax papuensis*. To do this, we must provide ourselves with an aquarium and some small glass jars, each of which should be provided with a clean sandy bottom and suitable aquatic plants growing in it. Besides these, it is advisable to have a



Emergence of Anax papuensis Burm. from the egg: Left, **pronymph emerging from egg-shell;** centre, **young larva emerging from pronymphal sheath;** right, **the young larva free.** (All figures × 20.)

[R.J.T., *del.*

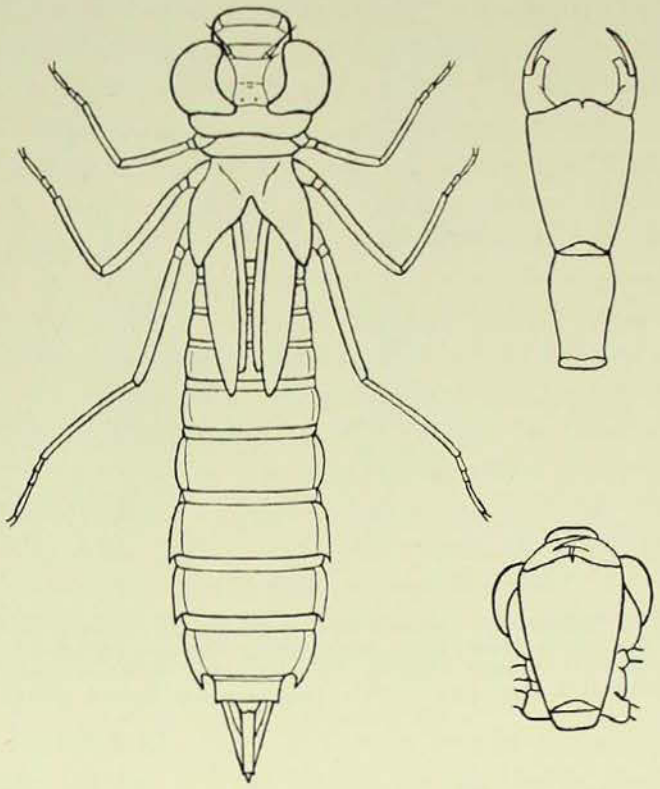
few Petri dishes containing water with a little duck-weed floating on it. We begin our study by gathering the water-lily leaf in which we have observed the female *Anax* to oviposit. Holding it up to the sunlight, we see at once the slits made by the insect, and, on cutting these open, we have no difficulty in finding the elongated eggs. It is best not to separate these out, but to cut small sections of the leaf with the eggs still *in situ*, and place these in one of the Petri dishes for observation. If necessary, a few of the eggs can be separated out for examination under the microscope. We shall pass over here the changes which occur in the egg during the embryonic period, which, in the case of *Anax*, occupies a little less than three weeks. When the time for hatching approaches, the embryo can be seen clearly within the egg by using transmitted light, and the two large eyes begin to darken. Some little time before actual hatching, the heart can be seen beating. The pulse is at first only about thirty beats to the minute, but it slowly increases to about eighty. A vesicle filled with nearly colourless blood next appears between the actual head and the egg-cap, and a peculiar pulsating organ appears in the head itself. This organ swells up rapidly and fills with blood, causing the head to swell and to exert great pressure on the egg-cap. The latter gives way suddenly under this pressure, and the little embryo flows smoothly out from behind it for its full length. One observes with surprise that it is not an active larva, as one would naturally expect, but a smooth, swathed, inactive thing with its appendages folded neatly against its body, just as in the case of a chrysalis or pupa. This little creature, which is quite unable to fend for itself, is known as a *pronymph*. As it moves forward out of the egg-shell, one anticipates that it will pass out freely into the water. However, this does not happen; instead, it comes up with a full stop just as it is free for its full length, and it is then seen that the end of its body is provided with a strong spine which catches against the split egg-shell, and thus holds the little creature in position for a minute or two. There it stays, swaying gently in the water, but only for a very short time. The pulsating organ in its head now appears larger than ever, and, beating regularly, draws in all the blood from the vesicle already mentioned and so causes the head to swell up very rapidly to about twice its original size. In less than half a minute from the birth of the pronymph, there is a second split along the back of the head, and from the pronymphal sheath there now emerges a true dragonfly larva, sometimes called a *nymph* or a *naiad*. This curious little creature is for the most part transparent, the only opaque parts being its large dark eyes, a big plug of undigested yolk in the middle of its alimentary canal, and the beautiful foliate gills situated in folds in the rectum. Its legs and mouth parts are free and are very soon brought into use, and the little larva will be seen to swim rapidly to some convenient object where it can lurk undetected and begin to feed.

To rear our larva, it is necessary to supply the water in the Petri dish with plenty of slipper-animalcula or else small water-fleas. The *Anax* larva is provided with a remarkable organ called the *mask*, peculiar to dragonfly larvæ, which is used to capture its prey. It is really a special-

ized lower lip or labium, but is of considerable length and is held folded back below the head and covering the mouth; one could imitate it roughly by covering one's face with one's hand while the elbow rests against the middle of the chest, only, in the case of the dragonfly larva, the mask is not attached to the shoulder, but actually to the underpart of the head. The mask itself ends in two strong lateral lobes, each armed with a sharp prehensile organ called the *movable hook*. When the mask is shot out, the lateral lobes fly apart and are then contracted by strong ligaments so that they close automatically and firmly on their prey. Held in this vice-like grip, the helpless victim is dragged struggling to the mouth of the *Anax* larva, where it is devoured at leisure by the powerful jaws.

The growth of the *Anax* larva is rapid, for it is very greedy, and there appears to be no limit to its feeding powers. Within a few days the first ecdysis or change of skin takes place, and the larva appears of a pale greenish colour. We are now able to note the method by which the larva travels through the water. It uses its legs but little, and that mostly for clinging to water-weeds. For actual movement through the water it progresses by a primitive kind of turbine action, shooting out water from its rectal gill chamber, and thus moving forward in a series of jerks. All the time the beautiful gills within the chamber can be seen to be working rhythmically to and fro, so that it is evident that water is being continually drawn in and out of the rectum irrespective of the need for progression.

When the young larva is a month or two old it should be placed in a small glass jar and provided with somewhat larger food in the form of small damselfly or mayfly nymphs. These it will attack very readily. A number of stages is now passed through, and before the larva is half-grown it is possible to see the tiny wing-buds forming on the back of the thorax. At each ecdysis these buds increase in size and become more elongate in form; beginning as small buds, they next become triangular flaps, and later take up a peculiar position, the hind wing-sheaths coming to overlie the fore.



Full-grown larva or nymph of Anax papuensis Burm. (×1½.) Upper right, **view of labial mask extended (×2); below, the same, folded into position of rest, ventral view (×2).**
[R.J.T., *del.*

During its growth the larva of *Anax* passes through some very peculiar colour changes, which are not fully understood. When it is about one-fourth grown, specimens are frequently found which are black in colour, with transverse cream-coloured bands; occasionally also brown specimens are found. Such specimens would be extremely conspicuous in a mass of water-weed, but it may be that they seek different habitats in nature, hiding on dark twigs or on the muddy bottom of the pond, in which case the change of colour would be very advantageous. As the larva grows, however, its original semi-transparent green colour is restored, and I have never found a dark coloured larva of this species more than half grown at most.

The larva will continue to feed and grow throughout the summer. By the time that it is half an inch long it is advisable to transfer it to a fair-sized aquarium, with various kinds of water-weeds growing in it, and a plentiful

supply of smaller insect larvæ as food. Not more than two or three *Anax* larvæ should be kept in one aquarium, for they are cannibalistic and readily make war on their fellows. During winter they will continue to feed, but do not grow so rapidly. With the advent of the following spring they again feed voraciously and grow very rapidly, so that, in a little less than a year after the egg was laid, the *Anax* nymph is full fed and ready to transform itself into a dragonfly.

Before the actual metamorphosis or transformation of the full-grown nymph into the adult winged dragonfly, the nymph ceases to feed and becomes listless and torpid. Internal changes of the tissues are already going on; the whole body becomes somewhat swollen, and the wing-sheaths, instead of lying flatly above it, stand up from it and are themselves evidently swollen. When the time for emergence has come, the nymph climbs out of the water, up the stem of a conveniently situated reed or other aquatic plant, and fixes itself firmly by means of its powerful claws. The internal swelling now increases at a more rapid rate, particularly around the large compound eyes and at the back of the thorax. The first splitting of the nymphal skin occurs in the middle of the dorsal line on the thorax, and extends rapidly forwards on to the head. It is probably brought about by the insect arching its thorax strongly in an effort to withdraw its head from the tight nymphal skin. This is actually very soon accomplished by the widening of the split, and the head is followed by the thorax, which bulges out from the crack as it widens backwards. Next the legs and wings are withdrawn from their sheaths, and then the insect hangs with its head backwards motionless for some time, with its abdomen still imprisoned, until the action of the sun has hardened its legs. These are then brought into action, being waved about until they are able to get a tight hold on the stem above the nymphal skin; very often this is only accomplished by means of a series of jerks, which help to draw the abdomen partially out of its sheath. Once the emerging dragonfly has succeeded in getting a firm hold of the stem, it quickly withdraws its body, which is then seen to be longer than that of the nymph, but not as long as that of the fully developed adult fly.

The dragonfly now moves upwards on the stem, so as to be quite free from its nymphal skin or exuviæ. At this stage it is practically defenceless; no doubt, many fall a prey to spiders and birds. However, rapid changes are still going on; the body continues to elongate, and the wings, which first appeared as small bags filled with a greenish fluid, expand rapidly through the blood being driven into them. As they expand, they narrow, so that the two sides of the original bag come together and finally fuse, except along the courses of the veins, where small channels are left for the blood and nerves. It is a most interesting sight to watch the expansion of a dragonfly's wings. The operation usually takes about ten minutes; the basal portions expand first, and then the distal. The colour of the freshly expanded wings is usually pale greenish owing to the still included blood, and the incomplete fusion of the two sides gives the wing a definite iridescence. This does not disappear until the action of the sun has completed the drying of the wings—a process which sometimes takes several days, and during which the flight of the insect is necessarily feeble.

As soon as it has strength to fly, the newly emerged dragonfly betakes itself to some sheltered spot where it can rest, free from the chance of capture by its enemies, until such time as it is strong enough to sally forth on its own in search of prey. Thus, within one year of the laying of the egg, the whole life-cycle is completed, and a new generation of swift, strongly flying dragonflies is ready to greet the early summer sunshine and to carry on the race for another year.

Some Australian Ticks

By Anthony Musgrave.

DOWN the ages in many climes the small noxious animals known as ticks have proved themselves to be a source of intense suffering or death to man and his domesticated animals.

Ticks are members of the class Arachnida, which includes such eight-legged animals as spiders, scorpions, harvestmen and solpugids, and, with the mites, are grouped into the order Acarina. They are not to be confused with the six-legged insects which constitute a separate class, the Insecta. Ticks are placed in a superfamily, the *Ixodoidea,* which is subdivided into two families, the *Ixodidæ* (Hard Ticks) and the *Argasidæ* (Soft Ticks). About forty species of ticks have been recorded from Australia.

The *Argasidæ* are easily distinguished from the *Ixodidæ* by the leathery integument which invests their bodies. The *Ixodidæ,* on the other hand, possess a hard shield or *scutum,* which in the male covers the whole body and prevents any great distension, and in the female forms a small patch on the anterior part of the dorsum, the rest of the body being capable of great distension. In the *Argasidæ* the capitulum, which includes the mouth-parts, is ventral in position and hidden from above, while in the *Ixodidæ* it is placed at the anterior end of the body and is plainly visible. The spiracles or breathing pores are very small in the *Argasidæ* and situated anterior to the bases of the fourth pair of legs, while in the *Ixodidæ* they are generally large and placed well behind the bases (coxæ) of the fourth pair of legs.

In the *Argasidæ* sexual dimorphism is slight, but in the *Ixodidæ* it is very marked. The *Argasidæ* when gorged show only a slight dorso-ventral thickening, but the females of the *Ixodidæ* when gorged swell enormously in size.

LIFE HISTORY.

A tick passes through four distinct stages in its life history: egg, larva, nymph, adult. The transition from larva or "seed tick" to adult takes place by a series of moults; the larvæ may be identified by the six legs, the nymph may be differentiated from the adult by the absence of the genital pore. Ticks vary in their life histories. In some ticks, such as the Cattle Tick (*Boophilus annulatus australis*) all the stages are passed on the host, the female dropping to the ground when engorged. In the Dog Tick (*Ixodes holocyclus*) and its allies each stage when engorged drops from its host, moulting taking place on the ground. Some ticks confine their attentions to one species of animal or group of animals, while others are impartial in their choice.

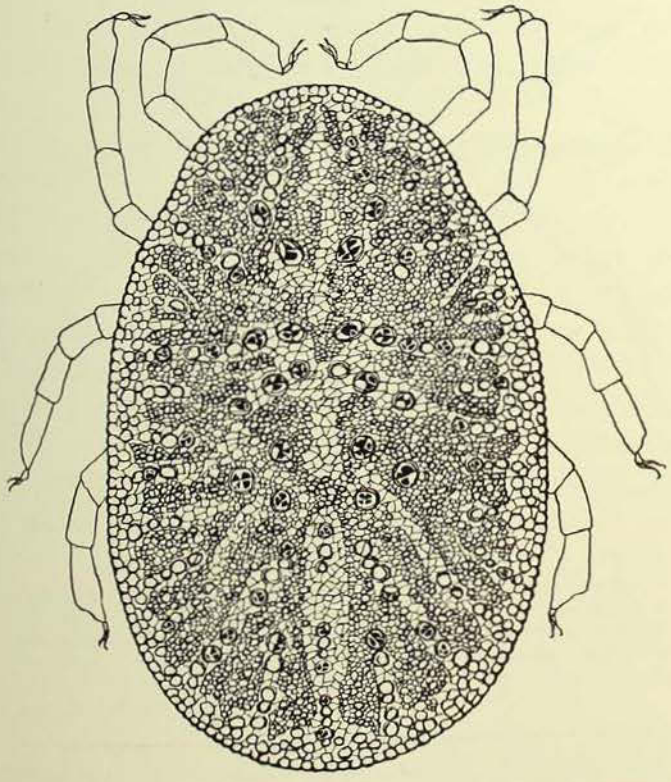
FAMILY ARGASIDÆ—SOFT TICKS.

These leathery flattened ticks resemble bed-bugs, and never increase much in size after feeding. They have been recorded as attacking man, birds and bats. Two genera are included in this group, *Argas* and *Ornithodorus.* A well-known member of the first-named genus is the Fowl Tick (*Argas persicus*), a species world wide in its distribution and introduced into Australia. It may be met with in coops and fowl houses, hiding by day in crevices. It is the vector or transmitter of the organism of avian spirochætosis, and it has been recorded that in Persia it commonly attacks man, its bite being regarded as very dangerous, particularly to strangers.

The eggs of the tick are found in crevices in the woodwork of fowl-houses, and about two or three weeks elapse before the young ticks emerge. The young or seed ticks, as in the similar stage in other kinds of ticks, have only six legs.

They crawl on to their host and there attach themselves, remaining from four to ten days before leaving to rest and moult. This period takes from four to nine days, and at the end of the moult the fourth pair of legs has been acquired. Each tick is now a nymph, and remains in hiding during the day, issuing forth at night to attack its host and returning to its retreat long before the dawn. Before complete maturity is attained, it moults twice. The adult female tick may measure nearly half an inch in length. The males are short-lived, but the females may live for long periods, one isolated female living for two years and three months, while another in a group lived for four years and five months.

The Fowl Tick has formed the subject of articles by various authorities in Australia, among which may be mentioned those by Mr. W. W. Froggatt in the *Agricultural Gazette of N. S. Wales* for March, 1912, and by Mr. P. Rumball in the *Queensland Agricultural Journal* for August, 1925. The Department of Agriculture, N.S.W., has recently issued a pamphlet forming "Diseases of Animals



The Fowl Tick (Argas persicus), a frequenter of fowl houses and coops.
[Nancy B. Adams, *del.*

Splintered wood infested with Fowl Tick.
[From *Poultry Farming in New South Wales.*]

Leaflet No. 41," entitled "The Fowl Tick (*Argas persicus*) and Spirochætosis (Fowl Tick Fever)", and to which readers are directed for particulars regarding control and treatment.

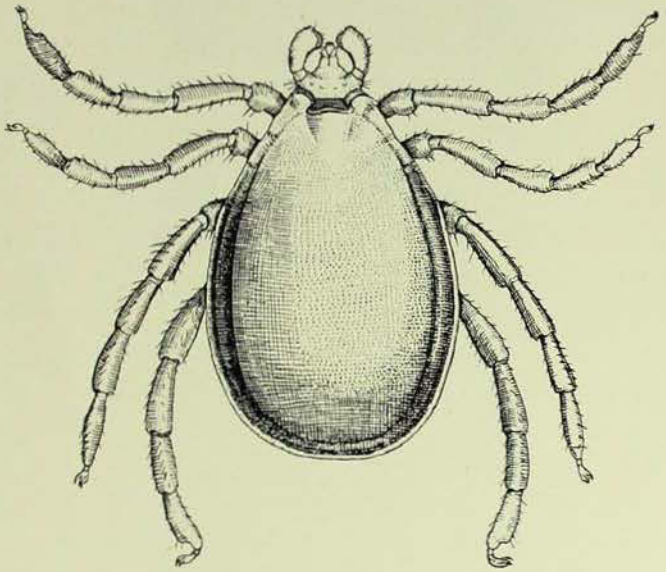
FAMILY IXODIDÆ—HARD TICKS.

Some ten genera of the family Ixodidæ are represented in Australia, and some members of the genera, *Ixodes, Boophilus, Amblyomma* and *Aponomma*, are here dealt with. These ticks are readily identified by the hard scutum or shield present on the anterior part of the body of the female or covering the whole body of the male.

The Bush or Dog Tick.

Some eleven species of ticks of the genus *Ixodes* are recorded from Australia,

and of these the form best known is the Dog, Bush, or Bottle Tick (*Ixodes holocyclus*). This species occurs commonly along the coastal region of eastern Australia, and it has also been recorded from



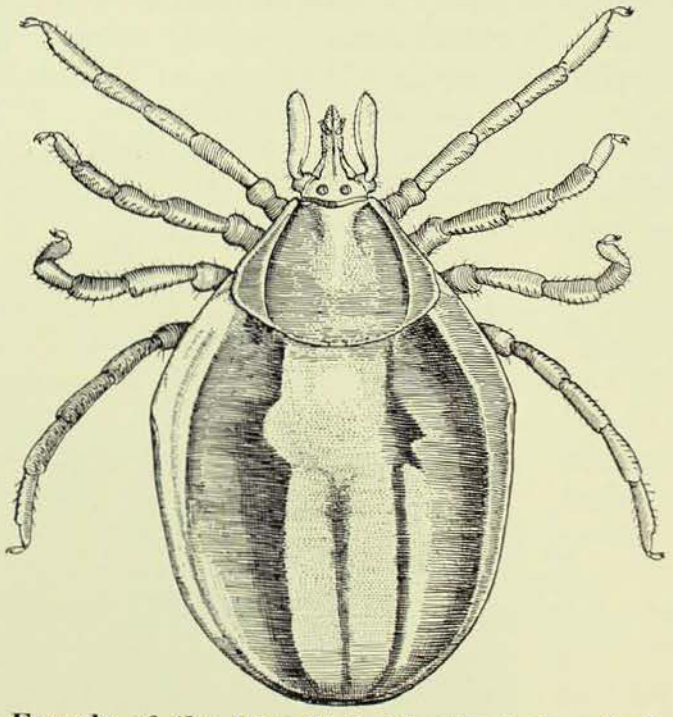
Male of the Dog Tick (Ixodes holocyclus); it may measure 3 x 2 mm. The yellowish scutum covers the whole of the body.
[E. A. King, *del.*

the Bunya Mountains, Queensland, from South and Western Australia, while Nuttall and Warburton also record it from India. It is plentiful in the vicinity of Sydney on the northern shores of the harbour, and is particularly abundant in the suburb of Mosman, and from Manly to Narrabeen, where every year during the spring and summer dogs and cats succumb to the effects of tick poison. The species has been recorded from a number of hosts, such as the Pouched Mouse (*Phascologale*), kangaroo and wallaby, rat (*Rattus rattus*), duck, Ant-thrush (*Pitta*), the Common Opossum (*Trichosurus vulpecula*), but about Sydney the bandicoot (*Perameles*) appears to be its natural host. Mr. A. J. Marshall has recently recorded it from the Sugar Squirrel (*Petaurus breviceps*).[1]

In 1921 Dr. Sydney Dodd showed that paralysis in dogs was due to *Ixodes holocyclus*, which had long been suspected as the cause. It was not, however, until 1926 that the life history of the species was described by Mr. I. Clunies Ross, of the Veterinary School, University of Sydney.[2] I have drawn on his paper for much of the information embodied here.

Tick paralysis occurs in man, the dog, and other domesticated animals on the east coast of Australia. Only the mature female of *Ixodes holocyclus* causes the disease, the male and the immature stages being relatively harmless. These immature ticks or "seed ticks," as they are called, are, nevertheless, capable of causing severe irritation, and, as the late Dr. E. W. Ferguson has pointed out, "attack human beings in large numbers (over 200 have been taken off a single individual)."

A single mature tick may cause fatal paralysis in man and the dog, and it is considered that the causal factor in the production of the disease is a toxin secreted by the salivary glands of the tick. In dogs the symptoms of tick paralysis are loss of co-ordination commencing in the hind legs, the forelegs, head and neck



Female of the Dog Tick (Ixodes holocyclus), which when unfed measures 3·2 x 1·7 mm. or when gorged about 11 x 9 mm. The reddish-yellow scutum occupies the anterior end of the body.
[E. A. King, *del.*

[1] A. J. Marshall: *Australian Museum Magazine*, Volume IV, No. 8, October-December, 1931.

[2] I. Clunies Ross: "The Bionomics of *Ixodes holocyclus* Neumann, with a redescription of the Adult and Nymphal Stages and a redescription of the Larvæ," *Parasitology*, Cambridge, xvi, December, 1924.

becoming subsequently affected. Death appears to be due to respiratory paralysis. Mr. Clunies Ross[3] and Dr. Sydney Dodd[4] have stated that there is a period of five or six days before the onset of symptoms. This has been determined by them experimentally, but the consensus of opinion is that symptoms may be manifest in the animals within twelve hours after attachment, and death may take place long before five days have elapsed.

Some people are of the opinion that dogs born and reared in a tick-infested locality will come to enjoy immunity from the disease, or that once an animal has recovered from an attack of tick paralysis it will be immune. It would appear from information I have been able to acquire, and from the researches of Clunies Ross, that no faith can be placed in these surmises; animals may appear to be immune from attacks for some time, only to succumb eventually to a "bite."

The late Dr. E. W. Ferguson published in *The Medical Journal of Australia* for October 4, 1924, a paper entitled "Deaths from Tick Paralysis in Human Beings." In it he lists eight cases that ended fatally. These were mostly children of tender years, three or under, though one child was thirteen or fourteen. This shows the need for watchful care on the part of parents with young children in a tick-infested locality.

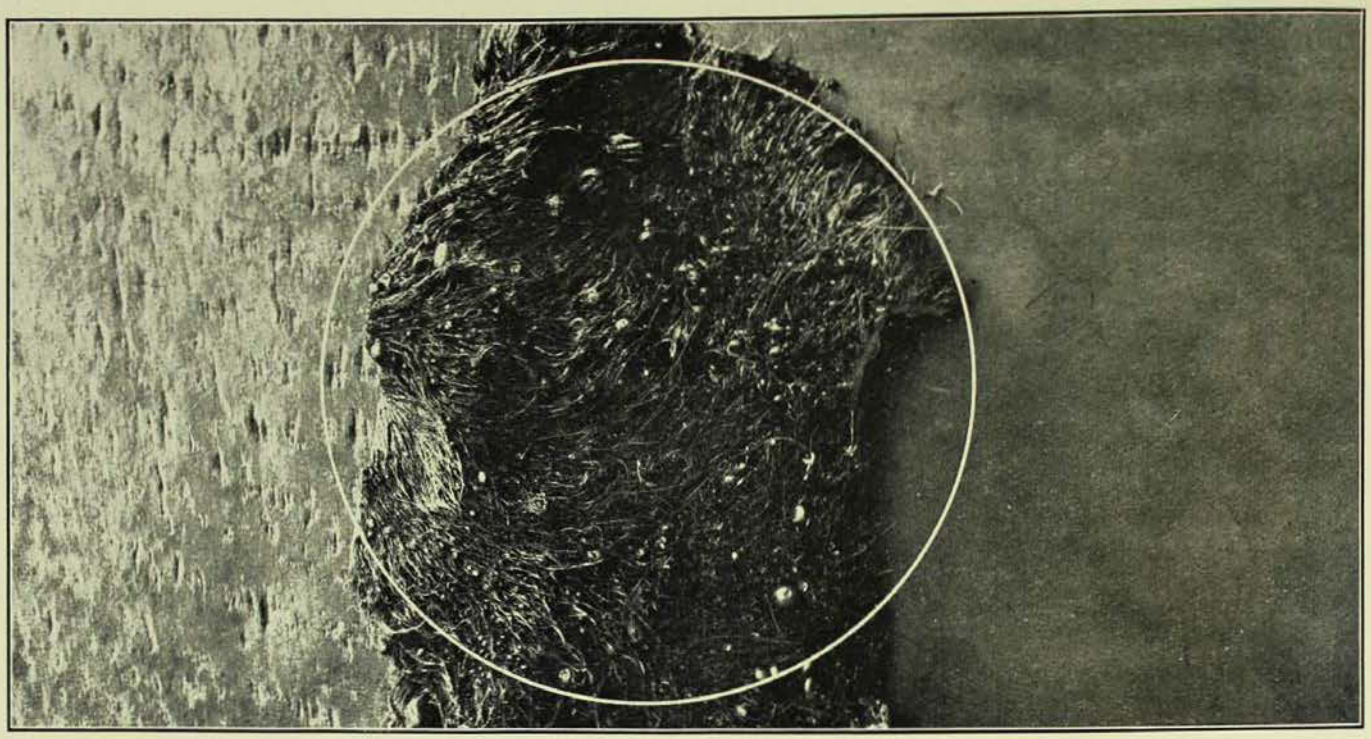
Fear is frequently expressed that a mature tick will work its way under the skin and into the body or head of its host. There are no grounds for this belief; the skin in the vicinity of the tick may become reddened and swollen so as to surround it, but it never burrows beneath the skin. It must breathe while engorging, and, as will be seen below, if the breathing apertures become clogged the tick will die.

Treatment.—Methods adopted for destroying the tick embedded in the flesh of human beings are numerous and varied, but usually are modifications of those cited below. To destroy the tick should be the first consideration. This may be accomplished by dabbing on either turpentine, kerosene, paraffin oil, castor oil, methylated spirits, tincture of iodine, or any of the lighter and more penetrating oils. The effect of the oil is to close the two breathing pores or spiracles situated near the base of the legs. After the oil has been applied a short time may elapse before the next operation, that of removing the tick, or, if the victim is away from home and no forceps handy, the operation can wait, care being taken to see that the tick is kept "well oiled." When opportunity permits, the tick may be seized with a pair of smooth-pointed forceps, and prolonged gentle pressure on the body of the tick should induce it to relinquish its hold. Forcible removal of a tick usually results in the head portion or capitulum remaining embedded in the skin, the files of teeth on the hypostome holding it firmly in position. Sometimes it may be found that a tick can be dislodged *in toto* owing to its not having had sufficient time to effect a hold. Some resort to the method of snipping off the body of the tick after an application of turpentine or kerosene, leaving the head part to work its way out; but such a method is not recommended.

In the case of domestic animals, the dog or cat requires to be carefully searched, particularly round the ears and nape of the neck, and the tick or ticks destroyed by turpentine or some specific as suggested above. If the animal is showing symptoms of tick paralysis, it may be given enough bicarbonate of soda (or baking powder) to cover a sixpence, in butter, lard, or milk, every two or three hours. No meat, only milk, should be given to it, and it should be kept warm. Some animal owners have found that bicarbonate of soda is not always effective, and, in advanced stages of the disease, administer instead three drops of *nux vomica* in milk or a teaspoonful of brandy.

[3] I. Clunies Ross: "An Experimental Study of Tick Paralysis in Australia," *Parasitology*, Cambridge, XVIII, December, 1926.

[4] Dr. Sydney Dodd: "Tick Paralysis," *Agric. Gaz. N.S.W.*, xxxii, April 2, 1921, pp. 265-272; May 2, 1921, pp. 331-337.



The Cattle Tick (Boophilus annulatus australis), showing, on left, tanned hide with tick marks; in circle, ticks on hide of beast; and right, tanned hide free from tick infestation. Hides through courtesy of Michaelis, Hallenstein Pty., Ltd., Melbourne. Infestation by ticks causes so much damage to local hides that hides have to be imported into Australia. Injury to hides by brands and by ticks are two problems facing the tanner in Australia.

[Photo.—*G. C. Clutton.*

Others prefer a decoction of tobacco juice, while a Collaroy resident has implicit faith in a liquid made by boiling the roots of the common bracken fern. I give herewith a method suggested by Mr. Terence Hinder, the well-known dentist, which appeared in *The Mosman Daily* for Saturday, October 27, 1923. He says: "Firstly, locate the tick, then apply a drop of turpentine on the body of the tick; leave for five minutes, then draw the tick out with tweezers. If the dog shows any symptoms of paralysis in the hind legs (or any other form of sickness) give immediately the following mixture: Two drops of tincture aconite in a dessertspoonful of aniseed water every four hours; between doses give one teaspoonful of brandy; keep on until the dog is quite well. Any reputable chemist will make this us for you. The following food may be given three times a day: bovril, one teaspoonful; half an egg, 2 oz. milk. During the tick season give dogs a little sulphur in milk once a week. Keep dogs warm while undergoing this treatment."

The Cattle Tick.

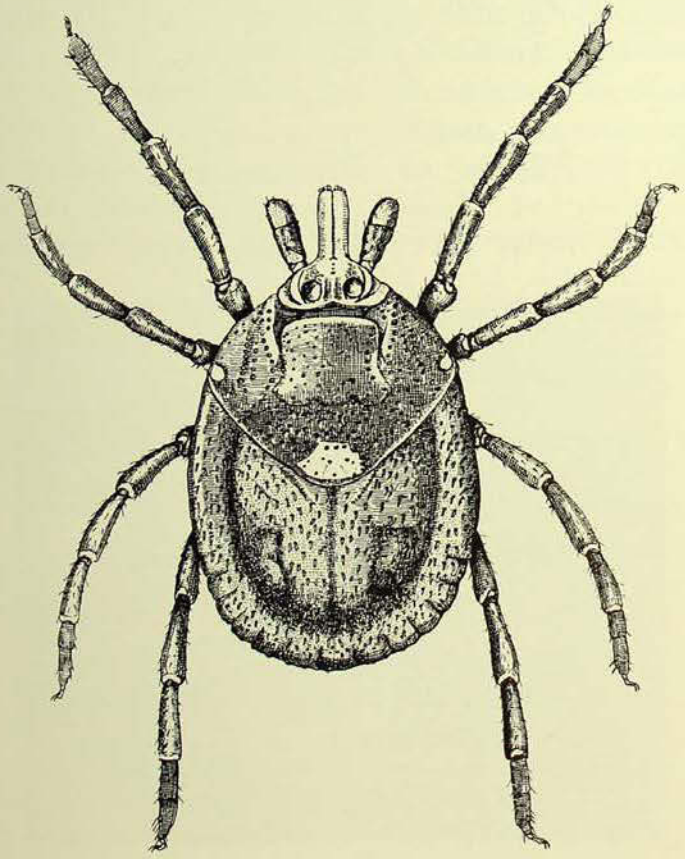
In point of economic importance, the Cattle Tick (*Boophilus annulatus australis*) may be regarded as the first of all our ticks. The species is but briefly dealt with here, but it has formed the subject of a comprehensive account published by the Institute of Science and Industry and forming Bulletin No. 13, now out of print, but available in public libraries.

The tick owes its importance to the fact that it is a pest to cattle by causing tick fever, or redwater fever, owing to its being the vector or transmitter of *Piroplasma* (*Babesia*) *bigemina* or bovine piroplasmosis, and it also causes tick worry, tick poverty or tick anæmia by infesting the beasts in such countless numbers that they lose condition and die.

According to Gilruth, the tick appears to have been introduced into Australia from Batavia in August, 1872, on Asiatic (Brahma) cattle. Its appearance in Australia seems to have been first noted at Glencoe, south-east from Port Darwin, in 1880-81. It has spread over nearly all

Queensland with the exception of the arid parts, and as far south as the Richmond River in New South Wales; it has spread also to the Kimberley district of Western Australia. The tick is apparently closely allied to, if not identical with, the Texas Fever Tick (*Boophilus annulatus*) of the United States of America, and differs only in slight structural features.

The fully engorged and matured tick drops from her host to lay her eggs which may number about 3,000. From these the "seed" or larval ticks emerge after a fortnight or three weeks, according to weather conditions. They crawl up the grass blades, herbage, stumps, or fences, and there await any animal or object that may brush past. Once a larval tick has reached its host, it crawls about until it has reached a soft spot on the skin, attaches itself by means of its mandibles, and begins to suck up the blood of its host. It moults after a week spent on its host, passing from the six-legged larva to the eight-legged nymph. It moults again at the end of a week, and the sexual organs having developed in the interim, the tick is now mature.

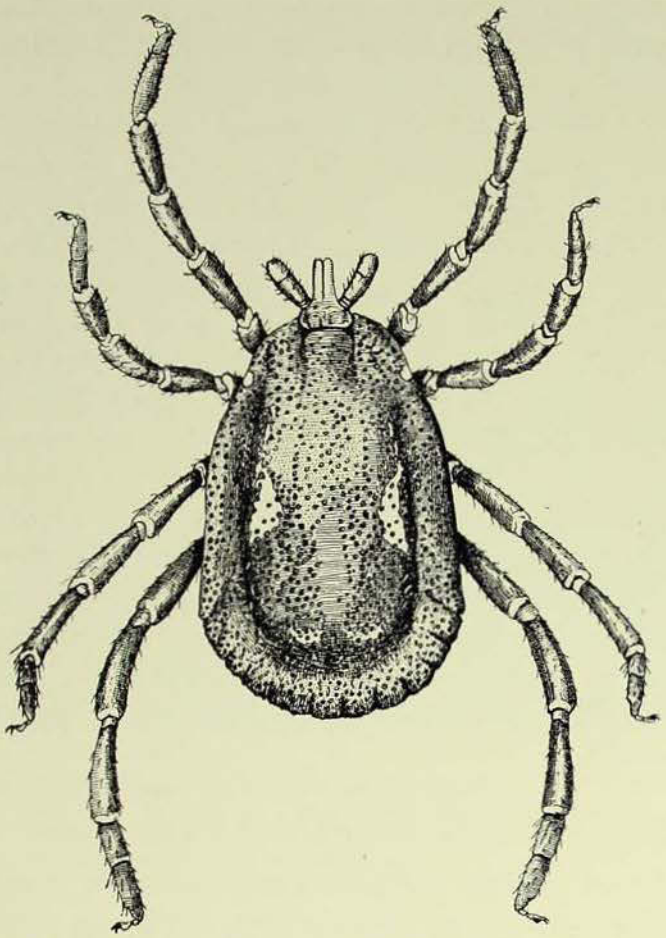


Female of the "Kangaroo" Tick (Amblyomma triguttatum), from North Queensland.
[E. A. King, *del.*

In the work cited above, it is stated: "The loss from mortality caused by tick fever in Queensland alone is estimated at seven million pounds sterling. Considerable loss from this cause also occurred in the Northern Territory and Western Australia. The decrease in the value of leather production of Queensland amounts to about £114,000 for one year alone. Further, the affected States have suffered considerable direct loss from mortality caused by tick worry, interference with the natural increase of the herds, retardations of growth and improvement of stock, from diminished production of meat, milk and dairy products."

The "Kangaroo" Tick.

The genus *Amblyomma* contains some eight species of ticks which occur on marsupials, reptiles and domestic animals. Of these I have selected the somewhat handsome tick, *Amblyomma triguttatum*, which I designate the Kangaroo Tick, since it is represented in our collection from kangaroos from north Queensland and Western Australia. It is recorded also from the platypus, and cattle, dog and horse. The male may measure about 3·2 mm. in length, while the female, unfed, may measure 5 × 3·2 mm. and engorged 13 × 11 mm., according to Fielding's work. It has a wide distribution, occurring in New South Wales in addition to the localities mentioned. The male is elongately oval in shape, reddish-brown in colour, with the scutum ornate, and with irregular long pale patches on the sides of the scutum and a pair of pale spots at the posterior end of the body. The female is also oval in shape and reddish-brown. The scutum is heart-shaped, with a pale shining spot at the posterior angle which serves as a ready means of identifying the species, and pale spots may also be present in the antero-lateral fields.



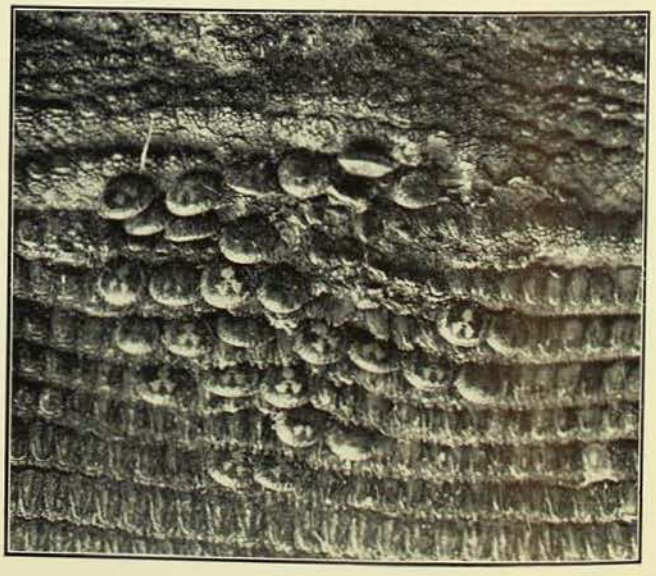
Male of the "Kangaroo" Tick (Amblyomma triguttatum).
[E. A. King, *del.*

The Noddy Tick.

When Messrs. Tom Iredale and G. P. Whitley of this Museum were on Michaelmas Cay, off Cairns, Queensland, they found a species of tick, of the genus *Amblyomma*, occurring in numbers on the Noddy Terns (*Megalopterus minutus*) and on the herbage of the island. The roof of the hut which housed the scientists and the men engaged at work on the bore, served as a resting place for the noddies, which frequently dislodged ticks from their bodies. These ticks crawled or dropped to the ground or on to the occupants in the hut beneath. In his diary Mr. Whitley wrote on Friday, May 21st, 1926: "Ticks are obnoxiously plentiful. Some are very small, not much bigger than a pin's head, others like fair-sized spiders, whilst on the web between the toes of the noddies there are hard brown parasites. The noddies appear to be more 'ticky' than the Wideawakes (*Onychoprion fuliginosa*), and the grass, etc., in their rookeries is full of ticks, so that one's legs become sprinkled with them when walking through it. Even young birds have ticks clustered upon their chins. Several 'ticky' noddies died today." On Monday, May 24th, 1926, he again writes: "Going round the cay at half tide, I stooped to pick up what I thought was a small cowry, but found that it was a huge tick which had evidently fed to repletion on some noddy and dropped off its host on to the beach where it crawled slowly along. If it had not been caught, it would doubtless have given rise to numerous young. So far as I know, there is at present no check on ticks here. I had one in my abdomen last night, dropped kerosene on it and pulled it out. It caused a swollen, red, inflamed area around it, which was quite painful."

The "Goanna" Tick.

The genus *Aponomma* includes five Australian species occurring on goannas (*Varanus*) and snakes for the most part, though one species, *A. ecinctum*, may frequently be met with on the black passalid beetle (*Aulacocyclus kaupi*). The commonest species of the genus is *Aponomma decorosum*, nearly every goanna in New South Wales or Queensland bearing a number of these ticks embedded in its scaly body. It has also been recorded



"Goanna" Tick (Aponomma decorosum) on skin of Varanus from Blue Gum Knob, Upper Chichester Valley.
[Photo.—*G. C. Clutton.*

from a python. The specimens in the accompanying illustration were taken on a goanna in the Upper Chichester Valley, near Dungog, nearly all being males. The male is almost circular in shape, and about a twelfth of an inch or 2·5 mm. in length. The scutum is reddish-brown, while a whitish margin which encircles it is broken posteriorly by eleven festoons or rectangular areas. A whitish triangular-shaped or inverted "Y" mark occurs in the centre of the scutum. The female is a larger tick and, according to Mr. Fielding, may measure from 9 to 12 mm. or nearly half an inch in length.

CONCLUSION.

These are but six of the forty species of ticks recorded from this continent, representing those forms most likely to be encountered. It will be noticed that two are introduced species, whilst of the other three indigenous forms only two are known to attack man.

Of recent years ticks have been studied more than heretofore, and some important contributions have appeared on the group. The most outstanding of these is that entitled "Ticks: A Monograph of the Ixodoidea," by G. H. F. Nuttall, Cecil Warburton, W. F. Cooper, and L. E. Robinson, much of the information and the classification adopted in this article being derived from this work, which deals with ticks from all over the world. In 1925 the late Dr. E. W. Ferguson published an article in the *Australian Zoologist,* Vol. iv, pp. 24-35, on Australian ticks, listing all the species then known. In 1926, Mr. J. W. Fielding, of the Australian Institute of Tropical Medicine, Townsville, North Queensland, produced a very useful compilation entitled "Australasian Ticks," which forms Service Publication (Tropical Division), No. 9, of the Division of Tropical Hygiene of the Commonwealth Department of Health, in which he gives figures and descriptions of all our known ticks and appends a list of the literature relating to the group.

In conclusion, I would express my appreciation of the help afforded by Dr. K. K. Spence, Mr. Tom Iredale, and Mr. H. S. Grant in drawing my attention to specifics for "tick bite."

Notes and News

IN the October-December number of THE AUSTRALIAN MUSEUM MAGAZINE attention was directed to fourteen of the twenty-three species of birds illustrated on the coloured plate appearing in that part. Since then Mr. Neville W. Cayley's *What Bird is That?*, a comprehensive guide to all the known species of Australian birds, has been published. It was from this handbook, then in course of preparation, that the plate was taken. The space available in the current number of the MAGAZINE is insufficient for discussion of the remaining nine birds, except in a very brief manner; if so treated the observations would duplicate the notes given in Mr. Cayley's book. The Editor, therefore, refers the reader to *What Bird is That?*, which is reviewed elsewhere in this issue.
—EDITOR.

Mr. Akira Kamito, Entomologist, Department of Agriculture, Ministry of Agriculture and Forestry, Tokyo, Japan, visited the Museum during November and inspected our collections. He is interested chiefly in the pests of rice, and Mr. K. C. McKeown, Assistant Entomologist, formerly of the Water Conservation and Irrigation Commission at Leeton, New South Wales, was able to supply him with particulars regarding the destruction of rice by insects in that area.

* * * *

During November, Dr. G. A. Waterhouse, Trustee and Honorary Entomologist, made a collecting trip in the northern parts of the State, and as a result several interesting and valuable specimens have been added to our collection of butterflies.

Mr. G. P. Whitley, Ichthyologist, recently returned from a vacation spent at Rarotonga, Cook Islands, where he made a collection of marine animals for the Museum. He also secured a series of photographs and much information regarding the history, the natives, and the zoology of that part of the South Seas. It is anticipated that subsequent issues of the MAGAZINE will contain articles by him on these subjects. The fishes obtained by Mr. Whitley at Rarotonga will be of value for comparison with collections recently obtained from Oceania, particularly a series from Nukualofa, Tonga, contributed by the Rev. A. H. Wood, M.A., and some well preserved shore fishes from Suva, Fiji, presented by Mr. J. S. Callaghan. Mr. Whitley has noted that the majority of the fishes in these collections show an interesting similarity to those of the Great Barrier Reef of Queensland.

* * * *

In November, Mr. Anthony Musgrave, Entomologist, visited the Dunedoo and Binnaway districts on his annual holidays, and paid a short visit to the Warrumbungle Mountains. Insects and spiders were collected on the trip, and these form a useful addition to the collection, since little is known entomologically of this region. While in the Binnaway Scrub he secured six examples of a rare Skipper Butterfly (*Trapezites luteus* Tepper), hitherto known only by one example from New South Wales, preserved in the Australian Museum.

Book Review

WHAT BIRD IS THAT? By Neville W. Cayley. Angus & Robertson, Limited, 1931. Price: 12s. 6d.

Australia is fortunate in being the home of many interesting and beautiful birds, and also of many accomplished and enthusiastic ornithologists and bird-lovers. There are also several fine works devoted to the description and portrayal of our avifauna, yet there was room for the book under review, which will certainly play an important part in furthering a knowledge of, and fostering a love for Australian birds. It is a succinct yet complete guide to our birds, every species of which is figured in colour by the author, who has long been recognized as a leading painter of birds.

The author has, in general, adopted the plan of grouping the birds by their habitats, which has the merit of bringing together the kinds which are normally found living in the same area. For that large class which desires to know the names and something of the habits of the birds observed in a bush ramble, by the river bank, or on the heath land, this arrangement is more useful than if the grouping were on the lines of a strictly technical classification, which is for the serious student and the expert. Identification is rendered easy by the admirable plates, in any one of which the birds are all drawn to the same scale, a key indicating the dimensions in proportion to life size.

The letterpress relating to the various figured species can be readily found by searching for the corresponding numbers. The descriptive notes are brief yet full of information, giving scientific and alternative common names, distribution, food, habits, kind of nest, appearance of eggs and breeding season. There is a very full index of scientific and common names.

The printing of letterpress and plates has been excellently done, and the work is in every sense one which reflects great credit on all who have been associated in its production. The price is very reasonable, and places the work within the reach of anyone who desires to possess a copy.

C.A.