The AUSTRALIAN MUSEUM MAGAZINE

Vol. V. No. 8. OCTOBER-DECEMBER, 1934. Price—ONE SHILLING

The Sugar Glider.

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

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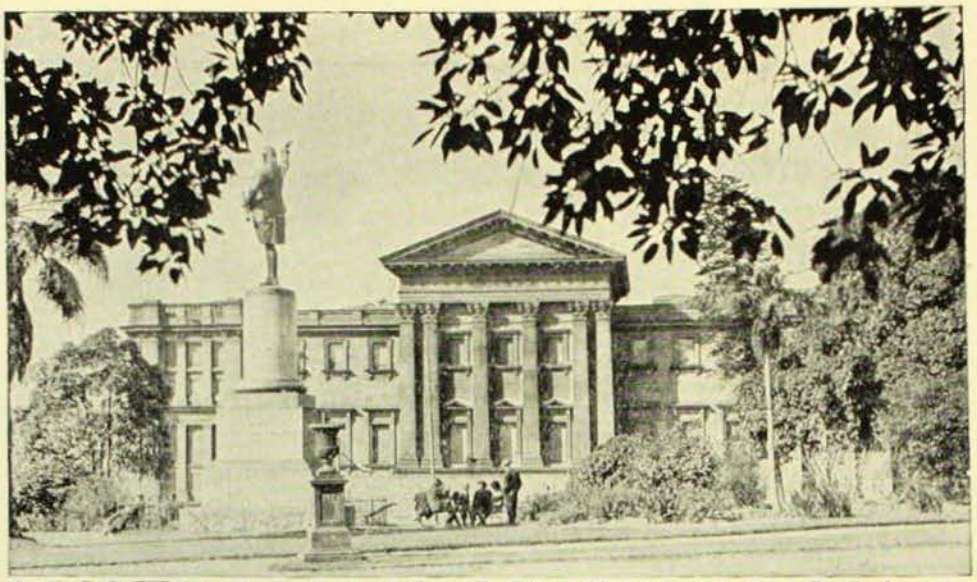

THE AUSTRALIAN MUSEUM MAGAZINE

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■ OUR FRONT COVER. The Sugar Glider (*Petaurus breviceps*), sometimes known as the Lesser or Short-headed Flying Phalanger, is by Ethel A. King. It is one of a series of postcards issued by the Australian Museum.

These dainty marsupials are distinguished by their evenly bushy, non-prehensile tails and the skin-folds on the sides, which, when extended, enable the animal to make long gliding leaps.

It is mainly nocturnal, dwelling in tree spouts by day and displaying great activity by night. Its food consists of eucalyptus blossoms and other honey-bearing flowers, and insects. It swoops from tree to tree and branch to branch, its brushy tail acting as a rudder, while the thumb-like great toe, which gives the name phalanger to all Australian "opossums", renders the hind foot a splendid climbing organ.

The species has a wide range over eastern and northern Australia, and has been introduced into Tasmania. A smaller form occurs in Papua. On outgrowing the pouch the single young one is carried on its mother's back.

See Marsupial Gliders or "Flying Possums", by E. le G. Troughton, on page 257, this issue.

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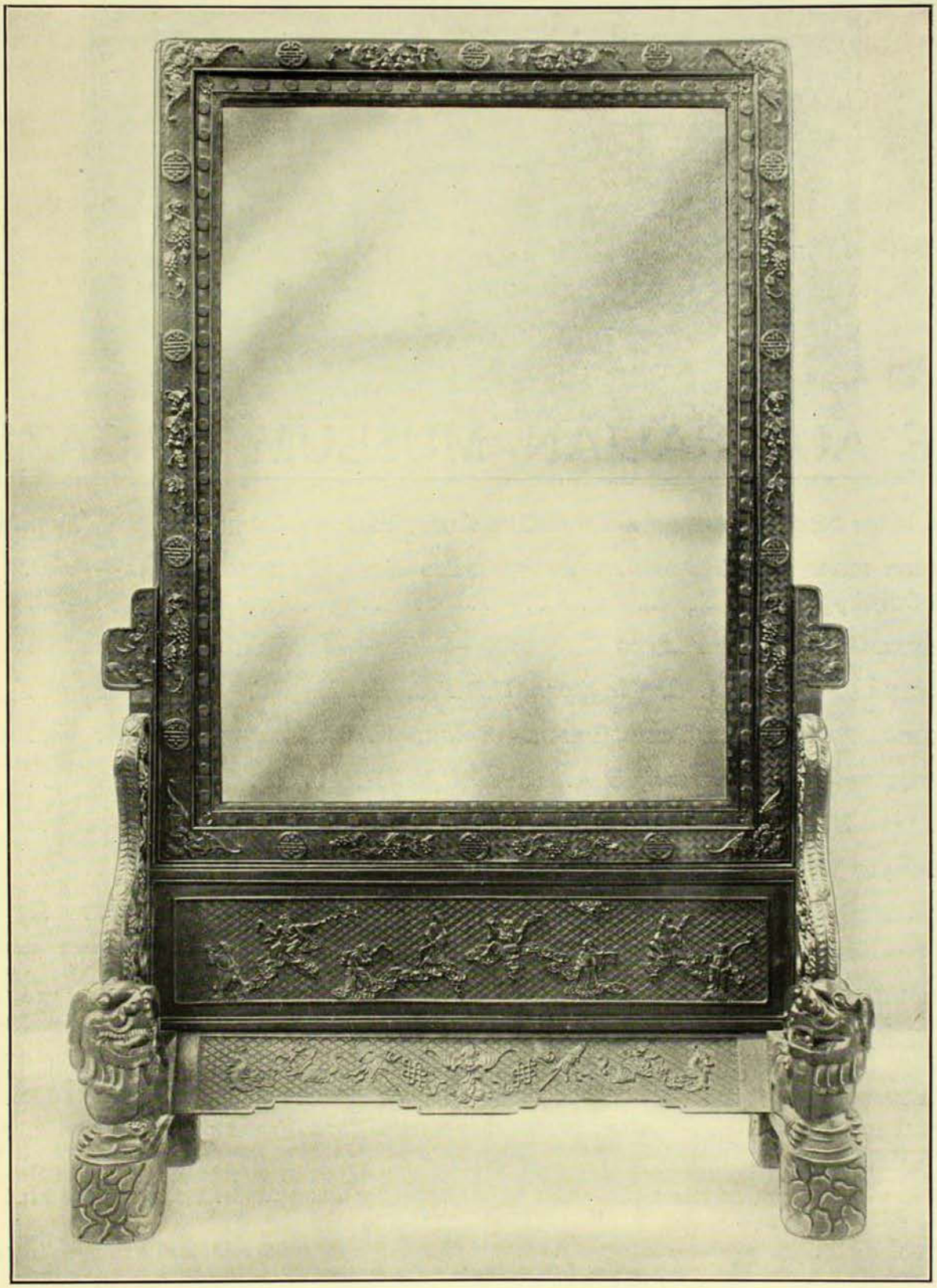


Mirror from the Temple of a Thousand Ages, Peiping, China. Australian Museum exhibit.

[Photo.—*G. C. Clutton.*

THE AUSTRALIAN MUSEUM
MAGAZINE

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

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

VOL. V, No. 8. OCTOBER-DECEMBER, 1934.

A Mirror from the Temple of a Thousand Ages, Peiping, China

THIS remarkably beautiful example of Chinese wood carving is from the Temple of a Thousand Ages, near the Summer Palace in Peiping, and was presented to the Australian Museum by the Hon. J. See, Premier of New South Wales at the beginning of this century.

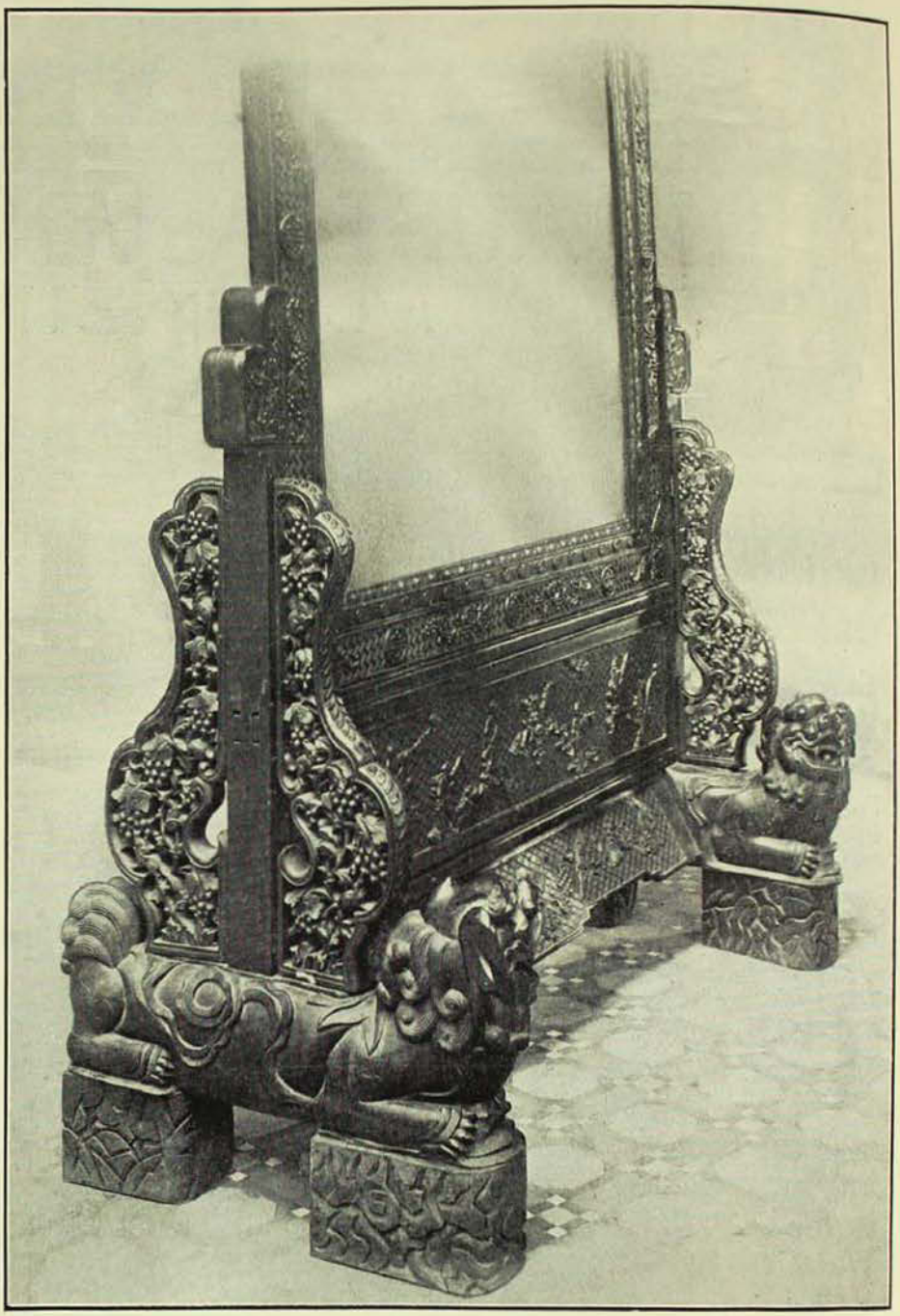
The mirror is supported in a frame and stand of intensely hard black wood, highly polished. There are two frames, of which the inner is eight feet ten inches in height by five feet two inches in breadth; the inner half of the surface is embossed with a Greek fret pattern, and the outer half has a number of oval and circular figures, the design of each being a labyrinth divided into four quarters, carved in relief upon a plain surface. The outer frame is more massive, and is mortised to the upright sides of the stand. It is carved in a very elaborate manner, with a groundwork consisting of a combination of the Greek fret and labyrinth. There are graceful bunches of grapes and circular labyrinth figures in relief on this base, consecutively carved right around the frame, with a figure of a bat in each corner.

There are two panels attached to the bottom of the frames between the sides of the stand. The upper one, which is part of the stand, bears eight human figures in various attitudes, carved in relief. They are all men, and some are holding symbols of authority; one is carrying a basket and holding a torch, as though to guide him at night, and another is holding a staff. The four on each half of the panel are looking towards the middle. The lower panel, which is at an angle of forty-five degrees to the other, is decorated with nine figures, also carved in relief, there being a dragon, a bouquet holder, an umbrella, and a scroll in that order from the edge to the middle in each half. In the centre is a bat, with wings outspread, looking downwards, and holding a flower in its mouth.

The stand consists of a plain post at each end, which is three feet eight and one-half inches high, with a projection at the top, upon which there is carved a bat,

flying, and holding in its mouth a circular labyrinth figure, to which a tassel is attached. The remainder of the surface is carved in a labyrinth pattern. Two wings project at right angles from these uprights at each end. Each of the wings is a lovely fretwork carving, two and a quarter inches in thickness, representing numerous bunches of grapes, with rats amongst them, drinking the juice.

The frames and the wings rest upon the backs of two grotesque and highly conventionalized figures, the faces of which are like gargoyles. There is one at each end. They are apparently lions, in an attitude of defiance, with staring stalk eyes, flowing mane, and open snarling mouth; the animal in each instance is crouched upon the ground, with the forepaws horizontal to the body, as are the hind legs. The tail and mane are striated. A peculiar horn-like projection, pointing forwards, is carved slightly at the back of the middle on the top of the head. These lions are supported upon blocks, with a carved leaf pattern. In the mouth of one of the lions is a movable wooden marble, evidently carved *in situ*—that which should be in the mouth of the other is missing. The figures are two feet ten inches in length, one foot eleven inches in height, and eight inches in breadth.



The base of the mirror from the Temple of a Thousand Ages, Peiping, is a beautiful example of Chinese art.
[Photo.—*G. C. Clutton.*

The entire height of the mirror and stand is nine feet five inches, with a breadth of five feet eleven and a half inches. The stand proper is two feet nine inches from front to back.

The conception of this splendid example of Chinese art is greatly to be admired. It combines geometric, zoomorphic, and floral elements in a harmonious and rhythmic pattern, and truly exemplifies not only the appreciation of the beautiful by the Chinese, but also their ability to express it.

F.D.McC.

Marsupial Gliders or "Flying Possums"

By E. Le G. Troughton.

IT is an axiom of evolutionary progress that Mother Nature abhors a vacuum, and many and devious are the artifices used to adapt her creatures to an ever-changing or new environment, and also maintain a natural balance between the hunter and hunted. The modification of inward and outward structure of a group of animals of common ancestry to suit various phases of their environment is known as *adaptive radiation*, and it is because the marsupials illustrate very remarkably this great principle of evolution that they are so interesting to nature lovers as well as to the student.

Prehistoric isolation made Australia both a cradle and preserve of marsupial life, and in this ancient haven of refuge the natural process of adaptive radiation organized a regular army corps out of the primitive ancestral stock: the marsupial mole and wombat represent the tunnellers, a vast array of kangaroos and smaller creatures the land army, while some possums adopted the gliding habit and represent the aerial forces. Air as a moulding agent comes next to water, which wrought the outward resemblance between a whale and fish, and so we find that three great groups of vertebrates at different periods of earth history have independently evolved wings from their modified fore-limbs, giving them complete control of the power of flight.

The pterodactyls were lizard-like animals which flourished in the age of reptiles long before human ken, and their wings differed from those of birds in having a membrane spread from the body to the greatly elongated fifth finger. The fore-limbs and digits of birds are greatly reduced and modified to support the arrangement of feathers which replaces the expanse of wing-membrane required by bats, which is stretched over the four remarkably lengthened fingers, while the well-developed thumb has a hooked claw for climbing or suspension.

The genesis of their aerial mastery is comparable with the more recently developed gliding flight of several genera of Australian possums, which really consists of volplaning leaps sustained by the skin-folds stretched between the fore- and hind-limbs, enabling them to skim through space like animated kites. One can picture the gradual development of wings as the ancestral reptile or bat increased the extent of leaps from trees or rocky crags by stretching out the sides and limbs until such membranes spread to cover the spaces between the elongated fingers, so that bats, instead of merely gliding down from heights, began to fly as efficiently as most birds and probably better than any pterodactyl.

The adaptation of our possums for their brief aerial jaunts, however, has not progressed to special modification of the hand as in bats or their near relative the Cobego or Kaguan of Malaysia and the Philippines. This insectivore has the skin-fold extending between the long fingers as well as around the body, and so appears to represent an intermediate stage. The development of gliding membranes in three orders of living mammals, represented by a foreign insectivore, squirrels, and some Australian possums, evidences another powerful principle of evolution known as *convergence*, by which similar habits and environment by adaptation mould animals which are worlds apart zoologically as well as geographically into most deceptive superficial resemblance.

The so-called "flying" possums are often referred to as squirrels because of the

outward resemblance noted by early settlers, but the term is very misleading, as the true squirrels are rodents or gnawing animals more nearly related to rats and rabbits than to any marsupial. Even the word "opossum" is an American Indian one for an entirely different family of marsupials, but ever since Captain Cook noted the superficial likeness and applied the name to the ring-tail at Cooktown in 1770, the name has been generally applied to most of the Australian family of Phalangeridæ. Our naturalists have tried to popularize the word phalanger, referring to the adaptation of the foot for climbing, but the old established and more attractive term has come to stay. As the differences are mostly well understood, it seems advisable to accept the inevitable, perhaps shortening the word to possum, slightly to emphasize the distinction, apropos of which it may be noted that Captain Cook almost seemed to anticipate the Australian love of brevity by omitting the initial O in his journal.

The term of Glider or Gliding Possum is introduced here as better indicating the spurious kind of flight of these marsupial aeronauts, which are represented by several genera and range from the insectivorous mouse-like Pygmy Glider to the leaf-eating Greater Gliding-Possum with a head and body about seventeen and tail about twenty inches long. The comparative ease with which gliding membranes are developed is clearly shown in the possum family, where we find them independently acquired in unrelated genera, and the prehensile clinging tail of the non-gliding ancestral animals changed into a well-haired plume or even a furry feather to act as rudders or tail-planes for the gliders.

The Pygmy Glider, for example, in its small form and insectivorous dentition, is an offshoot of the pygmy or dormouse possums, which represent the primitive ancestral stock of the possum family. Members of the genus *Petaurus*, however, with the non-volant Striped Possum of Queensland, are apparently derived from Leadbeater's Possum of Victoria, which almost exactly resembles a *Petaurus* shorn of its side-planes, the dentition of all showing a transformation from an insectivorous to an omnivorous diet owing to the addition of blossoms and fruits.

PYGMY GLIDER (*Acrobates pygmæus*).

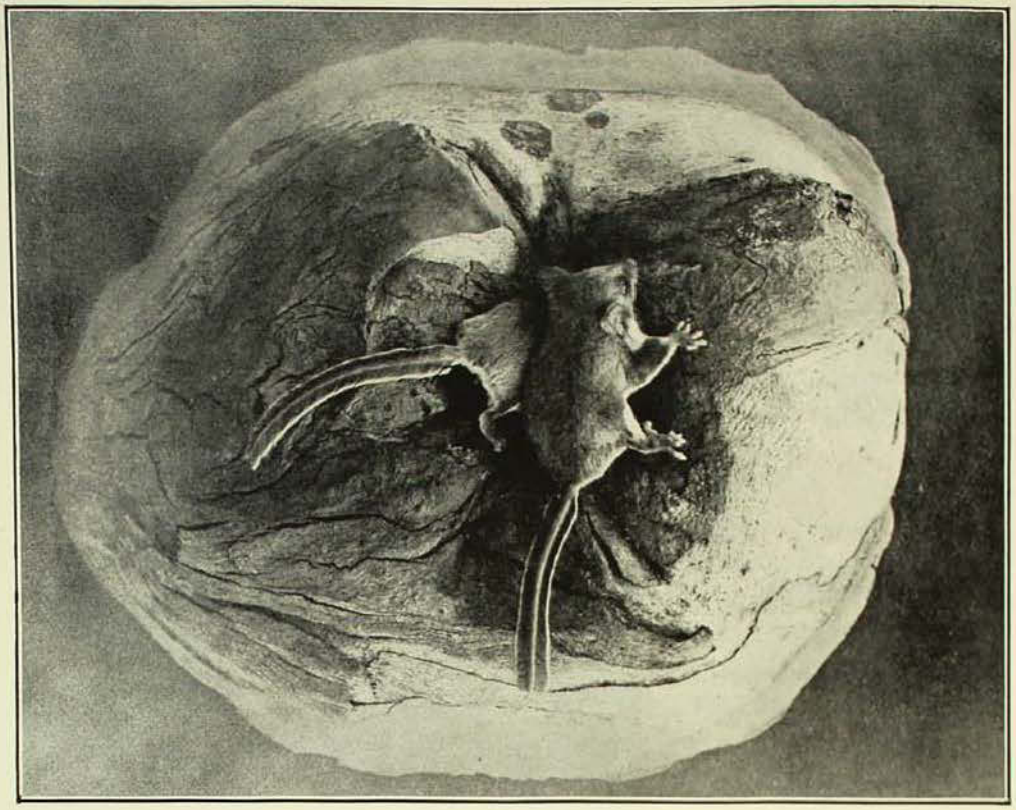
This gentle little creature, which might also be aptly called Feather-tail Glider, is the smallest of the marsupials capable of gliding flight, and is at once recognized by the definite side-folds and feather-like tail. It was one of the earliest species discovered by the settlers about Port Jackson, and was given the specific name *pygmæus* in 1793 by Shaw in his "Zoology of New Holland", which, in conjunction with the later generic name, gives the unusually appropriate translation of "pygmy acrobat".

The range of the single continental species extends over the gum forests of the eastern region from south-east South Australia, round to northern Queensland, where a poorly characterized sub-species was described from the Herberton District by De Vis, past Director of the Queensland Museum. In 1892 a second species was described by the Hon. Walter Rothschild from "one of the small islands in Northern Dutch New Guinea", greatly extending the geographical range of these tiny gliders.

Quite common in the eastern States, owing to their small size and nocturnal habits they are rarely observed, unless brought in by cats or discovered during the felling of timber, and although it is one of the species most frequently received at the Museum, from as near the city as Killara, specimens are generally accompanied by expressions of surprise at the existence of the tiny marsupial.

In the early days, according to the naturalist Gould, they were usually discovered owing to the blowing down of tree limbs in which they rested. If this occurred in the daytime, the torpid creatures might not be seen, but when the limbs were thrown on the traveller's fire the little inhabitants were quickly driven

out. Occasionally as many as four or five were discovered in this way, and Gould says: "A more charming little pet cannot be imagined, an ordinary-sized pill box forming a convenient domicile for the tiny creature, in which it lies coiled up during the day, becoming more and more active as night approaches. Its food consists of the saccharine matter which is so abundant in the flower-cups of the ever-blossoming *Eucalypti*, for which well-sweetened bread and milk forms an excellent substitute. The agility it displays among the branches in the night-time is very great; it not only passes over, around and beneath them, but, aided by the membrane attached to the sides and limbs, leaps from one bunch of flowers to another with the greatest facility."



The Pygmy or Feather-tail Glider is the smallest marsupial capable of volplane-like flight, which is aided by the skin-folds between the limbs, the feather-like tail acting as a rudder. The scientific name (Acrobates pygmæus) is unusually apt, meaning a "pygmy acrobat".

[Photo.—*Harry Burrell.*

Since Gould's account was written it has become evident, as the teeth indicate, that insects probably form the bulk of the food. This is shown by the fact that the teeth have not degenerated to suit a pulpy diet, as in the Honey Possum of south Western Australia, although white ants are a favoured insect food, while the sweet secretions of some of the scale-insects are also included.

The saccharine nectar of blossoms no doubt supplies a very attractive flavouring, which accounts for the success of sugar-sweetened bread in captivity, but it is now recognized that both bread and milk cause digestive troubles and shorten the life of captive marsupials. Small quantities of diluted honey and condensed milk more nearly approach the natural diet, and for all the small possums should be supplemented with native blossoms, of which the bottle-brushes appear to be most favoured.

Nowadays it is unfortunately more usual for such small mammals to be discovered by domestic cats than otherwise, as shown by an interesting account from Miss Sternbeck, of Mangrove Mountain, in the Hawkesbury district north of Sydney. It is stated that in addition to a larger species of flying phalanger (*Petaurus breviceps*) there is a tiny one called "flying mouse" apparently very common, as a friend's cat is continually bringing them home in the evening, and a rather amusing account of the cat's sagacity follows: "The flying mice being so tiny, are almost invariably unhurt, and my friends, in order to set them free, bribe the cat with a saucer of milk and a large piece of meat in exchange. Hence the cat invariably brings them to one or other of the household, quite cheerfully depositing the little creature and await-

ing the reward. Occasionally someone is awakened at night by one being placed on the pillow, but puss gets her pay whatever the time may be." Another instance of the cat's intelligence was shown when one of the household liberated a small diamond sparrow which had been given over, not realizing that its captor could see her, since when the feline blackmailer has not brought any spoils to that particular person.

The Sugar Glider is one of the most attractive of marsupials, and makes a delightful pet. The bushman's name of "Sugar Squirrel" was derived from the readiness with which sugar, honey and jam are taken by captives, combined with the misleading likeness to a true squirrel. Note the tail curled under in the manner employed in carrying nesting materials.

[Photo.—*David Fleay, B.Sc.*

The little gliders are found in small family groups—sometimes of immature males and females, or a female and her family—secreted in a knot-hole or dead limb at from two to fifty feet from the ground. The nest is globular, usually consisting of gum leaves, though shredded bark is sometimes used, and the entrance is neatly closed when the inmates are at home. Although any hole or crevice may be used for a home, a favoured site is the hollow centre of the large malformed knobs often seen on gum trees.

Only four young can be accommodated in the tiny pouch, though observations have shown, as with many marsupials, that numbers in excess are born only to perish when outdistanced in the instinctive race to the teats, to which the four successful competitors remain firmly attached for many weeks, whereas the litters of non-marsupials may suckle at will.

THE SUGAR GLIDER (*Petaurus breviceps*).

Though this beautiful animal is one of the most attractive marsupials, easily bred in captivity and making a delightful pet, no suitable popular name has hitherto been applied to it. Those generally used, such as lesser and short-headed flying phalanger, or possum, are unwieldy, and that of sugar squirrel is misleading, although the animal is superficially squirrel-like. The name of Sugar Glider is adopted here as brief and suitable for popular use, reflecting both the captive's love of sugar derived from the blossom-eating habit, and the volplaning ability which is due to the presence of the gliding membranes.

This smallest species of the genus has the widest range, occurring in the more coastal areas from the south-eastern

border of South Australia through the eastern States to the Northern Territory, where a slight variation in size and colour has led to the recognition of a sub-species (*ariel*). The animal is stated to have been introduced from Port Phillip into Tasmania in 1835, but it is now so widely spread as to suggest the possibility of its being indigenous there. It is notable that the species is represented by an even smaller relative in New Guinea (*papuanus*), which supports the idea that the Tasmanian animal may be an original inhabitant.

Although the general coloration is very similar to that of its nearest relative, the Squirrel Glider, it is readily distinguished by having a more rounded evenly furred tail, which is also noticeably shorter, never exceeding nine inches, and being equally short-haired at the base and frequently white tipped.

The soft grey-clad little animal is actually one of the hardiest of the possum family, and adult captives from the bush exhibit a spit-fire temper, inflicting bites with the long piercing incisors, and painful scratches with the sharp claws, the innumerable marks from which often serve to indicate the nocturnal landing places on tree-trunks. Remarkable ability is shown in the length of the glides in comparison to its size, and Fleay has recorded a glide of fifty yards, in which the force of impact no doubt was reduced by the usual slight upward swoop at the end. It is unusual amongst the rather quiet marsupials in its variety of calls, which range from the hissing notes heard from the nest, through a shrill yapping grunt, to a sharp droning scream of disagreement, which commences loudly and rapidly subsides into a few faint grunts.

Unlike the largest Glider and other possums, these animals are not leaf-eaters, insects, native fruits, and tender buds and blossoms forming the main diet; it has been suggested that the long front incisors are used for tearing young branches after the juicy inner wood. Their remarkable gliding powers and great activity enable the small creatures to hunt over a considerable area in one night, and, in view of their appearance, and the readiness with which honey, sugar and jam are taken immediately after capture, it is not difficult to understand why the bushman's name of "Sugar Squirrel" was applied to them.

They haunt both open bush and heavy forest country, the daytime retreat being hollows in high or low limbs, in which a mass of leaves forms the nest, while the deserted nest of a Ring-tail Possum may be adopted as a home. Two or more may live together, the larger numbers apparently consisting of the original pair and mature young, which remain with them for several seasons. The distinctive, somewhat musky scent of the animals permeates all their nesting sites, and becomes almost unbearable in large hollows where many generations have added to the leafy nest.

In the *Victorian Naturalist* of 1932, David Fleay provides very interesting notes on the nest-making of captives, which were observed hanging upside down by the hind feet while biting leaves off gum boughs and transferring them by means of the fore-paws to the tail, which was then twisted around the bundle, the Glider then running lightly along the branches into the nesting box. Similar habits were described to me some years ago by Miss Lily Ivey, of Elizabeth Bay, Sydney, whose pet was the surviving twin of an accidentally killed parent. Small twigs of gum leaves were usually placed in the cage, and with these it enjoyed playing, licking and biting the leaves, and tearing off bark and chewing the wood.

One day all the twigs disappeared, and it was supposed that they had been broken into small pieces and taken into the sleeping quarters above; a few evenings later, after running to the sleeping box, he astonished his mistress by bustling down again with a bundle of leaves and twigs held close to the body by the tail, which was twisted tightly around it. The bundle was quite five inches long by about three in width, and he seemed very proud of the newly acquired trick,

running about the cage and having something to eat before returning to his bedroom, experiencing considerable trouble in getting his burden through the small entrance, and returning to collect small pieces dropped by the way.

In southern Victoria the young, which are usually two in number, are born generally in July, while the breeding season appears to occur later as one goes north. At night the parent has been observed to sit upright and hold the pouch open with her fore-paws while carefully licking the tiny pink infants. The tenacity of life in these pouch-embryos, as the young on the teats are called, has been strikingly demonstrated by successful attempts to rear them after removal from the teats. The pet reared by Miss Ivey was smaller than a shilling, with the mouth gathered into a tiny round opening, into which a small straw was inserted to convey milk from an eye-dropper. The mite was quite distended after the two drops which were given five or six times a day—a difficult operation, requiring the assistance of two extra foster nurses; warm milk with very little sugar was given, and it was quite three weeks before it could lap for itself.

An excellent detailed account of a similar experience is given in the *Australian Zoologist* of 1931 by Miss Florence Irby, of Casino, on the north coast of New South Wales. The body of the parent, killed by a cat, was frozen stiff, but the naked embryo was still wriggling, firmly attached to the teat, from which it was loosened with great care. Although it was sightless and so small that when curled up closely it fitted easily on a shilling, experiments to test the erroneous belief that new born marsupials are utterly unable to reach the pouch unaided, showed that some sense or instinct led the tiny immature creature direct to the warmth of an outstretched hand even when held a foot away. The account continues: "It seemed hopeless to try and save a creature so small, young and unformed—one could only press its mouth into a teaspoonful of warm milk and water every hour or so. Without seeming to drink, it must have absorbed a little of the beverage, for next day, to our surprise it was still alive. At the end of two days of spoon-feeding the shape of the mouth completely changed, forming two normal lips. . . . At the age of four days it lapped milk and water from the spoon like a kitten . . . . and would sometimes squeak, just about as loudly as a baby mouse." A daily record of growth is given, including the formation of eyelids, opening of the eyes, and gradual furring of the body; but it must be borne in mind that in both instances of artificial rearing, the pouch-embryo had already been growing for some time on the teat, as it would certainly be less than a quarter of an inch long at birth. This fact does not in any way detract from the remarkable achievement of patient care in rearing the tiny young, but naturally affects any estimate of growth changes.

The diet notes on the two captives vary considerably, due doubtless to their unnatural upbringing, but the information is of great interest, as indicating a more varied wild menu than is generally supposed. According to Gould, sweetened bread and milk was suitable for captives, but it causes digestive troubles from fermentation, and the nearest approach to a natural diet is best for all marsupial captives. Milk was taken by Miss Ivey's pet only when young, and it now drinks plenty of water. It is exceptional in refusing insects or honey, and likes any cooked vegetables, especially baked potatoes, cauliflower, pumpkin, chokoes, tomatoes, and every kind of fruit, especially grapes; it does not like lettuce, and enjoys arrowroot biscuits dipped in tea, and cake. A most interesting observation was that it killed young mice, pouncing on them with great speed and excitement, and nipping them at the back of the head, which may account for reports of the wild animal's aggressive ability to scare off such flesh-eating foes as the Brush-tailed Pouched-Mouse.

On the ninth week after its removal from the pouch, Miss Irby's fosterling

The Squirrel Glider is a close but somewhat larger relative of the Sugar Glider. Very similar in coloration, but readily distinguished by the longer and fluffier, more squirrel-like tail, which has the lovely flounces of grey fur over an inch and a half long near its base. An early discovery of the "first-fleeters", it was described and illustrated in 1789 in the account of Governor Phillip's voyage to Botany Bay.

[Photo.—*David Fleay, B.Sc.*

became partly insectivorous, clutching small moths and other insects with astonishing agility as they flew by, and having a special weakness for the larvæ of hornets, climbing to the mud nests and breaking them open. At four months it was a perfect half-size replica of the mother, and spent much time with teeth and claws, combing every hair backwards. A gentle, sleepy creature by day, waking only for a drink of milk or piece of biscuit or cake, it then wound its tail tightly around its face and curled up body and slept on till dusk, when it became a sprightly whirlwind, dashing up the window curtains and leaping on to anyone nearby.

It often destroyed a vase full of flowers in eagerness to suck the slight amount of honey from the blossoms, and catch any insects clinging to them. It would chase crickets round the room like a cat after mice, and then tear them to pieces, also favouring silver-fish, and the great dragon-flies which floated over the grass at night, of which only the gauzy wings were left. In conclusion, Miss Irby pens a charming picture of the "deliriously happy little creature of the night, curled up now, beside me, a biscuit clutched in one small pink paw, too lazy even to eat, as it dreams of honey-scented flowers and the winged things it will catch tonight".

THE SQUIRREL GLIDER (*Petaurus norfolcensis*).

This species was described and figured in 1789 in the account of the voyage of Governor Phillip to Botany Bay as "The Norfolk Island Flying-Squirrel", the size and general colour of the back being compared to that of the American grey squirrel. The specific name unfortunately perpetuates the error in habitat implied in the name used by Phillip, which doubtless arose from the fact that his account dealt also with the "Establishment of the Colonies of Port Jackson and Norfolk Island". Although there can be no doubt that the species did not inhabit Norfolk Island, the earliest name, based on Phillip's account, must be used and, in any event, it serves to recall its early history and east coast habitat. The range

is not so extensive as that of its smaller and commoner relative, extending from Victoria to north of Cardwell in Queensland, from which locality a new species, *gracilis*, now regarded as a sub-species, was described by De Vis.

Apart from its larger size, this species is readily distinguished from its closest relative by its longer and fluffier, more squirrel-like tail, which is not tapered off as in the Sugar Glider, but has the lovely flounces of grey fur, over one and a half inches long near the base, extending to the tip. It inhabits the coastal ranges, favouring fairly dense white-barked eucalypt country, but is so rarely seen or captured that little is known of its habits. So alike, however, are the dentition and general appearance to that of its small relative (*P. breviceps*) that the general habits and diet detailed under that species are applicable in every way to the present one.

According to Gould's observations, it preferred the forests adorning the more open and grassy parts of the country to the thick brushes near the coast. The natives captured it for its flesh, as well as the skins, which they disposed of to colonists, who sometimes used them for the trimming of dresses or making boas, as with the Chinchilla and similar fur-bearing animals. Its usual food was given as insects, the honey of flowers, and the tender buds and leaves of eucalypti, sopped bread and milk being regarded by the naturalist as an excellent substitute diet in captivity, though probably not keenly relished by the unfortunate captive.

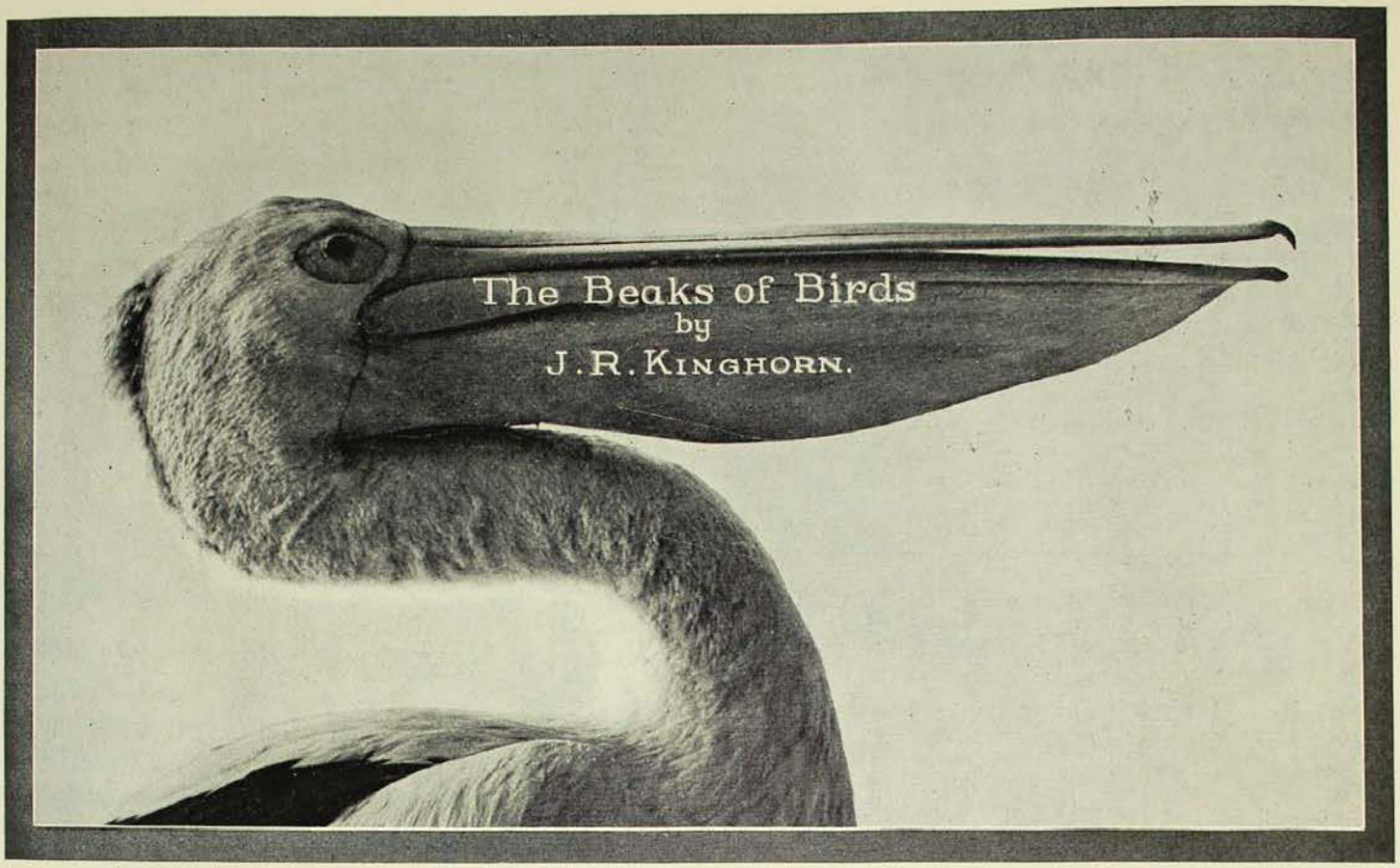
He also referred to the performance of enormous leaps, doubtless exceeding the fifty yards credited *breviceps*, which enable the animals to pass from tree to tree without descending to the ground, and to the slight ascent at the end of a leap, which minimizes the shock of landing. They will scamper over the ground for several hundred yards to reach a new food supply, and it is mostly during these land excursions that they fall victims to cats, which their gliding abilities probably help them to avoid in the trees. There is an interesting account given in the "Penny Cyclopædia" of 1839 of the animal's ability to change direction while gliding. A Squirrel Glider which was allowed to roam the deck of a vessel sailing off the coast of "New Holland", had reached the mast-head, from which it sprang to avoid the sailor sent to bring it down. The ship rolled heavily at that moment, so that continuance of the leap must have plunged the little aeronaut into the sea, but to the relief of the anxious watchers it suddenly appeared to check and modify its course to alight on the deck. It is from many accounts such as this that one realizes the great pleasure which the quaint furred animals afforded settlers during the early days of colonization, as well as their urgent claims for adequate protection under present-day conditions.

[In the succeeding issue the author will deal with the Yellow-bellied Glider (*Petaurus australis*) and the Greater Glider (*Schoinobates volans*). Limitations of space, unfortunately, prevented their inclusion in the present contribution.—Editor.]

Dr. Randall-Colyer, who was a delegate to the Pan-Pacific Women's Conference at Honolulu, took with her a small collection of articles made and used by the Australian aborigines, also a selection of the publications and postcards issued by the Museum.

* * * *

The late Mr. Stanley de V. H. Alexander for many years assiduously gathered from various sources of publication extracts relating to precious stones. Eventually he had these bound, and, through the kindness of Mr. H. L. Cameron, they have been added to the Museum Library. Such collections are extremely useful, and we are much indebted to the donor for his consideration in making this collection available to us.



The Pelican uses its beak as a fishing net, and the dilatable pouch of the lower jaw as an attaché case.

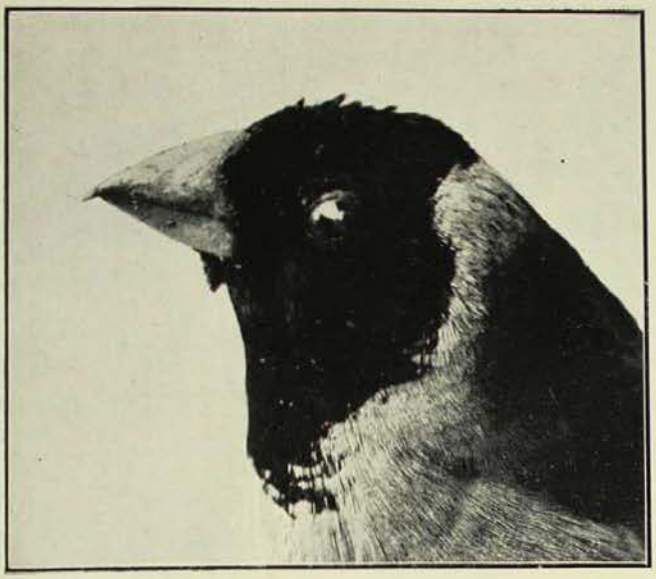
[Photo.—*G. C. Clutton.*

JUST how many lovers of nature have paused to consider what a very remarkable organ is the beak of a bird? No matter what shape it may be, it is used in the performance of many duties during the course of everyday life. Primarily it is used to obtain food, but also as a toilet set when feathers have to be preened; as a brad-awl by woodpeckers; as a crow-bar by such birds as turnstones; as a needle by tailor birds and other allied species that sew leaves together when constructing the home; as a spade by such birds as bee-eaters, pardalotes and the like when tunnelling the home in some bank of earth; as a knife, spoon and fork when the owner and the young have to be fed; and as a complete set of carpenter's tools when the home itself is under construction.

It is very easy to let the imagination run away when making such a list, and no doubt many readers will be able to suggest other duties performed by the beak, but no matter what use it is put to we can be sure that the work is well done.

The gradual evolution of the beak has been brought about by the quest for food, certain types of food being available only to those birds which have a beak structurally adapted to securing it, and it is through the study of beaks (and often the legs and feet) that students of ornithology can determine with a fair degree of accuracy the types of food eaten by a certain species of bird.

The commonest type of beak is perhaps that of the sparrow and allied birds, such as finches, buntings and waxbills, among which are many, though not very great, modifications. Such beaks are used mainly to crush seed, though they are used by some birds to catch insects or nibble at fruit. If we were to examine the beaks of the vast army of flycatchers, robins, fantails and the like, we would find that they differed from those of finches (seed eaters) in being somewhat softer, more flattened generally, much



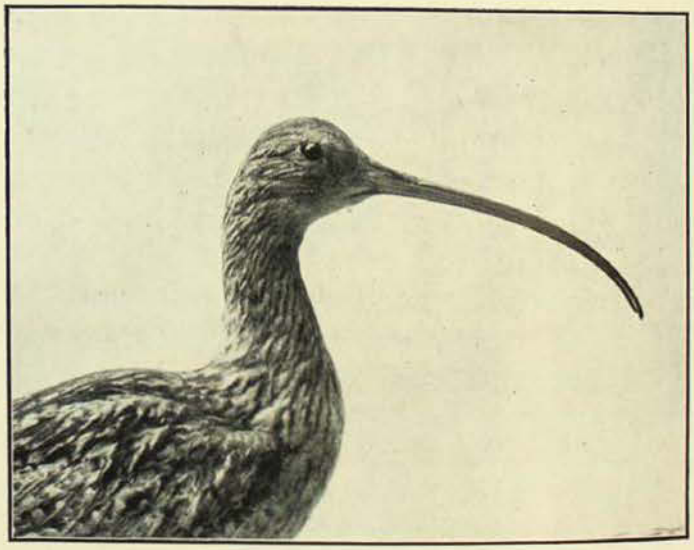
The beak of the Finch and its relatives is typical of the seed eaters.
[Photo.—*G. C. Clutton.*

broader at the base, and often provided with bristles which fan out from the gape and thus help to direct insects into the beak when taken "on the wing".

A very noticeable variation is to be found in the shape, size and location of the nostril. This may be oval, round, a mere slit, or tubular, as in the petrels. It may be situated at the base and be either exposed or hidden by feather tufts, or it may be more towards the centre of the beak, as in ducks, gulls and waders, or nearer the tip, the extreme variation being found in the kiwi, which is unique in having the nostrils at the very tip.

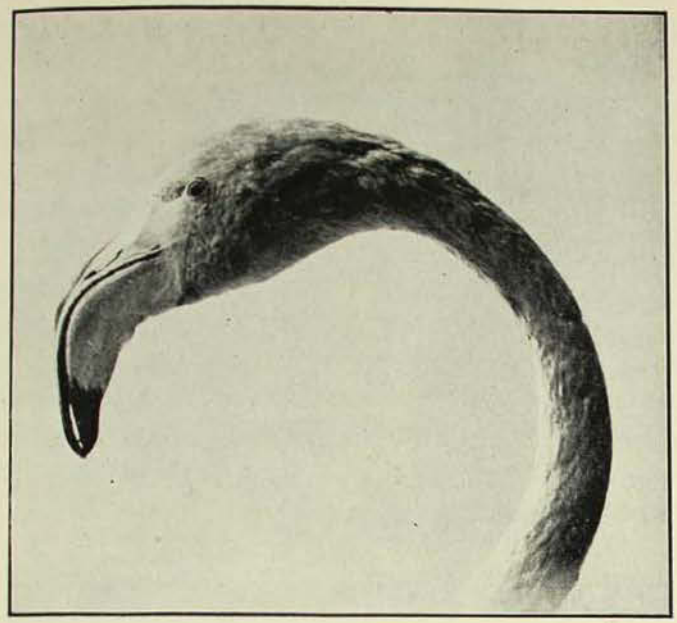
Taking the quest for food as our main basis in giving some examples of shape and size, let us commence with the ground birds. Among the plovers and their allies are some which prefer to forage on the dry plains and others which frequent the marshy places, and so on, occasionally eating the same kinds of food, but usually different kinds procured under varying conditions. The beak of the typical plover is comparatively short, somewhat swollen at the tip, and is adaptable to picking up very small aquatic creatures, such as pond snails. As a contrast to the plover there is the curlew and whimbrel, in which the beak is very long, strong and curved downwards along its entire length, thus making it more comfortable for the bird to search for food without having to turn the head so far downwards.

In the majority of wading birds the tip of the beak is provided with a special adaptation in the form of a highly sensitive nerve centre, so that dainty morsels of food can be more easily detected when the beak is thrust down into the mud. Furthermore, as the pressure of mud would be too great to allow the bird to open its beak when thus submerged, nature has evolved a special mechanism whereby the tip alone may be opened sufficiently to grasp and pull out any worm or other item of food encountered. The same pliable tip is found in the beak of the avocet, though here is an interesting modification, the curve of the bill being upwards instead of downwards, thus enabling the owner to probe under stones, logs, seaweed, and other debris with greater ease and efficiency than would be the case if the beak was perfectly straight. The most interesting variation in curved beaks of the waders is to be found in the wrybill of New Zealand.



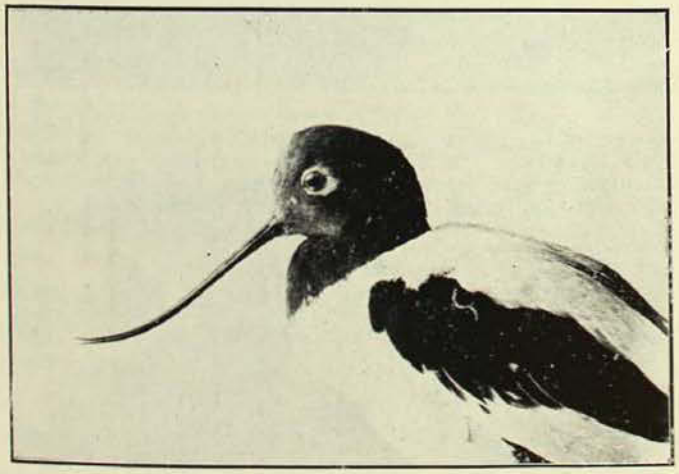
Curlews, Whimbrels and other waders have long straight or curved beaks for probing in marshy places or long grass.
[Photo.—*G. C. Clutton.*

Instead of being curved up as in the avocet, or down as with the whimbrel, it is curved to the right, never to the left, and as far as is known no other bird can balance this by having a bill curved left. Just why the wrybill has lateral curve remains a mystery. As a contrast to these waders, which can feed comfort-



The Flamingo turns its crown downwards and uses the top half of its beak as a scoop.
[Photo.—*G. C. Clutton.*

ably and at the same time keep an eye open for approaching enemies, an opposite extreme is to be found in the flamingo, which turns the crown of the head towards the water, using the top half of its beak as a scoop (towards the body) when catching the aquatic creatures upon which it feeds.



The Avocet's beak is curved upwards for easier probing under debris or skimming the water for food.
[Photo.—*G. C. Clutton.*

In another wader, the spoonbill, a highly specialized form of beak is to be found. It is broad, flat and somewhat blade-like throughout its entire length, the tip being expanded and spoon-like, and used for puddling in the mud, thus disturbing the inhabitants and enabling the bird to make a selection of the most desirable type of food.

Adaptation to the quest for food is also shown strongly among ducks and geese. The Screamers of South America have a beak not unlike that of the domestic fowl, and it can be used for picking up seeds or varying the diet with terrestrial or

The Spoonbill has the tip of its beak expanded for puddling the mud, thus disturbing the inhabitants before a select diet is secured.
[Photo.—*G. C. Clutton.*

aquatic plants. A somewhat similar, though more goose-like beak is that of the Australian Magpie Goose, or the Cape Barren Goose, both having beaks that can be used for collecting many kinds of food, but the extreme variation is to be found in the pink-eared duck and others of the shoveller tribe, in which the beak is considerably depressed, expanding slightly towards the tip, and well provided along its entire length with comb-like lamellæ, which form a sieve between the outer edges of the upper and lower mandible, through which water is strained while tiny aquatic creatures are retained as food. The pelican, in addition to its long blade-like bill, which is specially adapted to catching fish, pos-

Eagles, Hawks and their relatives have strong, sharply hooked beaks for tearing flesh.
[Photo.—*G. C. Clutton.*

sesses a large, fleshy, dilatable pouch attached to the lower jaw, which can be used as an attaché case in which to store surplus fish to be eaten at leisure.

Among parrots and birds of prey, such as hawks, eagles and owls, the development and general shape of the beak are somewhat similar, all being strongly hooked, and used for breaking or tearing food into small particles—seeds in the case of parrots and flesh in the hawks and eagles. The extreme range in size among parrots is very striking, from the tiny bill of the grass parrakeets to the enormous one of the black cockatoo, the former being used for collecting grass seeds and the latter for tearing bark and timber from trees in search of wood-boring grubs.

The most remarkable beaks are to be found among hornbills and toucans. Though the beaks of the hornbills are large and grotesque, they are by no means heavy, the interior being composed of a network of cellular structures. They are very efficient weapons of offence and defence, as well as excellent resonators, thereby increasing the volume of the bird's cry. The casque on the bill is an excellent shock absorber, and protects the nerve centres when it is used as a hammer to break open the larger nuts on which the bird feeds.

The beaks of the toucan tribe, like those of the hornbills, appear heavy and far too big for the owner; nevertheless they are light and very sensitive, and apparently sometimes irritable, as the birds often may be seen scratching them with their claws.

Hornbills have grotesquely shaped beaks; the casque on the top being an excellent shock absorber, a hammer for breaking nuts, and an excellent resonator.
[Photo.—*G. C. Clutton.*

There are so many types of birds, each with some greater or lesser modification or special adaptation of the beak, that the subject can only be introduced in these pages; but perhaps through this article a new avenue of thought will be opened up to lovers of nature, and greater pleasure and profit will result from their walks through the bushlands, their journeys over the plains, their visits to parks and gardens, and even through studying such birds as visit their own home plots.

Typical patterns employed for the nose and face. They are longitudinal, and consist of the repetition of a simple motif. This is usually composed of a combination of short straight lines put together in a variety of ways. Below are two of the many designs that may be devised.

[Photo.—*R. V. Oldham.*

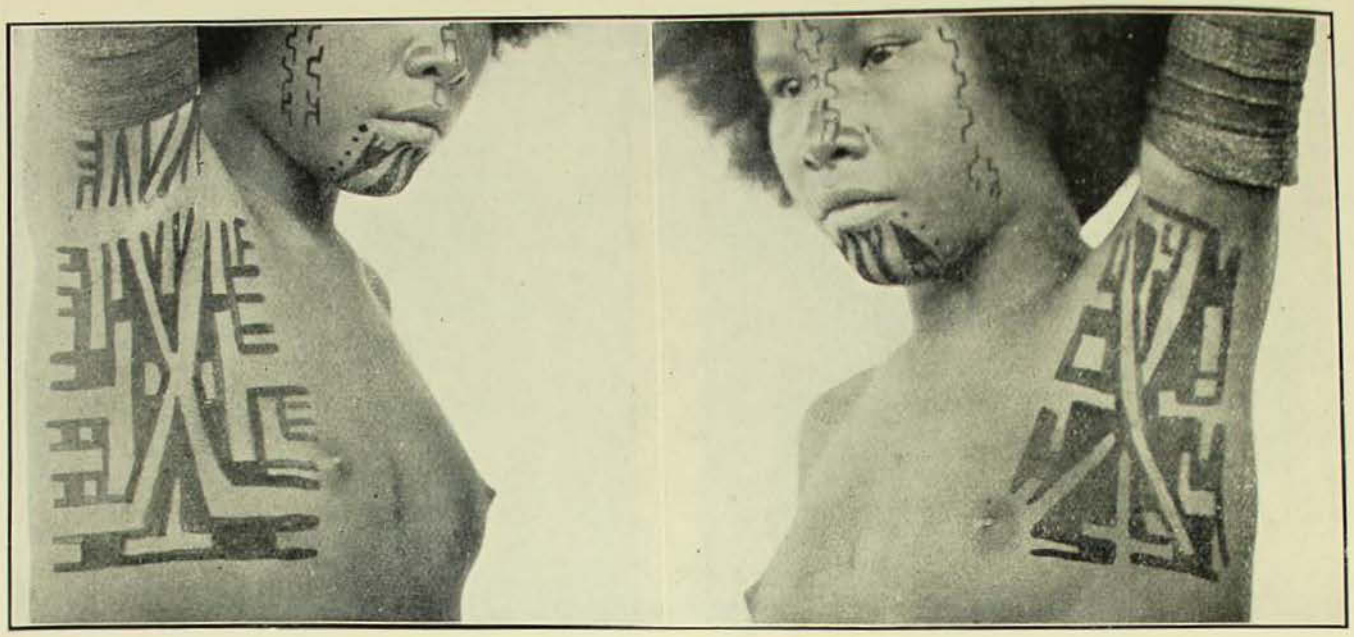
Tattooing of the Motu Tribe, Papua

By Roland V. Oldham.

AS far back as the old men can remember, tattooing has been one of the tribal customs of the Motu people, whose territory is situated in the environment of the Port Moresby District, Central Division. Nowadays, owing to the persuasions of missionaries, the practice is gradually falling into disuse. In answer to questions as to the reason for tattooing, some natives say that the letting of blood involved in the process promotes the growth of the young girl; others declare that a plentifully tattooed young woman is a far more desirable bride than one whose skin is not so decorated. It is the general opinion, however, that the natives are content to undergo discomfort and allow their skins to be permanently stained simply because it was the custom of their forefathers, and they have no wish to break away from a practice sanctioned by tradition.

Fashion in Tattooing.

Usually it is only the women who are tattooed. Sometimes small boys bear tooth-like markings, which extend from the corners of the mouth towards the ears, or down the nose. Many boys and girls, now that the knowledge of writing has been brought to the Motu, have their names tattooed on their arms or legs. In the old days, if a man killed one of his fellows, he was at liberty to assume a line of tattoo from the shoulder to the small of the back. If he had



Armpit designs built round an X.

[Photo.—*R. V. Oldham.*

killed two people, he had two lines—one on each side of the spine. Three lines—one on each side of the spine and one down the spine itself—denoted a warrior who had killed many people, and he was, of course, accorded no small measure of respect for his prowess. Some years ago, a few old men were to be seen bearing a design across the upper chest and shoulders showing that they had taken human life.

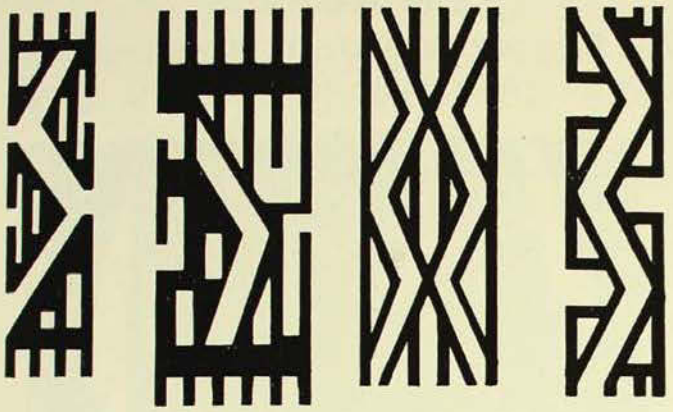
Nevertheless, except as a mark of distinction, tattooing is limited to womenfolk. It is not long since the whole body of every Motuan woman was covered with designs, which were commenced when she

The operation of tattooing may be performed by any woman who is sufficiently competent in the art. Here the operator is about to tap the thorn into the skin so that the stain, already painted on the little girl, may penetrate beneath the surface and remain indelible for the rest of her days.

[Photo.—*R. V. Oldham.*

was a small girl of about five years of age, and were completed just prior to her marriage.

There is a fixed general order in which the parts of the body are tattooed. The face is frequently the first portion to be



The triangle or zig-zag lines enter into most of the body patterns.
[R. V. Oldham, *del.*

treated, then the arms and the lower portion of the abdomen. This is followed by the inner side of the thighs and the

Some of the above designs are here depicted.
[Photo.—*R. V. Oldham.*

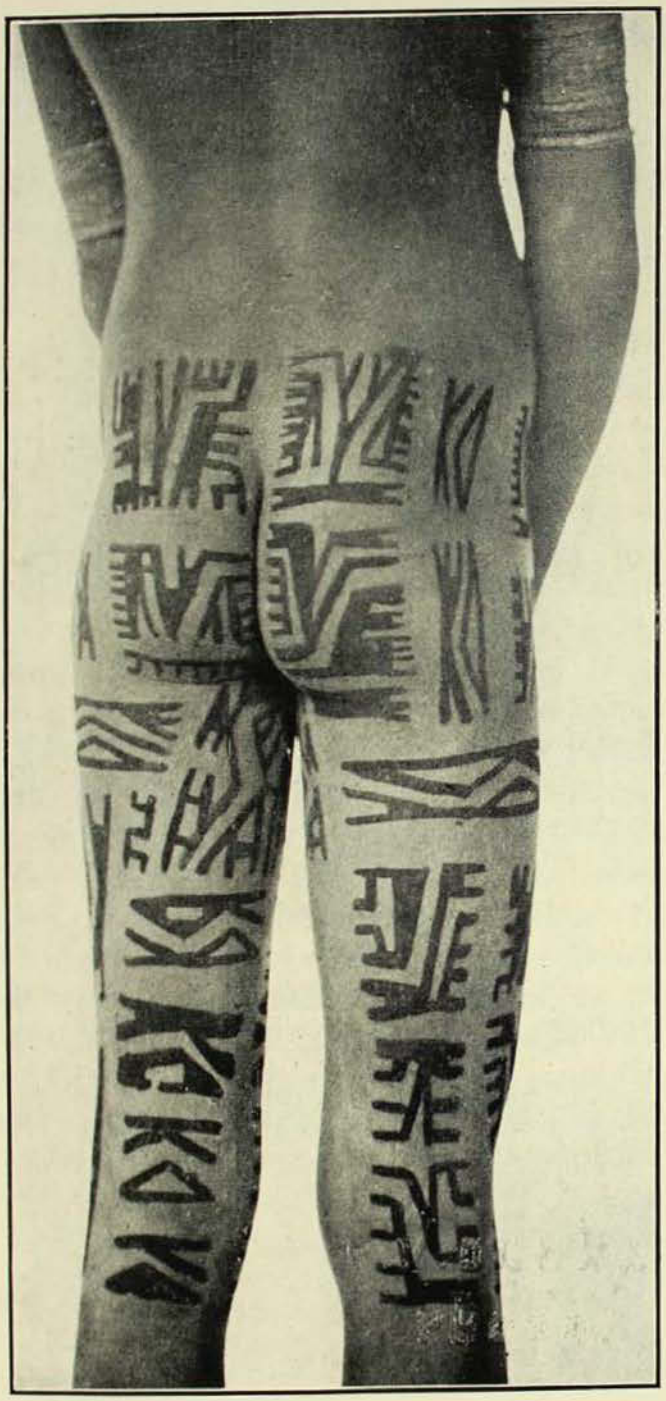
inside of the arms. Now comes an interval of a year or more, after which the back from the waist down to the knees is tattooed, next the outside of the thighs and the armpits. The shoulders and the upper portion of the back are then treated. Later comes the small of the back and the sides of the body. After another interval, the bare portion from the waist halfway up the chest is tattooed. The whole of the body has now been covered, with the exception of the legs and the upper chest. The latter portion is tattooed when it is decided that the girl is to be married. Some girls refuse to have this part tattooed because it is a particularly painful operation and entails much suffering.

According to tribal custom, the legs from the knees down to the feet should not be tattooed unless the father or some close relative has helped to construct a lakatoi and made a successful trading voyage in it. (The lakatoi is a large vessel composed of a number of dugout canoes lashed together, and is used in the annual trading expeditions to the Gulf.) The legs may be so treated when the girl is about eight years old. Should she not desire to have her legs tattooed, she may have a line of tattoo from the eyes down past the corners of the mouth to the lower jaw. These lakatoi marks are, together with those assumed by the homicide, the only ones which have any real significance today; all other markings are just decorative.

IMPLEMENTS USED.

The articles used in tattooing are few in number and very simple. One is a small, round stick or *iboki*, about half an inch thick, and from eight to ten inches long. Usually it is tapered, having at one end a covering of plaited cane. The other implement is a piece of lime twig with a thorn projecting at one end, termed *gini*. For finishing off a tattoo, the *gini* may have three or four thorns tied together to render it more efficient.

The colouring matter used in the process is obtained by burning tree gum and collecting the soot on an inverted potsherd. The pigment is made by mixing the soot with water, and has the appearance of a dense indian ink. It is far more effective than ordinary soot or lampblack, perhaps because of its sticky nature.



Designs imprinted upon the thighs and backs of the legs when the girl is about twelve years old.
[Photo.—*R. V. Oldham.*

OPERATION OF TATTOOING.

The pattern which is to be imprinted into the skin is painted on and allowed to dry. The *gini* is held in the left hand, with the point of the thorn almost touching the skin. The *iboki*, held in the right hand by the small end, is used to tap the *gini* with sufficient force to cause the thorn to pierce the skin. By moving the thorn over the painted pattern the ink is imprinted in the skin. When the incisions have healed, the tattoo shows through clearly and cannot be erased.

THE DESIGNS.

The face patterns are of two types. The one most commonly used is built up of

Another pattern used for the thighs and buttocks.
[Photo.—*R. V. Oldham.*

short straight lines at right angles to one another. These lines are put together in many different ways, according to the whim of the operator; a few of the variations are illustrated. The second facial design has for its basis a triangle.

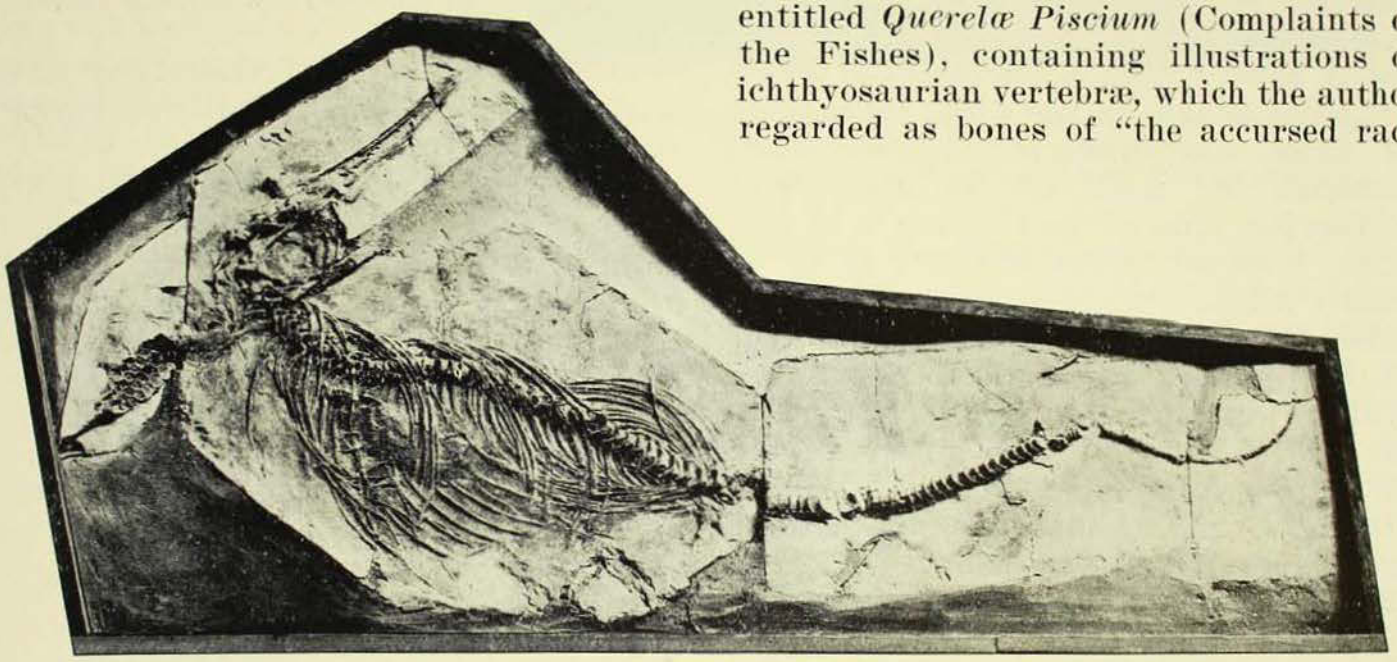
The patterns traced upon other parts of the body are shown in the photographs. It may be noted that as a general rule they follow the form of a triangle. One of the armpit patterns is built round an X.

I have chosen children as my subjects because their designs are not distorted by growth. The tattoo patterns have been outlined afresh with the black pigment obtained from the residue of burnt gum, in order that they may show up more clearly on the dark skins.

Ichthyosaurs

By C. Anderson, M.A., D.Sc., C.M.Z.S.

OF the various Orders of reptiles which flourished in the Mesozoic era and became extinct at its close, before the mammals became the dominant race, the ichthyosaurs are probably one of the best known. But when their remains were first discovered these were not recognized as reptilian at all, and it was only when careful study of well-preserved specimens was made that the true nature of the animals was made clear.



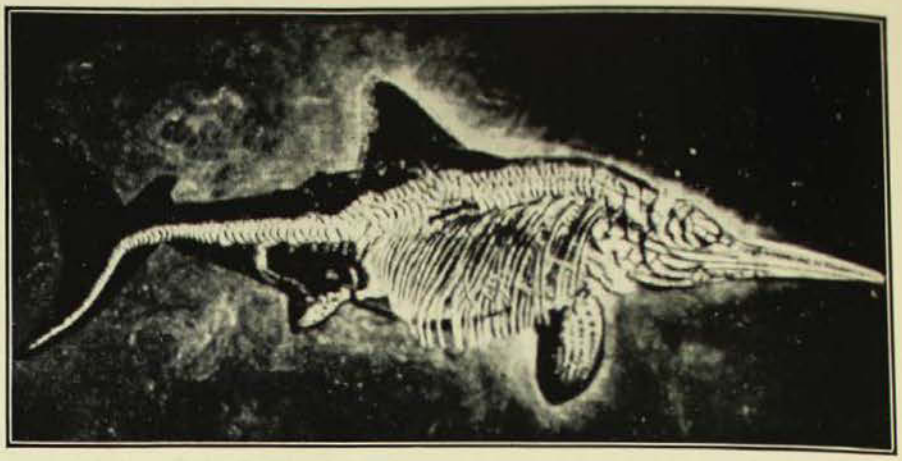
Skeleton of Ichthyosaurus tenuirostris, from Lyme-Regis, Dorsetshire, England. Australian Museum specimen.

[Photo.—*G. C. Clutton.*

EARLY DISCOVERIES.

Towards the close of the seventeenth century, a Welshman named Lhuyd published a work containing illustrations of the remains of ichthyosaurs, which he believed to be fishes. Lhuyd accounted for these and other fossils by supposing that they grew in the earth from germs derived from living animals, the spawn of fish and eggs of other animals being carried up in vapours to the clouds, whence they descended in rain. This was not the view of Johann Jacob Scheuchzer, a celebrated Swiss geologist, who somewhat later published a curious book entitled *Querelæ Piscium* (Complaints of the Fishes), containing illustrations of ichthyosaurian vertebræ, which the author regarded as bones of "the accursed race destroyed by the flood". It was this same Scheuchzer who at a later date described the skeleton of a large fossil salamander as "Homo diluvii testis" (Man, witness of the flood); a cast of this celebrated "sorrowful skeleton of an old sinner drowned in the flood", which now bears the name *Andrias scheuchzeri*, may be seen in the palæontological gallery of the Australian Museum. Scheuchzer was a firm adherent of the hypothesis that all fossils were remains of creatures that had been overwhelmed in the universal deluge, and apparently he had the orthodox low opinion of the race of men who inhabited the earth prior to that purifying catastrophe.

In 1814 Sir Everard Home, a famous English anatomist, published in the *Transactions of the Royal Society of London* a paper entitled "Some Account of the fossil Remains of an Animal more nearly allied to Fishes than any of the other Classes of Animals". In this paper Horne described and figured an almost complete skull and other bones of an ichthyosaurus found in Dorsetshire, but he did not recognize the true nature of the animal. His conclusion is interesting, for he says: "These particulars, in which the bones of this animal differ from those of fishes, are sufficient to show that, although the mode of its progressive motion has induced me to place it in this class, I by no means consider it to be wholly a fish, when compared with other fishes, but rather view it in a similar light to those animals met with in New South Wales, which appear to be so many deviations from ordinary structure, for the purpose of making intermediate connecting links, to unite in the closest manner the classes of which the great chain of animated beings is composed." No doubt Home here had in mind the platypus, of which he published a description in 1802.



A remarkable specimen of Ichthyosaurus in the American Museum of Natural History, showing the outline and imprint of the body; from Holzmaden, Germany.
[From the *American Museum Journal.*

Koenig, sometime Keeper of Geology in the British Museum, was, in 1821, the first to use the name *Ichthyosaurus* (fish-lizard), apparently regarding the animals as being intermediate between fishes and reptiles. In succeeding years the structure of these creatures was carefully studied by various learned men, such as Conybeare, Cuvier, and Owen, and it was clearly recognized that they constituted a peculiar Order of extinct reptiles, the Ichthyosauria.

REMARKABLE DISCOVERIES.

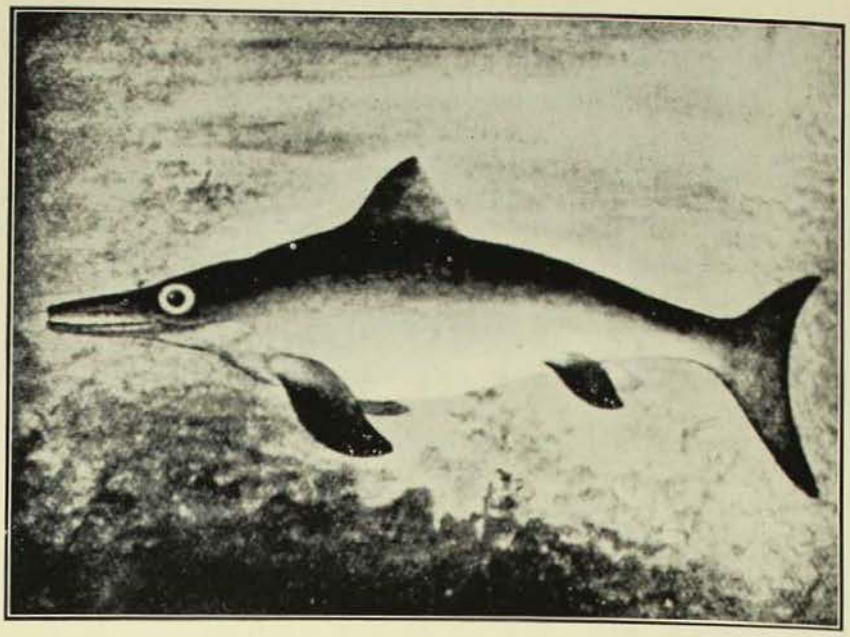
Many fine specimens of these interesting extinct reptiles have been found in various parts of the world, including Australia, and we now have a very good knowledge not only of their bony structures, but also of their bodily appearance and their habits.

Near Lyme-Regis in Dorsetshire and at other places in England where Liassic sediments, the older beds of the Jurassic system, are found, magnificent and well preserved skeletons have been at various times unearthed, sometimes when sections of sea cliffs, undermined by storms, have fallen on the beach below. But the most instructive specimens have been obtained in the Holzmaden district of Württemberg, Germany, where ichthyosaurian remains of Jurassic age have been found in great abundance, in some of which the outline of the body is completely preserved. Older specimens have been found in the Triassic rocks of California, which on account of their greater age (estimated as 180 million years, as against 150 million for the Jurassic ichthyosaurs) throw some light on the early history of the order. Yet our knowledge of their immediate ancestors, their nearest relatives, and their evolution is still incomplete. The rocks in which ichthyosaurs are found are always marine in origin, hence it is clear that they lived in the ocean, and it is unlikely that they ever came ashore.

STRUCTURE AND APPEARANCE.

The ichthyosaurs, which varied in length from two to thirty or more feet, presented a startling similarity in outward form to

the long-nosed dolphins, and, like these and other whales, they were descended from land-living ancestors, which through a long course of evolution had become perfectly adapted for a life in the ocean. They had a cylindrical stream-lined body, with a long slender snout, the jaws armed with sharp recurved teeth, which occupied a groove in the jaws and were not set in separate sockets as in the crocodiles and similar reptiles. There was little evidence of a neck, and the smooth scaleless body tapered to a long powerful tail, ending in a vertically placed, bilobed caudal fin resembling that of certain fishes, and the end of the backbone was continued downwards into the lower lobe. In the whales the caudal fin is placed horizontally, no doubt a provision to enable these warm-blooded animals to make a quick ascent to the surface. Some of the Holzmaden specimens have also preserved the impression of a large dorsal fin, which was apparently supported by calcified sinews; the presence of a dorsal fin is unique among reptiles, even such as are adapted for an aquatic existence. The eyes were very large, and the eyeball was surrounded by a strong ring of bones, the purpose of which was doubtless to protect the eye and give greater control over vision; this provision probably indicates that the ichthyosaurs were accustomed to descend to great depths in the ocean waters, where the pressure is considerable. The joints of the backbone were disc-like, and deeply concave at both ends like those of fishes; no doubt in life the hollows were filled with elastic tissue, which imparted pliancy to the vertebral column.



The probable appearance of an ichthyosaur swimming beneath the surface of the water.

[From Lankester, *Extinct Animals.*

The animals had two pairs of flippers, of which the front pair were the more powerful. The bony structure of these flippers was very remarkable, considering that the ichthyosaurs are descended from terrestrial forbears with limbs adapted for progression on land. The upper arm and upper leg bones were short and thick, and the remaining bones of the limbs were so numerous and so different in shape from those of other reptiles that at first sight it is hard to believe that these paddles can have been evolved from normal reptilian limbs. They have more than the regulation five fingers and five toes, and the bones of the fingers and toes are not limited to the usual three, but are numerous and have a polygonal shape, fitting closely together to form a sort of mosaic. The whole was bound together by integument to form a flipper resembling that of the whales, in which we have the same multiplication of the bones in each finger, though the fingers themselves do not exceed the customary five.

The ichthyosaurs and the dolphins present an instructive example of what is known as *convergence in evolution*, for here we have two entirely different kinds of animals, which nevertheless have in each case become fish-like and perfectly adapted to a life in the water, though their ancestors were land-living creatures with normal walking or crawling limbs.

Some of the curious features of the ichthyosaurs have been wittily described

in rhyme by the late John Stuart Black, the genial Professor of Greek in the University of Edinburgh:

Behold a strange monster our wonder engages!
If dolphin or lizard your wit may defy.
Some thirty foot long on the shores of Lyme-Regis,
With a saw for a jaw and a big staring eye.

A fish or a lizard? An ichthyosaurus,
With a big goggle eye and a very small brain,
And paddles like mill-wheels in clattering chorus,
Smiting tremendous the dread-sounding main.

HABITS.

As has been said, the ichthyosaurs were marine reptiles, and probably they never came ashore, not even, like the turtles, to lay their eggs. Skeletons have been found with numbers of small specimens, of the same species and all of about the same size, inside the body cavity. From this it has been concluded that some ichthyosaurs at least produced their young alive, and the probability is that this was general throughout the Order. It is also probable, however, that they were cannibals, for in several cases the small contained ichthyosaurs had evidently been swallowed.

The food of ichthyosaurs was mainly fish, for the capture and retention of which their teeth were well adapted, but apparently squids also formed part of their menu, for the hard parts of these are also found. One ichthyosaur specimen has been found in the stomach of which is a mass composed of the remains of more than two hundred belemnites, extinct relatives of modern squids. It is evident that the jaws of ichthyosaurs could not be opened widely, as is the case with snakes, and their prey must have been mostly of small size.

The fact that their remains are found in such abundance in certain localities would indicate that they were gregarious in habit, as are the marine mammals, such as seals, dolphins, and porpoises.

AUSTRALIAN REPRESENTATIVES.

In Australia remains of ichthyosaurs have been discovered in rocks of

Specimen showing the bony ring round the eyeball of Ichthyosaurus australis, Flinders River, Queensland. Cast in the Australian Museum.

[Photo.—*G. C. Clutton.*

Cretaceous age, the period following on the Jurassic, which was apparently the golden age of the European forms. The first to record the occurrence of ichthyosaurs in Australian rocks was the late Sir Frederick McCoy, who, in 1867, described, under the name *Ichthyosaurus australis*, certain remains from the Flinders River, Queensland, consisting of two portions of the skull, teeth, vertebræ, paddles and leg bones. He estimated the length of *australis* as twenty-five feet, and at any rate it was a fairly large member of the Order. Later, in 1888, the late R. Etheridge, Junior, described *Ichthyosaurus marathonensis* from the same locality, his specimens consisting of parts of the upper and lower jaws. In 1922, Mr. H. A. Longman, Director of the Queensland Museum, described as *Ichthyosaurus australis* a large ichthyosaurian skull from rocks of the same age near Hughenden, Queensland, and suggested that *Ichthyosaurus australis* and *I. marathonensis* are identical.

It will be evident that so far the ichthyosaurian remains found in Australia are but meagre in quantity and by no means complete, but it is evident that these interesting reptiles did exist in the Cretaceous sea of Australia; and it is possible that more and better specimens may yet be discovered here.

Australian Shells

SLIT SHELLS AND FALSE LIMPETS

By Joyce Allan.

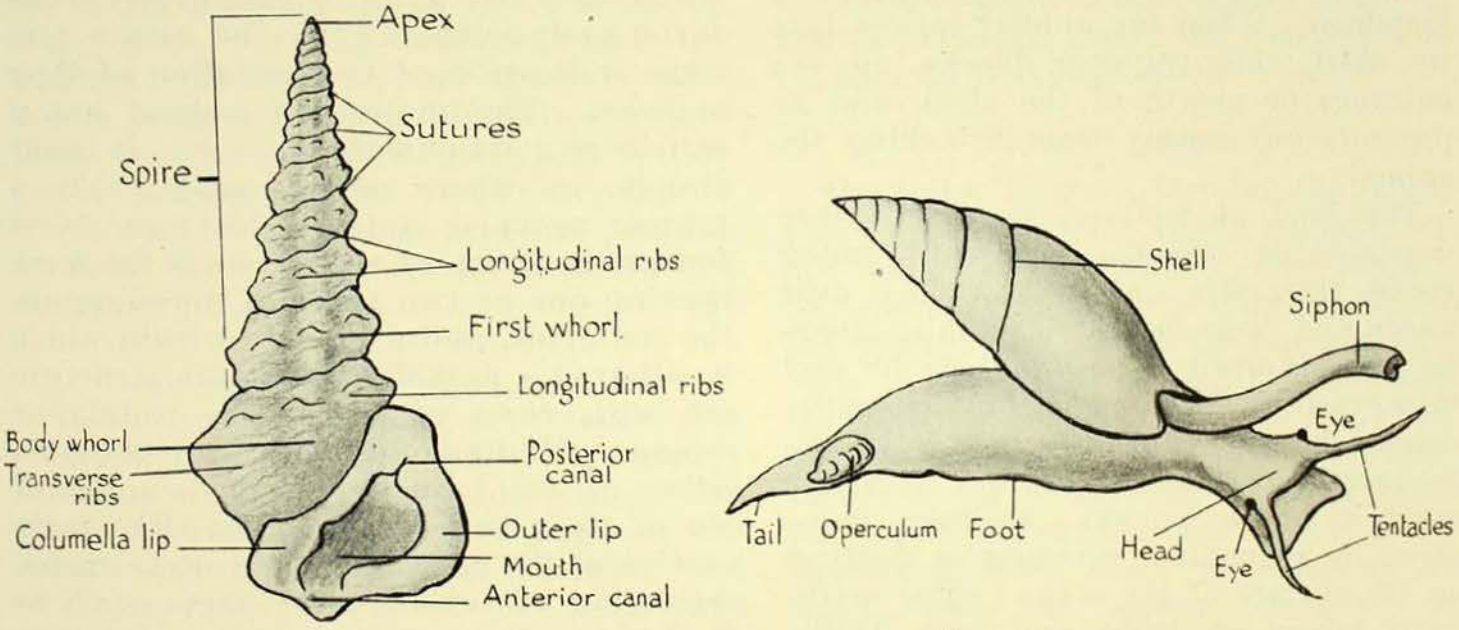
INTRODUCTION.

BECAUSE of their brilliant and lasting colours and pretty shapes, shells have been considered by people of all ages to be some of the most attractive objects in the world. Moreover, they are easy to collect, are not easily broken, and are not liable to decay, hence they make excellent objects for a collection. The best way to learn about shells is either to build up a collection for one's own use, or have access to someone else's, the former way being preferable, as it encourages individual collecting, with often valuable results.

Shells are found all over the world; along shallow shores and right down to the deepest parts of the great oceans, in freshwater streams and rivers, on land and on high mountain tops. The most beautiful in shape and colour, however, are found amongst the clear warm waters of coral reefs in tropical seas, and it is these which are usually found in the collections of amateurs. The size of shells varies considerably. Some are so tiny that a microscope is necessary to distinguish them, the largest being the Giant Clam, which may reach a length of several feet.

It must be remembered that a shell is only a part of a complete animal. It is really an outside protective covering of a soft bodied animal called a mollusc, such as an oyster or snail, but all molluscs do not have this external shell. Some are so formed, as the octopus is, that they do not need this protection, and their shell is therefore discarded soon after the embryo hatches, or is internal, as in squid-like and other animals; it may even be rudimentary, as in the sea-hares.

The shell is formed mainly of carbonate of lime, which is added layer by layer to the growing shell, and so long as the animal continues to grow it increases its shell correspondingly. When the animal



Topography of a univalve shell and animal.

reaches maturity, it is still able to repair any damage or breakages in the shell by adding more carbonate of lime.

In their everyday existence molluscs have to defend themselves against enemies as other animals do, and various devices are employed for this purpose.

Some have their shells ornamented with sharp spines, or covered with hairy or velvety growths, completely hiding the bright colours underneath. Many are able to camouflage themselves to such an extent that it is difficult to distinguish them from their surroundings; others, by giving off a fluid when handled or disturbed, can either make their escape under this cloud, or startle their enemies. On the foot of a great many of the molluscs is fastened an *operculum* or trapdoop. When the animal retires into its shell, this trapdoor blocks up the entrance or mouth of the shell, and so prevents any enemy from attacking the animal.

The food of molluscs may be either vegetable or animal. A great number spend their life quietly crawling over weeds and rocks in search of this, others lie in wait until it passes them by and then grasp it. With many, food is simply carried into the digestive organs of the mollusc by means of a current of water taken in by the animal. Molluscs move about by swimming, crawling or floating on the surface of the ocean; some settle when young on rocks and stay firmly fixed there, or burrow into the hardest sandstone, rock or wood, where they remain all their life. A great number burrow into sand and mud, and many fasten themselves by means of fine threads to rocks, other shells, or floating timber and wharf piles.

Shells have been used since very early days for ornamental purposes, and their animals as food and bait. Practically in every country of the world today either the shells are used in some way or the molluscs are utilized as food, especially in the Mediterranean and Asiatic countries.

Shells have their proper place in the animal kingdom, and are divided into classes, orders, families, genera and species as other animals are. The main groups are those consisting of a single valve or part, spirally coiled like the snail, the *univalves*; those with two valves joined together by a hinge at one end, like the oyster, the *bivalves*; the *multivalves*, Loricates or Coat-of-mail Shells, in which eight, sometimes seven valves, overlap one another and are held in place by a fleshy girdle. Then there are all those with no shell, an internal shell or a very rudimentary shell. These are usually spoken of as "naked molluscs".

THE MOLLUSCAN ANIMAL.

Though we know them familiarly only by the home which they make, and in which they live and die, the variety of the form and colouring of the shells give some indication of the variation of their makers. The molluscan animal has a structure particularly its own, in some simple, in others more complex. In a typical univalve animal this consists of four main parts, of which one is the head, bearing one or two pairs of sense organs, the tentacles, and a mouth, within which is situated a flexible ribbon-like structure set with rows of teeth, the radula or tongue. Rudimentary eyes are situated either at the base or on the summit of one of the pairs of tentacles. The main portion of the animal is the visceral mass, consisting of the internal parts, such as the kidney, liver and stomach. There is a two-chambered heart and a well developed nervous system. The ventral portion forms the foot, a thick muscular mass, which is the organ of locomotion. Finally, the greater part of the body is enclosed in a fleshy skin, the mantle, which lines the shell and which is responsible for its formation. In some shells this mantle can reach well beyond the shell, curling over its sides and almost completely enclosing it, as in the cowries. In the spire of the shell the mantle is attached to the body, but in the body whorl is free from it, and forms a thickened collar, fitting the shell mouth, and through the opening thus formed the foot protrudes. In aquatic forms water

is taken into the gill-chamber by means of the siphon, a tubular prolongation of the mantle, which fits into the anterior canal of the shell, and which must keep in contact with water to enable the mollusc to live. The gills extract oxygen from this water, and supply it to the heart. Waste water is then ejected through the siphon. Sense of sight is unimportant, but sense of touch is well developed in the mantle edge, tentacles and lips. The structure of bivalves and multivalves will be discussed when dealing with these groups later.

The Australian shells are particularly striking and interesting, especially those from northern Australia, and as many of them occur also in different islands of the south Pacific, make an interesting study both for the scientist and the amateur collector. There must be now nearly seven thousand different kinds of shells known from here alone, and in this and following articles it is intended to write of and illustrate as many as possible of those most likely to be found along the Australian coasts.

SLIT SHELLS.

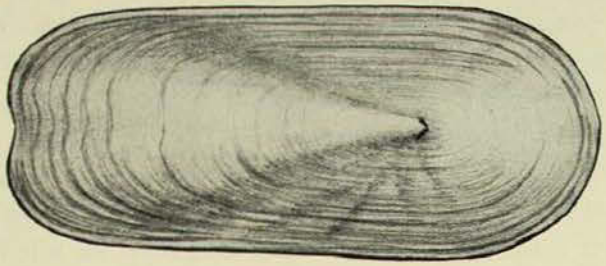
These form a group of very small, few whorled, thin univalve shells with pearly interiors and a conspicuous slit on the upper portion of the outer edge of the mouth opening. Owing to the small size of the Australian species, they need to be examined with a microscope to see the slit, which in the live specimens is occupied by the anal siphon. Slit shells form the family Scissurellidæ, live mainly on seaweeds in deep water, and are generally obtained by dredging, although some are occasionally found on beaches. There are four genera of slit shells in Australia, differing from each other chiefly in the fasciole slit. In the genus *Scissurella* the shells have small spires, large body whorls, rounded mouths and the slit fasciole extends nearly to the apex from the outer edge of the body whorl, with an upturned rim on either side of it. From the outer edge of the mouth for some distance back, in the adult specimens, the slit is open and is occupied by the anal siphon. In *Scissurona* the spire is elevated, the body whorl has an oval mouth, and the deep slit is well above the periphery of the shell. The shells of *Schizotrochus* are like those of *Scissurella*, but the slit is on the lower part of the whorl instead of on the upper. In *Schismope* the slit fasciole is shorter, extending for about one and a half whorls, and is enclosed except for the part on the outer edge, where the anal slit is.

Owing to the slit shells being rarely found on Australian beaches, only one species of the family has been figured. This is Atkinson's Slit Shell (*Schismope atkinsoni*), the commonest species of the genus *Schismope*. It is only about two millimetres high, is light brown in colour and is found all round the coast of Australia, except the far north.

FALSE LIMPETS.

The False Limpets, forming the family Fissurellidæ, are limpet-like animals, but are not closely related to true limpets. The shells usually have either a slit in the margin or a hole on the top, and have their apex slightly behind the centre of the shell. Many of the species are small, though some are large, and the family contains many well-known shells found on Australian shores. The animal is well developed, with short tentacles on the head, and the siphon occupies the marginal slit or the hole on the top. Most False Limpets live between tide marks, and are easily found. A few live in deep water and are rarely seen.

There are a number of genera in the family, the position and character of the slit being the main differences separating them, but only the chief ones are mentioned here. The genus *Scutus*, the shells of which are sometimes called Shield or Duck's Bill shells, includes the largest member of the False Limpets. The shell rests on the back of a large animal much bigger than it, and the mantle of the animal folds over the shell, almost completely covering it. Shield shells are found throughout Australia generally, mostly under stones between tides, and



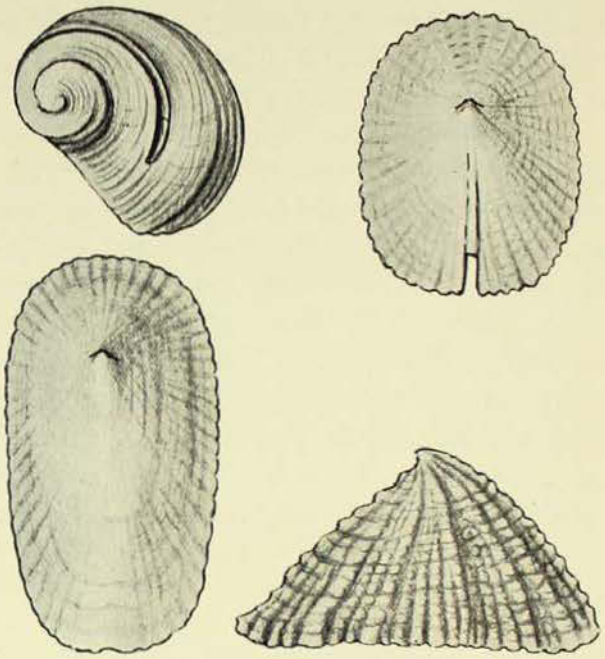
The Shield shell (Scutus antipodes) is carried on the back of a large black slug-like animal, the Elephant Slug. It is very common under stones at low tide along the coast of New South Wales.
[Joyce Allan, *del.*

the animal is often called an Elephant Snail. The common Sydney shell is white or pale buff, grows to about five inches long, is solid and heavy, and has a large black animal. A broader species than the Sydney one, *Scutus astrolabensis*, but somewhat resembling it, occurs in South Australia, and must not be confused with it. In northern Australia a smaller species than these two is easily distinguished from them because the surface is heavily sculptured with lines radiating from the centre to the margin. The posterior end is also broader than the anterior end and the inside is bluish. This species is called *Scutus unguis*.

In the genus *Tugalia*, white depressed shells, the anterior margin is slightly channelled, the surface finely sculptured and the apex is well back. Average specimens are between an inch and one and a half inches long, and they are found in New South Wales and South Australia. The Flat False Limpet is about an inch or more long and is one of the commonest found in the previously mentioned States.

The Cap-shaped False Limpet belongs to the genus *Montfortula*, in which the shells are cap-shaped, much elevated and have their apices near the middle of the shell and well curved backwards, is brown, and about three-quarters of an inch high, and is found in Queensland and New South Wales. It has the characteristic radiating ribs from the apex to the margin, and the anterior short marginal notch with an internal groove leading to the apex, characteristic of the genus. The genus *Montfortula* is found in tropical and subtropical seas.

The most commonly found species of the Notched False Limpets (*Emarginula hedleyi*) is a small, white, heavily cancellated shell about one-quarter of an inch in size, which lives in shallow water in New South Wales, Victoria and South Australia. Notched False Limpets, forming the genus *Emarginula*, are small shells with recurved apices and an anterior slit on the margin, which varies



Atkinson's Slit shell (upper left) is found round the Australian coast, except in the far north. False Limpets live between tide marks and are easily found. The three figured here are the Notched (Emarginula hedleyi), Flat (Tugali parmophodea), and the Cap-shaped False Limpet (Montfortula conoidea).
[Joyce Allan, *del.*

in length. The surface is cancellated by concentric lines running round the longitudinal ribs. They are found in shallow water to ninety fathoms.

A deep brown shell, with wide and narrow radiating bands of a deeper shade, and having an almost central opening, belongs to the Rayed Keyhole Limpets, or genus *Amblychilepas*. This genus, in which the shells are oblong and depressed, is found in southern Australia and Tasmania. The one figured has the surface covered with fine radiating striations and is about three-quarters of an inch long. It is found crawling about in shallow pools at low tide. The Pitted Keyhole Limpet (*Cosmetalepas concaten-*

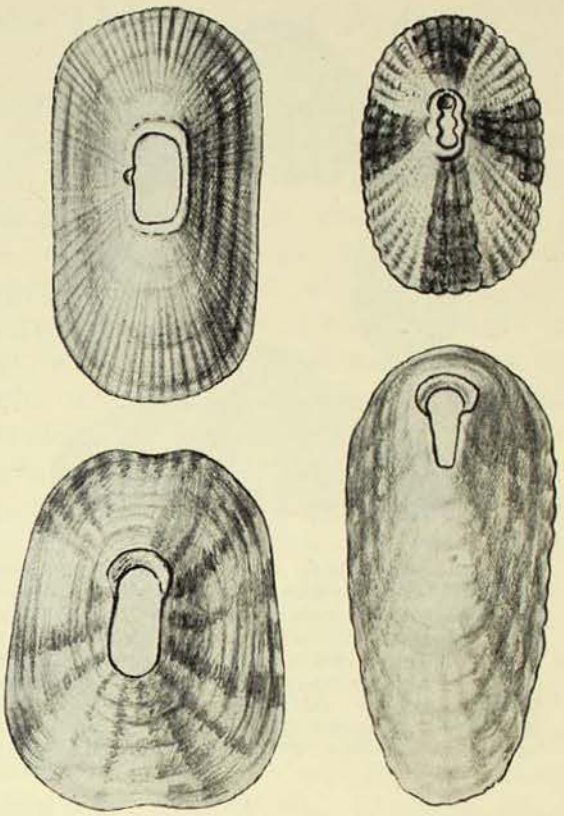
atus) differs from the above species mainly in the surface of the shell, which, instead of being rayed, is finely ornamented with small rounded pits.

Somewhat resembling the Rayed and Pitted Keyhole Limpets in shape, are the Calloused Keyhole Limpets, forming the genus *Sophismalepas*. In these the apex of the thick flattened shell is perforated by a large hole surrounded inside with a strong rounded callus. The shell is also finely cross-ribbed, and is much smaller than the large animal, the mantle of which however, does not cover the shell when the mollusc is crawling. The best known species is a blackish-brown one, with a very pretty rose-pink and white animal. When crawling about in shallow water the animal reaches to about twice the length of the shell, and has a yellow foot bearing numerous papillæ. The mantle does not cover the shell, but is produced into numbers of branched wavy processes which surround it. The shell grows to about an inch long, and is found living on the coasts of southern Queensland, New South Wales, Victoria and Tasmania.

There is another species of the genus *Sophismalepas, S. oblonga*, which extends from Western Australia round to Victoria, but up to the present it has not been recorded from New South Wales, Queensland or Tasmania.

The true Keyhole Limpets, genus *Fissuridea*, include some of the best known of the False Limpets, and are easily recognized by the opening in the shape of a keyhole on the top of the shell. They are usually more conspicuously marked than others of the family, and the surface is cancellated with intersecting lines. The anal siphon passes through the hole on the summit. Keyhole Limpets inhabit the seaweed zone, where they move actively about, but some live as deep as fifty fathoms. Young Keyhole Limpets are spirally shaped, with marginal slits, which become filled with shelly matter as the animal grows, and travel up the shell until in the adult specimens the holes reach the summits of the shells.

The True Keyhole Limpet is larger than most False Limpets, as an adult specimen may be two inches long. The shell is elliptic and elevated, sculptured with strong radiating ribs, with finer ones between them. The colour varies from white to yellowish-brown, and broad



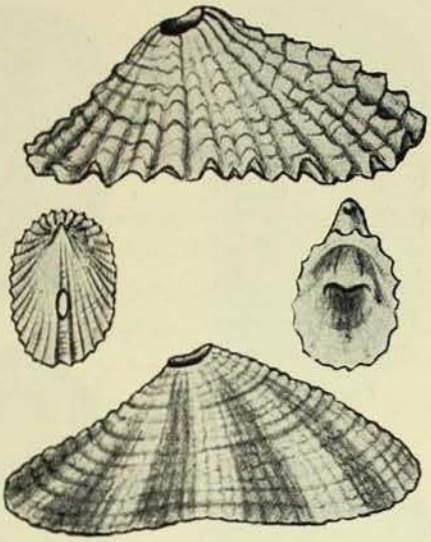
Openings, often keyhole shaped, characterize the Keyhole False Limpets. From left to right are the Calloused Keyhole Limpet (Sophismalepas nigrita), Cross Keyhole Limpet (Fissuridea quadriradiata), Rayed (Amblychilepas javanicensis) and Posterior Keyhole Limpets (Macrochisma tasmaniæ).
[Joyce Allan, *del.*

darker bands of colour extend from the apex to the margin. The hole in the apex of the shell is conspicuous. This species is found in southern Queensland, New South Wales and Victoria.

Juke's Keyhole Limpet (*Fissuridea jukesii*) is easily recognized on account of the strong radiating ribs sculpturing the shell. The deep interstices between these ribs are cut into deep pits by frilled concentric laminæ. The colour of the shell is whitish or speckled with blackish-brown, and the length is between an inch and an inch and a half. The species occurs in north Australia. The Cross Keyhole Limpet is a very pretty little

shell, about half an inch long, with four broad black rays forming a conspicuous cross against the white shell. It is found under stones at low tide in Queensland.

Posterior Keyhole Limpets, belonging to the genus *Macrochisma*, are easy to identify because of the small anal aper-



The upper and lower figures are, respectively, Jukes' Keyhole Limpet (Elegidion jukesii) and the True Keyhole Limpet (Elegidion audax). A perforation near the anterior margin of the shell distinguishes the small Fissure False Limpet (Rimula exquisita), and the Deck Limpet (Puncturella galerita) has a deck-like plate within the shell.
[Joyce Allan, *del.*

tures close to the posterior margins of the shells. They are found in warm seas in rock pools at low tide.

In southern Australia and Tasmania a Posterior Keyhole Limpet (*Macrochisma tasmaniæ*), with the posterior margin of the oblong shell strongly curved up, and the wedge-shaped opening much broader posteriorly than anteriorly, is often found. This shell varies from an inch to an inch and a half in length, and is whitish-yellow with irregular radiating ribs speckled with brown.

In the genus *Rimula*, or Fissure False Limpets, the shell is thin and cancellated, with a perforation near the anterior margin a little higher than in the Notched False Limpets. Several species are found in sandy mud in shallow water, or dredged in from ten to fifteen fathoms. A beautiful little shell of this genus is found in about 17-20 fathoms of water on the Queensland coast, is less than one-quarter of an inch in length, and is fawn coloured.

Small conical shells with a spirally recurved apex and with either a lanceolate or oval fissure on the front slope or the apex, form the genus *Puncturella*. Inside the shell is a plate extending forward and forming a deck-like structure. The surface of the shells usually shows minute granulation under a strong magnifying glass. The genus is mainly a deep-sea one, but odd shells are sometimes found washed up on beaches. Because of the deck-like plate inside the shells, they are known as Deck False Limpets. A microscopic species, between one and two millimetres in size, occurs in Queensland, and is pale buff or white coloured. Owing to its being a deeper water form and because of its small size, it is rarely found, but it is figured here in case readers may sometime possess one.

The Amazing Adventures of Billy Penguin. By Brooke Nicholls. (Angus and Robertson, Limited, Sydney). Price, 4s. 6d.

This entertaining little book for children tells the story of a small Golden-crested Penguin which made its way across the sea from the icy Southern regions to the coast of Victoria. Here he met the menfolk, and being a sociable little fellow, much petted by his captors, enjoyed himself immensely until, tiring of a life of ease, he set out in search of further adventures, eventually making the long and perilous journey back to his Antarctic home. The remarkable Mutton-birds, Killer Whales and other queer folk whom Billy Penguin encountered on his travels, all help to build up a tale of absorbing interest to grown-ups and children alike.

The book has been attractively illustrated by Dorothy Wall, whose decorations for her own story-books for children will be recalled with delight.

N.B.A.

Sir Tannatt William Edgeworth David,

K.B.E., C.M.G., D.S.O., M.A., D.Sc., F.R.S.,

Emeritus Professor of Geology in the University of Sydney.

BY the death of Sir Edgeworth David, which took place at Sydney, 28 August, 1934, Australia has lost one of its most distinguished and best loved citizens, and geological science one of its foremost students and exponents.

He was born in 1858, at St. Fagants, near Cardiff, Wales, the son of the Reverend William David, and was educated at Magdalen College School and New College, Oxford, of which he was Senior Classical Scholar. He came to Australia in 1882 as Geological Surveyor on the staff of the Geological Survey of New South Wales, and in that service he spent nine years, his most outstanding work being on the tinfields of New England and on the coal measures of Newcastle and Maitland.

In 1891 David was appointed to the Chair of Geology in Sydney University, and with characteristic energy and enthusiasm he devoted himself to teaching and other activities connected with the University. He was a most inspiring lecturer and teacher, as is evidenced in the splendid band of geologists, his old students, who now occupy prominent positions in Australia and elsewhere. He also took a leading part in University affairs, and was for eight years Dean of the Faculty of Science, twelve years Chairman of the Professorial Board, besides being a member of the Senate. He retired from the Chair in 1924.

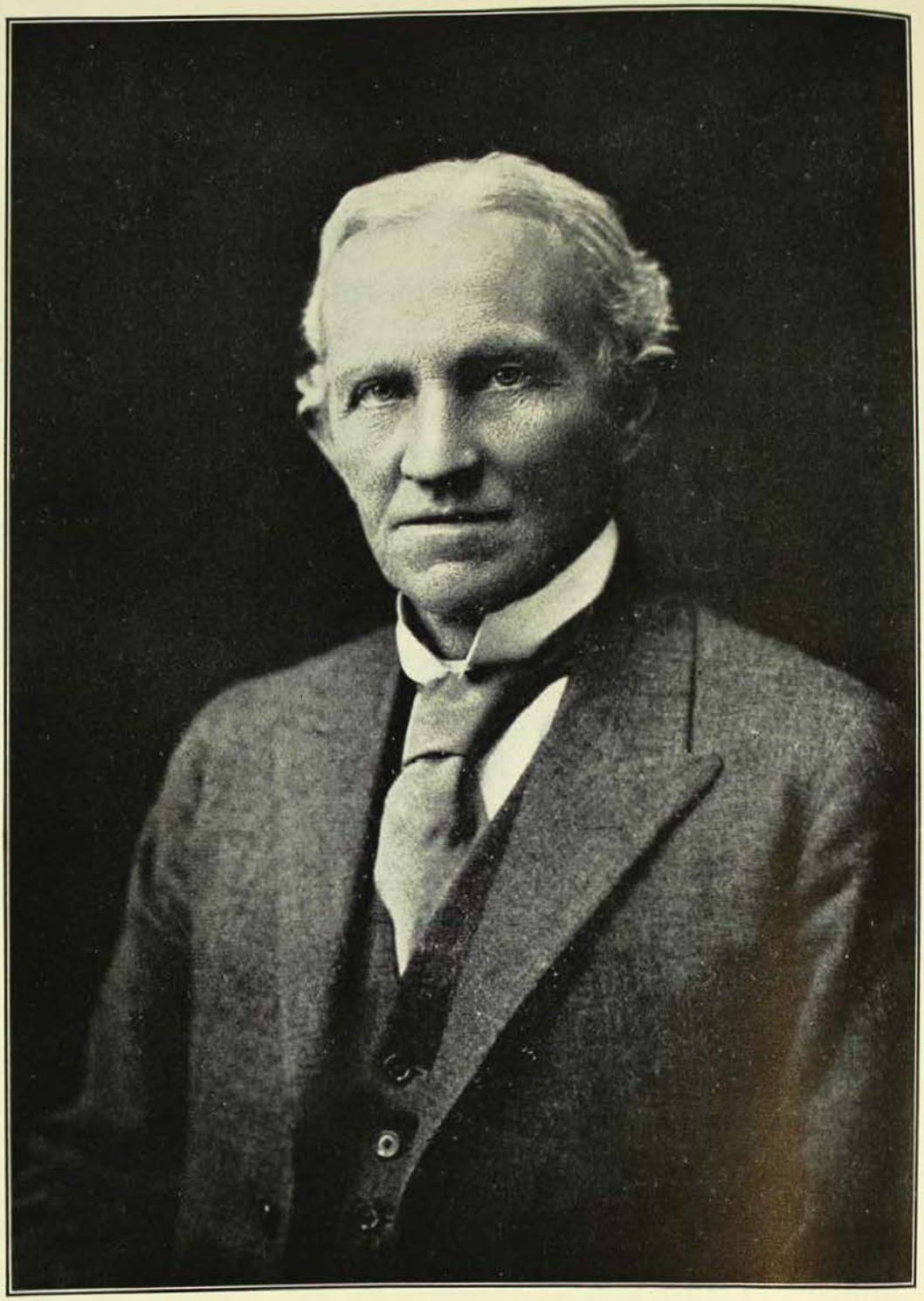
In geological exploration and research he was indefatigable, and his achievements in this field were acclaimed all over the world. He had a profound knowledge of Australian geology, to all branches of which he made notable contributions, and shortly before his lamented death he had published a splendid geological map of the Commonwealth, accompanied by descriptive notes which form the best short account of Australian geology. For some years he had been engaged in the production of a comprehensive work on the geology of Australia, and his whole thought and effort were given to this *magnum opus*, which, unfortunately, was left unfinished.

David had a decided taste for adventure, and was a noted explorer. In 1897 he led an expedition to continue boring operations at Funafuti, Ellice Group, to test the validity of Darwin's theory of coral atoll formation, and in 1909 he accompanied the late Sir Ernest Shackleton to the Antarctic. Though he was then at an age when most men would hesitate to face the arduous toil and rigours of Antarctic exploration, he played a man's part, and with Mawson and Mackay he made a long and toilsome sledge journey to the South Magnetic Pole, and he also led a party which made the first ascent of Mt. Erebus.

Again, in 1914, he felt the call of duty, and at the age of fifty-seven enlisted in the A.I.F., and served in France with the Australian Mining Corps, supervising tunnelling operations and subsequently becoming Geological Adviser to the British Expeditionary Force. While at the front he sustained severe injuries when he fell a distance of eighty feet down a shaft in the Messines sector, injuries from which he never fully recovered. For some time before his death he suffered acutely from rheumatoid arthritis, and was partially crippled, which must have been martyrdom to one of his active habit, but no word of complaint ever escaped his lips, and with heroic fortitude he carried

on his work as usual, making his way to and from the University with the aid of two sticks.

In addition to his University work, Sir Edgeworth took a leading part in the work of various scientific and other public bodies. He was President of the Royal Society of New South Wales in 1895 and again in 1910, President of the Linnean Society of New South Wales in 1893-94, and 1894-95, and at the time of his death was an active member of the Councils of these two Societies. He had twice been President of the Australian and New Zealand Association for the Advancement of Science, and was the first President of the Australian National Research Council. He was a Trustee of the Australian Museum from 1891 to 1924, and his services to the Museum were many and various. He was the recipient of many honours in recognition of his scientific work, including the Bigsby Medal of the Geological Society of London (1899), the Wollaston Medal of the same Society (1915), the Conrad Malte-Brun Prize of the Geographical Society of France (1915), the Mueller Medal of the Australian and New Zealand Association for the Advancement of Science (1908), the Clarke Memorial Medal of the Royal Society of New South Wales (1919).



T. W. Edgeworth David.

David was an accomplished scholar and linguist, with a profound and wide knowledge of the masterpieces of literature, both ancient and modern, and was

always ready to produce from his well stocked mind apt quotations from his favourite authors, and this ability greatly enhanced his charm as a lecturer, conversationalist and raconteur. He had a fund of humour, and was the life and soul of any gathering of which he was a member.

But aside from his eminence as a scientist and a scholar, he will always be remembered with deep affection by all who came under the spell of his personality for his fine human qualities, his courage, his kindly, generous, and unselfish nature, his innate modesty and his sympathetic interest in the struggles and work of others, whom he was ever ready to help out of the stores of his knowledge and experience.

His broadmindedness and high ideals were strikingly illustrated during the memorable meeting in Australia in 1914 of the British Association for the Advancement of Science. David was conversing with Professor A. Penck, when a pressman sought an interview. The subject of the Great War, which had just broken out, obtruded itself, and David, placing his arm round the shoulders of his German colleague, observed: "All men of Science are brothers." This remark so impressed the members of the German Entomological Society that, with David's name and the date, August, 1914, attached, it appears on the official correspondence and publications of the Society.

There have been and are scholars and scientists aplenty, but there was only one David; he was "a veray parfit gentil knight".

C. ANDERSON.

PHOTOGRAPHS OF NATIVE LIFE.

An attractive exhibit will shortly be installed in the Ethnographical galleries. It consists of two hundred carefully selected enlarged photographs of the natives of Australia, nomadic people who depend upon hunting for their subsistence, and of New Guinea, where the natives live in more or less permanent villages and cultivate crops. The two series thus form an interesting contrast of adaptation to differing environments, and illustrate well the retarding effect that long isolation has had upon the Australian aborigines.

The Australian series includes camp life, making and use of implements and weapons, hunting and fishing, navigation and dwellings, initiation and totemism, sorcery and burial.

The New Guinea series illustrates the daily round of tasks that occupy the natives, such as gardening, fishing, house-building, the making of weapons and pots, and other domestic gear. Villagers may be seen engaged in festival preparations, making gifts to their trading partners, and taking part in tribal ceremonies.

These action photographs will enable visitors to view aspects of native life which could not be revealed in any other way. Moreover, the weapons, utensils, ornaments and other objects displayed in our cases may thus be seen in their proper setting.

A large number of the photographs were secured by research workers in anthropology of the Australian National Research Council, to whom we are indebted for the use of the negatives. Our thanks are also due to Dr. E. A. Briggs, Captain F. Hurley, and Mr. G. Aiston, for the splendid series of photographs which they have made available.

Locusts and Grasshoppers

By NANCY B. ADAMS.

THE terms "Locusts" and "Grasshoppers" are very frequently incorrectly used, since some confusion exists regarding the difference between the two groups of insects. They belong to the same Order—the Orthoptera—but the Locusts are members of the Family Acridiidæ, while the Grasshoppers belong to the Family Tettigoniidæ.

A typical locust has straight narrow forewings which cover and protect the gauzy hindwings when at rest. Its antennæ are short and stand out in front of the head like little horns. The body is short and cylindrical, and in the female four horny plates are found at the posterior end. By means of these plates little circular holes are cut in the soil and the eggs are deposited in groups in these holes.

Each batch of eggs is covered with a frothy mass which dries quickly and forms a papery covering which protects the eggs from moisture and changes of temperature. In the case of the Plague Locusts enormous numbers of eggs are laid close together in hard bare patches of ground, and when the young ones emerge they remain in swarms. These baby locusts are somewhat similar in form to the adults, but are wingless. As they increase in size they shed their outer skins, until after a series of about six moults their wings are completely developed and maturity is reached.

The males are furnished with a simple sound-producing apparatus consisting of a row of pegs on the inner side of the hind thighs, and a series of veins or ridges on the outer surface of the forewings. The familiar chirruping of the locust is caused by the insect rubbing its legs against its wings. Two little ears are found, one on each side of the body.

A typical grasshopper has long slender flexible antennæ, and the female has a long sabre-shaped ovipositor. The eggs are placed in rows on twigs and grass-stalks, to which they are attached by means of a sticky substance. The young ones develop in a similar manner to the locusts, but they never occur in swarms, and are usually found in pairs living in long grass or trees. The sound is produced by the males by means of a file on the left wing-cover working under a rasping edge on the right wing-cover. The ears are generally found on the forelegs just below the knee.

PLAGUE LOCUSTS.*

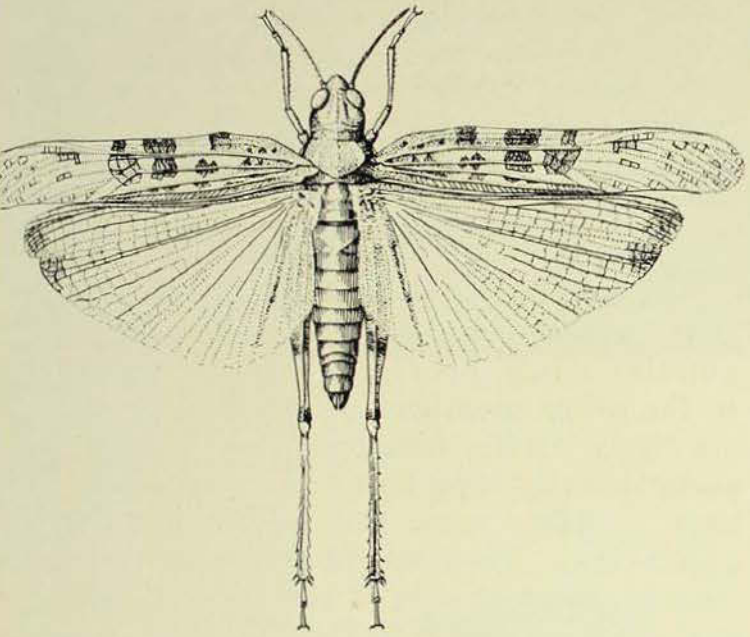
Locusts are widely distributed throughout the world, and from Biblical times have been recorded as occurring at intervals in countless numbers. That they were recognized as a scourge is evident from their inclusion in the Ten Plagues of Egypt.

The commonest Plague Locusts in Australia are *Chortoicetes pusilla* and *Calataria terminifera*, which are closely related to those mentioned in the Bible. *Chortoicetes pusilla*, sometimes known as the Small Plain Locust, varies a little in size. The male is usually one inch to an inch and a half in length, bright yellow mottled with brown, the forewings finely marked with black. The delicate semi-transparent hindwings are banded along the outer margins with black and the tips are light brown. The gauzy inner surfaces of the wings are sometimes faintly tinged with blue. The female is a little larger, more subdued in colour, and her brown

* A short account of Plague Locusts, by Mr. G. H. Hardy, will be found in AUSTR. MUS. MAG., I, 4, 1922, p. 120.

markings are darker than those of the male.

Calataria terminifera, popularly known as the Larger Plain Locust, is light brown mottled with dark, the markings being particularly distinct along the front margins of the forewings, where they form an irregular row of spots. The hind shanks are bright red.



The Larger Plague Locust (Calataria terminifera).
[Nancy B. Adams, *del.*

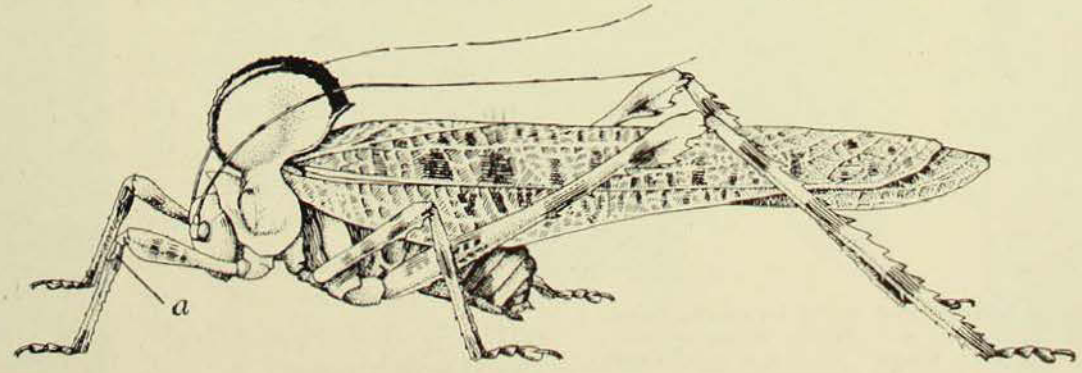
These two species of locusts are extremely destructive, and each year cause an incredible amount of damage. Sometimes particularly favourable climatic conditions and an absence of natural enemies cause them to increase rapidly, until vast armies are congregated round the hatching grounds. Having exhausted the food supplies near by, the young wingless hoppers advance in alarming masses, devouring all leaves, grass, and young plants, and leaving behind them a barren waste stripped of every vestige of vegetation. When fully developed they are equally destructive. The winged hordes darken the sky as they approach in thousands, descending to feed when inviting fields are found, making the world a nightmare filled with their moving bodies. When they rise in clouds and fly to fresh feeding grounds they leave the earth barren and desolate.

The following results of investigations by the Department of Agriculture of the locust plagues of last season are interesting. The first main brood hatched out in December, 1933, within the Warren and north of Tottenham areas, and also between Condobolin and Forbes. The hatching beds were distributed over an area of 522,240 acres. The second brood hatched between middle and late February, the area of beds being spread over 2,944,000 acres. The area affected by this second swarm was calculated at 21,000,000 acres severely damaged, and 11,750,000 acres moderately damaged. The total grazing loss from these areas was estimated at £2,687,000 plus the cost of hand-feeding stock, while the total wheat loss was calculated at £920,500.

There are many species of locusts which never occur as plagues, and one of the most interesting of these is *Coryphistes cyanopterus*, which is often found resting on the trunks of trees in open forest country. It is greyish-brown, with the wing-covers mottled and the head and thorax roughened to resemble bark, so that it is an excellent example of protective resemblance.

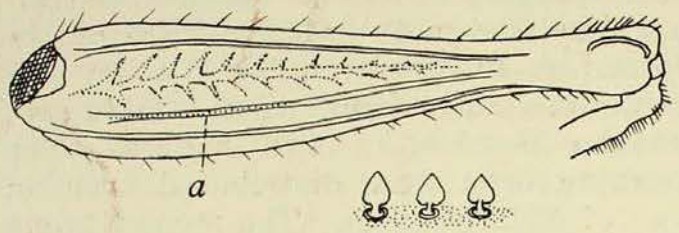
GRASSHOPPERS.

Among the grasshoppers are found an extraordinary variety of habits, and since



The Crested Grasshopper (Alectoria superba). a, ear.
[Nancy B. Adams, *del.*

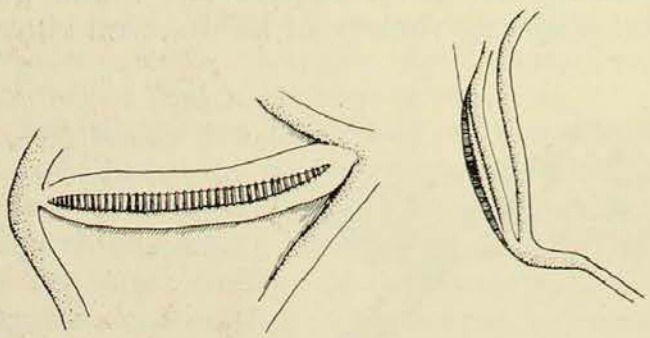
each member is specially adapted to its mode of life, an equally large diversity of form. One of the most striking is the Crested Grasshopper (*Alectoria superba*). It is a long slender insect, pale green, mottled with dark brown. Its thorax is decorated with a circular crest edged with red, and on each side of the thorax below the crest is a sharp spine. It is rarely found in the neighbourhood of Sydney, but is quite common in the dry west.



Hind-femur of an Acridiid. a, rows of pegs, three of which are shown greatly enlarged.
[*After* A. D. Imms.

The Mountain Grasshopper (*Acridopeza reticulata*) shows a wide difference between the male and the female. The former is long and slender, dark brown, irregularly marked with deeper brown, while the female is short and stout and has no wings. Her wing-covers are curved so that they fit closely over the body, and are crumpled so that they look like little dry leaves. When disturbed, the female stands on tip-toe and raises her wing-covers to disclose bright red, white and blue stripes on her body beneath, and if she is particularly agitated a little vivid orange collar is puffed out round the base of the neck. When her peace of mind is restored, the collar is withdrawn and becomes invisible.

One of the commonest members of the Family Tettigoniidæ is *Paragryllacris combusta*, a large brown Grasshopper with very long antennæ. It stays in hiding during the day, usually taking refuge in crevices in the bark of trees. It frequently comes into houses at night, and wanders about over the furniture.



Sound producing apparatus of a Grasshopper. Left: Lower surface of left wing-cover, showing file. Right: Upper surface of right wing-cover, showing scraper.
[Nancy B. Adams, *del.*

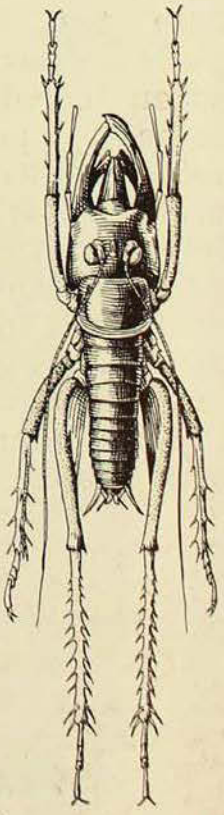
Cædicia valida, which is one of the most beautiful grasshoppers, is also one of the most destructive. It is a clear pale green, the wing-covers beautifully shaped and veined to resemble leaves. It is a nuisance to orchardists, for it eats large pieces of rind from fruit, leaving unsightly bald patches.

"CAVE LOCUSTS."

The "Cave Locusts", which are really true grasshoppers in spite of their popular name, provide a striking contrast to the other members of the family. They are ugly little wingless creatures with exceptionally long legs and antennæ. They have neither ears nor sound-producing apparatus. They spend their entire lifetime in the darkness of the caves, an eerie and unwholesome existence compared with that of their relations, who seem to be so essentially connected with the trees and sunshine.

The largest member of the Family Tettigoniidæ is the so-called King Cricket (*Anastostoma australasiæ*), found in New South Wales and Queensland. It is a large dark brown insect with an enormous head and very powerful jaws. Like the Cave Locusts, it is wingless.

The cicadas, which are also commonly referred to as locusts, do not belong to either of the families Acridiidæ or Tettigoniidæ, but are members of an entirely different Order, the Hemiptera.



The Large King Cricket (Anastoma australasiæ).
[Nancy B. Adams, *del.*