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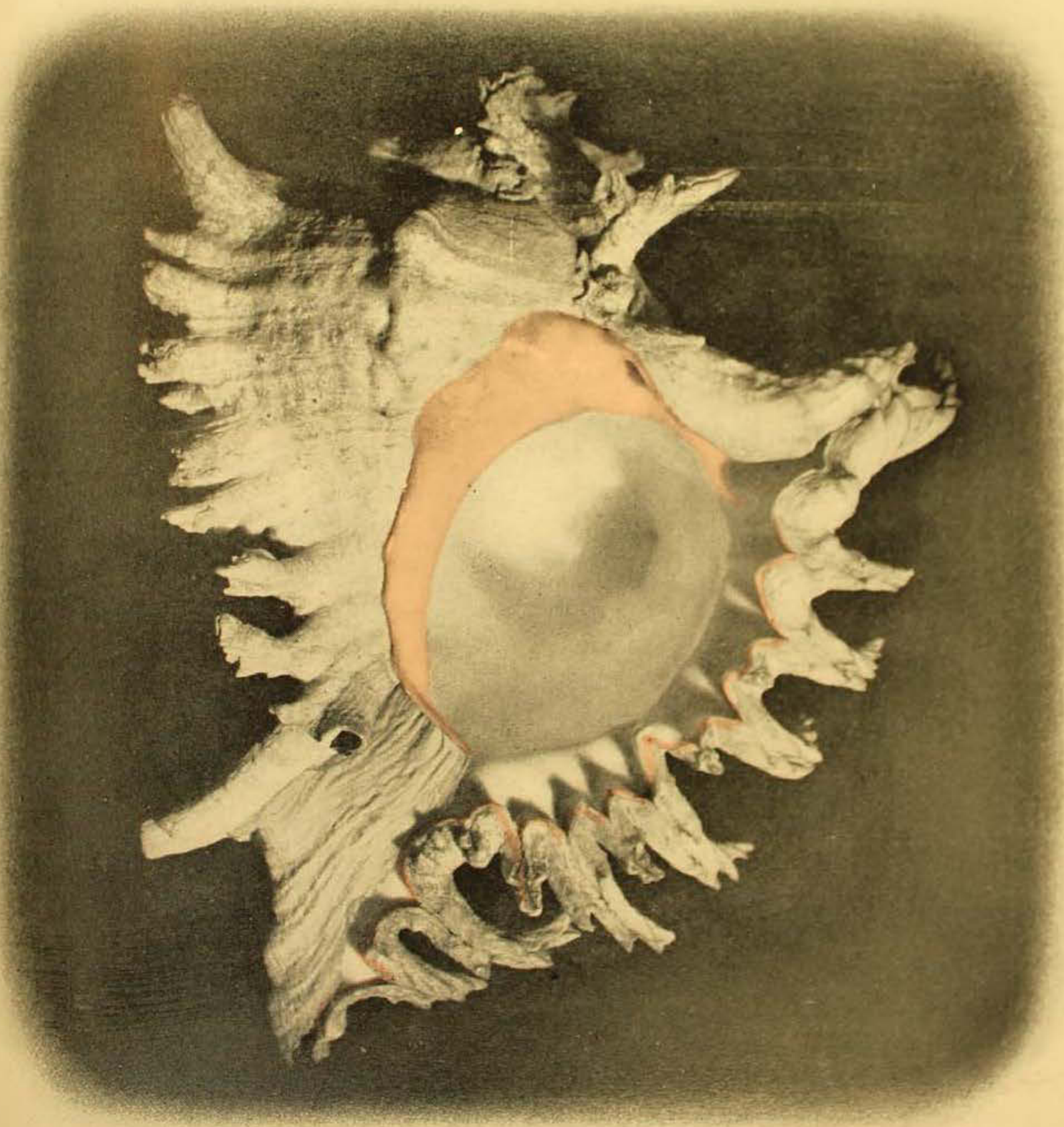

The Branched Murex Shell.

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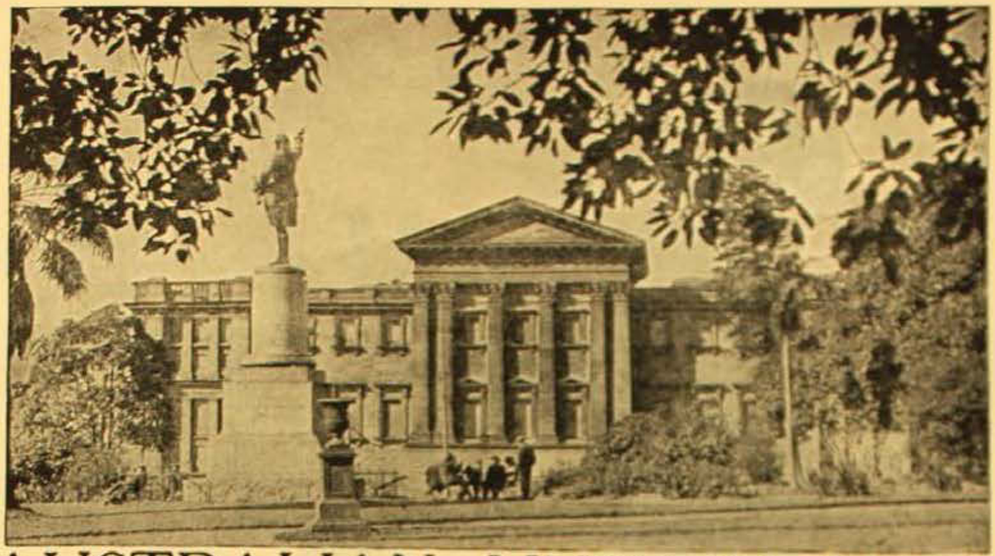
THE AUSTRALIAN MUSEUM

HYDE PARK, SYDNEY



THE AUSTRALIAN MUSEUM MAGAZINE

ADMIRALTY ISLANDS CARVINGS .. .. *Frontispiece*

MUSEUM STORAGE 289

THE ART OF THE ADMIRALTY ISLANDS—*Frederick D. McCarthy* 290

THE KANGAROO FAMILY—ROCK-WALLABIES—*Ellis Troughton, F.R.Z.S., C.M.Z.S.* 295

TOM IREDALE—*Gregory M. Mathews, C.B.E.* 299

AUSTRALIAN INSECTS. XXII. HOMOPTERA, 3—PSYLLIDAE AND APHIDIDAE—*Keith C. McKeown, F.R.Z.S.* 300

CHARLES ANDERSON 304

TREATMENT OF SNAKE BITE—*J. R. Kinghorn, C.M.Z.S.* 305

KEEPING DRINKING WATER PURE—*Elizabeth C. Pope, M.Sc.* 309

BAKER'S CREEK GORGE—*T. Hodge-Smith* 314

THE CLASSIFICATION OF AUSTRALIAN BUTTERFLIES—*A. Musgrave* 317

(*Photography, unless otherwise stated, is by G. C. Clutton.*)

● OUR FRONT COVER. This is a reproduction of the Branched Murex Shell (*Chicoreus ramosus* Linn.) on view in this Museum.

The Branched Murex Shell is one of the largest and most ornate coral reef shells, attaining a length of more than twelve inches. Its rose pink interior and almost pure white exterior form a striking contrast, which makes it a great favourite of collectors throughout the world.

Its habitat ranges throughout the coral islands of the Indo-Pacific, extending as far south as the Great Barrier Reef, where many fine specimens are obtained. The solid, branching spiny processes ornamenting the shell indicate different growth stages, and incidentally serve to strengthen and protect the shell. The mollusc inhabiting the shell, like other members of the family, is carnivorous and highly organized. Delicate fleshy folds from the animal when it is alive extend partly into the canals of the branches round the shell opening.

VOLUME VIII, NUMBER 9. SEPTEMBER–NOVEMBER, 1944.

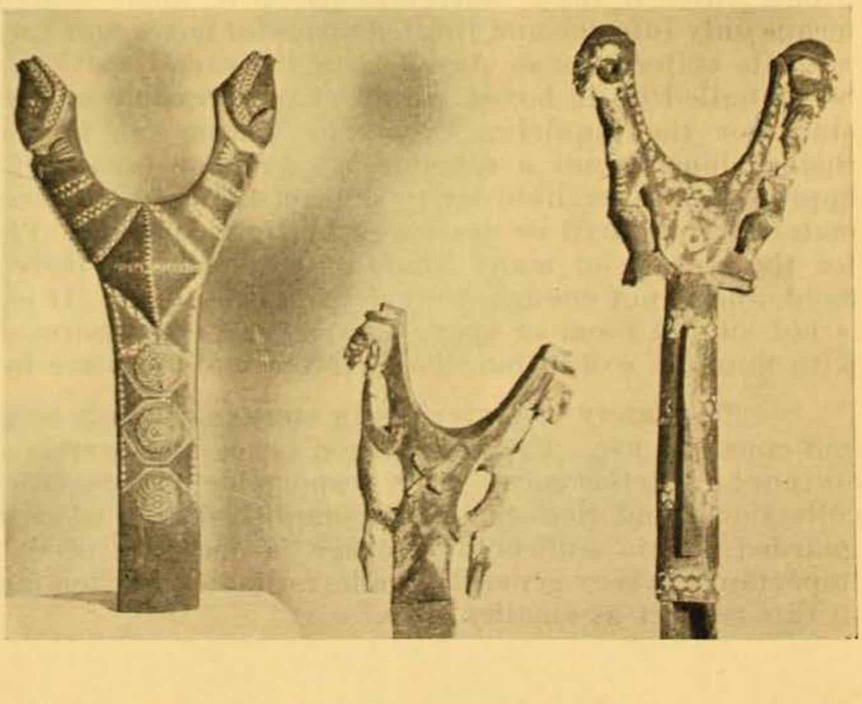
The Art of the Admiralty Islands

By FREDERICK D. McCARTHY

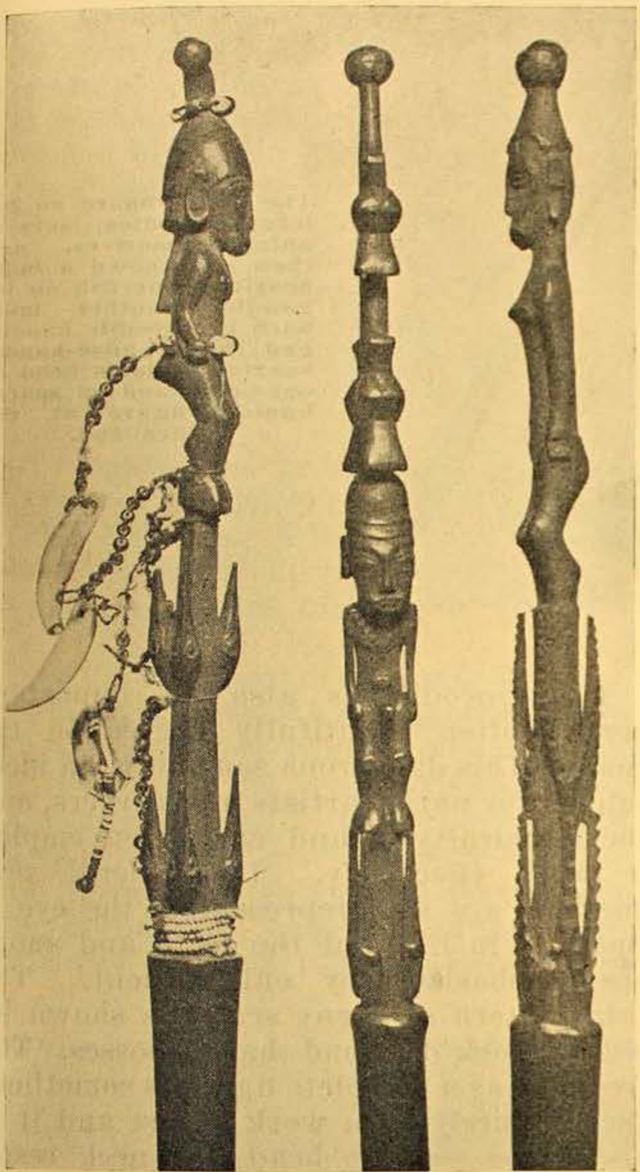
MELANESIAN art, as a whole, constitutes an astounding array of techniques and styles, of motives and designs, carried out in a wide range of materials. Its inspiration may be purely aesthetic or a combination of this factor with social and religious attitudes. Moreover, in this region of dark-skinned, frizzly-haired people the art varies from island to island and from one locality to another on the larger islands, so that the general principles applying to one cultural area may be quite different from those of a neighbouring area. One of the most interesting of these local art styles is to be found in the Admiralty Islands which are situated at the north-western end of the Bismarck Archipelago. They consist of one large island, the Great Admiralty, surrounded by numerous small islands. There is a population of about thirty-thousand natives, who are divided into three cultural groups, namely the Manus, a sea-loving folk who live in houses built on piles along shallow shores and lagoons, the Usiai, a somewhat backward people who inhabit the bush-lands on the Great Admiralty Island, and the Matankor, an industrious group which has settled on the smaller islands.

Now this distribution of the natives has had an important bearing upon their mode of life and in particular upon their arts and crafts. The Manus live chiefly by fishing and trading and are noted canoe-men, the Usiai depend mainly upon their gardens and the products of the bush, while the Matankor are not only fishermen and gardeners but are also the finest wood-carvers in the Admiralty Islands. In addition, local groups of villages specialize in the manufacture of particular articles; for example, excellent woodwork, basketry, and obsidian implements are produced at Balowan, wooden beds at Rambutchon and so on through the various items made in the archipelago.

We find, therefore, owing to some extent to the nature of the economy of the Admiralty islanders, that a high standard of craftsmanship and artistic merit are prime considerations in assessing the worth of articles exchanged in the all-important trade that exists throughout



This group of mast-head forks show typical combinations of figures in the round with decorative motives. The one on the left is surmounted by pigs' heads, the one in the middle by human heads combined with crocodiles, and the one on the right by two human figures. The zigzag, kapkap, and toothed motives are effectively used.



These lime-spoons are carved in a hard dark wood, which is highly polished, in contrast with the treatment of other objects illustrated, all of which are painted a soft red and bear designs in black on white. The two lime-spoons on the left bear carvings of men, and the one on the right a woman. The head-dress in the middle is ornamented by two pairs of birds. These carvings are characteristic of the Admiralty Islanders' representation of the human figure.

the group. This aesthetic evaluation of everyday things is well borne out by an inspection of the products of these natives prior to the degeneration in their work that took place after the introduction of European materials by traders. All types of utilitarian objects are tastefully decorated. Some articles are made for purely artistic purposes alone. Thus the art of this area, as a general rule, is not dominated by a ritual inspiration and in this respect it offers a striking contrast to that of the southern Solomon Islands.[1] The Admiralty Island artist is interested primarily in the shape and form of an article and in a symmetrical arrangement of the decorative elements.

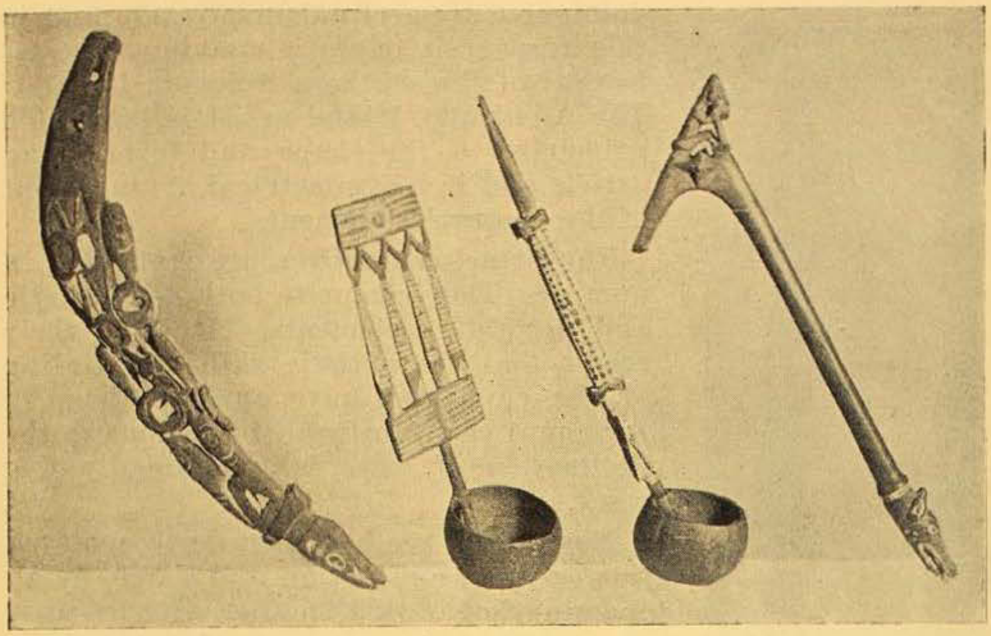
The principal motives are restricted in number. They comprise both naturalistic and decorative elements. It is to their credit that the artistic skill and feeling of the craftsmen have enabled them to surmount their cultural limitations in the production of what is undoubtedly fine work.

Now let us see how they have achieved this excellence of design and shape, by an examination of the smaller articles that come within the category of art and, in a subsequent article, by a description of the magnificent wooden bowls and drums. The Australian Museum possesses an excellent collection of specimens from the Admiralty Islands, most of which was obtained in 1887 and earlier years by Captain Farrell and others.

NATURALISTIC MOTIVES.

The human figure is perhaps the most important motive. Although it is stylized, it is notable for the well rounded modelling of the limbs and shoulders. The legs and arms are bent and the toes and fingers are not always shown. The head, too, is distinctive; it is comparatively large and fairly long and is usually covered by a head-dress which extends in a series of steps down the back of the figure. The forehead is high and broad, the eyes are usually almond shaped but are sometimes round and the nose is well formed. The ears are prominent and are represented with a large perforation surrounded by a thin loop of lobe, as in life, the reason being that ornaments are inserted in this perforation or are hung from the lobes of their ears by the people on ceremonial and other occasions. The large elliptical mouth has the tip of the tongue showing between the open lips, but the teeth are not indicated. The

[1] THE AUSTRALIAN MUSEUM MAGAZINE, Vol. viii, 5, July-September, 1943, pp. 154-59.



The canoe-board on the left embodies several animal motives, and then are shown a ladle bearing four fish on its handle, another ladle with a crocodile handle, and an adze-handle bearing a dog's head at one end and a seated human figure at the other end.

natural position of the chin is occupied by the mouth, thus giving the carved face an expression not only of surprise, but of a slight imbecility, somewhat like that of a cretin. The cast of features, in fact, is Mongoloid rather than Melanesoid, a characteristic of this art which indicates an Indonesian or Micronesian influence in the style.

The human figure is employed widely in Admiralty Islands' art as part of the decoration of various objects. Large figures of the male and female are carved on the door-posts of the men's clubhouses. On many spears a male figure is incorporated in the ornate portion of the head just below the obsidian point. On the handles of coconut-graters and of adzes a standing figure is neatly carved on the grip end and a reclining figure on the elbow of the haft. Some of the forked mast-heads bear this motive on the outside of each arm and it sometimes forms the handle of ladles and lime-spoons. The legs of the wooden beds may be fashioned as the upper part of the human body, or a face joined to a long pointed body is carved on each corner. Thus the artist embodies the head, the upper part or the whole of the human body in his pattern of decoration in such a way that it harmonizes with the other motives, or forms the dominant feature of the design.

The crocodile is also an important motive often beautifully carved in the round. This dangerous saurian is an ideal subject for native artists and carvers, and the Admiralty Island craftsmen employ it most effectively. Its general proportions are well represented, the eye is small as in life, but the teeth and snout are emphasized by enlargement. The skin pattern of horny scales is shown by red or black diamond-shaped bosses. The crocodile as a complete figure is sometimes carved purely as a work of art and it is also to be seen on head and neck rests. The head of the animal is beautifully carved on the ends of canoes, paddles, adzes, coconut-graters, and on the top of both arms of some of the forked mast-heads. The crocodile fits perfectly into decorative panels in high and low relief, as on the paddle-blades, canoe-balers, floor-boards of houses and on the handles of many implements. One interesting point is the manner in which the fore-limbs are represented as a collar round the body where it joins the shaft on the end of which it is carved.

Then on many of the above objects is to be seen an interesting combination of the human figure and the crocodile. The former is usually posed as though it is held by the latter's jaws, but in some carvings the man appears to be sitting on the crocodile's snout. It is worth noting that in many other parts of Melanesia, more especially on the large posts of ceremonial and canoe houses, a crocodile, a shark or other fish is shown holding a man or a bird. An Admiralty lime-spoon in the collection has at one end a crocodile holding two turtles.

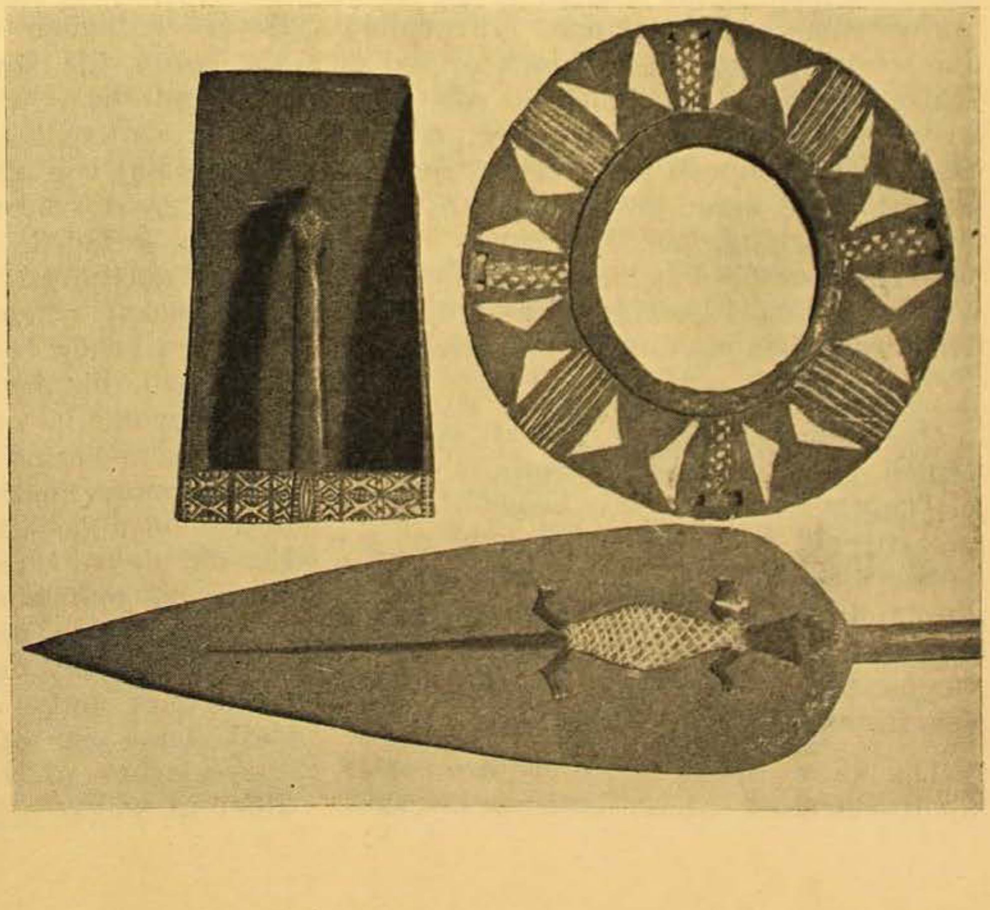
Other naturalistic motives employed in the Admiralty Islands are fish, birds, lizards, the pig, opossum, turtle and perhaps a few others. They are used in a similar manner to the crocodile, but not as commonly. Fish and birds are often represented in rows and pairs on the filigree canoe-carvings. One paddle in the Museum's collection is adorned with a lizard exceptionally well carved on the pear-shaped blade.

DECORATIVE MOTIVES.

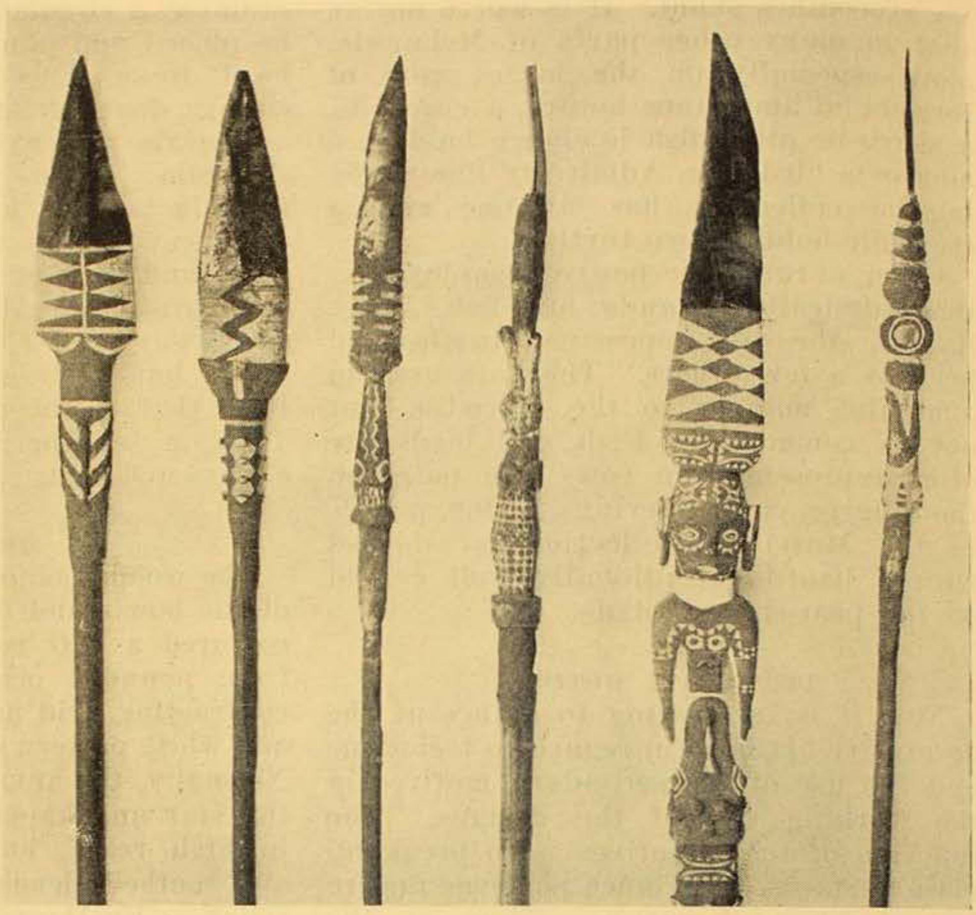
Now it is interesting to glance at the decorative art both in regard to technique and the use of the secondary motives in the working out of the designs. The function of these motives is to break up plain surfaces, to balance patterns and to form borders of panels. Thus, on the triangular butt of the adze-handles, for example, a circular design or a star may be placed and along the shafts of mast-head forks a combination of spirals, zigzags, double triangles, toothed triangles and ovals may extend from one end to the other. The circular motive is a reproduction of a filigree tortoise-shell ornament known as a "kapkap". The front and back of the article are treated as a pair and are decorated in exactly the same way, and this applies to the two sides, but their designs usually differ from that of the other pair of surfaces. Thus a symmetrical arrangement is always achieved.

METHODS.

The wooden objects, with the exception of the bowls and lime-spoons, are always coloured a soft red with a paint made from pounded ochre and this forms a contrasting field against which the black and white pattern stands out very clearly. Normally, the human figure and animals, the star and kapkap motives are carved in high relief, but the zigzag, triangle and toothed elements are usually in low relief. Furthermore, the three latter motives are usually painted black and



The canoe-baler (top left) bears bands of decorative motives on its sides and front and a bird's head at the top of the handle, the rat-stopper board (top right) displays a radial design of zigzag, anvil, triangle and parallel line motives, and the paddle exhibits a well balanced carving in high relief of a lizard.



Obsidian-headed spears. The decorated portion of their shafts is covered with Parinarium-nut gum and the surface is then painted red. Several of them display the crocodile, and one the crocodile holding a man. Note the use of the secondary decorative motives.

their scooped-out fields white. The black paint is made from manganese and the white from coral limestone. Throughout the work the artist uses black or red on white against a red field and sometimes black on red and in this manner produces attractive compositions.. The designs, however, are never painted on an object without carving, nor in respect to the material described is there a reliance on highly polished surfaces as in some Melanesian islands, notably New Hebrides, New Caledonia and Fiji.

One other technique might be mentioned. The handles of combs, the hilts of daggers and the ornate heads of spears are covered with the black gum of the parinarium nut, which is then moulded into rounded surfaces. The gum is easy to carve before it hardens, and on the combs it is modelled into excellent representations of the crocodile's head.

The many objects mentioned are not all upon which the carver lavishes his skill. Actually, the Admiralty islander is surrounded by the fine products of his clever craftsmen. When a man enters his house his love of art is at once appeased by the carved and painted domestic utensils and implements; when he goes out fishing or on a voyage in one of the great trading canoes his aesthetic sense is satisfied by the ornate prow and stern, mast-head, balers, paddles and spear-racks; when he sits down in the evening to chew betel and lime, or attends a festival, his feeling of well-being and contentment is enhanced by the artistically shaped and decorated instruments. Furthermore, in the men's club-house the posts and floor-boards are carved, and in the old days, when he went to war, his weapons, too, bore the traditional art motives of his people. The Admiralty islanders, therefore, have reason to be proud not only of their high manual skill, but also of the application and appreciation of their art in so many different ways.

The Kangaroo Family

Rock-Wallabies

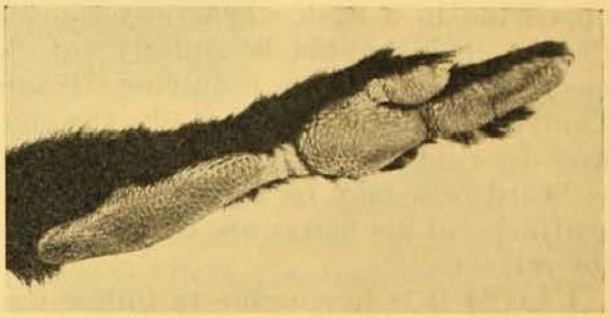
By ELLIS TROUGHTON, F.R.Z.S., C.M.Z.S.

THE present article in the kangaroo series, which began with this volume of the MAGAZINE,[1] is concerned with the distinctive group known as Rock-Wallabies. These attractive small wallabies, as the popular name indicates, haunt the rugged country favoured by their giant wallaroo cousins of the kangaroo family. They were once found in most rocky ranges and amongst boulder-strewn outcrops throughout the mainland, but are not present in Tasmania or New Guinea.

Their rock-dwelling habits have developed modifications of the hind-feet and tail, which distinguish the "rockies" from all their wallaby brethren. The tail is more uniformly slender and brushy and usually tufted at the end, acting as a rudder-like balancer for the agile creatures. It therefore lacks the thicker base characteristic of the tails of typical wallabies and kangaroos, which use the tail as a lever when grazing or moving slowly, and as a balancer when speeding. The hind-feet of rock-wallabies are specially well padded and the soles roughly granulated for safe landings after great leaps, and to avoid slipping while scurrying along the rocky tracks polished by countless generations. About the Jenolan Caves and other limestone regions, visitors are often surprised to note that rocky tracks and even limestone walls may have highly polished surfaces, actually caused by the friction of the feet and fur of the wallabies, which imparts a glass-like sheen to the limestone, as shown by several examples in the Museum.

HABITS AND HAUNTS.

The agility of the various species of rock-wallabies is really astounding and it is improbable that any other furred animals could leap so daringly to narrow ledges and amongst jagged rocks without relying upon the fore-limbs as well as the hind ones. If hotly pursued some distance from rocky outcrops, leaning trees may easily be scaled at top speed, the wallaby springing as high as possible up the trunk to gain a fork or limb. There it will perch, gripping only with the padded feet and central toes, which bend more freely than those of other long-footed wallabies. The tail meanwhile hangs downward as a prop or balancer, so that, if treed by any chance, the general attitude is quite suggestive of the tropical tree-wallabies of north-eastern Queensland and New Guinea, dealt with in the preceding article. As befits its rock-hopping habit, however, the rock-wallaby retains the disproportionate development of the hindquarters typical of the family, instead of the possum-like reduction of the hind-limbs, and increased grasping ability of the fore-limbs, seen in tree-wallabies.



The hind foot of a rock-wallaby is specially padded, and the sole roughly granulated, for safe landings on narrow ledges of rock.
Photo.—A. Musgrave.

Various kinds of grasses provide the main diet of rock-wallabies, so that the general structure of their dentition shows a much closer relationship with typical wallabies than with the mainly leaf-eating tree-

[1] Troughton: THE AUSTRALIAN MUSEUM MAGAZINE, Vol. viii, No. 1, June-August, 1942, p. 17.

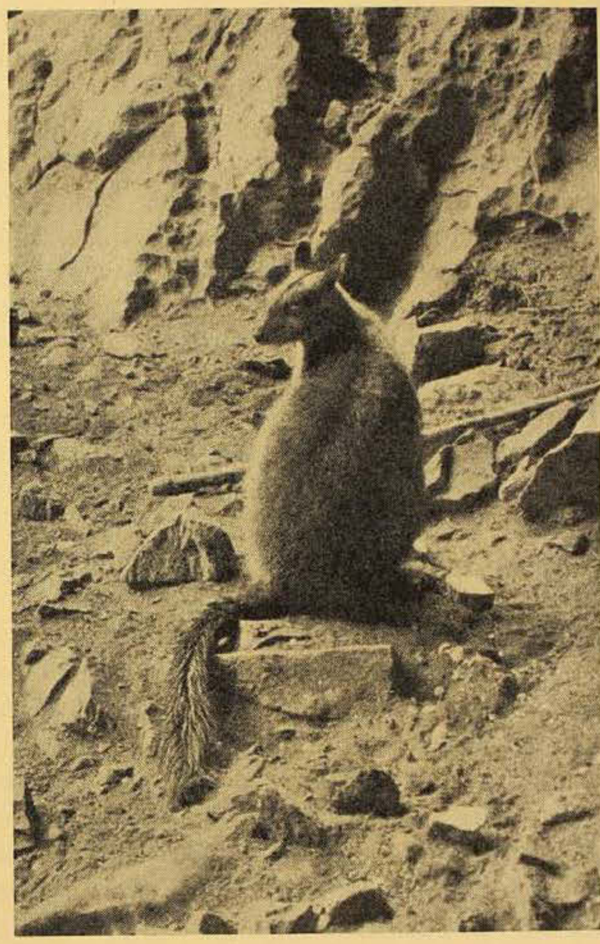
wallabies of the tropics. However, rock-wallabies favour many kinds of foliage and wild lilies, as well as roots and bark upon which they may subsist in very dry regions when there is no rain to fill their rock-pool fountains.

Like most of the kangaroo family they lie up during the hottest part of the day, while the coldness of their rock-shelters generally drives them out for a sun-bath in the morning and late afternoon. At such times, many an early explorer must have been cheered along his lonely way by the sight of the little sun-bathers, squatting bolt upright on rocky spurs and silhouetted in the glow of the setting sun. Occasionally, the "rocky" may trust to colour-protection and remain "at the alert" with intent gaze, though disappearing in a flash when fully alarmed. Should their haunts be quietly invaded, one may often hear an inquiring "Thump! Thump!" of feet, something like the signal used by rabbits. If no answering thump is heard, one may be sure that the little sentinel and his mates are on the *qui vive* for retreat.

Usually it is impossible to follow them, as there are favourite tracks leading to the safety of their cave-haunts, in which they will lie hidden and allow a close approach, which unfortunately makes them easy prey wherever foxes and wild dogs exist. In spite of their amazing agility, rock-wallabies also fall victims to quite sluggish enemies because their haunts are usually inhabited by large carpet snakes or pythons which easily catch the young and less powerful wallabies. As with many marsupials, the lack of an acute sense of self-preservation, which would make them such attractive tourist assets in our national reservations, actually endangers their survival beyond the next few decades of our civilization.

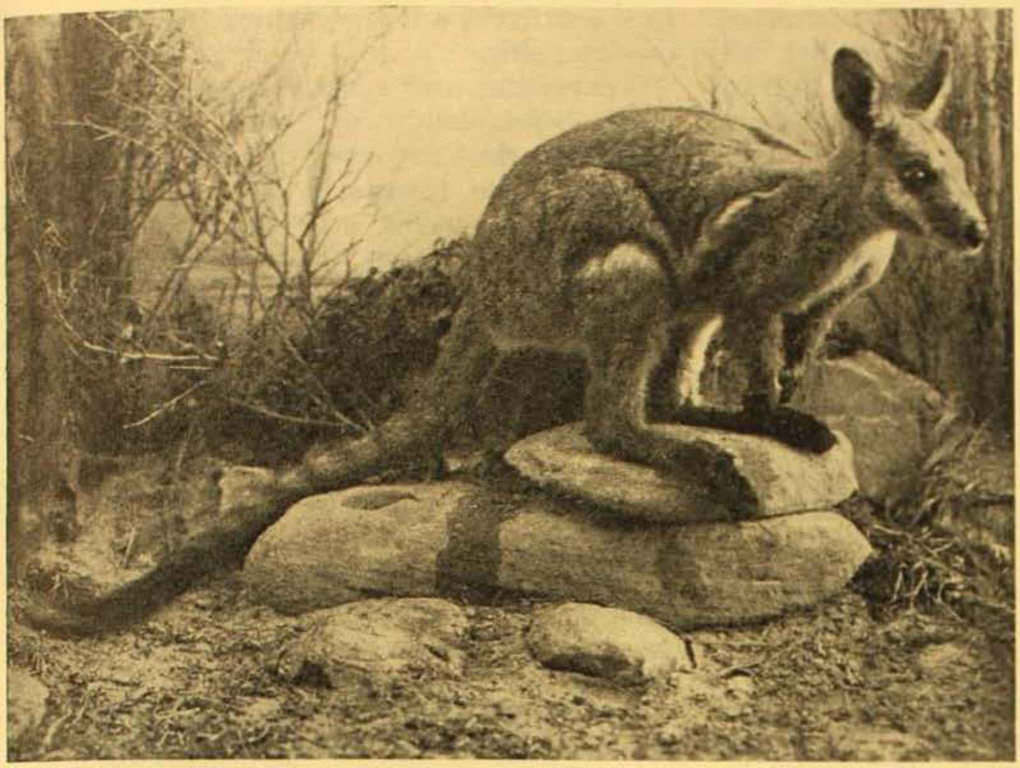
BRUSH-TAILED ROCK-WALLABY.

It will surprise most readers to learn that of the many species and geographical races described since the early work of the great naturalist Gould and his collectors, ten full species of rock-wallabies are still recognized. These larger species are placed in the genus *Petrogale* of 1837, from the Greek meaning a rock-weasel, in reference to the rocky haunts. This indicates much early confusion as to the mammalian relationships of the unique Australian marsupials. The best known is the sombre but richly tinted Brush-tailed Rock-Wallaby of the mountainous



The Brush-tailed Rock-Wallaby, made known in 1825 by a sketch of a "New Holland" specimen. The quaint marsupial is a special attraction at the Jenolan Caves, but its natural range, the mountainous regions of eastern New South Wales, is now seriously limited by the activities of man and the introduced fox.
Photo.—A. Musgrave.

regions of eastern New South Wales. First species to be described, its original description was based on drawings of a "New Holland" animal from near Sydney, which were published in 1825. As the popular name indicates, the most distinctive feature of the local species is provided by the thicker brushing of the tail throughout its length, a feature to which the specific name of *penicillata*



The Bar-tailed Rock-Wallaby, originally described from the Flinders Range, South Australia. Most brilliantly coloured of its genus, this species has been known by the name of "yellow-foot". The bright yellow "barring" of the tail is the most striking feature of its spectacular ensemble.
Photo.—Harry Burrell, O.B.E.

refers. The rich, dark yellowish-brown colour and stout build of this fine species seems to reflect, as with the wallaroo of New South Wales, the sombre gorges of its mountain habitat.

The friendly and attractive nature of the Brush-tail species is well-known at the Caves House at Jenolan, where they are fed daily by visitors with suitable scraps of bread and greens. Elsewhere they have become so scarce and isolated in range, owing to the ravages of the fox and dingo and exploitation by man, as to cause anxiety for the survival of the beautiful marsupial. One early account likened them to monkeys because of the spectacular agility which Gould considered sufficient protection from aborigines and dingoes. Unfortunately, settlement and the fox have since banished them from many favoured haunts, and one can only hope that colonies will survive in some mountain strongholds remote from man, or in primitive sanctuaries from which the fox may be eliminated.

BAR-TAILED ROCK-WALLABY.

The most brilliantly coloured of the genus, second only to the New Guinea tree-wallaby amongst brightly coloured members of the kangaroo family, is the Bar-tailed species originally described from the Flinders Range in South Australia. It is, moreover, one of the largest of the genus, its overall length being 52 inches, half of which is accounted for by the tail. Usually called the Yellow-footed Rock-Wallaby in nature books, because of the bright coloration of the feet to which the specific name *xanthopus* refers, the dark brown and bright yellow ringing of the tail provides the most striking feature of a really sporting ensemble.

Following the steady disappearance of this lovely wallaby from many of its old haunts, Professor Wood Jones stated in 1924 that its elimination from the southern region of the State appeared certain, because the softly-furred and brilliantly-coloured pelts were far too attractive for survival within reach of man, as long as trading in marsupials' skins was permitted. Although now totally protected in South Australia, such protection is not provided by the three adjoining States, so that it is not surprising to find that pelts are commonly disposed of in the markets of the other States, though illegally taken within the boundaries of South Australia.

It is a typical example of the kind of treatment which has been afforded all that is most striking and beautiful of our flora and fauna. Animals have been eliminated from the natural haunts which they should, at least partly, share in peace with man for his pleasure and the instruction of the young. The tragic fate of various species of marsupials in competition with introduced enemies, and inter-state trafficking, would seem to prove beyond possible doubt that Federal control provides the only adequate means for unifying State laws for the conservation of the unique fauna of the Commonwealth.

The discovery of the Bar-tailed Rock-Wallaby in the Flinders Range was one of the last made by the naturalist-explorer Frederick Strange, who was killed soon afterwards by blacks on the Percy Isles, off mid-coastal Queensland. Referring to the loss of this resourceful collector, Gould regretted that the name of one who sacrificed his life in the cause of natural history had not been commemorated in this fine species. Little did any of those venturesome souls, who found in our fascinating fauna a lure greater than the greed for gold in a new country, realize that in less than a century many of their discoveries were doomed to extinction by the follies of their fellow men.

Of the other large and generally plainer species, several occur along the far northern coast and in tropical Queensland where it is hoped that either the drier conditions, or tick-infestation of tropical brushes may limit the activities of foxes. There are also several island species, such as the one named *longmani* after the present Director of the Queensland Museum, because of the assistance afforded the Hubert Wilkins expedition which obtained specimens on Groote Eylandt in the Gulf of Carpentaria. Another insular species was described by Professor Wood Jones from Pearson Island, Investigator Group, at the eastern end of the Great Australian Bight, where it had long been an attractive sight on the granite boulders when viewed from passing ships.

Travelling awkwardly in open country, with head held low and tail arched upwards, they are very different creatures amongst the fantastic granite boulders, where there seems no leap they will not dare and no chinks into which they will not hurl themselves. These island wallabies have no obvious natural enemies, although sea-eagles, crows and the large seals known as sea-lions may perhaps occasionally take toll of the sick or very young. Their habit of sitting calmly exposed at all times of the day, however, suggests that there is little normal threat to their safety. It is undoubtedly upon such island communities, with the creation of other island sanctuaries, elimination of fire risks, the fox and competition with domesticated stock, that the survival of many small kangaroos and other marsupials must finally depend.

LITTLE NORTHERN ROCK-WALLABY.

The smallest of its kind is the Little Rock-Wallaby, which is now placed in a genus to itself, because of the discovery that the molar dentition is unique amongst marsupials, in that the teeth are renewable throughout life by sliding forward like the contents of a slot machine. This small species, with head and body about 14 inches long, was first collected near the mouth of the Victoria River in the north-west corner of the Northern Territory; the range was afterwards extended across to Arnhem Land and to the North Kimberley region of Western Australia, by the description of a sub-species.

The original specimen, in the British Museum, was obtained by Lieutenant Emery on sandstone heights about fifty miles from the mouth of the Victoria River, during the first survey of the northern coast by H.M.S. *Beagle*, under Commander Stokes, in 1839. In this area at least, the early surveyors felt no doubt as to the suitability of the north for settlement. Commander Stokes[1] said: "As

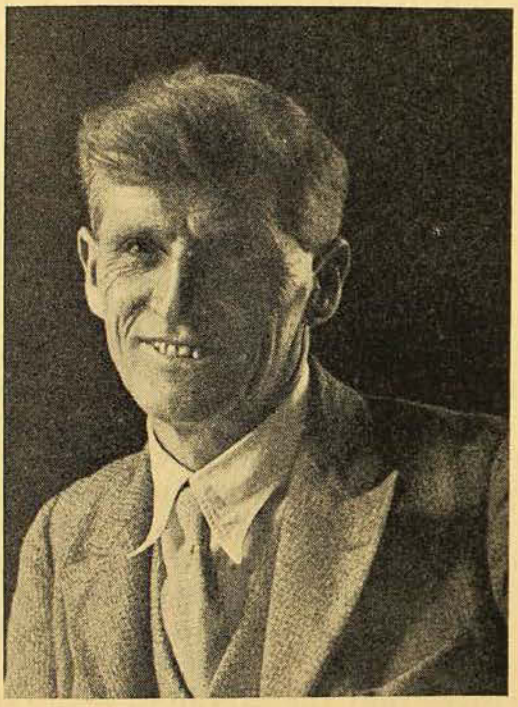
[1] Stokes, J. L.: "Discoveries in Australia", Vol. ii, 1846, p. 40.

we ran in between the frowning heights, the lead gave a depth of eighteen and twenty fathoms, the velocity of the stream at the same time clearly showing how large a body of water was pouring through.

"'This is indeed a noble river', burst from several lips at the same moment; 'and worthy', continued I, 'of being honoured with the name of her most gracious majesty the Queen'. A glance at the map will show that we have not overrated its importance, or acted hastily in calling it the Victoria; and it must be admitted that as the Murray is to South-eastern Australia, so in value and importance is the great river Victoria, to the opposite side of the continent."

Should Stokes's forecast of the importance of the Victoria River region ever be fulfilled, one wonders if it will inevitably spell the doom of these odd and gentle little rock-haunting kangaroos. In view of the past lamentable failures in providing for conservation, it becomes vitally necessary that unified Federal control should make adequate provision for sanctuaries and protection *in advance* of any intensive settlement of the remoter parts of our continent.

TOM IREDALE



(Photo.—A. Musgrave.)

Mr. Gregory M. Mathews, C.B.E., writes: "Tom Iredale—just that, and how descriptive of the man! He was born in the "Dales" on 24th March, 1880, of an ancient stock; after leaving school he became interested in business and was working in New Zealand when he heard that I had started a work on the birds of Australia. He at once thought that he would be able to help, as the work was obviously to occupy many years.

"He had a flair for zoological nomenclature, and the 'rules' were newly promulgated and much opposition was forthcoming from many quarters, but Iredale followed the rules. Naturally he did not then know Australian birds, but my collection was rapidly growing and those in London and Tring were available. His phenomenal memory was a great help and as Sherborn was then collecting the original zoological references, Iredale and I were able to get information from him that enabled us to keep abreast of the times. I might say here that many people did not profit by the work of Sherborn.

"Iredale was always willing to help a fellow worker, and he has been connected with the formation of more lists than anyone, and on many subjects—birds, shells, mammals, fish, etc.—a position in the zoological world that probably will remain unique.

"His direct way of approaching a problem did not always please, but his judgments were so often correct that people accepted his ruling on many points.

"The last thirty years have passed lightly over him, mellowing him and making him more tolerant, but it is impossible to realize that he has reached the retiring age. The energy that he always possessed has not diminished, and we all trust that he will be spared many years to continue the work that has been such a pleasure to him."

Australian Insects. XXII.

Homoptera 3—Psyllidae and Aphididae

By KEITH C. McKEOWN, F.R.Z.S.

THE remaining families of the Homoptera contain very specialized forms, small and inconspicuous, and often remarkably adapted for their particular mode of life: they are the Psyllidae (Psyllids or Lerp Insects), the Aphididae (Aphids or "Plant-lice"), the Aleurodidae (Snow-flies) and, the most specialized of all, the Coccidae (Scale Insects, Mealy Bugs, and gall-making Coccids). The Psyllids and the Aphids are dealt with here; the remaining groups will receive consideration in the next article of the series. These families contain very many insects of great economic importance.

The Psyllidae are of unusual interest since they appear to take the place of the Aphids in Australia. They are strange little insects with squat, frog-like larvae and nymphs which cluster in great numbers upon the foliage of various native plants. Some face the world naked, but the majority construct delicate waxy or sugary protective coverings under which they live and undergo their transformations or make galls in plant-tissue. The adult insects are dainty little creatures, somewhat resembling miniature cicadas.

Representative of the naked forms are *Tyora sterculiae* and *Psylla sterculiae*, both of which infest the sappy young foliage of the Kurrajong. *T. sterculiae*, the Star Psylla, congregates on the leaves, the little pale-green larvae and nymphs being remarkable in bearing a number of long white waxy filaments, four or five in number, on the extremity of the body and radiating like the points of a conventional star. Where the insects are numerous, the massed filaments often give the mass a flocculent or woolly appearance, very conspicuous on the green of the leaves despite the small size of the individual psyllids. *P. sterculiae* deposits its bright yellow eggs on the soft twigs, where the insects on hatching out cluster and suck up the sap. In both these forms the insects may be found in all stages of development at the same time, forming little family parties of parents, eggs and young. The Fig Psylla (*Mycopsylla fici*) produces blobs of white sticky sap upon the leaves of the Moreton Bay Fig under which the immature insects shelter. The constant draining of the sap by the many needle-like mouths causes the leaves to fall prematurely; dropping to the ground, they accumulate upon city footpaths, where they become a nuisance by adhering to the shoes of pedestrians. It is among the lerp-making forms, however, that we find the greatest interest and beauty of a great diversity. In discussing the effect of these insects upon vegetation, W. W. Froggatt writes: "These tiny homopterous insects belonging to the Psyllidae are well defined in Australia under the popular name of 'lerp insects', in reference to the remarkable little structures that the larvae of many species produce from the surplus sap they suck up, discharge from the anal segment, and spin into protective shields with their hind legs. Moving about under the lerp scale, they feed upon the sap until full-grown, when they usually crawl from under the shelter and rest on the surface of the leaf, while the pupal skin splits down the back, and the perfect, minute, winged, cicada-like insect emerges.

"When these insects are numerous, large areas of forest, particularly eucalypts, are so badly infested that all the foliage

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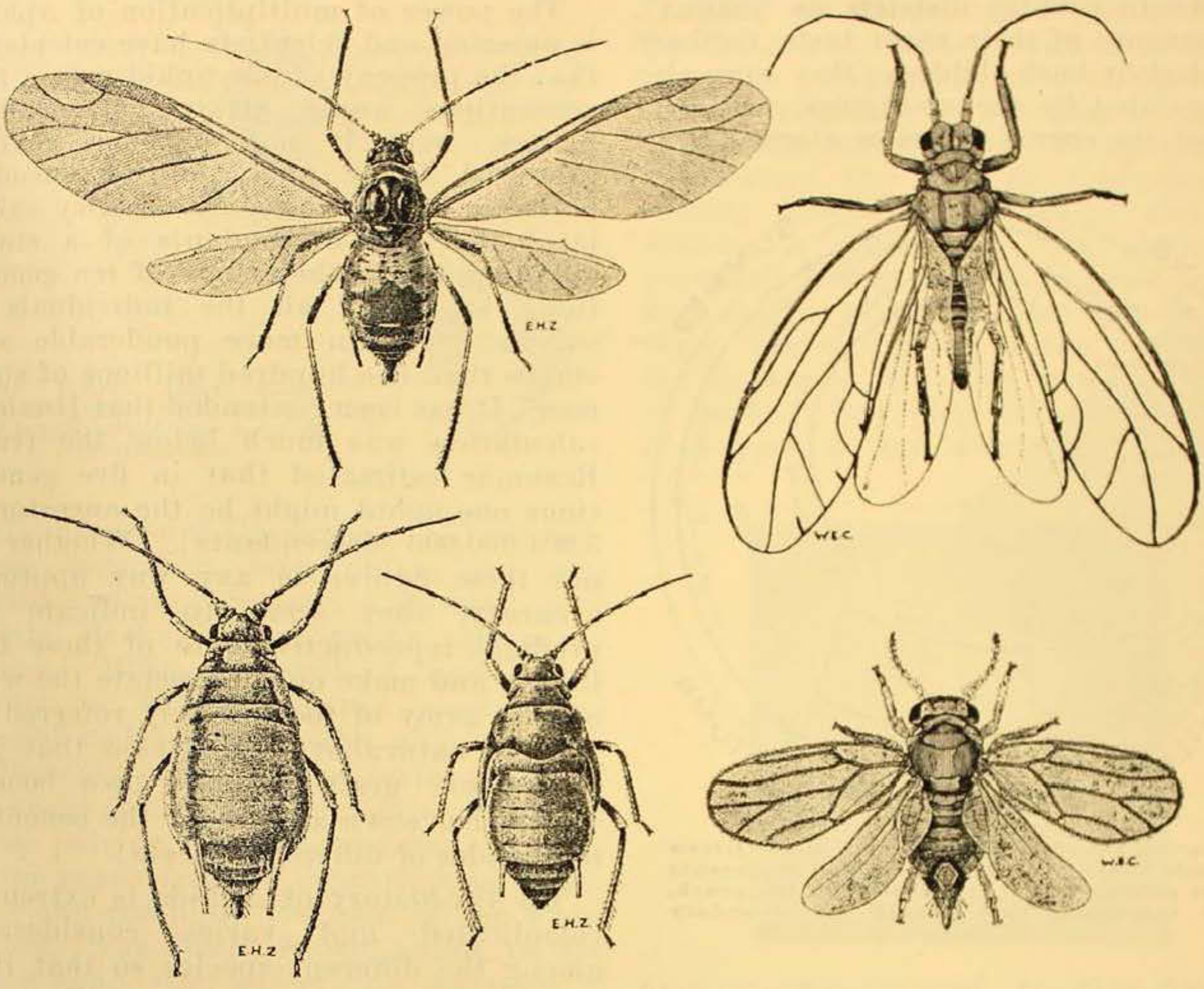


Left: The life-history of the Green Peach Aphid (3 figures); winged viviparous female, wingless viviparous female, and nymph of winged viviparous female. Right: Adult of the Star Psyllid (above) and adult of the Kurrajong Twig Psyllid. (All enlarged.)

becomes discoloured through the sap being sucked up; the leaves dry up and fall, and thousands of trees become defoliated and look in a very unhealthy condition, or as if they had been ringbarked. If suitable climatic conditions carry on the successive generations of lerp insects through several years, this constant infestation causes the tops of the gum trees to die back, and the forest rangers state that the timber becomes of an inferior quality to that of uninfested trees. Generally, however, these insects come and go; and I doubt if an occasional infestation does much harm to the trees, as under normal conditions they shed the damaged leaves and a fresh growth of foliage appears without the growth of the timber being affected."

The form of the protective lerp scale is extremely diverse, ranging from white flakes of irregular outline, resembling drops of candle-grease, in *Lasiopsylla rotundipennis*, the mollusc-like lerp of *Rhinocola pinnaeformis*, the remarkable fern-leaf-like covering of *Eucalyptolyma maideni*, to the amazing rounded covering of *Cardiaspis tetrix*, formed of a mesh of fine golden threads, through the interstices of which the little insect may be seen moving about like some strange bird in a cage of gilt wire. The lerp scale of the Sugar Lerp (*Spondyliaspis mannifera*) is conical like a miniature limpet shell, white and covered with a hairy coat of fine filaments. These scales are massed upon the leaves of eucalypts and sometimes, apparently following a change of temperature, become detached and fall, to cover the ground beneath the trees like small snowflakes. They are popularly known in country districts as "manna". On account of their sweet taste, they are relished by bush children; they were also appreciated by the aborigines, who consumed the sugary flakes or steeped them

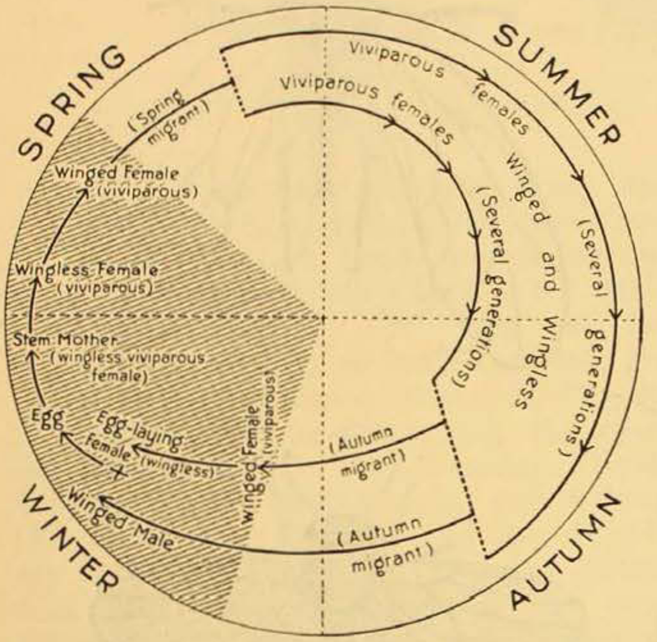


Diagram showing the life-cycle of the Green Peach Aphid. The shaded portion represents that portion of the cycle spent on the peach, the remainder that passed on secondary hosts.

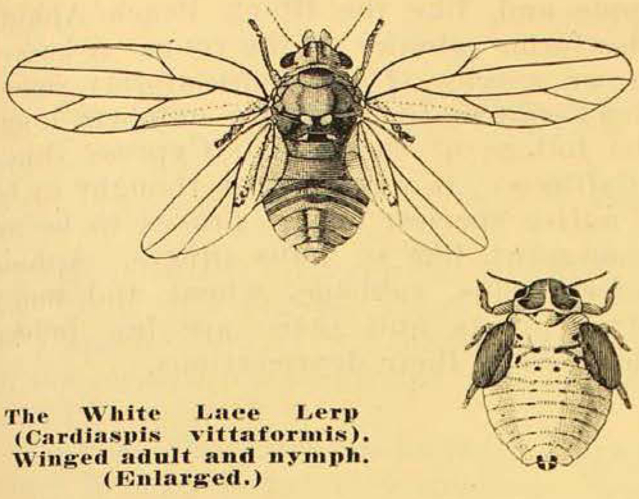
in water to concoct a somewhat insipid drink. Much work and observation is necessary before we possess an adequate knowledge of our Psyllids and their life-histories.

APHIDS OR PLANT-LICE.

With one possible exception, all the Aphids (family Aphididae) appear to be immigrants to Australia and to have come into the country with introduced plants. Many of them are of the greatest economic importance and are serious pests of cultivated crops. Aphids are small soft-bodied insects with two tube-like projections (cornicles) rising from the hinder part of the back. They have sucking mouth-parts and, in the immature stages, are, of course, wingless; the adults occur in both wingless and winged forms. The two pairs of wings, where these occur, are gauzy and delicate with a simple venation; the fore-wings being much larger than the hind.

The power of multiplication of Aphids is amazing and scientists have calculated that the progeny of one aphid over a few generations would attain astronomical figures, were it not for the control exercised by a multitude of enemies, parasitic and predaceous. Huxley calculated that the descendants of a single aphid would, in the course of ten generations, supposing all the individuals to survive, "contain more ponderable substance than five hundred millions of stout men". It has been contended that Huxley's calculation was much below the truth. Reaumur estimated that in five generations one aphid might be the ancestor of 5,904,900,000 descendants! Whether or not these figures in any way approach accuracy, they serve to indicate the prodigal reproductive rate of these tiny insects and make one appreciate the work of that army of foes already referred to. The old naturalist Bonnet said that just as we sow grain for our own benefit, Nature has sown aphids for the benefit of multitudes of different insects!

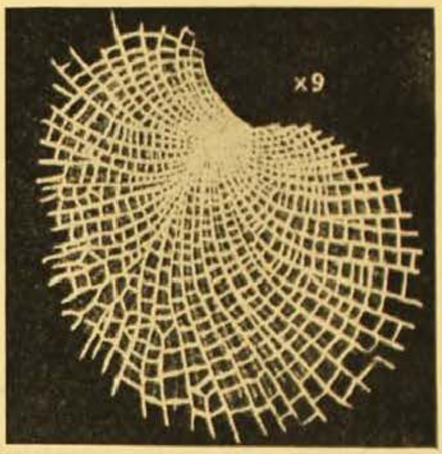
The life-history of Aphids is extremely complicated and varies considerably among the different species so that it is impossible to set down any outline that can be described as typical. To give the reader some idea of the life-cycle of these insects, those of two widely differing forms, the Green Peach Aphid (*Myzus persicae*) and the Black Peach Aphid (*Anuraphis persicae-niger*) may be briefly sketched. The egg-laying females of the former deposit their large, shining black eggs upon the buds of the peach tree in May or June; these hatch in late July or early August into minute, wingless green aphids. In an incredibly short time these aphids—all of them females—produce living young, the process continuing through generation after generation. All these spring generations of aphids are wingless and, as indicated, females; males are unknown. In early summer a change takes place and winged females appear. These winged insects migrate to other—or secondary—host plants and continue the production of wingless young—again females—which live on these secondary



The White Lace Lerp (*Cardiaspis vittaformis*). Winged adult and nymph. (Enlarged.)

hosts throughout the summer and autumn. These secondary host plants are very varied and include peas, Capeweed, sow-thistle, dock, Iceland poppy and many others. With the chill of approaching winter, a further change occurs and winged males and females appear. This is the only occurrence of males so far as we know throughout the entire life-cycle. After pairing, the winged females return to the peach trees to deposit their winter eggs and complete the turn of the wheel of life. The Black Peach Aphid, on the other hand, over-winters on the roots of the peach trees and migrates to the lower branches of the tree in early spring.. The first aphids to appear are shining black, wingless females which give birth to living young in great numbers. Later in the year, winged females put in an appearance and fly to other trees, where they, in their turn, produce living young. This species is not known to lay eggs and males appear to be entirely unknown. These are two life-histories of distinct species, both with the same host-plant, and serve to show the impossibility of generalizing in such matters and some of the intricacies of parthenogenesis—the production of young without the intervention of the male—over considerable periods at least.

Aphids are frequently attended by ants for the sake of a sweet secretion, honey-dew, which they excrete, produced from the surplus sap absorbed in feeding—often in such quantities as to coat the leaves of the plant with a sticky varnish, upon which sooty fungi grow and thrive. The foraging ant approaches a feeding aphid and strokes or tickles it with its sensitive antennae, an operation to which the aphid usually responds by ejecting a copious drop of the coveted fluid. This process of stimulating the flow of honey-dew is usually known as "milking" and the aphids, in consequence, are sometimes popularly known as "ants' cows". The ants are not always content with leaving their "herds" exposed to the weather in the situations in which they find them in nature; they erect structures formed of soil-grains and debris over them to



Lerp scale (enlarged) of White Lace Lerp, typical of the dainty protective scales produced by many species of Psyllids.

form a "byre" or "cowshed", placing a strong guard at the entrance to prevent the "cows" from straying, or the entry of undesirable intruders. It has been recorded how the ants take the aphids into their nests to care for them during the cold winter months, tending the aphids' eggs as their own and farming out the young upon the roots of suitable food-plants and later transferring them to the upper portions of these plants, with the coming of spring. To appreciate fully the most amazing aspect of this behaviour, one must remember that such a vegetarian diet is entirely foreign to the ant larva which insists on provisions of an animal nature. These observations are well authenticated, but data of a similar nature are wanting in Australia, although we know that the social insects take aphids and Coccids into their nests in the cold weather and "byres" are common objects in the bush.

Possibly the most familiar aphid in Australia is the Rose Aphid (*Macrosiphum roseae*) which swarms upon the buds of the gardener's most cherished roses, sucking up the sap and bringing his hopes of prize blossoms to naught. The Woolly Aphid (*Eriosoma lanigerum*), in which the immature forms are covered with a white waxy secretion, infests the apple and, like the Black Peach Aphid, also forms colonies on the roots. A hairy, brown species (*Cinara thujafolia*) sometimes swarms in immense numbers upon the foliage of the native Cypress Pines (*Callitris*); it was at first thought to be a native species, but it proves to be an immigrant, like so many others. Aphids infest beans, cabbage, wheat and many other plants and there are few indeed that escape their depredations.

CHARLES ANDERSON

As these pages are being completed for press we record, regretfully, the death of our former Director, Dr. Charles Anderson, M.A., C.M.Z.S., on 25th October. For forty years he had been associated with this Museum, firstly as its mineralogist and chemist, and subsequently as its Director, retiring in 1940. A man of simple tastes and possessing a deep love of science for science's sake, he contributed greatly to the advance of knowledge. To readers of this MAGAZINE he will be remembered by many lucid and informative articles, but he built his reputation on the more important contributions to the *Records of the Australian Museum* and other scientific journals. A man of wide knowledge, and truly erudite, he was ever ready to assist, for none—tyro, correspondent, or colleague—ever appealed in vain.

Dr. Anderson had been President of the Royal Society of New South Wales, the Linnean Society of New South Wales, the Anthropological Society of New South Wales, and the Geographical Society of New South Wales. The American Museum of Natural History, New York, had elected him a Corresponding Member.

Since his retirement he had been attached to the Censorship Service. He is survived by a son, Mr. M. S. Anderson, B.V.Sc., and two daughters, Mrs. E. C. Ballek and Miss Margaret Anderson. His remains were interred at South Head Cemetery, Sydney. He was in his sixty-eighth year.

For biographical details, see THE AUSTRALIAN MUSEUM MAGAZINE, Vol. vii, No. 7, December, 1940–February, 1941, pp. 220-221.

Treatment of Snake Bite

By J. R. KINGHORN, C.M.Z.S.

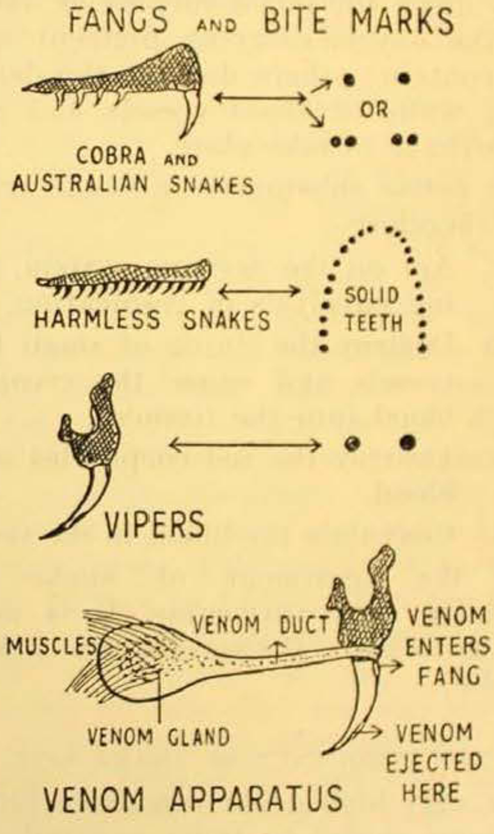
THE really dangerous snakes of Australia number approximately 12 species, but if we confine ourselves to the recognition of groups, this number would be reduced to six.

The most dangerous snake is the Taipan, which happily is not very common. Next in line is the death adder which is followed closely by the tiger snake (*Notechis scutatus*) a species rarely found north of Brisbane, and the brown snakes (*Demansia*) of which only large specimens (4 to 6 feet in length) are to be feared. The bites of various kinds of black snakes (*Pseudechis*) and copper heads (*Denisonia*), though causing severe symptoms, are seldom fatal to man.

THE VENOM APPARATUS.

Venomous snakes differ from non-venomous ones in the possession of a venom apparatus. This consists of a pair of enlarged canalized or grooved teeth, the fangs, situated on the maxillary bones, one on each side near the front of the jaw. To each of these fangs there is fitted a tube or duct which opens over the entrance to the canal or groove at the base of the fang. The tube stretches backwards below and behind the eye, and terminates in a bag known as the venom sac or gland, which is situated between the muscles that open and close the jaw. When a snake bites, the effect is much the same as squeezing the rubber teat of an eye-lotion dropper, the venom being forced along the tube and down through the fang into the victim. Developing in the gums are reserve fangs, in various stages of growth, so that when the operational one is lost it is not long before another takes its place.

The dentition of snakes enables us to distinguish clearly between venomous and non-venomous snakes, and the nature of the wound caused by the bite is also informative. Venomous snakes cause two punctures or, if a reserve fang is almost in position on one or both sides, at most three or four fang punctures may be seen. The bites of non-venomous snakes exhibit a large number of puncture marks corresponding to the numerous teeth in the upper jaw, and between them there may also be smaller markings made by minute palatine teeth.



SNAKE VENOM.

The venom of snakes is a specially developed form of saliva. It has two uses so far as the snake is concerned. Snakes live mainly on small animals, birds, frogs and other snakes, which they swallow whole after they have killed them. The venom immobilizes the prey quickly and prevents its escape and, circulating through its blood stream, prepares it for the subsequent action of the snake's digestive juices. Just as saliva has ferments in it which play a part in digestion, so snake venom is a mixture of ferments and varies in composition from snake to snake. Some snake venoms contain a powerful clotting agent which causes coagulation of the blood, and others have an active substance which causes paralysis of the brain and nerves. When a small animal or bird is bitten its further movement is stopped almost at once either by the clotting of the blood in its vessels or by the paralysis of its nervous system. Not unnaturally, the digestive ferments in snake venom which help in the digestion of prey have also a destructive effect upon the cells of larger animals; for example, many snake venoms break down the blood corpuscles and set free the oxygen-carrying pigment which they contain; others damage the delicate lining walls of blood vessels and allow hæmorrhage to take place.

The active substances in snake venoms may, therefore—

1. Act on the nervous system, causing paralysis of respiration.
2. Destroy the lining of small blood vessels and cause the escape of blood into the tissues.
3. Destroy the red corpuscles of the blood.
4. Coagulate the blood in the vessels.

In the treatment of snake bite, especially with antivenine, it is advantageous to know the species that inflicted the bite.

THE FREQUENCY OF SNAKE BITE.

The very high death rate from bites of venomous snakes in India is attributable to special causes, mainly to the density of the native population and the relatively unclothed condition of their legs and feet. The small number of fatal snake bites in Australia, an average of about a dozen annually, may be related to the sparsity of its population and to the fact that there is only a relatively small poorly clothed native population.

The chief reason for the rarity of snake bite is that most snakes are shy and avoid man if they can. Only two or three species are really aggressive, and these happily are of rare occurrence. A few snakes which are nocturnal in habit, like the death adder and some of the vipers, lie up in the day time and are unlikely to bite unless they are disturbed.

The elapine snakes, which include all the dangerous Australian snakes, are distinguished by their biting apparatus, being provided with a canalized fang with a groove down the front face, so that when they bite, especially through clothing, a good deal of venom is likely to escape. In the venoms of the snakes the constituents which act on the nervous system predominate, but a few of them (for example, those of the tiger snake and brown snakes, *Demansia*) also have coagulant effects on the blood.

SYMPTOMS OF ELAPINE BITES.

The first symptoms are nausea, vomiting and faintness, quickly followed by drowsiness. Sometimes there is pain in the chest or abdomen. The patient walks like a drunken man; sensation is blunted. The eyelids droop, speech is slurred and difficult, and so is swallowing. The limbs become very weak, though not as a rule completely paralysed. Respiration becomes slow and finally ceases.

Very early after bites by the Australian snakes, the pupils become dilated and fail to react. The patient becomes prostrate, the skin blanched and sweating, the extremities cold, the pulse rapid and thready, respirations frequent and shallow, and shock symptoms may be present.

After the bites of elapine snakes whose venoms contain coagulant ferment, the patient may vomit or cough up blood as after the bites of some viperine snakes.

TREATMENT.

The main objects of treatment are: (1) To delay or prevent the entry of venom into the blood until it can be neutralized by giving antivenine; (2) to get rid of as much as possible of the injected venom from the bitten part; (3) to combat the general symptoms of poisoning; (4) to allay the patient's fears.

ANTIVENINE.

The most satisfactory method of treatment of snake bite is by the intravenous injection of antivenine. This is made by injecting at first very small, but gradually increasing, doses of snake venom into horses until they can tolerate large amounts. Their serum is now found to neutralize the venom which was used to immunize them. Unfortunately no single antivenine is available for the treatment of the bites of all snakes.

For the snakes of Australia very high potency tiger snake antivenine is available, of which large doses must be used in the treatment of bites by the death adder and taipan. For tiger snake bites about 3,000 units (2 to 3 ampoules, 14-21 c.c) of concentrated antivenine would probably suffice, whereas for bites by the taipan or death adder 6 or 8 ampoules (40-50 c.c.) of antivenine are needed for the initial dose, and as much again should be given if symptoms persist.

FIRST AID TREATMENT.

The first step in treatment is the application of a ligature. This gives time to get the patient to the doctor, who will give antivenine as soon as possible. Ligature is only applicable to bites on the limbs and should be applied at once tightly enough to stop all the blood flow to and from the limb. Though the most suitable ligature is a large, soft walled rubber tube, a large handkerchief, a boot lace or a piece of string tied tightly round the limb will serve. It may be tightened by inserting a stick and twisting this round. The ligature must be applied between the bitten part and the heart. It should be left in position for half an hour, after which it is wise to lift it for half a minute to allow fresh blood to enter the ligated part. This should be done every ten minutes for the next hour. Each time the ligature is lifted some venom will of course enter the circulation. If the ligature is on the lower limb the patient should not attempt to walk, because the movement of the muscles lifts the ligature and permits the entry of venom into the circulation. The ligature keeps the venom out of the general circulation until antivenine can be injected. In the case of some venoms it may localize part of the poison in the ligated part and in any case it affords time for measures to remove venom from the bitten part.

Immediately after applying the ligature steps must be taken to remove venom from the bitten part. If the bite is on the trunk where a ligature cannot be applied, these measures will have to be adopted straight away.

The first thing to do is to wash away any venom on the surface of the skin. This is particularly important in the case of elapine snakes in which, owing to the nature of the fangs, a good deal of free venom is nearly always left on the surface of the skin.

The next step is to excise the bite, or if it is on the body to cut out the bitten part. This may be done by lifting up the fold of the skin and tissues including the bites and cutting it out with a sharp knife. For this to be of any use it must be done within the first three minutes after the bite. All the tissues to the bottom of the fang puncture should be cut out, but this would be very difficult to do in the case of bites by snakes with large fangs like the taipan. As soon as the bite is cut out suction should be applied to the wound. This can be done by the mouth *if this is healthy*, because it has been shown that snake venoms in the mouth or stomach do not cause any poisoning because they are not absorbed, but are destroyed by the digestive juices. A simple method of applying suction without sucking by mouth is to burn grass or paper in a pannican or other available utensil and clap this over the wound. The heat drives most of the air out of the cup and as the air which is left in it cools, strong suction is exerted on the wound. This can be done repeatedly.

VENESECTION.

Another method of treatment by which some of the venom may be removed from the ligated part depends upon washing out the venom with some of the patient's own blood. This method can only be used when the patient reaches the doctor. It is only of use if the bite is in a limb and a ligature has been applied immediately and is still in position when the patient is seen. It is likely to be specially useful if antivenine is not available. Two ligatures are applied to the limb, one above the other. The upper one is applied just tightly enough to obstruct the veins but not the arteries. The lower one is the ordinary ligature. When the lower ligature is lifted, if a small opening has been made in a vein, blood instead of flowing back into the patient's circulation will flow out and carry with it some of the venom. The same method may be used in order to wash out venom from the wound which has been made by excising the bite.

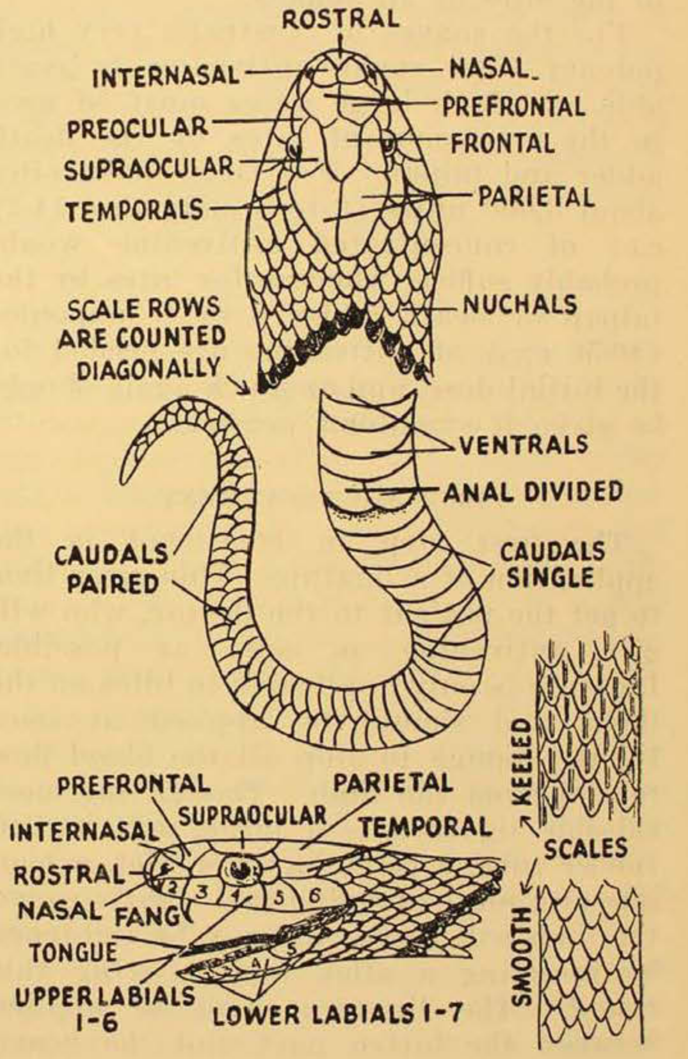
A useful early medical treatment is the application of a wet dressing of glycerin and Epsom salts, which causes a flow of serum and draws out venom from the wound.

GENERAL TREATMENT OF SNAKE BITE.

The patient should be kept warm and at rest. His fears should be allayed by impressing on him the fact that he has already escaped the severe and immediate dangers of snake bite and will certainly survive. Hot drinks are the best stimulants. After the bites of viperine snakes the severe shock-like symptoms can be combated by blood transfusion.

HOW TO IDENTIFY SNAKES.

The accurate identification of a snake depends not on colour and markings, as these vary considerably and may be very misleading, but on the comparative size and shape of the head shields, the teeth and fangs, the number of scales round the body, whether they are smooth or keeled, and the number of ventral scales from chin to base of tail. The anal scale may be single or divided, as also may be the scales under the tail (caudals). One of the reasons for this is that the number of ventrals and caudals indicates the number of ribs and vertebrae, whilst the head plates often give an indication of the disposition of bones forming the skull.



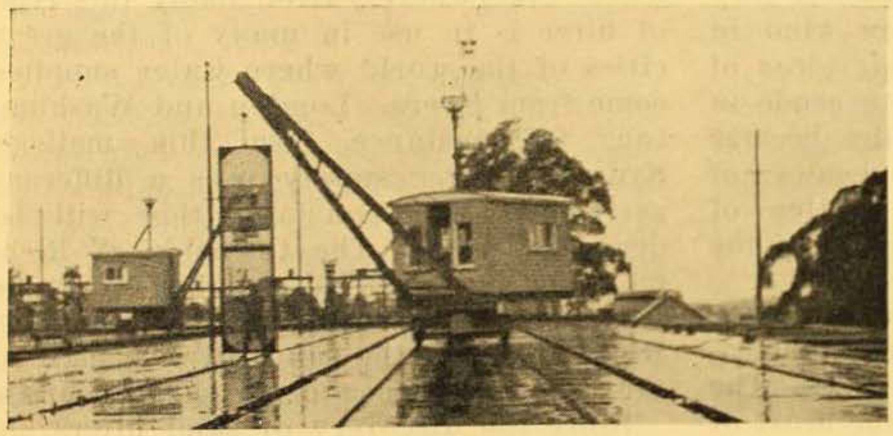
Keeping Drinking Water Pure

By ELIZABETH C. POPE, M.Sc.

IMMUNITY from disease enjoyed by modern large cities has been made possible only by the provision and development of pure water supplies, proper methods of sanitation and other health services. Without them, overcrowding of humans in large towns and cities would inevitably lead to the pollution of the water with germs and to consequent epidemics of diseases among the people who drank it. If germs of typhoid, cholera, dysentery or other water-borne diseases once gain access to a water supply, they can spread very rapidly through a population. It is, therefore, the work of a whole team of scientists employed by a water supply authority to see that such an occurrence cannot take place.

Besides germs, the water supply is populated by hosts of other plants and animals.[1] These, also, must be excluded from the water supplied to our homes or else they will become a nuisance, not only to the householder, but also to the engineer who has to convey the water from the reservoirs to the consumers. The story of how this is done in the water supply of Sydney and other parts of the world is full of interest, and each one of us who uses water from such a supply should know something of what goes on behind the scenes, if only to realize why rates have to be paid.

At this point it is interesting to pass in review what our remote forebears did to obtain supplies of drinking water. In doing this we will see also how, as the knowledge of the mechanics of supply and of purification advanced, big cities began to grow and the inhabitants no longer lived under the shadow of disease.



Sydney's water is purified by passing it through screens of fine wire mesh. One of these screens is seen here, hoisted from the side of the filter chamber for cleaning. An electric crane moves up and down along the side lifting the screens as required. The size of the screen may be judged by comparing it with the man's figure seen through the mesh.

No one can live without water. The aboriginal from our "Red Centre" or the shipwrecked sailor on a raft needs no reminder of this fact, but city dwellers tend rather to forget it. Come drought, come rain, they merely turn on their taps to obtain all the water they want.

The first civilized men were generally occupied in rural pursuits, and, like our settlers today, each little unit made its own arrangements about water and sanitation. Populations were scattered and, provided that the rainfall was adequate, wells, tanks and local streams provided for all their needs.

In 800 B.C. we find in ancient Sanskrit the following statement: "It is good to keep water in copper vessels, to expose it to the sunlight and to filter it through

[1] The animals and plants living in our water supplies were dealt with in a previous article, THE AUSTRALIAN MUSEUM MAGAZINE, Vol. viii, No. 8, June-August, 1944, pp. 267-271.

charcoal." These simple precepts, the treatment of water with copper, exposure to sunlight, and filtration, are three sound principles and, considering the limited knowledge of those far-off times, show amazing perception on the part of the adviser, as we shall see.

The Romans also seem to have been keenly interested in water supply, especially the mechanical side of the problem, and many of their aqueducts and baths still remain to testify to their engineering prowess. But after them, there was a sad backsliding.

The industrial revolution in Europe, in the latter half of the nineteenth century, changed the whole complexion of the problem of water supply. People flocked to the cities and towns where they could obtain work of the new kind in manufacturing concerns. Their ideas of cleanliness and sanitation were crude in the extreme and water supplies became polluted as a result. Epidemics of diseases were taken as a matter of course; they were part and parcel of the new kind of life in the towns.

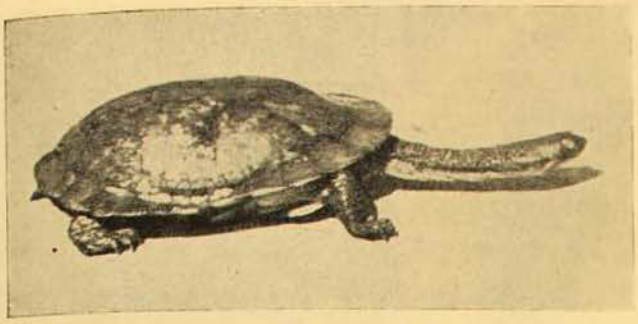
At this stage London drew its water from the Thames, and it was pumped, untreated, direct to the consumer. The water was drawn off right in the heart of the city and London's sewers also emptied into the river—upstream from the intake pipe of at least one of the big water supply works. Londoners, however, continued to drink and enjoy the water, and it was not till one public-spirited doctor drew attention to this horrid state of affairs in a scathing pamphlet, "The Dolphin", published in 1827, that they began to realize that all was not as it should be, and commenced to agitate for reforms in the matter.[1] As a result of this agitation, water was drawn from the river above the town and its sewer outlets.

In the early part of the nineteenth century a great advance was made. By this time the microscope, discovered by Leeuwenhoek, had been in use for well over a century and people were fully aware of the hosts of tiny creatures living in the water they drank. Naturally they had thought of them as possible causes of disease, and had hoped to find ways of keeping their drinking water free of microscopic creatures as well as the larger plants and animals which they had been able to see all along.

In 1829 a discovery was made which has been of far-reaching importance to the science of water supply. In this year it was found that most of the tiny plants and animals could be removed merely by percolating the water through a thick bed of sand. So successful was this method that it was introduced into water works everywhere. Even today this type of filter is in use in many of the great cities of the world where water supplies come from rivers. London and Washington, for instance, use this method. Sydney's water supply uses a different system of filtration and this will be described later. The township of Richmond in New South Wales, however, uses water pumped directly from Hawkesbury River and here the sand filter is used in the time-honoured way to ensure purity.

Since the discovery of sand filters, no major advance in methods of water filtration has been made, but nowadays, unlike the discoverer of the method, we can give the real reason for its success. It is a comparatively easy task to keep most of the larger denizens of the dams and streams out of the pipes and reservoirs. Coarse screens with wide mesh or big holes will effectively stop fish, eels, tadpoles and most worms, but, strangely enough, at the local water-works the Long-Necked Tortoise proves intractable in this respect. This small, heavy animal seems to be blessed with the 'excelsior' spirit which makes him want to climb ever higher. To him a filter screen is a dare and climb it he must. The writer's surprise knew no bounds when she peered into the mixing chamber from which water is sent to Sydney after the final filtration and saw literally dozens of small tortoises struggling in the froth

[1] An extract from this pamphlet is quoted in the previous article, *q.v.*, and the water supplied to the consumer is described together with the inhabitants thereof, THE AUSTRALIAN MUSEUM MAGAZINE, Vol. viii, No. 8, June-August, 1944, pp. 267-271.

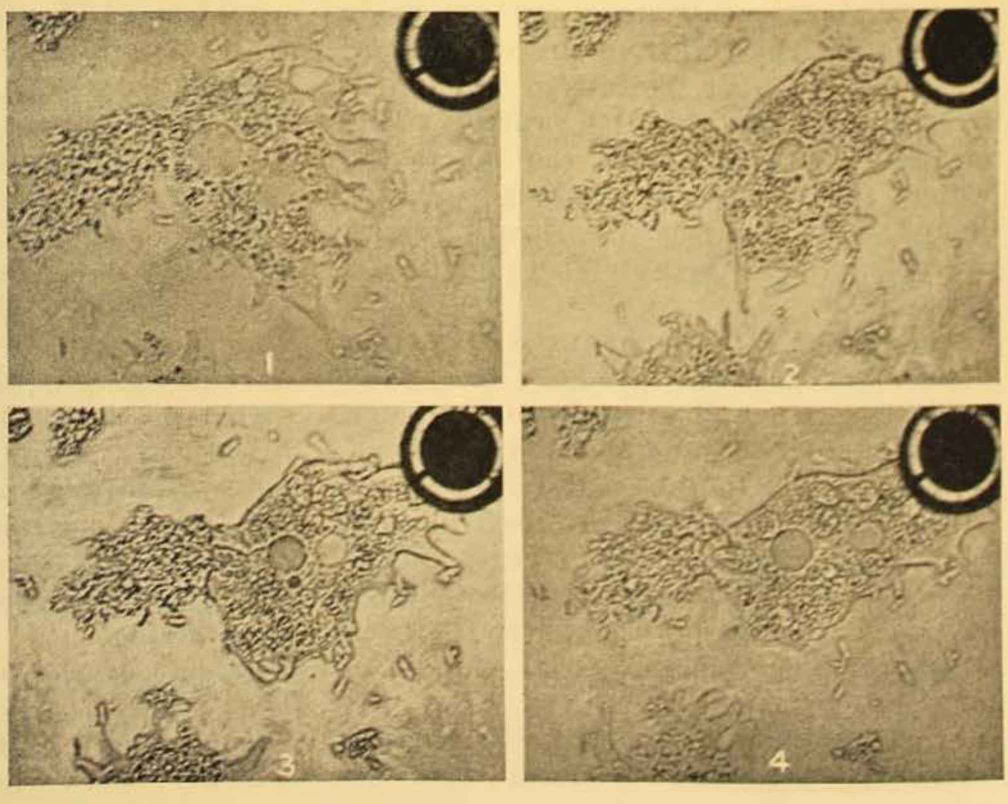


The Long-Necked Tortoise (Chelodina longicollis) defies the filter screens by climbing over them and so reaching the final mixing chamber of the filtration plant.
Photo.—E. C. Pope.

and boil of the water. How they live there and escape being swept into the long tunnels which run to the city is not known, but they are never encountered choking pump valves or other installations.

These larger creatures scarcely worry the engineer at all. His chief difficulty starts when he tries to remove the microscopic plants including the bacteria and animals from the water. Any filter fine enough to hold them back so slows up the the flow of the water that it becomes useless if a large quantity of water has to be dealt with in a hurry. This is where the sand beds are useful. Water will drain through sand beds at quite a fast rate (120 to 180 gallons per square foot per hour), and if the sand is fine grained, most of the small organisms are caught up and lie like a slimy carpet on or just below the surface of the sand. Microscopic examination of this 'living carpet' shows it to consist of sponges, rotifers (wheel animalcules) and other similar small animals. Browsing over its surface are also millions of tiny crustacea and insect larvae. This regular menagerie of organisms continues to feed as it did before it was deposited on the sand, consuming passing bacteria and other tiny plants like diatoms and desmids or else preying on the tiny animals. The sand is, therefore, not the only agent carrying on filtering—every small organism has to run the gauntlet of these vigilant creatures in the 'living filter'. This is what makes the sand such an effective bar to the bacteria and other minute organisms.

After a time the slimy carpet becomes so thick that the flow of water through it is retarded and may cease altogether. When this happens the flow of water is diverted to another filter bed and the choked one is drained and allowed to



Animals of the 'living filter' on the sand beds eat organisms smaller than themselves and so remove them from the drinking water. Here an Amoeba (on the right in figure 1) approaches and begins to engulf part of a mass of bacteria (figures 2 and 3). In figure 4 a clump of bacteria has passed into the interior of the Amoeba and digestion of them has begun.
After Comandon and de Fonbrune.

A speck of the sludge seen under the microscope. Microscopic plants and animals form the bulk of it. Inset: Some of the sludge held back by the 650 wire-mesh filter screens.

dry off. The film of organisms can be rolled up like a mat and removed, and the sand is then ready to be used again.

As already stated, this is not the method of filtration used to purify Sydney's water supply, because the principles involved are somewhat different from the ones which obtain overseas. In the first place our water is not drawn from rivers where pollution is likely. Instead, catchment areas are set aside and rigidly controlled to prevent human wastes and other polluting substances from contaminating the water. This means that, right from the start, the water controlled by Sydney's Water Board is less in need of filtration than overseas supplies because there are fewer germs in it.

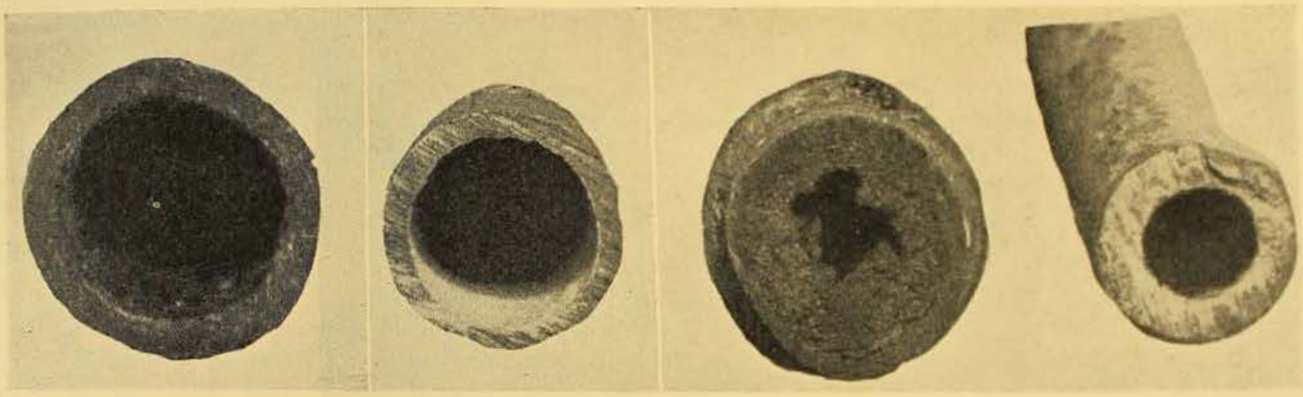
The water is brought to a filtration plant and passed through fine wire-meshed screens, 25 strands to the inch, known as six-fifty mesh, and made of copper wire. Hundreds of large frames carrying this wire mesh are used in each filter, and they have constantly to be removed for cleaning as the sludge quickly chokes them. The water that has passed through them is clean and quite fit for drinking. Ceaseless tests are carried out on it, however, and a careful watch is kept for harmful bacteria because they are not as effectively arrested by the wire mesh as they are by the 'living filter' of the sand beds. It is not essential in this instance, because the water is not already polluted when it reaches the screen.

Two principles besides filtering are involved in the purification of drinking water. If water is stored for a considerable time before use, many of the tiny organisms and all foreign matter begin to settle towards the bottom. After several days the water is noticeably clearer, and apart from the sunlit upper layer of water with its numerous microscopic floating plants and the attendant crowd of animals which feed on them, it is practically free from organisms in middle depths. Water for consumption is, as a rule, drawn off from this middle layer of water in the dams.

Just as on land, so among the plants in the water supply, there is a great outburst of activity in springtime. Occasionally some organism may multiply so greatly that it becomes a nuisance either by imparting a taste to the water or by discolouring it. When this happens chemicals are added to the water to kill them or to cause them to bunch together (form a floc) and so become too heavy to float. They then sink to the bottom where they cease to be a nuisance. One of the chemicals used extensively in this way is bluestone (copper sulphate), which kills algal plants very readily.

Another trouble-maker for the supply engineer is the type of bacterium which causes the so-called 'rusty water'. Certain types of these small plants are able to abstract iron from the water in which they live and finally deposit it on the inside of the water pipes, where it may, in time, choke them up completely. The bacteria do not need to consume iron-containing substances in order to live, and their production of the brown slimy deposit is, as it were, a mere by-product of their life processes, for they can live

fasten themselves to the sides of the pipes. Here they grow and multiply rapidly, for a constant stream of food and oxygen continually passes their doors and living conditions are very favourable. On two or three occasions pipes have been so blocked by molluscs that they have had to be removed or cleaned out. So we see that while wire-mesh filters are reasonably efficient in purifying our drinking water, they are not fine enough to hold back all the tiny larvae of the animals that live in water supplies. These may live to grow up in the pipes and, on rare occasions, an animal big enough to be visible with the naked eye pops out of one of our taps just to remind us of the



End view of four water pipes. On the left is a new type of iron piping lined with bituminous compound to prevent the workings of iron bacteria. Alongside it is an unused iron pipe for comparison with the next one, which is regular iron pipe badly affected by iron bacteria. On the extreme right is an old style lead pipe; it is unaffected by iron bacteria even after seventy years of service.

perfectly well in the absence of iron. It is a very annoying habit nevertheless, for water that is badly discoloured by their workings tastes and smells slightly and, though it is not considered actually unhealthy, it is unpleasant because it leaves a deposit on household utensils, stains baths and laundry, and also blocks up the pipe systems over a period of years. The pipes themselves do not rust, as can be seen from the accompanying illustration, for the thickness of the wall of the affected pipe is practically the same as in a new unused one. The mains are often flushed out to wash away the rusty-looking accumulations.

Other organisms which tend to choke pipes are small freshwater bivalves. Their larvae somehow elude the filters and

teeming millions of his kind which live 'way back home' in the reservoirs and dams.

On the whole, our water is pure and healthy, thanks to officials who constantly work to keep it so, and we should be grateful that their vigilance never relaxes. Daily they sample the water to see that it is up to standard, and if it falls below requirements they take steps to set it right by adding the appropriate chemicals or by taking other measures to purify it.

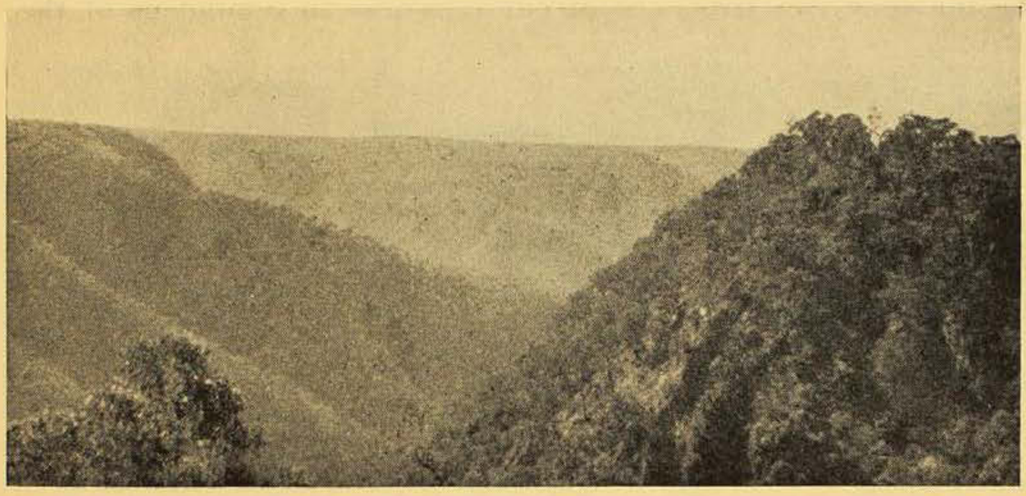
If you will now cast your mind back to the precepts given in 800 B.C. you will see how closely the advice given there for the treatment of water tallies with what is done today, even after centuries of intensive research.

Baker's Creek Gorge

By T. HODGE-SMITH

ALMOST at the head of Baker's Creek Gorge, on the eastern side, is the town of Hillgrove, about twenty miles easterly from Armidale, which is 360 miles by rail north of Sydney. It is 3,150 feet above sea-level. Less than a mile on the other side of the Gorge is the town of Metz.

loads of ore up its steep sides, always threatened with death from the frequent landslides, and then by bullock waggon on the monotonous journey over rough bush tracks either to Tamworth or Grafton, provides an epic of Australian pioneering of which unfortunately few Australians have any knowledge.

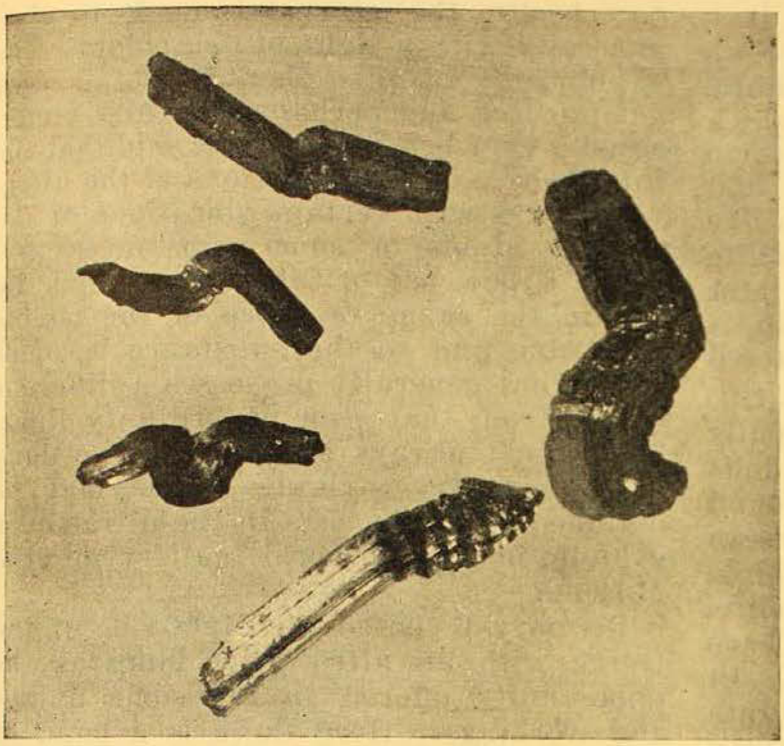


Baker's Creek Gorge from Metz, looking south-east. Photo.—T. Hodge-Smith.

Approaching Hillgrove from Armidale, one passes over undulating tableland country which, like all granite country, is somewhat poor except where, here and there, the remnant of an ancient (Tertiary) lava flow has produced a rich and sometimes extensive flat. On reaching the town the whole scenery changes with almost startling suddenness. Here one is standing on the edge of the Gorge peering down fifteen hundred feet in a vain attempt to see the creek below. Only a few miles further down the Gorge the creek plunges down another thousand feet where it leaves the hard granitic rock and passes over the softer slates on its way to join the Macleay River, one of the coastal rivers of the State.

Baker's Creek Gorge, which is a source of joy to the tourist, proved an almost insuperable barrier to the early miners in the field. The story of how they dragged

The first definite record of any mineral in the district was made in 1853 by the Rev. W. B. Clarke, who noted a specimen of antimony ore (stibnite) from Hillgrove. It was not until 1877 that the first discovery of payable ore was made by the Havershed brothers and Thomas. This ore was stibnite, the sulphide of antimony, and it was first mined at the Sunlight Mine situated in the Gorge itself. Antimony is a silvery-white metal with a crystalline structure. It is very brittle and can be easily powdered. The pure metal has little use in industry except in the powdered form, when it is used to give a steel-like polish to pottery. As an alloy with such metals as lead, copper, zinc, and tin, it has many uses. Type metal, Britannia metal, and certain anti-friction metals all contain antimony. As a war metal it is of great importance. The sulphide of antimony is used to form



Bent crystals of stibnite (antimony sulphide) from Hillgrove.

dense white fumes to mark the position of exploding shells, and also in certain detonator caps. The metal is used to harden bullets.

In 1881 the first speck of gold was discovered by Aaron Smith in the Garibaldi Shaft. Since that date the mining for gold may be said to have gradually replaced the mining for antimony.

Scheelite was first recorded in 1886 when a sample was tested by the Mines Department of New South Wales. Mining for the ore did not commence until 1898 when one and a quarter tons of ore valued at £30 was produced. Scheelite is a tungstate of lime and when pure contains 80·6 per cent. of tungsten trioxide which is the commercially important constituent.

The principal use of tungsten is in the manufacture of self-hardening high-speed tool steel. It is also used in the manufacture of permanent magnets, while pure tungsten is used in certain electrical apparatus such as voltage regulators, targets in X-ray tubes, and as filaments in electric light bulbs. In the last case it has been calculated that one ton of seventy per cent ore will make eighteen million lamps. As tungsten carbide with cobalt it is used in making cutting tools of very much greater efficiency than high-speed tool steel. It is of great importance as a war-time metal used in the manufacture of armour plating and armour-piercing shells.

The records of production for this field are by no means complete, but it is safe to say that more than two and a half million pounds have been won.

The geology of the field has been fully described by Mr. E. C. Andrews.[1] He considers "the field to consist of a series of fine sedimentary rocks, broken into and altered by several granite masses and by dykes of granitic origin". He postulates four separate granitic intrusions, of which the third is the most important as most of the gold and antimony and all the scheelite is intimately associated with it.

A peculiar effect of the pressure on the slates caused by these intrusions of granite is seen in what is known as "kicking slates", a variety of slate which tends to explode or "kick" when worked. On striking or boring this material it will fly out in all directions with great force. Mr. Andrews records an occasion when "a lump of stone about fifty pounds in weight was hurled out of the wall, and after

[1] Geological Survey of N.S.W., Mineral Resources No. 8, 1900.

passing through a three inch by two inch scantling, cut a man's body in two".

The usual action of intruding granite on the original sedimentary rocks which consisted of shales and sandstones is to convert them into slates, quartzites, and schists, and all these are found in the district. Some of the earlier granite intrusions have been affected by the later intrusions, and in many places it is difficult to distinguish between altered sediment and altered granite.

The lode material consists principally of quartz, though both calcite and dolomite have been found. The gold is found sometimes in the quartz and sometimes in the stibnite. Arsenical pyrites, a sulpharsenide of iron, and a little bournonite, sulph-antimonite of copper and lead, have also been found in the lode material. In places the stibnite has been converted into the yellow oxide, cervantite, and very occasionally into the cherry-red oxysulphide, kermesite.

In the lode there are often cavities or "vughs", as the miner calls them. Sometimes stibnite is found beautifully crystallized in these vughs, either as long prismatic crystals or as delicate tufts of hair-like crystals. More rarely the curiously bent crystals of stibnite have been found.

Scheelite is found associated generally with stibnite, quartz, and calcite. A peculiar and interesting occurrence of scheelite consists of a much altered rock with numerous sub-parallel veinlets of scheelite up to half an inch in thickness. This type is known locally as "ribbon scheelite".

Scheelite possesses the property of fluorescing under the action of ultra-violet rays. That is to say when the invisible ultra-violet rays are directed on to scheelite the mineral is made to glow generally with a light bluish colour. The explanation of this phenomenon is very complicated and perhaps not fully understood. Very briefly it may be said that the interference of the vibrations of the ultra-violet rays with certain vibrations of the surface atoms of some substances produces a new set of vibrations which lie within the range of those of the visible spectrum, and so the substance becomes visible but generally possesses a different colour from that seen by ordinary light. Tests must always be made in the dark and some very striking effects may be obtained as can be seen in the ultra-violet exhibit in the mineral gallery of the Museum.

Recently I visited the Metz side of the Gorge with an ultra-violet lamp as the opportunity offered to see some dumps and workings. Here there is a band of slate which has been intruded on the one side by the fine-grained granite of the fourth and last intrusion and on the other side by the coarse-grained granite of the third intrusion which is responsible for the presence of numerous small veins consisting mostly of quartz but sometimes containing antimony and scheelite. The ultra-violet lamp makes the detection of those veins carrying scheelite a very easy matter.

Surface prospecting must be carried out at night and is attended with a certain amount of risk for the careless prospector as scorpions and snakes also fluoresce. I can vouch that it is most disconcerting to find a piece of what seems to be scheelite change in your hand to a scorpion.

Much of the mining glory of this old field has passed, but who can say that with more modern methods it will not some day regain some of its former importance.

The Classification of Australian Butterflies

By A. MUSGRAVE

WOULD-BE students of Australian Entomology are finding the present lack of popular scientific literature a serious disadvantage. In the cities beginners are able to obtain information from museums and libraries, but, as an officer in the Australian Army Education Service points out, the dearth of handbooks is more keenly felt by the serviceman not engaged in forward operational areas, who is at a loss to know how to classify the representatives of the different families of butterflies he has collected. The present article is intended to treat with this aspect of the study of butterflies.

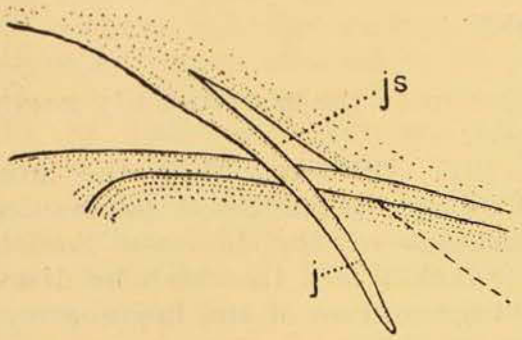
THE GROUP-STATUS OF BUTTERFLIES.

Butterflies and moths together constitute a group of the Class Insecta (Insects), the Order *Lepidoptera,* and are characterized by the possession of overlapping scales on the wings, as the term Lepidoptera implies: Gr., *lepis, lepidis,* a scale; and *pteron,* a wing. Two pairs of wings are present and three pairs of walking legs. The mouth parts are suctorial, consisting of a coiled proboscis for sucking up the nectar of flowers.

Classification in zoology commences with the tenth edition of the *Systema naturae,* published by the great Swedish naturalist Linnaeus in 1758. Since that time, however, the Linnean system has been enlarged and modified and many genera and groups considerably revised. Up to quite recent times it has been the fashion to regard the butterflies as a distinct suborder of Lepidoptera, the *Rhopalocera* (clubbed horns), as apart from the moths, the *Heterocera* (different horns). Butterflies have also been termed the Diurnal Lepidoptera in contradistinction to the more usually nocturnal moths.

In 1917, 1918 and 1919, the late Dr. R. J. Tillyard published papers in the *Proceedings of the Linnean Society of New South Wales* in which he discussed the wing-venation of the Lepidoptera and paid special attention to the wing-coupling apparatus. In his 1918 paper he divides the Lepidoptera into two *sub-orders* based upon the wing-venation: (1) the *Homoneura,* in which the venation of the fore- and hindwings is very similar and primitive, and includes only three families of moths, and (2) the *Heteroneura,* in which the venation of the fore- and hindwings is dissimilar. The butterflies and the vast majority of the moths are included in this suborder. Later (1926) Dr. Tillyard, in discussing the classification of the Lepidoptera in his *Insects of Australia and New Zealand,* places the butterflies as a Division, the Rhopalocera, to his suborder Heteroneura. Dr. A. D. Imms, of the University of Cambridge, in his work, *A General Textbook of Entomology,* 3rd Edition (1934), and again in his *Outlines of Entomology* (1942), adopts Dr. Tillyard's suborders, but places the butterflies in a superfamily, the *Papilionoidea.*

This group, division or superfamily is characterized by the antennae being dilated towards the ends to form a club. Maxillary palpi obsolete. Labial palpi moderately long. Forewings with vein Cu_2 absent, vein M_2 usually arising from or above the middle of the transverse vein. Hindwings without frenulum, vein Cu_2 absent, and vein $Sc\text{-}R_1$ arising out of a cell near base, thence strongly curved and diverging. It will be noted that the wing-coupling is always *amplexiform* and no wing-coupling spine (frenulum) is present, such as we find in the moths, with the exception of the archaic *Euschemon* (family Hesperiidae) in which a frenulum is present in the male and absent in the female.



Jugate method of wing-coupling of forewing to hindwing developed by moths of the suborder Homoneura. In the suborder Heteroneura, frenate coupling usually consists of a bristle or series of bristles.
After Tillyard.

FAMILY CLASSIFICATION.

Nine families of butterflies are recognized from Australia by Dr. G. A. Waterhouse in his book, now out of print, *What Butterfly is That?* (1932), a scheme employed by Dr. A. Seitz in his *Macrolepidoptera of the World, Fauna Indoaustralica,* Vol. ix (1908–1927), a work already mentioned by me in articles in this MAGAZINE. These families are: 1. *Papilionidae,* Swallowtails. 2. *Pieridae,* Whites and Yellows. 3. *Danaidae,* The Danaids. 4. *Satyridae,* Browns. 5. *Amathusidae,* Owls. 6. *Nymphalidae,* Nymphs. 7. *Erycinidae.* 8. *Lycaenidae,* Blues, Coppers and Hairstreaks. 9. *Hesperiidae,* Skippers and Darters.

Dr. A. D. Imms (in *A General Textbook of Entomology*) recognizes only six families, and three of the families recognized as such by Dr. A. Seitz and, again, by Dr. Waterhouse, viz., the *Danaidae, Amathusidae* and *Satyridae,* are incorporated by him in the *Nymphalidae* and there regarded as worthy only of subfamily rank. This scheme was in earlier use by Dr. Waterhouse and Mr. G. Lyell in their work, *The Butterflies of Australia* (1914).

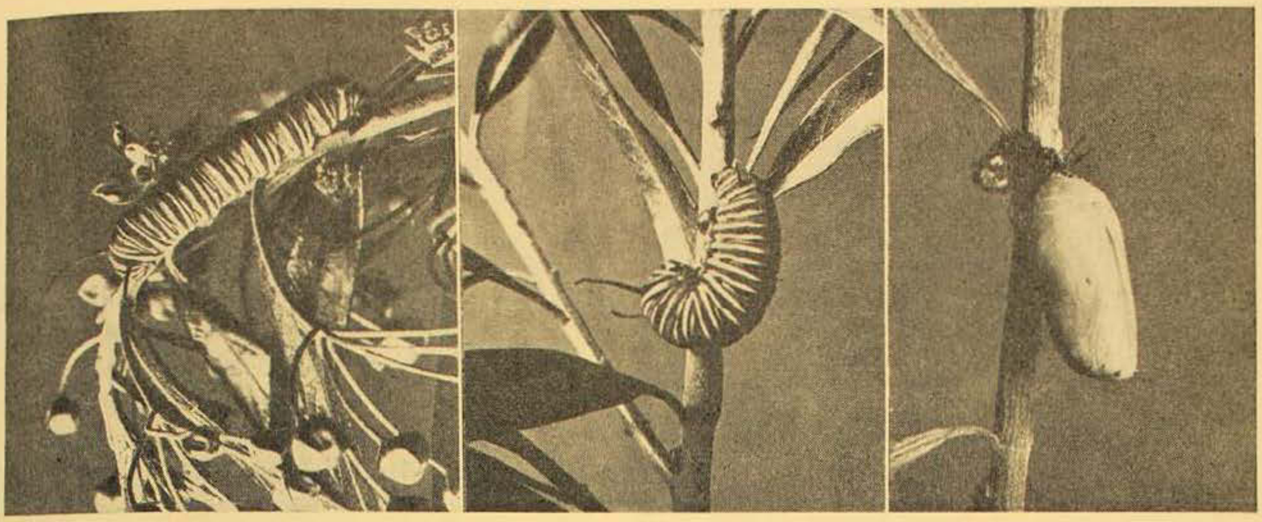
Classification is thus seen as an arbitrary method of deciding the systematic position of the various families, genera and species. When authorities differ in these seemingly important details, the amateur in entomology often feels at a loss and the future seems uncertain. In this eventuality it is perhaps best to realize that Nature, like human nature, objects to being tied down by hard and fast "laws". The student therefore may be advised to decide for himself between these reduced or expanded systems of classification. In the present article it is the intention of the writer to follow Dr. Seitz in the scheme of the arrangement of the families.

Before considering each family in detail it would be advisable first to consider briefly the life-history of butterflies and the structure of the adult insect, as these play an important rôle in classification.

LIFE-HISTORY.

Butterflies and moths pass through egg, larval and pupal stages before reaching the final winged adult stage. These developmental stages constitute perhaps the most interesting features of the study of the Lepidoptera.

Eggs are laid singly or in clusters on the insect's foodplant, the number of eggs and their appearance varying. From the egg hatches the *larva* or caterpillar, the time of its appearance from the first laying of the egg varying from days to months. The long, cylindrical larva has a hard head and strong jaws, but the body is usually soft. The body is divisible into 13 segments; the first three comprise the thorax and each is provided with a pair of jointed legs; the remainder, 4–13, make up the abdomen. On each of the 3rd to 6th abdominal segments and on the last segment there may be found a pair of unjointed legs or prolegs (claspers). During its larval stage the larva eats voraciously. It moults several times as growth proceeds, such a change, which involves the shedding of the chitinous head and skin, being termed an *ecdysis.* Each stage between moults or ecdyses is termed an *instar* and usually four instars take place. Each



Life-history of the Wanderer (Danaida archippus). Caterpillar on milk-weed. Caterpillar when pupating hangs head downwards attached at posterior end to a silken pad. Pupa finally hangs freely attached by the cremaster to silken pad. Note the old larval skin.
Photo.—A. Musgrave.

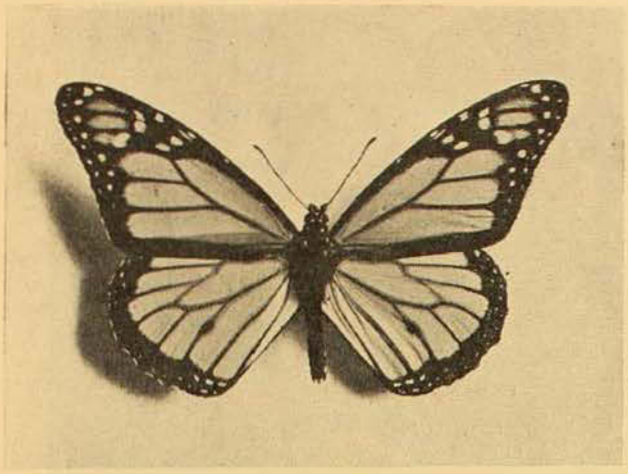
succeeding instar often differs in shape and colour. Some larvae confine their attentions to a particular kind of foodplant, others are more general in their tastes, and the larvae of the introduced Cabbage Butterfly, *Pieris rapae*, have been recorded from a number of garden plants. Some species of butterfly larvae feed only at night and others during the day. Certain species may occur singly on the foodplant, while others feed gregariously; others live in ants' nests and are tended by the ants.

The change from the larval to the *pupal* or *chrysalis* stage is an amazing transformation. In this stage the butterfly rests, internal changes taking place before the adult insect is able to emerge.

The caterpillar about to pupate usually looks for a suitable place in which to carry out this transformation. Pupation may take place upon the foodplant or away from it according to the species concerned. Some forms, such as the Hesperiidae, which live in shelters, pupate in the shelters. Those species of Lycaenidae which frequent ants' nests may also pupate in them, a well-known example being *Liphyra brassolis major*, which pupates inside its larval skin while living in the nests of the green tree-ant, *Oecophylla smaragdina*.

In those species in which the pupa hangs *head downward*, as in the Danaidae, Satyridae and Nymphalidae, the sole support of the pupa is the *cremaster*, a hooked process at the end of the pupa, which is fastened into a pad of silk which the larva first spins before commencing to pupate. In other forms in which the caterpillar pupates *head upwards* or horizontally, such as we find in the Papilionidae and Pieridae, a silken girdle spun round the middle serves as an additional support to the cremaster.

After making itself secure to the silken pad the larva rests for 24–48 hours and then pupation commences, the skin which splits down the back being gradually assisted down to the tail. To get rid of the old larval skin and to fasten the hooks of the cremaster into the pad of silk is a function demanding different methods by (1) those which pupate head upwards, and (2) those that pupate head downwards. Those in (1) have the silken girdle as an additional support and find little difficulty in raising the abdomen to cast off the old skin and place the cremaster into the silk pad. In (2) there is no silken girdle, but the larva, hanging head downwards, is firmly attached by the tail to the pad of silk. As the old larval skin splits it is worked tailwards, where it is grasped firmly by two abdominal segments. The pupa is now supported by the old skin, but it succeeds in withdrawing the end of the



Adult Wanderer Butterfly (Danaida archippus), a species said to be distasteful to birds.
Photo.—A. Musgrave.

abdomen from the skin and getting the terminal hooks of the cremaster caught in the silken pad. The pupa is thus suspended head downwards. Within a day or two the indications of the future eyes, antennae, wings and legs are plainly visible.

The time spent as a pupa varies according to the season and latitude, development being accelerated in the tropics to a few days or retarded in more temperate parts of the continent to six months.

If the caterpillar and pupa survive their many enemies such as parasitic wasps and flies as well as birds, the pupa may reach maturity. Then the skin splits down the back and the *adult* butterfly or imago withdraws itself from the pupal shell; the crumpled wings gradually spread to full size and harden and the insect is ready to fly.

STRUCTURE OF THE ADULT.

The adult butterfly, like other insects, is divided into three well-marked regions: head, thorax and abdomen.

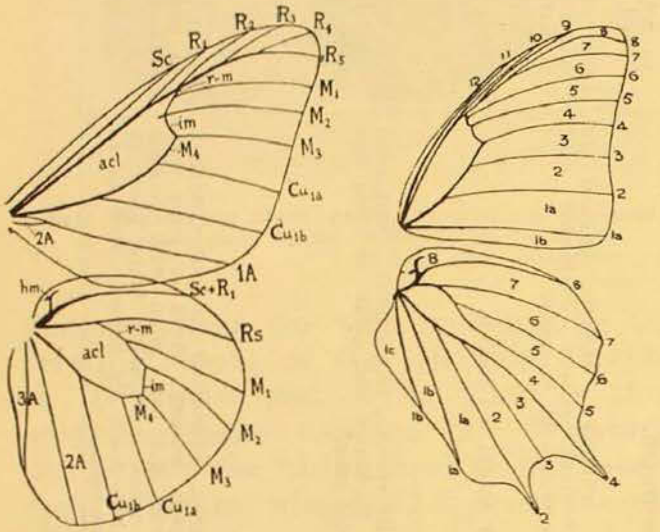
On the *head* are the eyes, antennae, proboscis and palpi. The antennae vary in length and in the shape of the club. The three-jointed palpi, situated on either side of the proboscis, have the two basal joints covered with scales and sometimes with hairs; the bare end joint provides characters for classification.

The *thorax* bears the wings and the legs and is divisible into pro-, meso-, and metathorax. A pair of legs is carried by each division, the two last-named carrying also the fore- and hindwings. The wings are highly important in classification. Specialized hairs called scales usually cover both sides of the wing-membrane and are inserted into sockets. The scales vary in shape, even on the same wing, from slightly flat hairs to broad scales. The free ends of scales are often serrated. As a rule the average amateur collector does not concern himself with the *wing-venation*, which is important in the classification of the Lepidoptera. In a typical butterfly wing there is a *basal cell* with outwardly extending veins. In a forewing the veins may be numbered from 12 to 1 from front to rear, and in the hindwing from 8 to 1. When other posterior veins occur they are termed 1a, 1b, 1c. This British numerical system, while used by systematic workers in the order, does not explain the relationships of the veins. The researches of two American workers, Comstock and Needham (1898–99), laid the foundations of the study of the Wings of Insects. As a result of studying the wings of nymphs and pupae they were able to show "that in the more generalized insects the principal wing-veins are developed about preexisting tracheae". They were also able to construct a diagram representing the hypothetical tracheation of a wing of a primitive nymph. They pointed out that: "In many insects the wings are corrugated like a partly open fan. In this case, the wing-veins that follow the crests of ridges are termed *convex veins*; and those that follow the furrows, *concave veins*." An earlier worker, G. E. Adolph, was the first to suggest that convex and concave veins alternated in an insect's wing. Comstock and Needham found the corrugating to be very marked in dragon-flies, may-flies and Orthoptera. The signs plus (+) and minus (–) are used to denote convex and concave veins respectively.

CLASSIFICATION TABLE.
(*After* G. A. Waterhouse.)

	Egg.	Larva.	Pupa.	Adult.
Papilionidae (Swallowtails).	Globular, usually smooth, laid singly.	Cylindrical, smooth and provided with two rows of fleshy tubercles on the back, thorax may be humped. Osmeterium present.	Head and thorax set at an angle to the abdomen; head bears a median horn, or two-humped process or it may be ridged or smooth. Suspended by cremaster and silken girdle.	Large species. Hindwings often tailed. All legs well-developed. Vein 1b absent. In forewing short vein near base of wing.
Pieridae (Whites and Yellows).	Spindle - shaped; higher than broad, vertical ribs and cross lines.	Cylindrical, smooth or with scanty short hairs; colour green or brown.	More or less pointed at both ends, with dorsal ridges and spines, or smooth, with wing cases strongly developed forming a keel-shaped projection. Suspended in a vertical or horizontal position by cremaster and girdle.	Medium or small size. All legs perfect. Forewing with never more than 11 veins, sometimes only 10. Hindwing with vein 1b present.
Danaidae (Danaids).	Spindle - shaped; higher than broad, vertical ribs and cross lines.	Smooth, banded, 2-4 pairs of fleshy tentacles, head small. Foodplants have milky sap.	Short, stout, smooth, often with metallic colours. Suspended by cremaster head downwards.	Usually large. Front legs imperfect in both sexes. Cells of both wings closed. In the forewing vein 1a is forked near the base.
Satyridae (Browns).	Nearly spherical, faintly ribbed, usually green.	Fusiform, bifurcate at posterior end, rough, green or brown, head large and hard.	Short, stout, smooth, in some species with ridges. Suspended head downwards by cremaster or lying loosely on ground.	Rarely large. Front legs imperfect in both sexes. Cells of both wings closed. Forewing usually with principal veins swollen at base.
Amathusidae (Owls).	Nearly spherical, smooth.	Cylindrical, hairy, head slightly bifid and often with a pair of horns, posterior end forked.	Suspended head downwards by cremaster, boat-shaped.	Usually large. Front legs imperfect in both sexes. Cell of forewing closed, palpi small.
Nymphalidae (Nymphs).	Very variable, vertically and horizontally ribbed.	Very variable; usually cylindrical, with branched spines, often with distinct horns on the head.	Very variable; smooth, angular or grotesquely shaped. Suspended head downwards by cremaster.	Large or medium sized. Wings angular or tailed. Front legs imperfect in both sexes. Cells of both wings open. Palpi large.
Erycinidae (Erycinids).	Not known for Australia.	Early stages not known.	Early stages not known.	Medium size. Front legs imperfect for walking in male, but perfect in female.
Lycaenidae (Blues, Coppers and Hairstreaks).	Very variable, smooth, nearly spherical or smooth and flattened at base and apex; pitted, reticulated or spined.	Usually woodlouse-shaped with retractile head, often hairy. Posterior segments often with dorsal glands, which secrete a fluid prized by ants.	Usually smooth, rarely hairy. Suspended by cremaster and girdle or lying free under sand.	Small size, brightly coloured. All legs developed for walking, but front pair less so than others. Hindwing without humeral veinlet.
Hesperiidae (Skippers and Darters).	Large dome-shaped, sometimes smooth, sometimes vertically ribbed.	Cylindrical or subcylindrical, sparsely hairy, head large and hard. Thorax tapered to form a long neck; during the daytime lives in a leaf shelter.	Elongate, cylindrical or subcylindrical, usually smooth. Head of pupa with shield and cap, often with peculiar processes. Pupation takes place in shelters made by larvae; head rarely downwards.	Usually small. Antennae wide apart at base, and often with hooked club. All legs perfect for walking.

A system of naming the principal veins of an insect wing was adopted by Comstock and Needham, viz., Costa (C), Subcosta (Sc), Radius (R), Media (M), Cubitus (Cu), First Anal (1st A), Second Anal (2nd A), Third Anal (3rd A).



Wing venation. Showing (left) Comstock and Needham notation (after Tillyard), and (right) Numerical notation (after Waterhouse).

With slight alterations the system used by them is still employed for the vein terminology. It has been shown that in an insect wing R_1 and Cu_1 (main stem of Radius and First Cubitus veins) are strongly convex and thus assist in naming the other veins. Dr. Tillyard has pointed out that the concave veins "may be partially or wholly lost, or partially fused with a neighbouring convex vein. *Sc* frequently fuses with R_1; *M* may fuse partially with *R*, *Rs* or Cu_1, or its main stem may be lost, as in most Lepidoptera; Cu_2 is often reduced, lost or fused with 1A."

The two notations of wing-venation nomenclature, British Numerical and Comstock and Needham, are compared with one another in Comstock's *The Wings of Insects*, and in Tillyard's *Insects of Australia and New Zealand*, and Dr. Tillyard's modifications of the C. and N. system have been adopted by Dr. Imms in his *Textbook*, and have been drawn upon by me in the accompanying table.

Venation of Lepidoptera. Table showing Comstock-Needham and Numerical Notations. (After *Tillyard.*)

Veins.	Forewings of Whole Order and Hindwings of Homoneura.		Hindwings of Heteroneura Only.	
	C.-N.	N.N.	C.-N.	N.N.
Costa	C	—		
Subcosta	Sc	12 }	Sc + R_1	8
Radius	R_1	11 }		
Radial Sector: ..	Rs	—	Rs	7
First branch ..	R_2	10	—	—
Second branch ..	R_3	9	—	—
Third branch ..	R_4	8	—	—
Fourth branch ..	R_5	7	—	—
Media:	M	—	—	—
First branch ..	M_1	6	M_1	6
Second branch ..	M_2	5	M_2	5
Third branch ..	M_3	4	M_3	4
First Cubitus: ..	Cu	—	Cu_1	—
Upper branch ..	Cu_{1a}	3	Cu_{1a}	3
Lower branch ..	Cu_{1b}	2	Cu_{1b}	2
Second Cubitus: ..	Cu_2	1c	Cu_2	1c
First Anal	1A }	1b	1A }	1b
Second Anal ..	2A }		2A }	
Third Anal ..	3A	1a	3A	1a

The methods of wing-coupling in the Lepidoptera are not dealt with in detail here, though it may be as well to point out that in the butterflies the frenulum and retinaculum are absent, and the *amplexiform* type of coupling which obtains in the Division is due to the upward pressure of the hindwing against the forewing.

The *abdomen* in butterflies is cylindrical and clothed with scales and hairs.

It is hoped that in future issues of the MAGAZINE it will be possible to treat with the various families of butterflies in greater detail.