

The AUSTRALIAN MUSEUM MAGAZINE

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



Australian Wild Life.

Attack and Defence Among the Insects

Keith C. McKeown

Some Ground-Dwelling Birds. Part I.

K. A. Hindwood, R.A.O.U.

Queen Nefertiti - - - - - *W. W. Thorpe*

Some Furred Natives of Our Coastal Region

A. J. Marshall, R.A.O.U.

Skates and Rays - - - - - *G. P. Whitley*

Aboriginal Flaked Implements - - *W. W. Thorpe*

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Bust of Queen Nefertiti. This beautiful cast, the only one in Australasia, was recently presented by Mr. Ernest Wunderlich, F.R.A.S. It forms one of the Museum's most interesting Egyptological exhibits. See page 270.

[Photograph by courtesy of *The Sydney Morning Herald*.]



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VOL. IV, No. 8.

OCTOBER-DECEMBER, 1931.

Australian Wild Life

THE discovery of a new continent naturally gives a great stimulus to zoological exploration, for institutions and investigators are of course eager to obtain and study the strange animals which excited the wonder of the first explorers of the new land. Australia, with its peculiar animals and plants, was, a hundred or more years ago, a veritable treasure house for the collector, and it has been said that the rapid growth of natural history museums in the English-speaking world in the early years of last century was largely due to the voyages of Captain Cook.

The Australian fauna has retained its interest for the scientist ever since, chiefly because of the primitive character which it possesses as a result of the long isolation of our island continent. The platypus and echidna, the marsupials, and other members of the Australian fauna, terrestrial and marine, are of exceptional interest scientifically. Hence we can readily understand why scientific institutions abroad are eager to acquire speci-

mens from our country for exhibition in their museums and study in their laboratories.

At the present time a party of American zoologists from the Museum of Comparative Zoology, Harvard University, is in Australia for the purpose of obtaining examples of its fauna for exhibition and study. The party is under the leadership of Dr. W. M. Wheeler, the eminent entomologist and authority on ants, and it is expected that the members will spend twelve months in Australia, collecting and observing. This is not the first occasion on which American collectors have visited Australia, for in previous years we have had Mr. C. H. Hoy, of the U.S. National Museum, Dr. W. K. Gregory and Mr. H. C. Raven, American Museum of Natural History, Dr. H. Lyman Clark, Harvard University, and others; and to all we have extended a hearty welcome and given whatever help was possible. For we realize that science knows no frontiers, that the work of our visitors has a stimulating effect on Aus-

tralian endeavour, and that we benefit immensely by contact and conference with colleagues from other countries. The isolation of Australia is still a factor in our life, and though we may say that we are severed from the world

By Nature's wise indulgence,

this insularity has its dangers and may beget insular ideas.

Fears have been expressed that intensive collecting for museums may result in serious depletion of our indigenous animals. With reference to the present American expedition, a writer in *Nature*, a leading British scientific journal, says: "We wonder how long the rare animals of the world will survive the tax of scientific collecting expeditions, and when the museum scientific worker will act on the principle that more is to be learned by studying creatures alive in their native haunts than by measuring their skins in a laboratory. We trust, in any case, that Australia will see to it that the 'bag' of the really rare creatures is strictly limited; for a bird in the bush in such a case is worth two in the hand."

It is doubtful, however, whether collecting for scientific purposes is really a menace to the fauna of a country as extensive as Australia, where settlement in many areas is still sparse. The collector has to skin and preserve his specimens with great care, and make measurements and copious notes, so that his "bag" is limited willy-nilly, if the best results are to be obtained. Moreover, most scientific collectors possess consciences, and, legislative restrictions aside, do not kill more animals than they require. The hunter and trapper, however, to whom skins are merely articles of commerce, has no such scruples, and even a short open season, such as is now and then declared in various Australian States, does incomparably more damage to the animals concerned than the efforts of scientific collectors spread over many years. It has been stated on good authority that in one open season in Tasmania, which is a comparatively small State, over one million

possums and wallabies were trapped, and in 1919-1920 no fewer than 5,250,000 possums and one million native bears were slaughtered in Queensland. In comparison with these appalling figures, all the examples of these animals preserved in the museums of the world constitute but a drop in the bucket.

There is a danger, however, that, owing to the activities of collectors from other countries, the types of new Australian species may find their way into overseas museums, with the result that they will not be available for examination by local workers. This can be obviated by a stipulation that the types of any new species are to be deposited in some Australian museum, and there is a Federal ordinance to that effect. Our most recent visitors have undertaken to leave in Australia examples of any new forms discovered by them, and, if this is done in all cases, the interests of Australian zoology will be adequately safeguarded.

The chief sentiment inspired in us by the visit of six American zoologists, who expect to spend twelve months collecting in Australia, is one of envy. We should deem ourselves fortunate if we were in a position to maintain even one collector in the field in our own State for a like period. We are told that the American expedition has been rendered possible by the generosity of a wealthy citizen of the United States. We offer our homage and congratulations. Unfortunately, such citizens are much rarer in this country, though it is true that from time to time public-spirited Australians have financed scientific expeditions, as in the case of the Elder and Horn expeditions to Central Australia. Monetary help on a smaller scale has more than once been given to this Museum to enable field work to be undertaken, and we are exceedingly grateful for such assistance. Generally speaking, however, what collecting has been done by the Australian Museum has been at the cost of its own slender resources, and often at the expense, wholly or partially, of the officers themselves.

Attack and Defence Among the Insects

BY KEITH C. McKEOWN.

THROUGHOUT nature all creatures are engaged in constant warfare, and most animals spend a great part of their lives in the endeavour either to eat some other animal or to escape being eaten. The chief enemies of insects are the birds, without whose efforts in this direction the world would shortly be overrun with such myriads of pests that no green thing would be left. Reptiles and amphibians also play a part in this control. Even the insect world itself is divided, as it were, into two camps, the vegetarian and the carnivorous, and in the case of those insects which prey upon their fellows, they may be divided for convenience into parasites and predators. The term "parasite" literally means "one who eats at the table of another," but we may define a parasite, for our purposes, as an insect which lives at the expense of its host. A "predator" is one which preys directly upon another. These predators may be either active or passive; a dragon-fly hawking for mosquitoes is an active predator, while the larva of a tiger beetle entrenched within its burrow, with only its horny head exposed, waiting like some insect Micawber for such insects as may pass within reach of its formidable jaws, may, perhaps, be classed as a passive predator.

Innumerable devices have been evolved to facilitate the constant struggle for survival in the face of such an array of foes, and chief among them may be mentioned, (1) to be distasteful, (2) to look distasteful, (3) to escape observation, and (4) to frighten enemies. There is a certain amount of overlapping in such a classification, but it will serve our purpose.

WARNING COLORATION.

Most of the aggressive or distasteful insects possess warning coloration; that is, they are strikingly or brightly

coloured, in contrast with those which are protectively coloured, as in the case of the larvæ of the Common Wanderer Butterfly (*Danaïda archippus*), which is prominently marked with cream and



The larvæ of the Steel-blue Sawfly (*Perga dorsalis*) which drive away parasitic wasps and flies by ejecting a strongly smelling fluid from their mouths.

[Photo.—K. C. McKeown.]

black. This caterpillar is rendered unpalatable by a strongly smelling fluid discharged from two evertible glands, situated behind the head; these are turned inside out much in the manner of a finger of a glove, when the insect is disturbed, and the odour liberated to the discomfort of the attacking foe.

Coloration at the one extreme serves to break up the apparent mass of the wearer and protectively obscure it, while at the other it invites attention as some glaring

label, which would denote danger to the consumer of the object bearing it, as in the case of a brightly coloured "Poison" label upon a bottle. An inexperienced creature tasting it would be impressed more by the coloration than by the size of the label. A bird does not instinctively avoid distasteful insects, but learns to discriminate wholly by experience. Imagine some young, innocent, and wholly inexperienced bird seizing upon some brightly coloured insect having a nauseous and acrid taste—ever after it will associate the effects with the colour and avoid it, so that from the point of view of the survival of the insect, although the individual is destroyed, the race will benefit by the accruing protection in the long run.

Perhaps the best defended insects are those which carry poisoned daggers, as in the case of the wasps and hornets, most of which wear the danger signal of bright red and black, which shows a pursuer at a glance that they are not to be tampered with.

As Miss E. Cheesman has said: "Ants especially are emboldened by the power to punish—possessed to a formidable degree by some of the ant races—by biting, stinging or shooting out evil smelling fluids. Confidence in their united powers of defence results in a brazen insolence which refuses to consider anything too formidable to attack." The "brazen insolence" of the common Bulldog Ant (*Myrmecia gulosa*) of our bush is too well known, in more ways than one, to require more than passing mention.

Many quite harmless insects have acquired a certain immunity by disguising themselves in the livery of the dagger bearers, and a number of longicorn beetles bear a very close resemblance to wasps; while certain of the Hawk-moths



The nest of the Green Tree Ant (*Ecophylla smaragdina* var. *virescens*).

[Photo.—Chas. Barrett.]

(Sphingidæ) have developed clear scaleless wings, and, with their bodies brightly banded with colour, their whole appearance is distinctly formidable.

The familiar ladybird beetles also wear the distinctive black and yellow coloration, and they are rendered unpalatable by secreting an acrid yellow fluid from the joints of the legs. The common Pumpkin Beetle (*Aulacophora hilaris*) is also distasteful to birds, and is similarly coloured. The Cantharid or blister beetles, well known in medicine, produce a caustic fluid capable of producing severe blisters should it come in contact with the skin; these insects are closely mimicked by the members of a distinct family, the *Lampyridæ*.

The curious Mountain Grasshopper (*Acripeza reticulata*) seems to carry danger signals also. The male is a typical long-horned grasshopper, slender and provided with well-developed wings: the female, on the other hand, is a curious stunted-looking creature, wingless, and furnished with a short, rounded body, banded with red, white and blue, covered with a pair of short, deeply hollowed, shell-like elytra. When disturbed, she stands upon tiptoes and, arching her

body, raises her elytra and displays all her colours, which have until this moment been concealed. This display is almost certainly of a warning nature, but accurate observations in the field are necessary as to the actual unpalatability of the insect.

Some of the Reduviid bugs are warningly coloured, and are armed with a stout beak or rostrum, which is capable of inflicting a painful poisoned wound if carelessly handled. Although coloured an olive drab, the Giant Water-bug (*Lethocerus indicus*), which is sometimes attracted in large numbers to the electric lights in the city on hot summer evenings, can also stab deeply; it is capable of killing comparatively large fish and frogs and sucking their blood. Among the water-bugs, the so-called water-scorpions somewhat resemble mantids in form (a curious case of convergent evolution), and are veritable tigers of the under-water world, preying upon the defenceless larvæ of other insects.

UNPLEASANT HABITS.

A Reduviid bug from Sumatra, the Feather-legged Bug (*Ptilocerus ochraceous*), has been recorded as possessing habits perhaps as curious as those of any insect. The bug preys upon ants, and is provided with a gland upon the thorax which secretes a fluid attractive to them. The ants assemble in large numbers to feed upon the secretion, which appears to intoxicate or drug them, for they soon become comatose, when their juices are sucked at leisure by the bug. Australia possesses several species of closely related Feather-legged Bugs, which are usually found under bark or stones; nothing appears to be known about their life history or habits, but they should afford a most interesting study to anyone who has the opportunity of investigating them.

Many of the plant bugs are protected by giving off evil smells when disturbed, and some of these insects are brightly coloured. The small, green, gauzy winged lace wing, with the bright golden eyes,

which is attracted to the light on summer evenings, is a particularly skilled exponent of this method of defence. Some of the carab beetles are capable of making themselves unpleasant in a similar manner, while the Bombardier Beetle (*Pheropsophus verticalis*), found under damp logs, is justly famous, for, when disturbed, it produces a visible cloud of acrid gas accompanied by a quite audible report.

The well-known larvæ of the Steel-blue Sawfly (*Perga dorsalis*), stout, black, spiny grubs, which cluster in repulsive masses on the eucalypts, drive off parasitic wasps, when they attempt to deposit their eggs upon them, by raising the head and tail and discharging a yellow fluid, smelling strongly of eucalyptus oil, from their mouths with excellent aim at their attackers, putting up such an effective barrage that their enemies are frequently repulsed without having effected their purpose.

Many caterpillars are hairy, and in some species these spines have a tendency to pierce the skin, break off, and, being barbed, create painful wounds. In the case of the Cup Moth (*Doratifera vulnerans*) the larvæ have the spines set upon tubercles, and they are erectile at the will of the insect, the tubercles, when the spines are elevated, looking like so many miniature sea anemones. These curious slug-like larvæ are commonly found defoliating eucalypts, and make their presence felt should they come in contact with the skin, as many a gatherer of gum-tips has learned.

The caterpillars of the Vine Moth (*Agarista glycinæ*) are moderately hairy, but they also seem to possess other qualities which render them unpalatable to most birds; the cuckoos, however, feed upon them as upon other hairy larvæ, having their stomachs especially designed for the reception of such bristly meals. Cuckoos form almost the only means of keeping the balance of Nature in the case of many moths with hairy larvæ, and without them it is probable that these insects would increase beyond all bounds. This balance of Nature is complicated and has

been compared to a chain of many links, but an intricate net would perhaps better describe it. How intricate it is may be illustrated by the justly famous example cited by Charles Darwin. Leaving out the intermediate links of the chain, or meshes of the net, it may be said that the amount of clover seed produced in any district depends on the number of cats, which sounds ridiculous. Clover, in England, is pollinated by Humble Bees. "The number of Humble Bees in any district depends in a great measure on the number of field mice which destroy their combs and nests. Now the number of mice is largely dependent, as everyone knows, on the number of cats. . . . Hence it is quite credible that the presence of a feline animal in large numbers in a district might determine, through the intervention, first of mice, and then of bees, the frequency of certain flowers in the district."

ARMS, ARMOUR, AND FORTRESSES.

Many of the beetles, especially the weevils, have hard integument, and are in some cases armoured with blunt spines or tubercles; these may possibly detract from the digestibility of the insect, although the evidence on this point cannot yet be considered conclusive. Weevils are also endowed with the protective habit of shamming dead, and, when disturbed, will immediately relax their hold upon the plant on which they may be feeding and drop to the ground, where they remain motionless for a considerable period until all danger has passed. This action appears to be quite a reflex one and outside the direct control of the insect itself; but its protective value is undoubted, as anyone can dis-

cover for himself by searching for a weevil on the ground while it is shamming death.

From actual unpalatable examples we may pass to those insects which, otherwise attractive to birds and predatory insects, construct what may be described as artificial defences of extraneous matter. The larvæ of caddis flies construct silken cases for themselves, covering them with sticks, stones and other materials, often of considerable weight, and frequently bearing a close resemblance to snail shells and other natural objects. In spite of these defences, trout devour caddis larvæ with apparent



The nest of the Milk Termite (*Coptotermes lacteus*), a veritable fortress of clay and triturerated wood for the protection of its inhabitants.

[Photo.—K. C. McKeown.

satisfaction, cases and all, without visible symptoms of indigestion—a practice which might be compared to eating oysters without removing them from their shells. On land, these caddis cases are paralleled by those of the Case Moths (*Psychidæ*), which cover their tough silken cases with closely fitted sticks and leaves, these they carry about with them throughout their lives, adding to them as they grow, and finally pupating in them. Such cases prove an effective defence against the attacks of most insectivorous birds, but seem to offer little protection against

parasitic wasps and flies, for the case moths suffer seriously from the ravages of these enemies.

The soft-bodied aphides enlist the services of a standing army of ants, which, bribed by the sweet honey-dew they secrete, provide a most efficient defence against intruders, biting and stinging as fiercely as though in protection of their own kind. The defensive measures provided by the ants are extended yet further, for the ants, in some cases, even build shelters of wood and soil fragments over their feeding "cows," the aphides, and post a strong guard at the entrance to

Stout silken community nests are also constructed by the Processionary Caterpillars; they shelter in these by day, leaving them by night to feed securely in the absence of their enemies. Although these caterpillars are covered with a thick coat of irritating hairs, they have elaborated an additional defence in the form of their stout silken fortress. The nests in themselves are very unpleasant objects to handle on account of the mass of loose discarded hairs interspersed through the rubbish which fills the silken bag. Aborigines will not sleep under a tree in which there is one of these nests for fear that it will fall upon them while they sleep, and that they will be blinded by the spines.

The larvæ of some beetles (*Cassides*) cover themselves with excrement, while those of several species of lace wings (*Chrysopa*) disguise themselves with the skins of their victims from which they have sucked the contents—as though a Red Indian were to adorn himself with scalps.

The white ants or termites erect veritable fortresses of clay and triturated wood, which are practically impregnable. These nests range from examples only an inch or so in height to the immense mounds

found in northern Australia. The worker termite is entirely defenceless, but the soldier, upon whom devolves the duty of defending the nest, although soft bodied, has the head armoured, and in some species there are formidable sabre-like jaws, or the head is produced into an awl-shaped beak. In the case of the common termite found in the bush in the vicinity of Sydney (*Coptotermes lacteus*), which constructs quite large nests, the soldier is capable of directing a jet of milk-like fluid from an orifice in the forehead, which produces evident discomfort in the attacking foe. Although blind, the worker and soldier termites are extremely sensitive to light, and, should the wall



The Spiny Leaf-Insect (*Extatosoma tiaratum*) among foliage; an almost perfect example of protective mimicry.

[Photo.—K. C. McKeown.]

repel invaders. The Green Tree Ants (*Ecophylla smaragdina* var. *virescens*) of northern Australia build themselves nests among the branches, of leaves woven together with silk produced by the larvæ, which are used by the workers in the manner of living shuttles. These ants have the unpleasant habit of dropping from their nests down one's neck, while one is forcing a way through the scrub, and biting savagely. They have an efficient system of guards both for attack and for defence, as may well be seen in the case of a fallen nest, when some of the ants will be seen to ring the nest round, while others skirmish about in search of the enemy.



The Great Brown Phasma (*Acrophylla titan*), which so closely resembles a dead branch among the foliage it frequents as often to escape detection.

[Photo.—K. C. McKeown.]

of the nest be breached, the workers promptly retire, while the soldiers immediately fill the breach with a living rampart of armoured heads and bristling jaws, giving way only to permit the passage through their ranks of a worker with a load of clay to repair the damage, and this will continue until the hole is completely closed; final repairs will be effected under cover of darkness.

PROTECTIVE COLORATION AND SIMULATION.

We now come to what is perhaps the most fascinating aspect of our subject—that of protective coloration or camouflage. We are all familiar with the term “camouflage” since it came into popular use during the war. Camouflage is to all intents and purposes pure bluff—to look like something which you are not is its object, as, during the war, ammunition dumps and gun emplacements were disguised as ploughed fields or similar innocent things, while, at the other extreme, logs were made into dummy guns to deceive aerial observers. Then there was the “jazz painting” of ships, which may be described as disruptive coloration, breaking up the mass and making the vessel look, when at a distance, like anything but a ship. This form of coloration was employed by the zebra and the Privet

Hawk-moth (*Psilogramma menephron*) larva long before man ever thought of using it in warfare. The caterpillar of the Privet Hawk-moth, with its striking pattern of stripes of green, white, and lilac, is surprisingly hard to detect, in spite of its bulk, when motionless among the foliage of its food plant. All classes of camouflage are to be found among the insects.

Camouflage may be classed as “aggressive” or “protective”; aggressive, where it aids an insect in stalking its prey; protec-

tive, where it enables its wearer to escape detection. But it may even effect a dual purpose, protecting a creature from its enemies while aiding it in the capture of its food.

The praying mantis is a fine example of the “aggressive”; for, coloured like the surrounding leaves, it is enabled to creep unseen upon its prey. It moves cautiously forward, scarcely placing one foot before the other, like a cat stalking a mouse, until the luckless insect is within reach of the spined forelegs, and then it is usually too late for escape. The female mantis is notorious for her habit of making a wedding breakfast of the male, but this hardly comes within our scope, as it is perhaps purely in the nature of a domestic difference between husband and wife.

Among the tropical forms are the flower-like mantids, some of which closely resemble orchids and other flowers. Resting upon the foliage, slightly swaying on its long legs like a wind-blown blossom, but otherwise motionless, it awaits some unlucky insect, which, lured by the seeming flower, flies straight to its doom in the clutches of the assassin—that is the end.

Closely related to the mantids are the Phasmids or stick insects, and here the camouflage is wholly protective, for the

Phasmids are inoffensive, slow-moving vegetarians. In some of their forms they are, as their popular name implies, stick-like; in others the body and legs are spines and produced into leaf-like expansions. How effective these disguises are may be judged from the accompanying illustrations. Stick insects are masters in the art of disguise; even their eggs are hard and seed-like in appearance.

The generally accepted explanation is that these cryptic colours and patterns, originally due to the tendency to variation inherent in all living things, have been reached through natural selection; those individuals which harmonize least with their environment being the most likely to fall a prey to their enemies without leaving descendants, whilst those that most nearly resembled their surroundings would probably transmit their advantage to another generation. In each succeeding generation the same agencies would be at work, so that eventually it becomes difficult for the pursuer to find his prey. This is well exemplified by experiments carried out with mantids; brown mantids tethered on green foliage quickly fell a prey to birds, while most of the green ones, harmonizing with their surroundings, escaped. The same result was obtained when the process was reversed and green insects were placed on brown and withered foliage. It is not pretended that protective coloration gives absolute immunity from attack to every individual; it does not, but it gives a chance to the most fit and certainly benefits the race.

Many of the long-horned grasshoppers bear a very close similarity to leaves, while the coloration of others matches the broken light as it filters through the leaves, and, while motionless, as they usually are by day, they escape detection even by the sharpest eyes.

Geometrid moths are coloured to match the bark of trees or the tints of weathered fence posts, and it has been reported that, in the industrial districts of England, moths of this group are developing a dark, almost black race; natural selection in the shape of birds, as in the case of the

mantids mentioned above, destroying the light forms, conspicuous as they rest upon the soot-grimed fences and trees, leaving the darker and more protectively coloured variations, which harmonize with their surroundings, to perpetuate the race. The larvæ, too, of these geometrid moths are protectively adapted both in form and colour; they bear a very close similarity to sticks and twigs, and, to heighten the deception, when disturbed they hold the branch with their posterior claspers or pro-legs and extend the body out at almost right angles to their support, and remain motionless until the danger has passed. Others, again, are coloured to tone with the lichen growth on trees and fence posts which they frequent.

Among the butterflies, this protective coloration has been developed to an amazing extent. Perhaps the most striking, and also the best known example is the Kallima butterfly of India and the Malay States. The upper side of the insect, exposed in flight, is brightly coloured with lilac and yellow, while the underside is leaf-brown with midrib, veins, fungus spots, and holes closely imitated, and the hind wings terminating in a slender tail or stalk. When the insect is at rest the wings are closed, with the underside only exposed, and the stalk-like tail pressed close against the branch. Imagine the discomfiture of a bird pursuing one of these insects, so brightly coloured and conspicuous while in flight, to have it dash into the shelter of a bush and immediately become invisible. This sudden change from conspicuous to inconspicuous must be of the greatest value to the insect—a case of now you see it and now you don't!

Many moths and butterflies, which are marked with prominent eye-spots, are believed to frighten young birds, which may encounter them suddenly, from their resemblance to the heads of owls and reptiles which destroy birds. The large Australian wood-boring moth (*Leto staceyi*) has been considered, when resting with the wings folded, to resemble the head of a Lace Lizard or Goanna (*Varanus varius*).

MIMICRY.

Among the butterflies we encounter perhaps the finest examples of mimicry to be found in the insect world. The term "mimicry" is usually applied in connection with those insects which, in themselves harmless and palatable, copy the general colour scheme of some other species or family which has a nauseous taste, or is capable of inflicting an injury upon its captor. This mimicry must not be considered to be due to any conscious effort on the part of the mimicker, but to be brought about by the action of natural selection taking advantage of variations, which, tending in the direction of the appearance of an unpalatable species, proves to be advantageous to the race.

In South America unpalatable species of Heliconid butterflies are mimicked by palatable species of the *Pieridæ*. Another example is that of the mimic of the large, showy, slow-flying *Danaida chrysippus*, which, trusting to its extreme unpalatability, has an almost brazen contempt for its enemies; this is *Hypolimnas misippus*. The male retains its typical colour, but the females have varied considerably from the ancestral type, and now closely mimic the distasteful Danaid. This extreme variation on the part of the females is almost inexplicable, but we find a key in the case of *Hypolimnas bolina*, which is distributed throughout India and extends to Australia; here the males are almost uniform, but the females vary in a most erratic manner; some are like the males, while others are like unfinished copies of the evil-tasting types. With this species the process of selection is evidently in progress, and it provides a wonderful example of an edible species in course of development of mimicry of an evil-tasting one.

Two types of mimicry are recognized, distinguished by the names of their discoverers. Mimicry by bluff, as in the case of palatable species mimicking an unpalatable one, is called Batesian; adoption of a common pattern of coloration by a number of unpalatable species is styled

Müllerian mimicry. It has been well said that the Batesian mimic may be compared to an unscrupulous tradesman who copies the trademark of a successful firm, Müllerian mimicry to a combination between firms to adopt a common advertisement and save expense. The efficacy of warning colours in an insect depends on the education of insectivorous animals, and to accomplish this education a certain number of individuals must be sacrificed for the good of the rest. If a number of species adopt a common trademark, the prescribed number of victims will be no greater, but the sacrifice will be spread over all the species instead of falling on the shoulders of one. The number of individuals mimicking a species must be less than that of the mimicked or the scheme fails in effecting its purpose, for if a bird, in the course of its education, finds that a large percentage of the warningly coloured insects are edible, it will continue to feed upon them in spite of finding an occasional unpleasant example, with the result that the numbers of all the species will be seriously reduced. It is generally the females alone of a species which mimic, the males retaining the ancestral coloration.

It has been possible to touch on the fringe only of the subject of "Attack and Defence among the Insects," for it is a vast one, and I have been forced to select one example here and another there out of the many thousands that have been recorded; but I hope that I have been successful in giving readers some little idea of how insects capture their prey and defend themselves from their enemies. It must not be thought that examples of camouflage, mimicry and the other means of protection exist only in the tropics—they are to be found everywhere, even among our commonest insects, but it is necessary to look for them. The coloration of animals is not meaningless; it is the outcome of an adjustment to varying needs imposed by the struggle for existence, and its true interpretation can be arrived at only by observation in the field.



Some Ground-Dwelling Birds

1. Nullarbor Quail-Thrush; 1a, female. 2 Cinnamon Quail-Thrush; 2a, female. 3. Chestnut Quail-Thrush. 4. Chestnut-breasted Quail-Thrush. 5. Spotted Quail-Thrush. 6. Rainbow Pitta. 7. Noisy Pitta 8. Blue-breasted Pitta. 9. Black-breasted Quail. 10. Painted Quail. 11. Chowchilla (Northern Log-runner); 11a, female. 12. Log-runner; 12a, female. 13. Fern-Wren. 14. Rock-Warbler. 15. Pilot-Bird. 16. Ground-Thrush. 17. Southern Scrub-Robin. 18. Northern Scrub-Robin. 19. Noisy Scrub-Bird. 20. Rufous Scrub-Bird. 21. White-throated Nightjar. 22. Spotted Nightjar. 23. Large-tailed Nightjar.

Some Ground-Dwelling Birds

By K. A. HINDWOOD, R.A.O.U.*

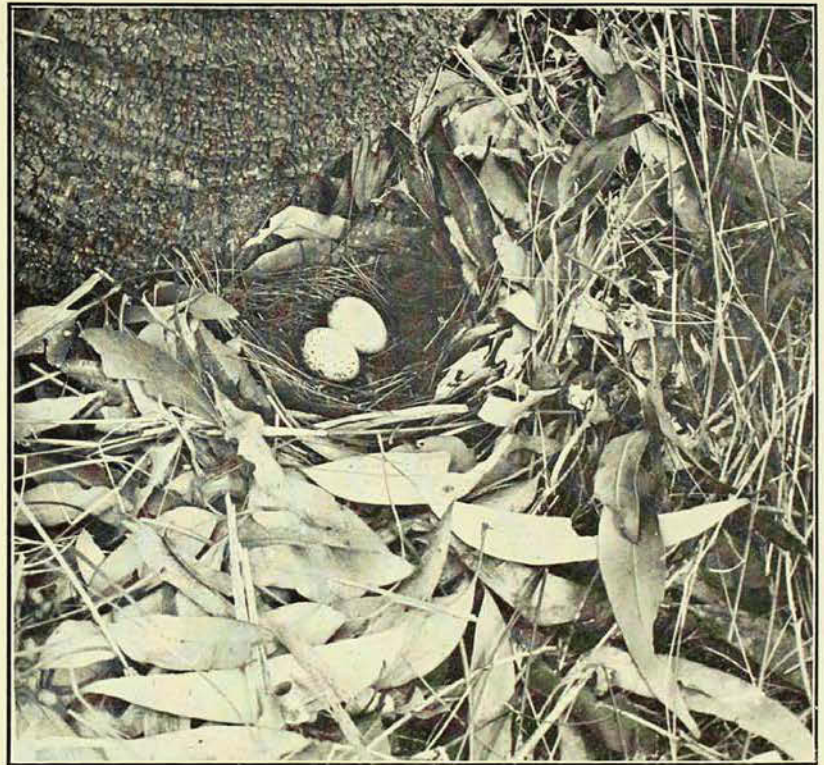
PART I.

AUSTRALIA, as a land of rare and interesting forms of bird life, is one of the outstanding regions of the world. A varied rainfall, one of a number of influences acting over such a vast continent, has produced types of country of great dissimilarity; birds have been so moulded and changed under the stress of these diverse conditions that to-day there exists a wonderful variety of species, and species in the making, for Nature never rests. In the latest check-list of Australian birds slightly more than seven hundred kinds are recorded, and in glancing through this synopsis one is surprised at the number of birds absolutely peculiar to Australia; birds that do not appear to have even distant affinity with those in other parts of the world; birds of ancient lineage, the remnant of an older avifauna, and aristocrats all. Another surprising reality is that many of them are ground-dwelling species of specialized habits, with a limited and often broken distribution.

THE SCRUB BIRDS.

In this respect the two members of the genus *Atrichornis* (Scrub-birds) are outstanding. Here are two species found only in restricted localities on either side of the continent. The occurrence of such closely related birds in areas thousands of miles apart indicates that in bygone

ages the whole of the southern portion of Australia was covered with a type of vegetation suitable to their habits—that is, semi-tropical or heavy forest growth. Pos-



Nest and eggs of the Spotted Quail-Thrush (*Cinclosoma punctatum*) at the base of a grass tree.

[Photo.—K. A. Hindwood.]

sibly the land between the east and west was inundated and became a vast inland sea, thus wiping out all connecting links. With the passing of this sea the Nullarbor Plain was created, and this, with an entirely different vegetation, effectively divided the ancient fauna.

The Rufous Scrub-bird resorts to the "Brushes" or Rain-forests of the eastern seaboard from the Macpherson Range (south-eastern Queensland) to the Chichester River (mid-eastern New South Wales).

Few indeed are the fortunate naturalists who have observed this elusive bird

* The coloured plate accompanying Mr. Hindwood's article is one of thirty-six which will illustrate *What Bird is That?* by Mr. Neville W. Cayley. More than seven hundred Australian birds will be depicted in colour in this work, the early publication of which is announced by Angus & Robertson, Limited, Sydney.—Editor, AUSTRALIAN MUSEUM MAGAZINE.

as it moves about in the tangled undergrowth. The rusty-brown colour of its plumage, its remarkably quick movements, and the dismal light of its haunts, combine to make it the mystery bird of the dense scrubs. Were it not for the powerful "Chip-chip-chip-chip" call of the Rufous Scrub-bird, its presence would never be suspected; apart from this call-note, the songs of other birds are rendered with an amazing degree of accuracy and not a little ventriloquism, for they seem to come from all parts of the forest.

The domed nest, about the size of a coconut, is outwardly composed of leaves, ferns, and twigs, with a curious lining of closely packed decayed wood, which has the appearance of wood-pulp.

The first examples of this species were secured by James Wilcox, from the Clarence River district, and were forwarded to Dr. E. P. Ramsay for identification; they proved to be new. Later, when Ramsay visited the locality, he found, to his dismay, that not one female was among the nine birds shot by him. It was not until some fifty years had elapsed, when the late H. L. White sent Mr. S. W. Jackson to the Macpherson Range in 1919-20, that the female was secured.

The case of the Noisy Scrub-bird, which inhabits, or inhabited, a restricted area in south-western Australia in the neighbourhood of King George Sound, is similar, though, as yet, the female remains undescribed; the few skins in collections are all males. In recent years some of the best field ornithologists in Australia have searched for this *rara avis*, but it has so far eluded capture. To say that it is extinct would be an unwise statement, for there are extensive tracts of country near the type locality where, possibly, it still exists in limited numbers. The nest and eggs of the Noisy Scrub-bird have not been discovered.

QUAIL-THRUSHES.

Quail-Thrushes, as a genus, have a wide distribution; excluding the northern portion of Australia, they occur throughout the continent. The five recognized species have much in common; for in-

stance, all have a white stripe above and another below the eye; the wings are marked with white, and the females are duller in coloration than the males.

As a group they illustrate very well how species evolve from a parent stock under the influence of different environments. Anyone knowing one species of Quail-Thrush would have no difficulty in ascribing another species to the same genus. The best known of the five, the Spotted Quail-Thrush (*Cinclosoma punctatum*), inhabits stony ridges and rocky areas, covered with dwarf trees, of south-eastern Australia and Tasmania. It is of a retiring nature, and, if followed, will run swiftly rather than take wing. The female appears to do most, if not all, of the incubating. They are most difficult birds to flush from their nests; one has to walk almost on top of the sitting bird before she will rise, and then it is with such a startling whir that the presence of a nest is often overlooked. The cup-shaped home is generally placed in a slight depression in the ground, at the base of some sheltering tree or shrub; it is lined with soft grasses, bark fibres, or other similar material; frequently dead leaves are placed on the ground around the nest.

Two eggs appear to be a normal clutch, though at times three are laid; they have a white ground, spotted and blotched with brown or reddish markings. When the young are born they are covered with blackish down.

What has been said above of the habits of the Spotted Quail-Thrush can be applied with slight variations to the remaining four species.

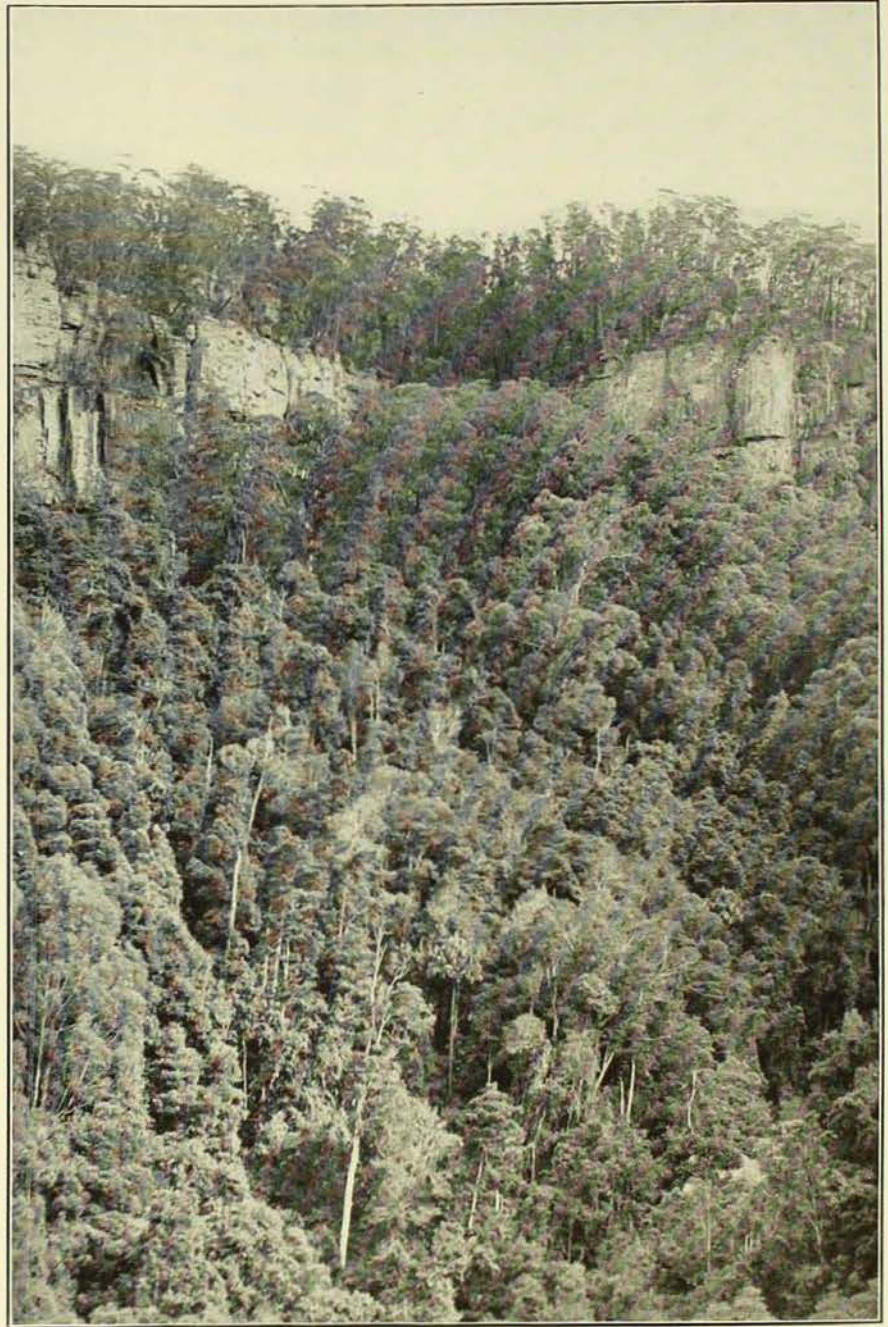
NIGHTJARS.

The Nightjars constitute a family of birds with a cosmopolitan distribution. In England they are termed Fern-Owls, Eve-jars, and Night-Hawks; in America and Canada such names as Chuck-will's Widow, Whip-poor-will, Mosquito-Hawk, and Bull-Bat, are used for the various species. The unusual name of Goatsucker is almost universally applied to Nightjars.

The word had its origin in the very old belief that they sucked the milk from goats, the ancients quoting, as evidence in support of this fallacy, the wide mouths and pink throats of the birds.

The spotted, barred, and curiously broken colours of the feathers of these birds find a counterpart in the Mopokes or Frogmouths (*Podargidae*), which are likewise nocturnal; also in the designs of the scales of many species of moths, as well as some, if not all, of the night-loving geckos. Perhaps it can best be considered in the light of obliterative or mimetic coloration whereby birds and other animals of pacific habits are enabled to escape detection when at rest during the day.

So much in harmony with their resting places are the Nightjars, that they are seldom discovered until flushed. Some pertinent observations bearing on this point were published by P. A. Buxton when explaining the colours of desert animals.* He remarks: "The most remarkable example that ever came under my notice was in Baghdad, Mesopotamia, in September. There was a small patch of ground of perhaps an acre, walled off, but not at that season of the year cultivated. In it one could always be certain of finding a score of Egyptian Nightjars (*Caprimulgus aegyptus*), but though the ground was absolutely bare, and though I visited the place repeatedly, I never succeeded in detecting a Nightjar before it flew." Providing obliteratively coloured animals remain immobile, we almost invariably pass them by.



Macquarie Pass, Illawarra, New South Wales. Typical rain-forest vegetation, the haunt of some interesting ground birds.
[Photo.—K. A. Hindwood.]

Two of the three species of Nightjars inhabiting Australia (*Eurostopodus mystacalis* and *E. guttatus*) have very fine hair-like feathers near the gape. In the third species (*Caprimulgus macrurus*) these have developed into strong and rather long bristles on both sides of the basal portion of the upper mandible, giving the effect of a "Kitchener" moustache. Presumably the bristles of all three species help the birds more readily to secure their food, which con-

* Buxton: *Animal Life in Deserts*, 1923, pp. 149-150.

sists of insects, such as moths and night-flying beetles. A somewhat similar development is to be observed in the Fly-catchers, the members of which group of birds obtain most of their food on the wing. The only time to observe Nightjars satisfactorily is at dusk, when they hawk over pastures and open spaces, their powerful wings enabling them to travel at a considerable speed.

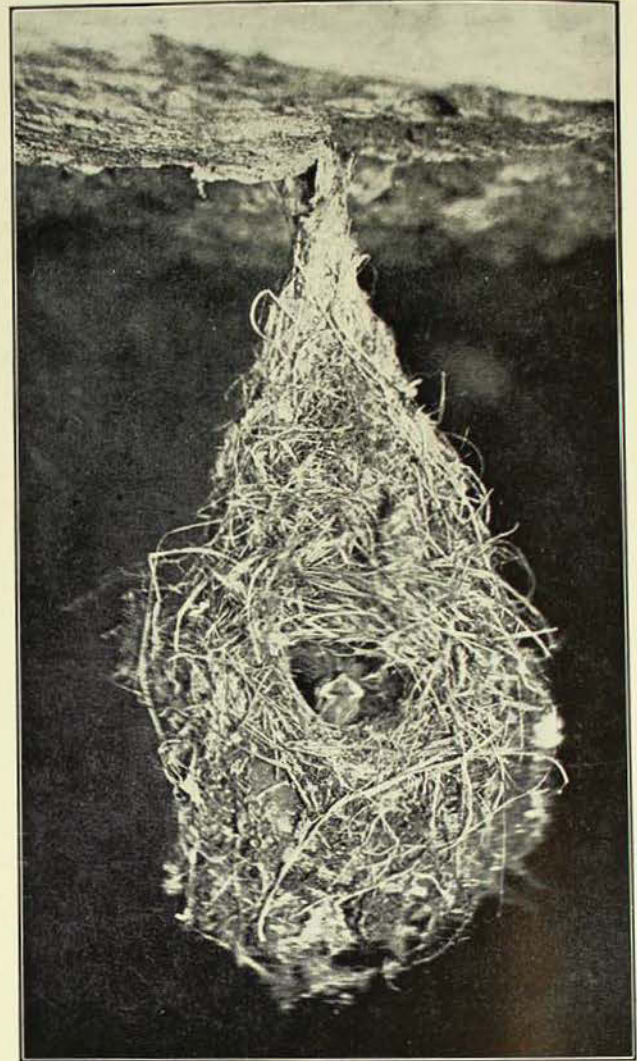
No semblance of a nest is made, the egg (or eggs, according to the species) being laid on the bare ground or on fallen leaves and *débris*. When the young Nightjar makes his entry into a world full of possibilities and, alas, impossibilities, he is covered with dark fluffy down, and is not easily seen against his earthy background.

PITTAS.

Pittas are extremely beautiful birds; their distinctive carriage, plump, well-proportioned bodies, short tails, and rather long legs, impart to them an elegance of bearing which is in keeping with the gorgeous and varied coloration of their plumage. For the most part, the colours occur in distinct patches and seldom blend; it is this contrast of one bright colour against another that adds considerably to their beauty, and excites our admiration.

The name Ant-Thrushes has, at various times, been applied to the Pittas; the true Ant-Thrushes, however, inhabit the northern portion of South America, and, whilst they may sometimes resemble the Pittas in form, they are quite distinct from them. The latter birds have an extensive distribution, ranging from China to Australia; they occur also in India, while one species (*P. angolensis*) has been recorded from the forest regions of tropical Africa. More than sixty species have been described, and according to Wallace they attain their greatest beauty in Borneo and Sumatra.

Three species only are found in Australia. The largest and best known of the Australian forms is the Noisy Pitta (*P. versicolor*), which is more generally



Nest of the Rock Warbler, showing the method by which it is attached to the ceiling of the cave. Its occupant is a young bird, open-mouthed in anticipation of food.

[Flashlight Photo.—K. A. Hindwood.]

called the Dragoon Bird. It frequents the dense tropical and semi-tropical forests of the east coast, from Cape York to north-eastern New South Wales. A single specimen was shot near Wollongong, some fifty miles south of Sydney, in 1883, though the southern limit of its range appears to be in the neighbourhood of the Manning River.

Almost entirely terrestrial in their habits, Pittas feed largely on land snails, the shells of which they break on a stone or small stump. By examining the fragments of shells surrounding these "breaking grounds" collectors have been able to trace new or rare shells, the occurrence of which had not hitherto been suspected

in the locality. The practice of hitting food against a solid object in order to remove the hard parts or to soften it, is common to a number of birds. A few years ago I remember watching a Sacred Kingfisher (*Halcyon sanctus*) energetically tapping its bill against a rock, around which was strewn the remains of cockchafer beetles and small crabs.

While the Blue-breasted Pitta (*P. mackloti*) ranges through New Guinea to as far as Java, its distribution in Australia is limited to the area between Cape York and Cardwell (north Queensland). According to the naturalists who have studied the habits of this bird, it is a migrant to Australia, where it breeds after arriving some time during the month of October.

The third species, the Rainbow Pitta (*P. iris*), is found in the dense bamboo jungles and scrubs of north Australia and in the north-west of the continent, particu-

larly near the coast. Most of the under-surface of the Rainbow Pitta is of an exquisite velvety-black; this, being opposed to the green, gold, and silvery-blue of the upper-parts, and the scarlet on the lower portion of the body, distinguishes it as the most beautiful of our three Pittas.

THE ROCK WARBLER.

Perhaps the most interesting species inhabiting Australia is the little Rock Warbler (*Origma rubricata*)*. Its restricted distribution, for the most part the sandstone country within a hundred miles of Sydney, and its unique nest, which is suspended from the ceiling of a cave or some similar situation, proclaim it as one of the world's outstanding birds.

(To be continued.)

* For full particulars of the habits of the Rock Warbler, see THE MUSEUM MAGAZINE, Vol. 3, No. 11, July-September 1929, pp. 379-384.

Last month we had the pleasure of welcoming to our shores a party of American zoologists from the Museum of Comparative Zoology, Harvard University, led by Dr. W. M. Wheeler, Professor of Entomology. On August 20th, the visitors were entertained in the Board Room by the Trustees and members of the Scientific Staff, when speeches of welcome were delivered by the President (Mr. F. S. Mance), Professor W. J. Dakin and Dr. C. Anderson, and replied to by Dr. Wheeler and other members of the party. The expedition includes Dr. Glover M. Allen, mammalogist, Dr. P. J. Darlington, entomologist, Dr. Ira M. Dixon, physician, Mr. W. E. Schevill, palæontologist, and Mr. Ralph Ellis, ornithologist.

It is the intention of our visitors to make a general collection of the land

animals of Australia for display and research, and to arrange exchanges and establish relations with Australian museums and institutions. The visitors were assured that all the assistance possible would be rendered by the Trustees and Staff of the Australian Museum.

* * * *

The Museum lectures have this year fully maintained their popularity. Attendances have been so large that, as a rule, the Lecture Hall was found inadequate to accommodate all who wished to hear the lecturer, and a considerable number were turned away. Formerly we have usually been able to arrange for "repeat" lectures, but this year this has been discontinued on the grounds of economy, and it is regretted that many would-be hearers have been disappointed.

Queen Nefertiti*

BY W. W. THORPE.

MR. ERNEST WUNDERLICH, F.R.A.S., a former Trustee of this Museum, and a well-known student of Egyptology, has generously presented a beautiful cast of the bust of Queen Nefertiti. The original was unearthed, prior to 1914, at Tel-el-Amarna, Egypt, and is in the Berlin Museum, whilst our cast is the only one in Australasia.

Nefertiti, or Nefer-tith, wife of Amenhotep IV, who reigned in Egypt during the XVIIIth Dynasty, about the 14th century B.C., was a native Egyptian of royal blood. Her ancestry is unrecorded, but it is reasonable to assume that she was the daughter of a princess. The mother of Amenhotep IV and wife of Amenhotep III, was Tatumkhipa, or Thi, the daughter of Tashratta, king of Mitanni, in northern Mesopotamia. On account of Amenhotep IV being partly foreign, it was deemed politic for him to marry one of Egypt's royal daughters. Very little is known of Nefertiti, though her husband, Amenhotep IV, was an outstanding figure in Egyptian history. He it was who tried to bring about a religious reform. On this

account he has been referred to as "the only man in ancient history." On the other hand, while debating the new religion with the hierarchy, he neglected his foreign possessions, and ignored the demands for succour from several of his governors. The change that he advocated was a kind of monotheism, or the restoration of the worship of Aten, the radiant energy of the sun. Within thirty years the old gods were restored, and this beautiful dream was over.

Nefertiti was also the mother-in-law of Tutankhamen. This son of Amenhotep III, by a wife who was not of royal rank, married a daughter of Amenhotep IV and Queen Nefertiti, and thus obtained the right of succession.

Attention is called to the elegance and degree of refinement which contrast sharply with the masculine strength and vigour of Greek sculpturing. The Egyptian lady was more delicately sensitive and feminine than any female depicted by the Greek masters, whose athletic and full-blooded goddesses belonged to an order of women quite different from those gentle aristocrats of the Nile Valley.

* See Frontispiece.

For some time work has been proceeding in the formation of a reference series of Australian birds' eggs. This is now completed, and its arrangement and accessibility will make it readily available for consultation by students of oology. As far as possible this collection, which contains about 1,200 clutches and 3,000 eggs, includes a complete colour series of the eggs of each species.

We have recently received from the British Museum (Natural History) a portion of the extensive collection of Tunicata and Chaetopoda made by the British Great Barrier Reef Expedition at Low Isles during 1928-29. This material is a valuable addition to our collections, as it is Australian in origin and has been examined and determined by leading specialists.

David Starr Jordan

(1851-1931)

N EARLY a quarter of a century ago a distinguished American visited Australia at the invitation of Dr. (now Sir) T. Edgeworth David, to lecture on the American University system. This was none other than Dr. David Starr Jordan, the doyen of ichthyologists, a naturalist and teacher whose life work did not stop at those activities, but embraced economics, languages, and even poetry in its scope. His ideas were rather "ahead of the times" and were not particularly well received here. He regarded the management and student life of our Universities as too chained to English tradition: "Australia," he wrote, "looms up huge, gray, and insurmountable . . . near and petty goals—honours, prizes, scholarships—are used in the schools, as in England, as substitutes for the real aims of education." He also criticized, and rightly so, the anti-Japanese feelings of the times, and condemned our then compulsory military training. His Puritan ancestry perhaps helped to make him fearless in his support of Prohibition and other Reform measures, and he was "advised not to speak so frankly in Australia, where the libel laws are very stringent."

In the scientific field it is as a naturalist and primarily as an ichthyologist that Jordan has achieved immortal fame. His studies on both recent and fossil fishes are published in hundreds of technical papers and books, many of them having been written in collaboration with other authorities or with his many pupils. Jordan and Evermann will always be famous for their monumental "Fishes of North and Middle America," and Jordan

himself, as recently as 1923, completed his "Genera" and "Classification of Fishes," which place all the known families of fishes, over 600 in all, in order, and render future work much easier.



Though he described but few Australian fishes, Jordan was always interested in local discoveries, and has given encouragement to three generations of Australian workers. His remarks on these colleagues, printed in his autobiography,

"The Days of a Man," 1922, are noteworthy:

The museum naturalists of Australia form an interesting and active group, the fact that the animals and plants of the region are still incompletely recorded adding zest to their study. Naturally I saw a good deal of the ichthyologists, even though I had no time for original investigation myself. Among them are three of excellent training and ability: Allan R. McCulloch, curator [of fishes] in the Australian Museum, a man of charming personality and a careful, accurate observer whose judgment in technical matters I value highly; Edgar R. Waite, his esteemed co-worker, then at Christchurch, but soon after called to the Museum at Adelaide; and J. Douglas Ogilby, the accomplished curator of fishes in the Queensland Museum at Brisbane, and author of numerous papers of importance. David G. Stead, the competent expert of the fisheries of New South Wales, is prominent as an advocate of peace, with a large interest in world affairs generally.

Ogilby named a Queensland shark *Scoliodon jordani* in honour of Professor Jordan.

The present writer never had the privilege of meeting this G.O.M. of ichthyology, but has a sheaf of charming letters

from him, all encouraging and mostly helping to elucidate technical points.

He sent the portrait, here reproduced, in which he is shown with a pet dog, and, in reply to my acknowledgment, wrote: "Dear Mr. Whitley, I am glad that you are pleased with our joint portrait and signature. A lady wrote me not long ago that she thought I looked more intelligent than the dog. Very truly yours, David Starr Jordan."

For over thirty years Jordan worked assiduously in the cause of International Peace, writing and lecturing in nearly every country of the World, but, in recent years, he retired, as President Emeritus, from the more active work in the Leland Stanford University, California, which he had watched and nurtured from its foundation until as "a nobler Athens" it arose to its present prominent position. For the past two years his health had been failing, and a recent cable records his passing on September 19th, 1931.

G.P.W.

Elsdon Best

(1856-1931)

After a long and useful life of seventy-five years, Elsdon Best, well known as an authority on the life and culture of the Maori, died on 9th September. He was born at Porirua, near Wellington, New Zealand, and up to the age of nine he lived mostly in the forest, where he imbibed a fondness for the simple life of the open spaces. For some time he was employed in the Civil Service, but a sedentary life in a town did not appeal to him and he soon struck out for the country again, where he worked on stations and on various bush contracts. In 1883 he went abroad to Hawaii and the United States, returning in 1886 to New Zealand, where he engaged for some

time in sawmilling. For over fifteen years he lived among primitive Maoris, where he had exceptional opportunities of studying and making records of this interesting race, their customs and mythology. On his return to Wellington he became associated with the Dominion Museum, and the data accumulated by him bore good fruit in the valuable series of publications of which he is the author. We owe to him fourteen Dominion Museum Bulletins, four books, and numerous articles in ethnological journals. In 1914 the New Zealand Institute awarded him the Hector Memorial Medal for his researches in ethnology. He was a foundation member of the Polynesian Society, formed in 1892.

C.A.

Some Furred Natives of Our Coastal Region

BY A. J. MARSHALL, R.A.O.U.

ALTHOUGH Australia possesses some of the most remarkable of the world's mammalian fauna, one regrets to admit how little is known of the habits of these interesting creatures. The reason probably lies in the fact that most of our mammals are strictly nocturnal, and therefore extremely difficult to study. The average observer, however keen, is rarely anxious to prowl forth on frosty winter nights, whilst the time of Museum workers is so strictly limited when on collecting trips that they rarely have any leisure to spend in the accumulation of field notes.

Many of our birds are almost entirely dependent upon small mammals for their food supply, so that a study of their habits naturally leads to an interest in the furred animals as well, and the notes provided below represent observations made by the author, over the last few years, upon some of the delightful creatures met with in our bush.

MARSUPIAL GLIDERS.

Among the many singular marsupials inhabiting the eastern coast of Australia, few surpass in beauty and interest the charming little Short-headed Flying Phalanger, or "Sugar Squirrel" (*Petaurus breviceps*). This animal appears to be still fairly numerous; a gratifying fact when it is considered how greatly the ranks of many of our loveliest marsupials have been thinned in the past. The general colouring of the "Sugar Squirrel" is a soft smoky-grey with paler under-parts, and a prominent black stripe running over the head from nose to nape, and continuing less distinctly as a black line down the back; the tail is of a clearer bluish-grey, becoming black about two inches from its tip. The soft grey fur is relieved by the large dark liquid eyes, the comparatively large oval naked ears, and a band

of black velvety fur edging the skin-folds along the sides. The total length of the average adult is about thirteen inches, the length of the tail being about seven inches.

Whilst upon the ground, the "Sugar Squirrel" moves with a series of short



Sunlight and shadow in the blackbutt and turpentine country, the haunt of the Greater, and Short-headed, Flying Phalangers or "Possums," and Black-tailed Wallabies.

[Photo.—A. J. Marshall.

leaps, the manner in which it also progresses up a tree-trunk. As is well known, our "flying" marsupials do not fly as bats do; they merely launch themselves into the air from a tall tree, and glide, with limb membranes extended to the utmost, to a lower bough or tree. These membranes run along each side of the body from fore- to hindleg, and when the limbs are outstretched, enable the marsupial to glide down in the manner of a kite. At

the termination of each glide or leap, the "Squirrel" ascends sharply upwards, thus minimizing the shock as it strikes its objective.

The Short-headed Flying Phalanger was introduced into Tasmania in 1835, and there it is stated to have far exceeded the size of those on the mainland. Where obtainable, they are eagerly sought after as household pets, but, despite their gentle appearance, will vigorously defend themselves when the occasion arises. This was demonstrated by a male "Squirrel" which was rescued some time ago from several Currawongs (*Strepera graculina*) which were attacking it. He was found in a portion of the forest composed chiefly of *Angophoras* and gums, and, despite his comparative diminutiveness, put up a good fight against his aggressors, springing furiously at them from time to time. When brought to the Bird Cabin in National Park, he exhibited no savagery, and, when protesting against unnecessary handling, did so with his teeth, which did not, however, break the skin of one's fingers as did the teeth of a smaller specimen on another occasion; no attempt was made to scratch, as a Silver-grey or Ringtail Possum would have done under the circumstances. The only note uttered during the whole time was a continuous "whirring" noise resembling that of the mechanism of a child's toy being set in motion.

Another specimen was discovered in a limp and apparently lifeless condition on the ground at the fringe of the scrub some time later. On examination, five ticks were found in one ear and four in the other, embedded in both the inner and outer surfaces. The ears are practically



The Short-headed Flying Phalanger, "Sugar Squirrel," or Flying Possum. This charming study shows the characteristic dark head stripe, and widely spaced digits, which are armed with needle-like claws. The flounces of grey fur along the "wing" membranes are reminiscent of the soft feathering of night-haunting birds, while the softly draped tail is an adequate rudder for the gliding flights amongst the trees.

[Photo.—A. J. Marshall.]

the only parts which are not protectively covered with thick heavy fur, so that it seems quite obvious why the ticks were located there. Placed near a fire, after the removal of the parasites, he recovered sufficiently to be able to "whirr" threateningly, and even make valiant attempts to chew my fingers, although the whole time his body was rather cold. Unfortunately, however, the little fellow suffered a re-

lapse and died about four hours after its discovery.

The ticks appeared to be of two varieties: the common "Scrub"-tick (*Ixodes holocyclus*) and the "Bottle-tick." Personally I am quite certain that both arachnids are *Ixodes holocyclus*, for, when the tick has been attached to an animal for some time, its body expands considerably and assumes a dark blue shade, this probably being responsible for the bushman's supposition that the bloated form of tick is a different species.

THE LARGEST FLYING POSSUM.

The Greater Flying Phalanger (*Petauroides volans*), the largest of the marsupial gliders, is also fairly plentiful on the turpentine- and blackbutt-covered hillsides of the Hawkesbury Sandstone type of country. Many times have I encountered this beautiful marsupial whilst out armed with a flashlight on nocturnal rambles in Sydney's National Park and elsewhere. Good hearing is essential if one is to observe the "Flying Squirrel"; for on a dark night the only way to locate them is to stand still and listen intently for the scrape of their claws on the rough bark as they leap upwards. Their eyes glow like ignited matches when the flashlight is trained on them, but they rarely make any serious endeavour to escape the searching rays. This marsupial, too, is frequently attacked by ticks: I have on more than one occasion found them lying dead in the bush with no apparent injury other than a few marks on the ears.

THE BLACK-TAILED WALLABY.

Black-tailed Scrub Wallabies (*Macropus ualabatus*), which are some-



The Ring-tailed Possum derives its popular name from the prehensile tail, which has a naked and roughened undersurface at the tip; when coiled around branches it is a very efficient "non-skid" climbing organ. Australian possums are also called phalangers in reference to the structure of the hindfoot, in which the 2nd and 3rd toes are webbed together (syndactylous), a character, however, not peculiar to the family. The great toe is opposable in a thumb-like way to the other digits as a further climbing aid, while the long and sensitive whiskers are helpful on nocturnal rambles.

[Photo.—A. J. Marshall.]

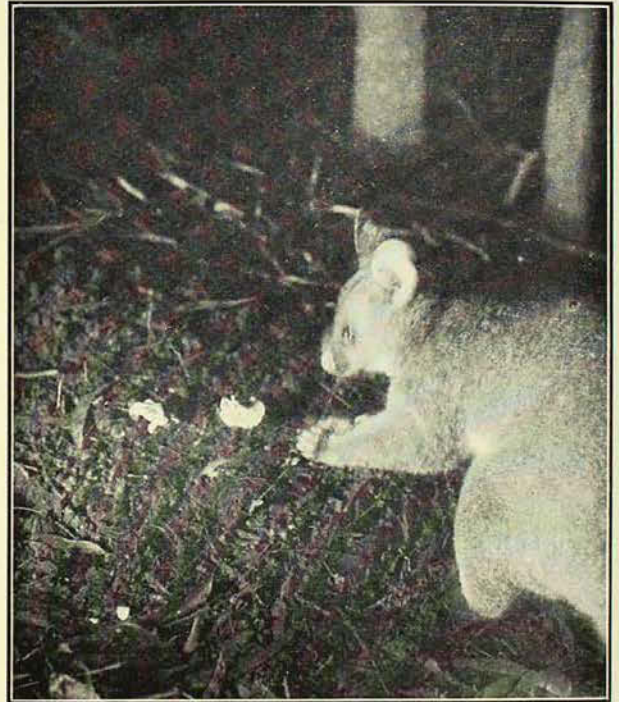
times called Scrub or Swamp Wallabies, are also seen fairly frequently on the heavily timbered hillsides. These shy marsupials appear to lead a solitary existence, usually feeding singly by night and lying on the sunny side of a large rock, or hidden deeply among stinging nettles and wild raspberries by day. A well-known ornithologist, Mr. P. A. Gilbert, in

a paper entitled "Migration," recently read before the Ornithological Section of the Royal Zoological Society of N.S.Wales, stated that this wallaby migrates from the coast to the mountains in the spring and returns in the autumn. My own observations support his contention, for during the winter I have flushed as many as ten "Black-tails" from the bush around Lady Carrington's Drive in one afternoon, but during the summer months I have had to journey much farther afield in order to see three.

A NEST-BUILDING POSSUM.

The Ring-tailed Possum (*Pseudochirus laniginosus*) is easily the commonest of Sydney's marsupials, and, with the possible exception of the Allied Rat (*Rattus assimilis*), is the only animal which prefers the heavy "rain-forest" or "scrub" to the timbered hillsides. Nests of this quaint little mammal are frequently discovered in the scrub, usually in a lillypilly (*Eugenia smithii*) or turpentine (*Syncarpia laurifolia*) sapling, as often as not within a few feet of the ground. It is usually about the size and shape of a "soccer" football, a five-inch entrance being made in the side. Bracken, palm-fibre, stringy-bark, ferns, dry grasses, and leaves are the most favoured materials used in construction, the nests usually being built in May or June, and for some time appearing to remain untenanted. About September it is not unusual to scare a female Ring-tail from her nest with two bright-eyed youngsters clinging to her back as she swings nimbly away out of danger, aided by her long prehensile tail. From October onwards the young appear to be left alone in the nest, in the day time at least, and grow steadily until about November or December, when one may occasionally flush two large youngsters from a nest, which by now is almost a mere platform, the young having quite outgrown it and flattened the sides. Whether the female possum returns at night to suckle the young after she leaves them in possession of the nest I do not know, but one rarely sees a female with the young during the daytime after

October, though perhaps the dates may differ considerably in various localities due to varying climatic and food conditions. Of ten new nests under observation this year, only one was occupied before August, and this by a large male possum which had probably misappropriated it. Quite often nests are built and never occupied, a habit common in some birds, notably the Babblers (*Pomatostomus*). After the female leaves her babies, one of which, by the way, is sometimes several shades darker than its twin, I imagine she returns to dwell in some favoured hollow spout or trunk, for I have often flushed female Ring-tails as well as Silver-greys from these hollows.



An adult Silver-grey Possum, showing the characteristic large ears, and beautiful texture of the fur, the value of which may ultimately threaten the animal's extinction. Attached to the "bait" is a string which releases the flashlight; taken in National Park, it illustrates how wild creatures may be photographed without harm in their natural haunts.

[Flashlight photo.—A. J. Marshall.

THE SILVER-GREY POSSUM.

The charming Silver-grey Possum (*Trichosurus vulpecula*) is another species which appears to be still holding its own despite the depredations of trappers and cyaniders for commercial gain. This popular marsupial, unlike the Ring-tail, produces only one "joey"

annually, and it may, even in its wild state, be tamed fairly easily. Many of the campers at Gundamaian have wild Silver-greys coming down from the trees to accept dainty morsels each night. Particularly successful in this respect is Mr. R. Buchanan, well-known to most of the Australian Museum naturalists, who, with his granddaughter Pat, has tamed several of these phalangers. At the time of writing, a mother Silver-grey comes down regularly every night to accept food, and is so tame that she scarcely resents one examining the "joey" plainly visible in the pouch. Her year-old son usually hovers a short distance away, eager to share in the banquet, though his mother always keeps him firmly at a distance until her own hunger is appeased.

NATIVE AND INTRODUCED RATS.

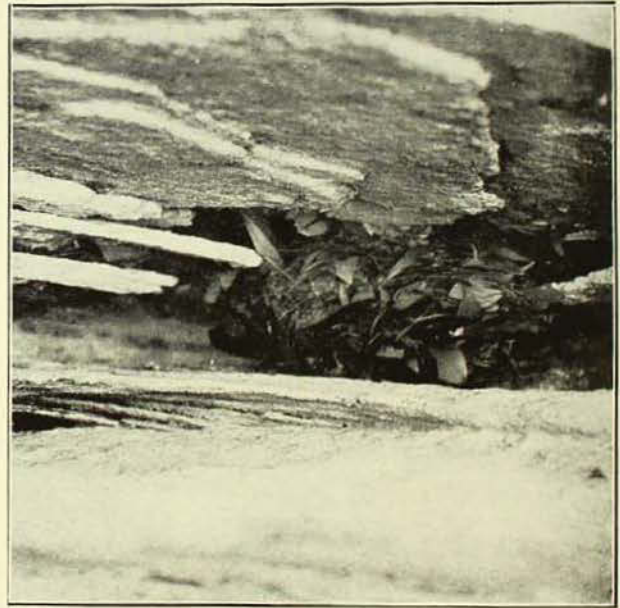
Among the smaller mammals, the "Allied Bush Rat" is undoubtedly the most common. Living in hollow stumps, and among driftwood in the heart of the scrub, or burrowing among rocks, this little rodent ventures forth at night to feast on the fallen seeds of the Cabbage-tree Palm (*Livistona australis*), and a trap baited with a raisin, if set at the foot of a "Cabbage-tree," will rarely fail to capture a rat.

It is interesting to note how completely the long-tailed introduced species (*R. rattus*) has adapted itself to our bush conditions, a fact which was not appreciated by earlier workers, and led to the species being given no less than three separate scientific names on the mainland and three in Tasmania as well. One of these names was published in Gould's famous work, *The Mammals of Australia*, with the following notes by Sir William Macleay: "The only example of this rarity which has yet been obtained has been presented to the Australian Museum. . . . It was caught at Elizabeth Bay, where it inhabits the lofty *Eucalypti*, and builds a nest among the branches, with leaves and twigs, like that of a bird." The name *arboricola* was provided as a tribute to these sylvan haunts, and it was not until 1897 that man's old enemy was

recognized as having adopted the simple life habits of the local species.

These similarities of habit are well shown in that when ship rats were accidentally introduced to Lord Howe Island they quickly adapted themselves to a semi-arboreal life and, unfortunately for the industry, fed extensively upon the exportable seed of the *Kentia* palms in the same way that the local species feeds upon the seeds of the Cabbage-tree Palm.

The Allied Rat is readily distinguishable from both introduced species by its much softer and thicker fur, while the much shorter tail distinguishes it from the Ship Rat (*R. rattus*), and the generally lighter build separates it from the introduced Sewer or Brown Rat (*R. norvegicus*).



A nest of the Yellow-footed Pouched Mouse, in a sandstone cave.

[Photo.—A. Musgrave.]

MARSUPIAL MOUSE.

An interesting little haunter of the sandstone ledges is the Yellow-footed Pouched Mouse (*Phascogale flavipes*). During the past three years I have located many of their cunningly hidden gum-leaf nests in wind-worn crannies in the roofs of caves and ledges, but until last July had never had the fortune to find the owners "at home," though I had twice startled Pouched Mice from their nests located in the foundations of the deserted

nests of Lyre Birds (*Menura novaehollandiae*) which were perched high up on the cliff-face in almost inaccessible positions. On the exceptional occasion I was walking along the foot of a particularly steep orchid-strewn sandstone cliff searching for Lyre Birds' nests, when I noticed the tips of a few leaves protruding from a hole in the roof of a cave some thirty feet above. After a stiff climb, I reached the nest and was successful in securing four out of the five mice within. Contrary to expectations, the feet were buff, not pure yellow as the specific name (*flavipes*) would lead one to imagine, while the back and head were dusky brown, grizzled with yellowish tips, the under-parts being paler.

When first startled from their nests, the "Yellow-foots" were easily captured, but once their eyes became accustomed to the brilliant sunshine, they were extremely difficult to handle. They are remarkably adept at running *upside down* along the pitted roof of the cavern, aided by their serrated foot-pads and sharp claws; in fact, it was essential for them to proceed in this manner to reach their nest. When

on the ground they progressed with a series of short leaps in a manner reminiscent of the little *Petaurus*, and they could race up a tree with the grace and agility of a Ring-tail. Two of these marsupial mice are now in the collection of the Australian Museum, where they were lodged for study purposes.

The nest was situated in a particularly orchidaceous section of the cliff; Rock Lilies, *Liparus*, and "Ratstails" clung to the sandstone around, "Grass" (*Cymbidium*) orchids grew plentifully in fallen logs nearby, whilst four species of terrestrial orchids grew profusely amid the dark green moss which covered the fallen boulders at the foot of the cliffs. In such lovely surroundings dwell these sharp-toothed little cousins of the marsupial "Native Cats," hunting their mixed diet of wild fruits and insects. Let us hope that their wise "safety-first" building activities will prove a salvation against the arch-enemy of our small mammals, the domestic cat gone wild, and that our great National Park will ever prove a haven to the native fauna for all time to come.

Mr. Ernest Wunderlich, F.R.A.S., a former Trustee, in addition to his gift of the bust of Queen Nefertiti described in this issue, has generously presented to the Museum Library a fine series of volumes published by the British School of Archaeology in Egypt. This is a very valuable donation, supplementing our own volumes to a very considerable degree.

* * * *

Through the kindness of Dr. H. L. Clark, we have recently received from the Museum of Comparative Zoology, Cambridge, Massachusetts, a series of foreign echinoids. This material will not only serve to fill gaps in our collections,

but will also be of great assistance in the study of our own Australian species.

* * * *

Recent visitors include Dr. J. Howard Cook, M.S., F.R.C.S., of the Uganda Mission; Professor William Wright, F.R.C.S., M.B., Ch.B., of the Royal College of Surgeons, London, who was much interested in some of the preparatorial work now in progress; Mr. F. E. Williams, Government Anthropologist, Papua; Mr. Leo Austen, Assistant Resident Magistrate, Papua; Mr. C. E. Hart, Honorary Correspondent, Guadalcanal, British Solomons.

Skates and Rays

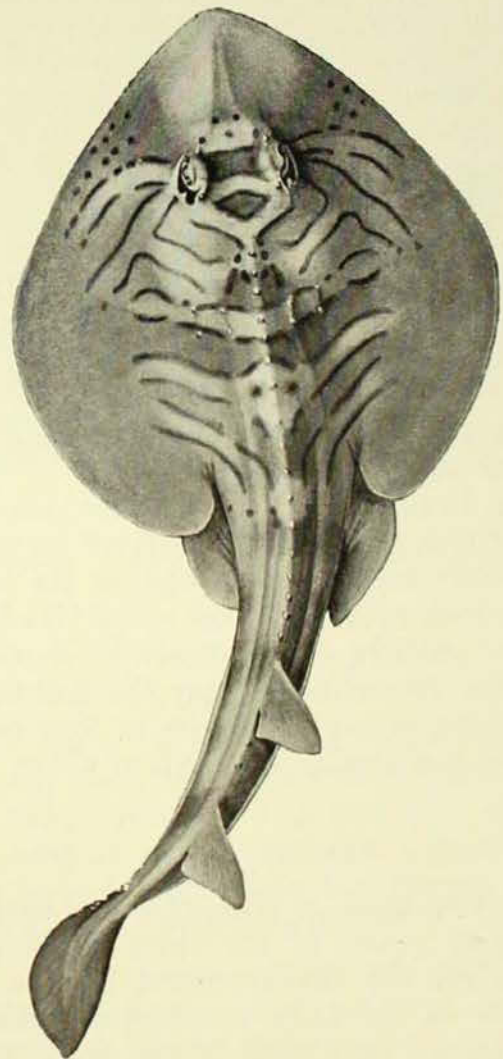
By G. P. WHITLEY.

A TYPICAL stingray is shaped somewhat like a boy's kite, the foreparts, consisting of the joined head and body, are flat and roughly diamond-shaped like the main portion of a kite, and the tail is generally more or less long and thin, and trails behind the body. Stingrays are closely allied to sharks in structure and anatomy, but differ mainly in being flattened. If one could imagine Mrs. Neptune using a mangle beneath the sea on washing day, it would not be difficult to conceive a stingray as a shark which has been passed through the rollers of the mangle, and emerged in such a depressed condition that its gill-slits have come to rest beneath its body, and its side-fins have been considerably widened. But this fantasy, of course, does not explain how stingrays really came into being. Probably the great-great-grandfathers and grandmothers of the sharks and rays millions of years ago had some sort of family separation; one group decided to swim along the bottom of the sea looking for food, whilst another more inspired group decided to search the upper waters to see what they could find. The bottom-hunters became flat and lazy, and skimmed over the sea-floor as if they were a part of it, and gave rise to the stingray family and its relations. The free-swimming ancestors developed graceful forms for speedy travel, and eventually became the shark family.

There were other family separations as well in the course of the ages, but the split between the sharks and the rays is the one which most concerns us here. The bottom-haunting rays inhabit all warm seas, and some extend into far northern and southern latitudes, but they prefer as a rule fairly shallow warm water in which to live.

CLASSIFICATION.

The true rays and their allies are grouped in an order, known as the Batoidei, of the large class of animals



A young Fiddler Ray (*Trygonorhina fasciata*) from New South Wales, showing the characteristic markings. (Illustration by courtesy of the Linnean Society of New South Wales.)

[Allan R. McCulloch, *del.*

which includes the sharks as well. For present purposes let us divide the rays into two groups which can be distinguished as the rays with thick tails

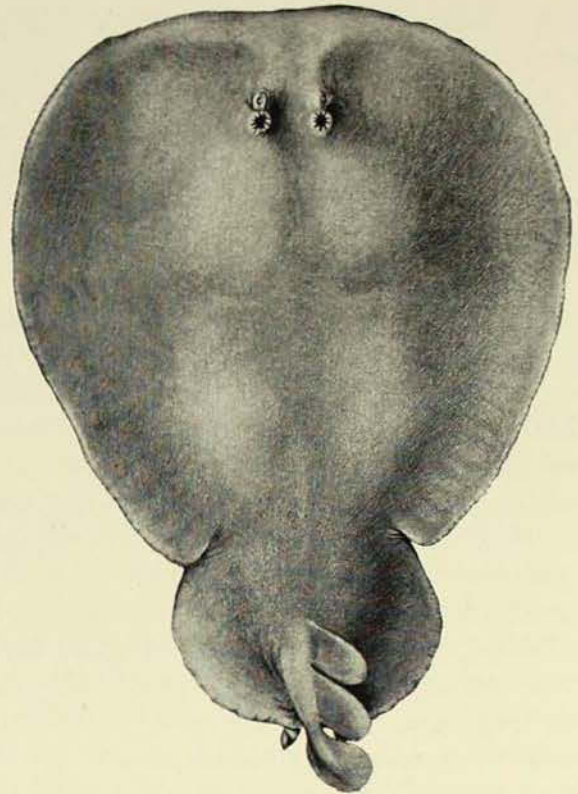
and those with thin tails. Rays as a whole do not require strong tails for swimming, so the more highly specialized of their ranks, the aristocracy of rays, rarely have any tail-fin at all, but only a slender whip-like appendage. The humbler members with thick tails betray their connection with the sharks and still use their tail-fin and small dorsal fin for swimming, whereas the thin-tailed rays just twist from side to side or wave their wing-like fins and swim gracefully in that way. Behind the eyes of a ray may be seen two apertures known as spiracles; water is taken in through these and passed over the gills and out through the gill-slits beneath.

The Shovel-nosed Ray is a common New South Wales example of a thick-tailed ray. It has a long tapering snout which looks as if it might be used for shovelling the sandy bottom over which the species is caught. A near relative is the beautiful White-spotted Ray of the tropics, which is met with in northern Australia. These rays are sometimes called Guitar Fishes, because in general outline they resemble that musical instrument.

The Fiddler Ray is another kind of Shovel-nosed Ray, but it derives its name from the striking markings on its body, which look rather like the scroll-like holes or the purfling of the body of a violin. Like the Shovel-nosed Ray the Fiddler is a common estuarine species in New South Wales, and attains a length of about four feet.

ELECTRIC RAYS.

Electric Rays or Numbfishes constitute the next group of the thick-tailed rays. These are all characterized by the possession of specially innervated areas of muscles on each side of the body which can generate an electric current at the will of the fish. The shock is sufficient to be felt keenly by man, and must be deadly to the fishes upon which the Electric Rays feed, or else a very effective protection against enemies. The little Numbfish of Tasmania and south-eastern Australia is commonly caught by the trawlers; it is a chestnut-coloured fish up to about thirteen inches in length, and



The Electric Ray or Numbfish (*Hypnos monopterygium*) buries itself in sand and paralyzes its prey by electric shocks. Specimen from off Cape Hawke, New South Wales. (Illustration by courtesy of the Linnean Society of New South Wales.)

[Allan R. McCulloch, *del.*

has a long thick tail. The common Electric Ray or Numbfish looks more like a lump of beef than a fish. The body is plump and often twisted into curious shapes so as to appear deformed, and the tail and dorsal fin, though developed, are very small; the eyes, too, are quite inconspicuous. I have several times seen this species washed ashore at Botany Bay. That it has well-developed electric powers may be appreciated from the following account of a Numbfish from the pen of the late A. R. McCulloch:

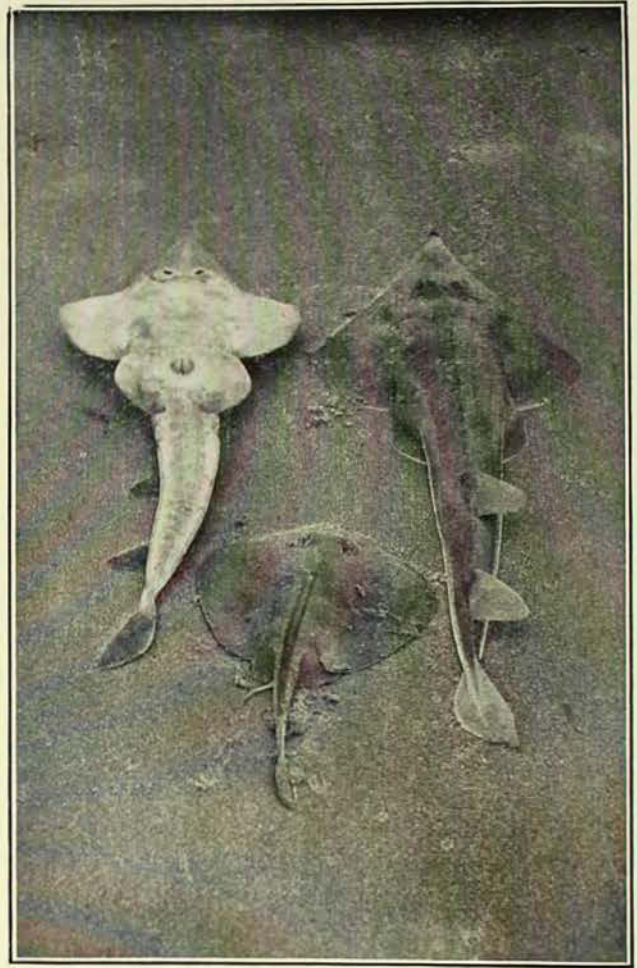
“A party of biology students from the University on their annual excursion to Port Stephens, recently discovered a medium-sized example of the common species, *Hypnarce subnigra*, in shallow water. It burrowed beneath the sand with extraordinary rapidity when it observed their presence, doubtless realizing the peculiar inquisitiveness of such people. But all to no avail. One member of the party seized a water-logged stick and

commenced to dig it out, while another, unaware of the identity of the prey, simultaneously stabbed it with a ferocious looking bowie-knife. Both jumped several feet in the air as they received a violent shock, and very nearly allowed the fish to escape. It was characteristically clumsy in its movements, however, and considered its greatest safety lay in seclusion beneath the sand. But the students were not to be denied the experience of testing its electric properties, so it was soon scooped out on to the beach, where it was prevailed upon to deliver about fifty successive shocks in a space of ten minutes or so. These were quite intense at first, but gradually weakened, and were felt from all parts of the fish, including even the ventral fins and the rim of the snout. An effort to kill the fish by stabbing it suddenly through the brain produced a discharge which resembled a blow on the biceps of the stabber, due to the sudden contraction of that muscle. . . . The electric organs of European numbfishes have been studied in detail, and most interesting data concerning them have been gathered together. The organ consists of a series of hexagonal cells arranged vertically between the upper and lower surfaces, and filled with a jelly-like substance. The discharge has all the properties of electricity, and will both cause a spark and magnetize a needle."

In deep water off the Indian coast there lives a curious electric ray which is quite blind.

SKATES.

The largest group of thick-tailed rays is the skate family, in which many species are classed. A skate has a long flattened tail with a small tail-fin at its extremity. The snout is generally pointed, and the ventral fins situated farther behind the pectorals than is usual in most rays. The back is generally studded with thorn-like spines, which are more plentiful in the males, but there is no dorsal spine such as is met with in the stingrays. The male skate has sharp cusps on his teeth, but the teeth of the female are flattened. Skates, or, as they are sometimes called,



Two Shovel-nosed Rays (*Aptychotrema rostrata*) and a common Stingaree (*Urolophus testaceus*) caught from the beach at Trial Bay.
[Photo.—A. Musgrave.]

Thornback Rays, lay eggs varying in size in the different species.

The egg is enclosed in a tough leathery or horny shell of a brownish colour, and is, as a rule, rather oblong, and with a kind of handle at each corner like a stretcher; it is known as a skate barrow, or more poetically, a mermaid's purse.

Of all the rays, skates are the most popular as food. The pectoral fins or wings are delicious when cooked, and have a rather gelatinous consistency due to the softness of the cartilaginous fin-rays. The common eastern Australian species is rather small, but is frequently caught by trawling and is worthy of the attention of epicures. Personally, after having eaten it and compared it with fresh fish aboard the trawlers, I must say that I found it more to my taste than such fish as flathead and nannegai.

In southern Australian waters large skates occur, some well over five feet in length, and these may one day be exploited commercially when people realize that there is a well-stocked larder in our seas apart from the one in our stockyards, upon which we draw so heavily. In the Orient, skates are dried for food, but fresh skates, rays, and sharks are some of the tastiest fish in the sea. Stingrays are sometimes sold as skate in Sydney and small fish-eating sharks, such as dogfishes, can often be procured disguised under the names "English Salmon" or "Smoked Haddock."

There are several species of skate in Australia, some of them of small size and beautifully ornamented, but the commonest is the trawled species *Raja australis*.

STINGAREES.

We now return to a consideration of the group which I have called the thin-tailed rays, and the most important family in this group is that of the stingrays or stingarees. Stingaree is merely an American and Australian corruption of the term *stingray*, and the expressions are practically synonymous. Those with a short tail and tail-fin and a spine have been designated true stingarees. In stingrays generally the tail is weak, often whip-like, and useless for swimming; it is, however, armed with one or more strong dorsal spines, from several inches to a foot long in large specimens, and having barbs along each side. Stingarees can inflict a severe wound by lashing the tail about and stabbing with the spine, and blood poisoning often ensues when a man is wounded by this mucus-covered weapon. I may refer to two cases here. The first, which comes from W. Australia, was reported in a Sydney newspaper; the second is quoted from a work on the fishes of Malabar, India:

"An incident unprecedented in the history of the pearling industry is reported from Broome: J. M. Archer, a diver, was attacked by a 5 cwt. Stingray, which drove its serrated barb right through his thigh, first piercing his diving dress and

three flannel garments. He was grievously wounded, and suffered agony before the pain was alleviated at the Broome Hospital." And again: "In one instance an old man was admitted to the Civil Hospital in Cochin for mortification of the arm, due to a wound inflicted by a stingray, which he attempted to drag out of the sea into a boat. It wound its tail round his arm, and dragged its spine through the muscles down nearly to the bone."

It has been suggested that there are venom glands associated with the spines of stingarees, but it seems that the slime of the fish entering the wound is responsible for the pain and poisoning which accompany an attack. Most of the stingarees encountered by fishermen are not very large, but huge specimens are met with in deeper water, and usually get their tails chopped off by the fishermen before they can do much damage. When Captain Cook's vessel the *Endeavour* made Botany Bay, the sailors caught several large rays, and the following description is taken from Hawkesworth's account of Cook's voyage:

Friday, 4 May, 1770.

[The Second Lieutenant] had observed that the large sting-rays, of which there is great plenty in the bay, followed the flowing tide into very shallow water; he therefore took the opportunity of flood, and struck several in not more than two or three feet water: one of them weighed no less than two hundred and forty pounds after his entrails were taken out.

Saturday, 5. The next morning, as the wind still continued northerly, I [that is, Cook] sent out the yawl again, and the people struck one still larger, for when his entrails were taken out he weighed three hundred and thirty-six pounds.

The great quantity of plants which Mr. Banks and Dr. Solander collected in this place induced me to give it the name of BOTANY BAY.

In Captain Cook's autograph journal, this locality was originally named Sting Rays Harbour, but these words were crossed out and Botanist Bay and finally Botany Bay were substituted.

Stingarees are common in all warm seas, and there are many species in Australia. Sometimes when the tide has ebbed

and left dry an extensive mud flat, the resting places of stingarees may be seen at intervals where clear spaces in the mud and sand have been scooped out by these creatures. They lie motionless on the bottom for considerable periods and feed on crabs, shellfish, and other small animals, which they can crush to pieces with their rows of close-set teeth. When wading at night near a coral isle in Queensland, I have seen small stony-eyed stingrays gliding over the sandy bottom inshore. A blue spotted species of great beauty is very common on the Great Barrier Reef, whilst huge brutes come over the coral reefs at high water, and leave again before the tide ebbs and strands them in the lagoon; but they leave traces behind, for one often finds clams or other molluscs with thick shells cracked as if they had been broken in a vice, and one can only wonder at the tremendous strength of the jaws of the mighty rays who can thus break up such seemingly impregnable objects. When wandering through a tangled maze of roots in the shallow waters of a mangrove swamp in north Queensland, I recently came across another kind of stingaree. In the shadows of the mangrove leaves and roots it was difficult to distinguish the features of the muddy bottom, with its crabs and fishes and molluscs, and as I was threading my way along a narrow laneway in the dim forest, it was only the timely recognition of a stingaree's tail protruding from a tangle of roots that prevented me from treading on the animal, for it was of the same colour as the shadowy mud and did not move as I approached. However, I managed to catch it in a net, and the specimen, which is now in the Australian Museum, proved to belong to a tropical species not then known from Australia.

Some of the stingrays have curious fashions so far as their tails are concerned. The Fan-tailed Ray has a flap of skin extending along the lower part of its tail, making it look like a long feather; its skin is used for making tambourine-like instruments in Sumatra. The Coach-

whip Ray has a tail several times as long as its head and body added together.

The common stingarees of Sydney are caught by the trawlers and sometimes sold in the fish shops as skate. They have a short tail with a rounded fin, but have the usual stingray spine and are most easily distinguished by their colours, their names being the Yellow-backed, Green-backed, Sandy-backed and Common Stingarees respectively.

The Rat-tailed Ray or Butterfly Ray is much wider than it is long, and is found in Queensland and northern New South Wales. It rather reminds me of a ghost like the ones children make by writing in ink on a piece of paper and then folding it so that the ink runs and forms a symmetrical design of fantastic shape.

The Butterfly Ray has wings up to three feet across, but its tail is very short and thin, and a pair of small eyes gaze from this expansive body with quite a surprised look about them.

Of what use are stingarees? There is at present practically no demand for them as food, and they are usually returned to the water after being caught. The skin in most rays is not so rough as that of sharks and consequently cannot be used for shagreen or employed for making leather. The fins are used in the production of gelatine, and the rest of the body makes good fertilizer. Natives of Pacific islands use the spiny skin of one of the stingrays as a rasp, and make needles or awls out of the spines of the tails of rays. In Australia, at least, the chief use of stingrays is as objects for dissection, and many specimens are used at the universities to teach the beginnings of vertebrate anatomy to students of science and medicine. The internal structure of stingrays, their brains, the heart, and other organs are of great interest, but hardly come within the scope of this article.

EAGLE RAYS.

Two more families of rays claim our attention, and this brief *résumé* of the Australian Batoidei will be brought to a close.

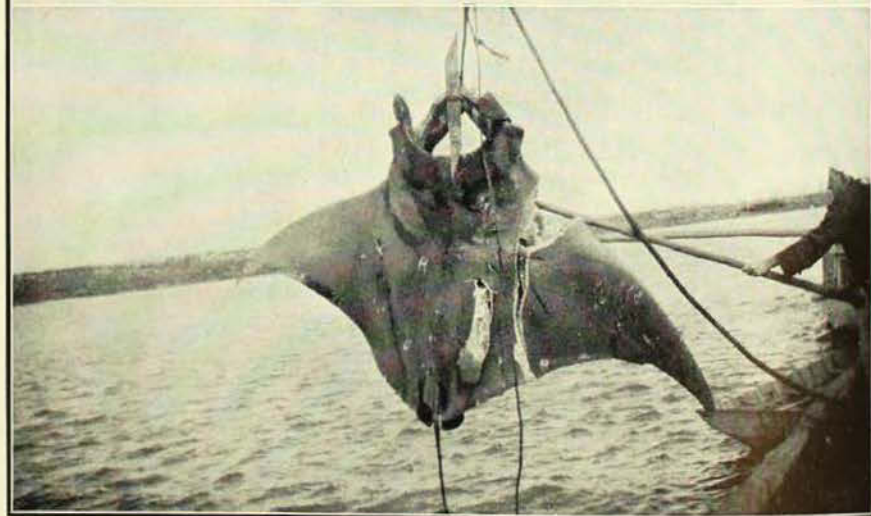
The Eagle Ray is a large animal with the top of the head elevated into a sort of dome quite unlike the rather flattened heads of most rays. It is an olive-brown species often ornamented with large blue spots, and is not uncommon at certain seasons in New South Wales and Victoria. It is also called the Mill Ray, because its teeth are in the form of flat plates which grind its food in a manner similar to the crushing of millstones. Crabs and molluscs are the main items in the Eagle Ray's diet.

The Spotted Eagle Ray is a graceful tropical species which apparently lives near the surface of the sea, and sometimes leaps clear of the water. It is dark grey, with nebulous spots of white on its back. It has a long tapering tail and a rather pronounced snout; from this it derives the name Duckbill Ray. This species is widely distributed, and reaches a width of six feet.

DEVIL FISHES.

The giant of all the rays is the Devil Fish. A mutilated specimen thirteen and a half feet wide is in the Australian Museum from New South Wales, but though several of these great animals have been caught in Australian waters, they have not been preserved and very little is known concerning the species. An outstanding characteristic of the Devil Fish is the presence of long arms or horns, one on each side of the mouth.

Smaller Devil Fishes are fairly common in Queensland and northern Australian



Giant Devil Fish (*Manta alfredi*) caught in Cape Hawke Bay. Top: Front view, showing horns on each side of the wide mouth. Middle: Under surface, showing wide gill-slits. Bottom: Dorsal surface. Width, fourteen feet.

[Photo.—G. E. Tanner.]

waters, where they are called Diamond Fishes. The giant Devil Fish, which may be over twenty feet wide, swims at the surface of the sea and is said to beat the

water with its huge wing-like fins, frightening a school of fishes into a dense mass; it then employs the horn-like arms to push its food into its mouth. Harpooning Devil Fishes is a thrilling sport in American waters, as these huge rays frequently tow a launch for a considerable distance before becoming exhausted, or may leap from the water and throw themselves at the boat, which is either capsized or smashed. The great Bat Fish of the West Indies is more than five feet across the fins when born. Accounts have been given of huge Devil Fishes attacking swimmers by grasping them in their

horns, and there is probably an element of fact in these tales.

It has been reported that a diver was at work at Thursday Island, north Queensland, when he noticed a great shadow over him. Immediately afterwards he was swept off his feet as a giant Devil Fish seized the life line and air-tube by folding its front flippers round them. Then, feeling the strain, it rushed off at full speed. The people in the boat did all they could, but by the time they had disengaged the line, the unfortunate man was dead.

The Maori name of the New Zealand "lizard," *Sphenodon punctatus*, is variously spelt. Some authorities use the form *tuatera*, and this was the spelling adopted in the July number of the MAGAZINE.

Since that was issued, a letter has been received from Mr. C. Bradney, of North Auckland, New Zealand, in which he informs us that the correct spelling of the name is *tuatara*, the second *a* being short; if it were spelt with an *e* the name would, according to the phonetics of the Maori language, be pronounced *tuateyra*.

We are obliged to Mr. Bradney for this correction and shall not offend again.

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In September the Rangers' League held an exhibition in the Blaxland Galleries of Messrs. Farmer and Co. This is the second Bushland Exhibition staged by the League, which is doing excellent work in

its endeavour to preserve and to create an intelligent interest in our native flora and fauna. The exhibits were of a diverse character, and included floral displays, exhibits of products from our eucalypts and other trees, articles manufactured from Australian timbers, photographs, drawings and paintings of bushland scenery and of animal and plant life. The Australian Museum contributed an exhibit of mounted mammals, birds and other specimens, and of aboriginal stone implements. A group of live Native Bears from Koala Park, Castle Hill, created great interest.

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At the end of August, Mr. J. A. Trimble, Senior Clerk, severed his connection with the Museum after twenty-two years' service. To mark the occasion members of the Staff presented Mr. Trimble with a smoker's stand and a set of pipes as mementoes of long and pleasant association.

Aboriginal Flaked Implements

BY W. W. THORPE, Ethnologist.

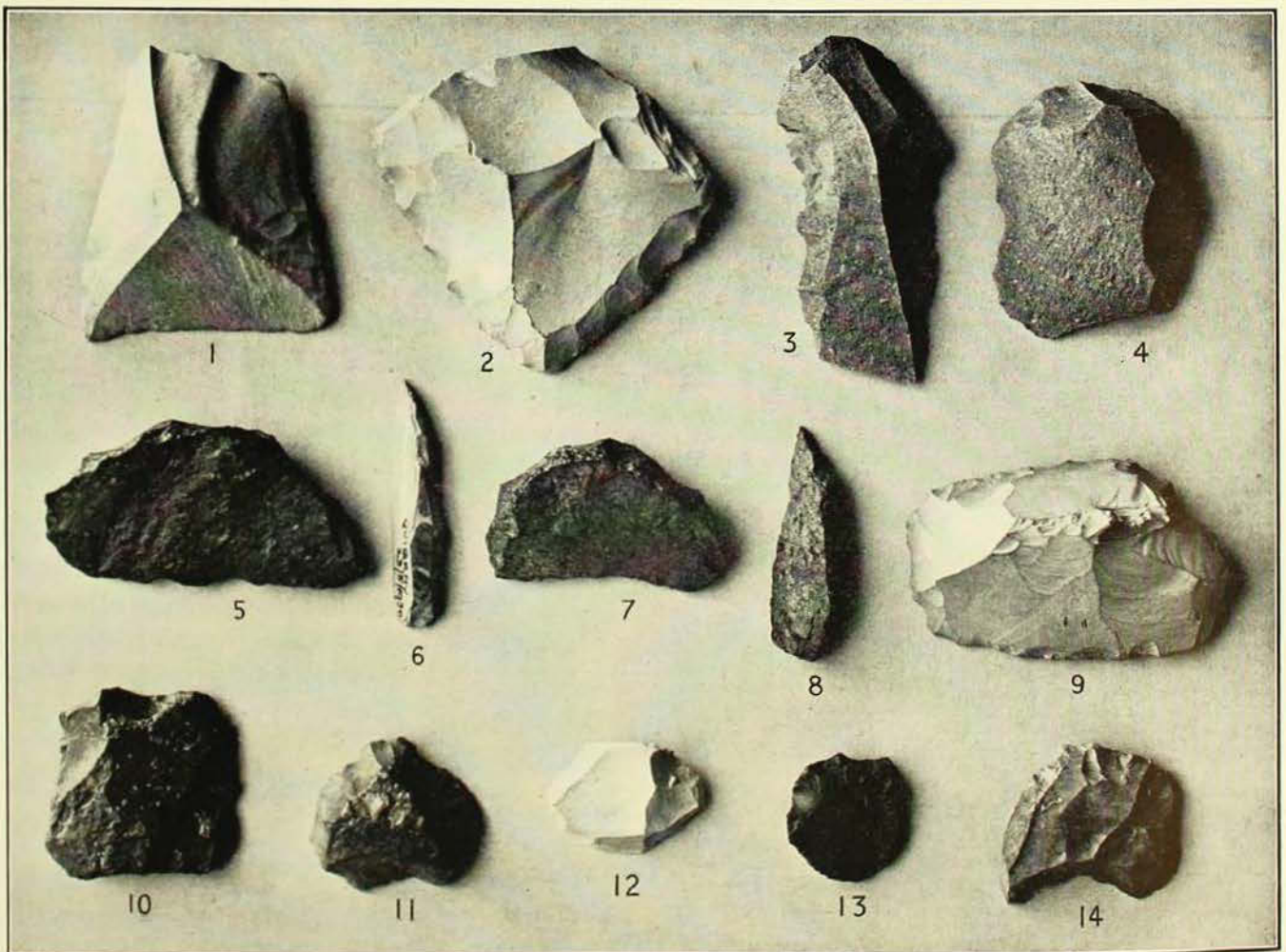
BEFORE the use of metals was discovered, man depended largely upon stone to supply material for his implements and weapons. The prehistoric peoples of Europe, Asia, and America used stone, and there are some races living to-day who depend upon it for the purposes indicated.

The Australian aborigines were skilled workers in stone, and, by reason of the number and variety of their artefacts, we can, in a measure, follow the development

of their lithic culture. From the simple flake to the more complex or specialized implement, it is an almost continuous story.

SILICEOUS FLAKEWORK.

On account of their peculiar fracture, siliceous or flinty stones lend themselves admirably to the practice of flaking and chipping. These stones have what is termed a conchoidal or shell-like fracture; that is, they break with a mathematically curved surface. This curve is inclined to-



Aboriginal Flaked Implements, from the coast of New South Wales (reduced by two-fifths). 1. Scraper, or knife (ideal form). 2. Delicately trimmed "graver." 3 and 4. "Side-scrapers." 5 and 7. "Eloueras," or chipped-back implements. 6 and 8. Chipped-back "points," or "scarfiers." 9. Trimmed scraper. 10. "Button" flake. 11-13 "Thumb-nail scrapers." 14. Notched scraper.

[Photo.—C. Clutton.

wards the opposite face of the mass, so that, when well directed percussion takes place, a sharp edge is normally produced. Conchoidal fracture is more pronounced in some forms of siliceous material than in others. By reason of the hardness and behaviour of the material when deftly broken, it was both difficult and unnecessary to resort to grinding flaked implements, though they are often found side by side with axes and knives which have been, in their manufacture, subjected to abrasive treatment.

Flakework is normally produced by two distinct processes, namely, flaking and chipping. The first consists of the removal, by *percussion* with a hard pebble, of a flake, or flakes, from a mass of stone. In the manufacture of a large implement, such as a chopper, reduction and shaping was similarly acquired. On account of the size of some flaked implements, the initial impact must have been considerable. In flaking, the mass or core was embedded in one hand, or rested upon a stone anvil. Simple flakes removed in this way were often used as knives and scrapers.

Chipping is a much more delicate process. The cutting, or other working edge, was trimmed, serrated, or made rugged by *pressure*. This was done with a piece of wood, bone, or stone, and in some cases with the teeth.

Some varieties of aboriginal flakework are highly specialized. While many flakes would be struck off, used, and discarded, there are quite a large number showing extensive and elaborate fashioning. Where the material was scarce, or hard to acquire, the working edges often show evidence of repeated retouching.

Such siliceous stones in many shades (chert, chalcedony, red, green, and mottled jasper, quartz, quartzite, obsidian, agate and silicified wood), we find amongst the materials used. Whether our aborigines were æsthetic in their

choice of stone is unknown. Probably the factor of utility was paramount, yet by reason of the fact that some of the smaller implements are of almost gem quality, one is inclined to believe that the aborigines were not entirely devoid of the sense of beauty.

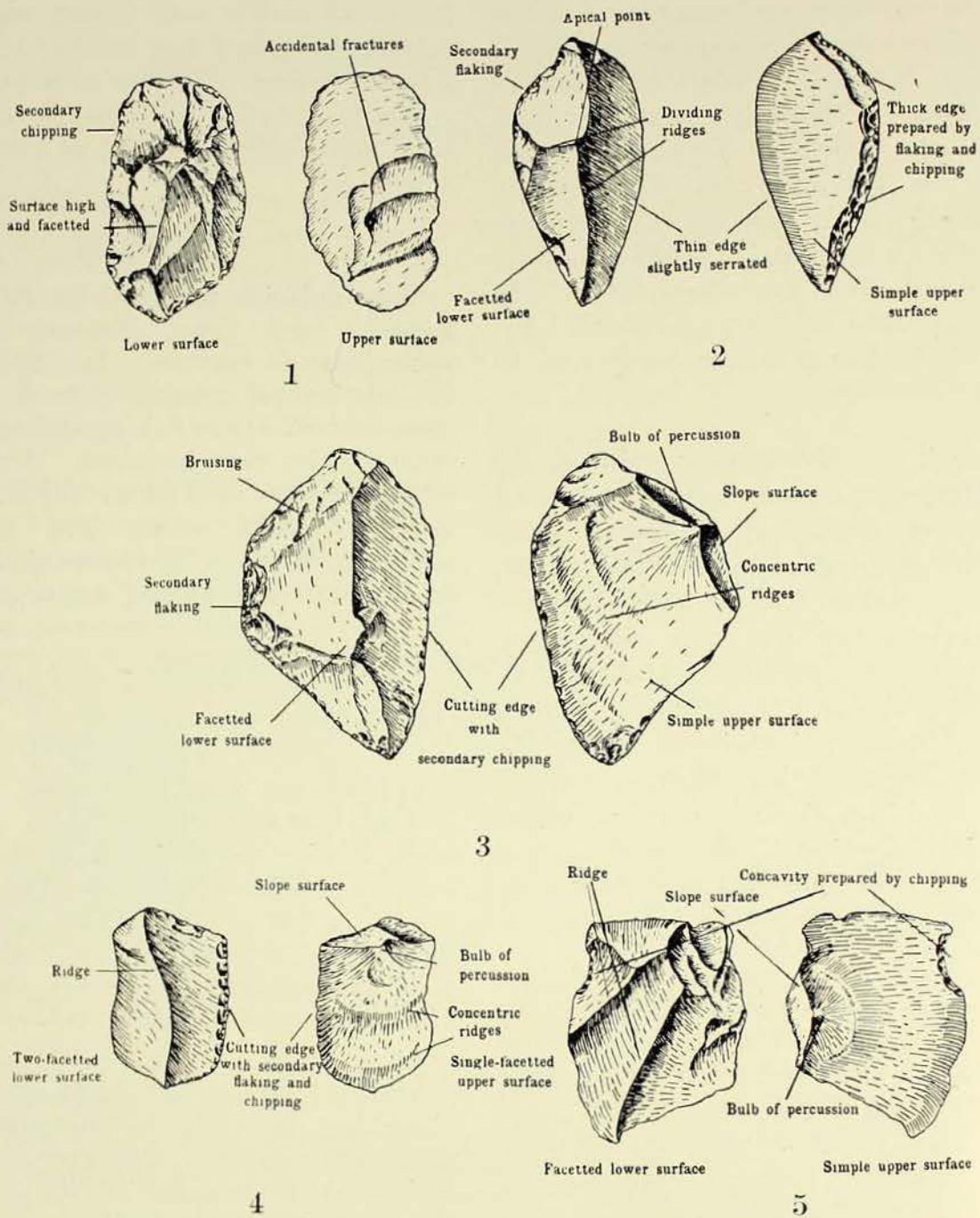
TRADE ROUTES.

That suitable material for flaking was traded over long distances by the aborigines is certain. Dr. W. E. Roth records several recognized trade routes in Queensland, where flaking-stone and other commodities were bartered. Then in New South Wales we find at north Cronulla silicified wood which had its origin perhaps fifty miles to the south, and Newcastle chert is found at native workshops situated considerable distances both north and south of this port.

COLLECTION AND STUDY.

It was not until late years that any intensive study was made of the flakework. This is to be regretted, for of several definite forms occurring in abundance on our coastal dunes the uses are conjectural or unknown. It would appear that anthropology as a science arrived about one hundred years too late.

The collecting of flakework has an absorbing interest, for the material is practically imperishable, and implements fashioned thousands of years ago—as those of prehistoric Europe and pre-dynastic Egypt—are to-day in the same condition as when used by the primitive artisan. Old camp sites, especially on the coast, seem to be inexhaustible. An enthusiast may feel that a certain area has been exhausted, but a chance visit often reveals new material. The passage of sand, influenced by variable winds, covers and uncovers these sites. Then, again, we find flaked implements in rock shelters, on washaways in the alluvial river flats, and occasionally in the vicinity of rock carvings. Along the river banks, at the base of large trees, on the edges of



1. A typical high-crowned scraper. 2. A primitive flake showing secondary chipping. 3. A simple scraper showing the typical method of formation. 4. A scraper with trigonal formation. 5. A typical "spokeshave" scraper.

[Lesley D. Hall, *del.*

clay pans, and around the billabongs these implements occur. The artisan has disappeared, the uses of many are unknown, and our lament is not only "would that we had loved him more," but would that our forbears had been more observant.

Since the above was written, an expedition, organized by the Anthropological Society of New South Wales, has excavated the floor of a rock-shelter near Ulladulla. All stone implements found during the excavation are to be presented by the Society to the Australian Museum.