The AUSTRALIAN MUSEUM MAGAZINE

Vol. XIII, No. 9 Price—THREE SHILLINGS

This painting, showing a messenger delivering a message stick, is the central feature of an Australian Museum exhibit dealing with Aboriginal methods of communication—message sticks, smoke signals and sign language. An article on the Museum's new Aboriginal exhibits appears on page 279.

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CONTENTS

● The photo on our front cover was taken by Australian Museum photographer Howard Hughes. The painting depicted is typical of the new techniques used in the Museum's Aboriginal section—techniques designed to make the exhibits both educational and entertaining.

VOL. XIII, NO. 9 MARCH 15, 1961

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Gemstones of Australia

By R. O. CHALMERS

GEMSTONES are varieties of minerals possessing special qualities of beauty, durability and rarity. The beauty of a stone in most cases depends on the colour, transparency and lustre. Australia's two most important gemstones are opal and sapphire.

Opal consists of silica combined with a variable percentage of water. The common variety is of world-wide distribution, occurring in resinous opaque masses of varying colour. The beauty of precious opal is not due to transparency or lustre but to a brilliant play of colours that flash in a ground-mass of common opal. This is due to structures within the opal breaking up white light into its component colours. Opal shows various colour patterns, each with a distinctive name, such as "pinfire", "flash" and "harlequin" opal. The value of opal depends in part on its depth of colour, its pattern and on whether red is a predominant colour.

Prior to the discovery of the famous Australian fields precious opal was found only in relatively small quantities in volcanic rocks in Hungary, Mexico, Central America and Nevada (U.S.A.). In Australia the opal fields of economic importance are found in the arid inland regions of the continent. The precious opal is distributed irregularly in veins or nodules of "potch" or common opal that is deposited from groundwater, fills bedding planes and joints in a fine-grained clayey sandstone, and occasionally replaces fossil shells and bones. A number of highly critical conditions have to be fulfilled before precious opal can form; hence, it takes its place among the precious stones because of its rarity and beauty. These qualities more than compensate for its relative softness.

The two chief New South Wales opal fields are White Cliffs, in the West Darling district, and Lightning Ridge, near Walgett, discovered in 1889 and the early 1890's respectively. Lightning Ridge is the home of the unique black opal, in which the colours flash out from a greyish or bluish-black background. The value of New South Wales opal is over £1,500,000, which is more than half the total Australian production of £2,500,000. These are official figures and are probably an underestimate.

In recent years New South Wales production has been negligible, the principal source being the two South Australian fields—Coober Pedy, on the road to Alice Springs (discovered in 1915) and Andamooka, at the northern end of Lake Torrens (discovered in 1930).

Although opal in western Queensland was discovered earlier and occurs over a much larger area than in the other two States, only a very small amount is now produced from one mine, the Hayricks, near Quilpie. The

A group of quartz crystals from Nundle, New South Wales.

curious "boulder opal," in which ramifying veins of precious opal occur in ironstone nodules, is peculiar to Queensland.

Sapphire is one of the precious varieties of the mineral corundum (aluminium oxide), possessing a deep-blue colour and perfect transparency. This gemstone occurs in many basalt areas throughout the eastern Australian highlands. In New South Wales sapphire has been worked commercially, on a small scale, along the banks of Frazer's Creek in the Inverell district. Practically the whole Australian output comes from Anakie, 192 miles west of Rockhampton, Queensland. Here it is recovered as water-worn fragments from ancient stream deposits of gravel, sand and silt, now lying under basalt flows. In addition to the blue variety, sapphires of a rich golden colour are found at Anakie. These golden sapphires rank as one of Australia's finest gemstones and deserve to be better known. Anakie is also noted for green sapphires and the lustrous black opaque star-sapphires that have aroused much interest in America.

Ruby, one of the rarest and most precious of all gemstones, is also a variety of corundum, but is not found in Australia.

Common corundum is opaque, is a non-descript, dirty, greenish-grey colour, and is valuable only as an abrasive. It is almost unbelievable that these lovely transparent blue, red, golden and green gemstones have exactly the same chemical composition and the same physical and optical properties as the common variety.

Beryl is a transparent green stone, sometimes with a yellow tinge. When beryl has a pale greenish-blue tint it is known as aquamarine. Occasionally gem-quality beryls were found in the course of tin mining in the Emmaville and Torrington districts in the New England area of New South Wales.

Emerald, the deep-green variety of beryl, was won from a tin mine near Emmaville some 70 years ago, but it was a small and short-lived industry. Commercial mining for emeralds has also been carried out at Poona, in the Murchison district of Western Australia.

Topaz is found in granite areas throughout the eastern Australian highlands, as in Tasmania and Flinders Island and at Stanthorpe, Queensland. The choicest gem variety however, comes from New South Wales. Large crystals, or waterworn pebbles, perfectly flawless and transparent, can still be recovered today from heaps of mullock left by tin miners along the banks of the Oban River, in the Guyra district of the New England tableland, New South Wales. When cut, these stones have a most attractive clarity and brilliance. All Australian topaz shows delicate tints of blue and green, a fact which surprises the layman since most people think of topaz only as a brownish-yellow stone of great brilliance because of the predominance of such material from the Brazilian fields.

Zircons occur in decomposed basalt at Hanging Rock, New South Wales, and are abundant in the gravels of various streams at Uralla, Inverell, Aberfoyle and Bald Knob, in the New England area of the same State. Zircons are also associated with sapphires at Anakie. Attractive stones ranging in colour from deep-red to golden yellow have been cut, but they are not sufficiently abundant to have given rise to an industry. In recent years pale-straw to colourless crystals from the Strangways Ranges, Central Australia, have been cut in Alice Springs. Incidentally, the blue zircon, which is the common stone in the trade, does not occur naturally. It is made by subjecting reddish-brown zircon to heat treatment. This is done in Bangkok, Thailand, on rough material from Indo-China.

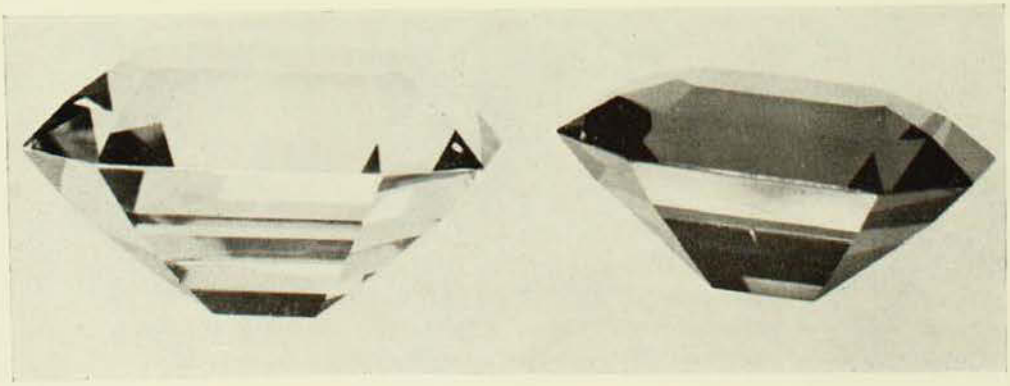
Garnet and various members of the quartz family, while very attractive and durable, lack value because they are among the commoner gemstones and are widely distributed in Australia. Worthy of note are the deep-red garnets of the almandite variety found in the Pre-Cambrian schists and gneisses of the Harts Range, Central Australia. These are sometimes cut and marketed under the name "Australian ruby," which is quite misleading and led a well-known Australian authoress into serious error in describing mining fields of Central Australia.

Rock Crystal

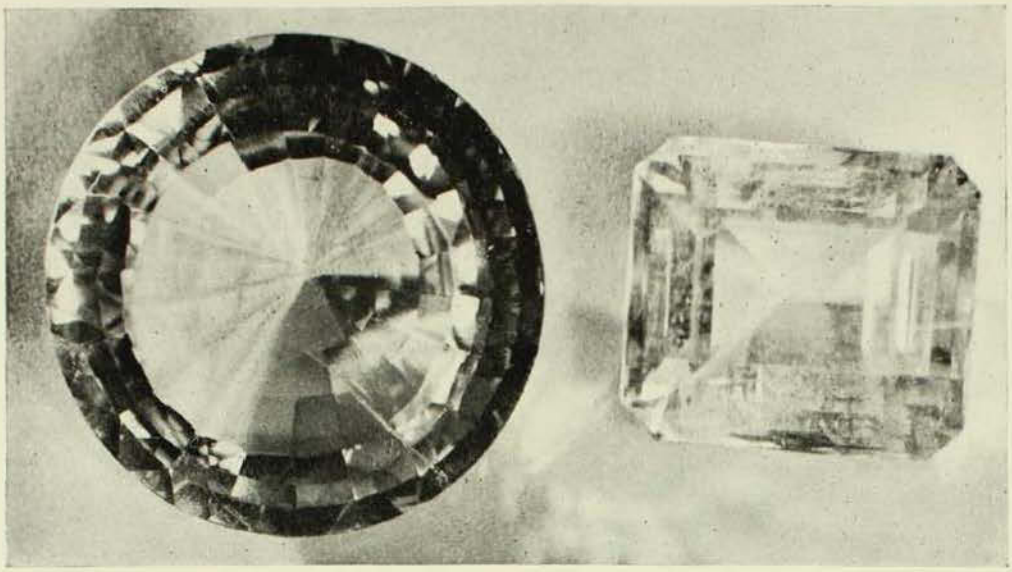
Clear, colourless quartz known as rock crystal, the yellow variety, citrine, the yellowish-brown cairngorm (the well-known decorative stone of Scottish Highland ceremonial dress) and amethyst, the beautiful purple variety, all occur throughout the numerous granite areas of the eastern Australian highlands, especially in the New England area. The clearest, most flawless and largest masses of rock crystal come from the well-known molybdenite and bismuth mines of Kingsgate, near Glen Innes. One of these masses weighed 25 lb. Perfectly clear crystals also have been found near Hanging Rock, Nundle and at the Conrad Mine, Howell. Waterworn pebbles of all the varieties of quartz are found in the gravels of the rivers in the Oban district.

Tourmaline of gem quality, both green and pink, is found only on Kangaroo Island, off the South Australian coast, although the common opaque black variety frequently occurs in granites throughout the continent.

Diamond is found in every State in Australia except the Northern Territory. The most important source is New South Wales, where it was first found about 100



Cut citrine (left) from Oban Creek weighing ¾oz., and cut cairngorm, weighing ½oz., from New England. Both these fine New South Wales stones were cut and presented to the Museum by O. le M. Knight.



A superb, perfectly transparent, pale blue cut topaz (left) weighing 1½ oz., from Oban, and a pale yellowish-green beryl, remarkably free from flaws and weighing a little over ½oz., from Heffernan's Wolfram Mine, Torrington, New South Wales.

years ago in a few localities on the Macquarie River between Bathurst and Wellington. Commercial mining first began in 1867 at Two Mile Flat, on the Cudgegong River, 19 miles north-west of Mudgee. In 1872, it was discovered near Bingara, on the Gwydir River, and finally the most important Australian field was discovered in 1875 at Boggy Camp, near Inverell, on Cope's Creek, a tributary of the Gwydir. Later this became known as Copeton.

The origin of diamond has exercised the minds of many geologists. In the Copeton district there is an occurrence of diamond embedded in a parent rock, dolerite, but apart from this the origin is quite unknown, every occurrence being in ancient stream gravels, often lying under basalt flows. In some places the diamonds have been washed into the alluvium of present-day stream beds. The ancient gravels are very often so firmly cemented together that in crushing them there is risk of damage to the diamonds.

Australian stones are small, seldom exceeding 6 carats (about one-thirtieth of an ounce). The average size is much smaller than this. The giants of the African fields are not found here. Australian diamonds are harder than diamonds from any other part of the world, but this is only a relative matter as diamond is the hardest of known substances, natural or artificial. They are nearly always slightly yellowish in colour and this, together with their small size, makes them mostly unsuitable for cutting as gemstones.

Diamond is indispensable as an abrasive because of its superior hardness, and during the war the Copeton field supplied a small but useful quota for industry. Recently, over a period of a few years, a large gold dredge working on the Macquarie River near Wellington, New South Wales, recovered an appreciable quantity of small industrial diamonds from the large amounts of alluvium put through in the search for gold, but, operations have now ceased. With these two exceptions, there has been no diamond industry in Australia for the last 40 years.

It will be seen that practically every well-known gemstone has been found in Australia except ruby. While our gemstones are of considerable scientific interest we cannot claim to rank as one of the world's chief producers, since only about one-half per cent. of the world's total production comes from this country. Nor can the gemstone industry claim great importance in Australia's economy, as it forms less than one-fiftieth per cent. of Australia's total mineral production. The two most noteworthy features of our gemstone industry are that Australia is the world's chief producer of opal and that Queensland sapphire production is by no means negligible.

[*Photos with this article are by Howard Hughes.*]

A particularly striking exhibit, part of which is seen above, shows how the Aborigines make and use stone implements. Their methods are demonstrated by cast hands holding actual implements.

Photo.—Howard Hughes.

NEW ABORIGINAL EXHIBITS AT THE MUSEUM

By FREDERICK D. McCARTHY

ONE of the most striking features of the modernisation and reorganisation of the Australian Museum's exhibits, now being carried out, is the new Australian Aborigines section.

This section has been designed to satisfy all types of visitors—to be attractive and interesting to the casual visitor, instructive to those wishing to learn about the Aborigines, and suitable for use by the Museum's education officers with school classes. The problems faced in preparing new exhibits are familiar to most curators in museums where only one display can be allotted to any particular phase of a subject and has to satisfy all types of visitors. By their very nature, the 20 new Aboriginal exhibits with which we are concerned in this article could not all be treated in the same manner, but fortunately space and light were adequate.

The labels contain the most up-to-date information about the Aborigines. A minimum of labelling is used in most of the exhibits; in some, however, a higher ratio of labels to specimens has been found desirable and, in several, what we consider to be over-labelling has proved to be essential to give the subjects their proper context.

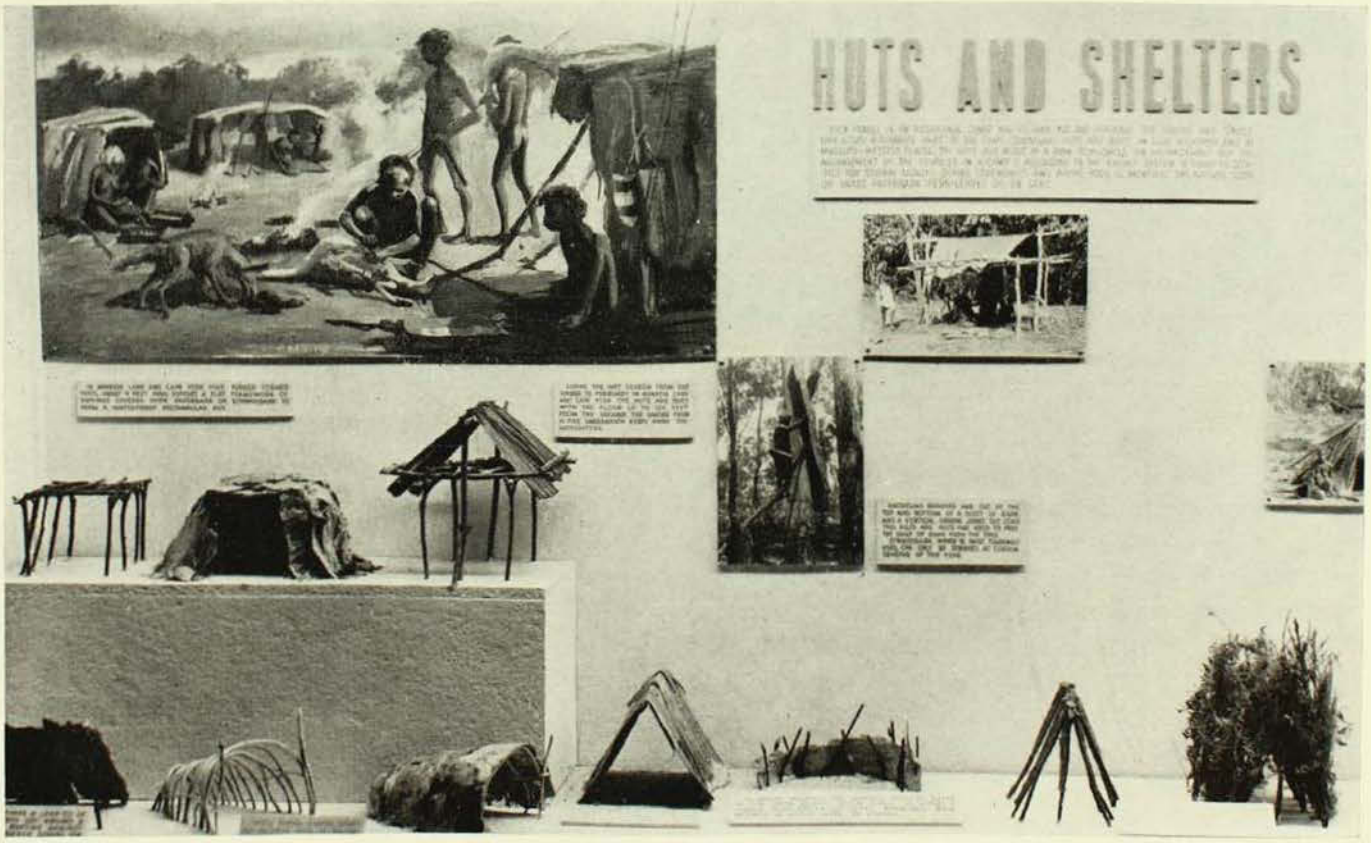
One of the most successful of these exhibits illustrates how the Aborigines make and use stone implements. The public generally know that the Aborigines were a Stone Age people in pre-white times, but to most individuals knapped implements look just like so many broken stones. The exhibit, therefore, has to be of an unusual nature to attract and interest the visitor and, this done, to teach him how to recognize such implements in the countryside.

The subject is important to the specialist because of the light it throws on the making

and uses of prehistoric implements elsewhere. It was decided to demonstrate each of the technical processes by using actual implements held in cast hands, and this problem was solved so successfully that an impression is given of a native standing behind the exhibit and poking his arms through holes in the wall. It has proved fascinating to the public. The exhibit begins with knapping techniques, followed by a section on the shaping and trimming of knapped implements and of an axe, from the rough flaking of a blank and the pecking of the body to the grinding and mounting of the blade. A liberal series of implements show the various stages of manufacture. The range of uses of implements, shown by paintings and specimens, include the cutting-up of a kangaroo, knocking oysters off rocks, trimming a club shaft, shaping a bark dish, and cutting down a sapling.

"The Stone Age in Australia" exhibit required a different treatment because, although archaeology is only in its infancy in Australia, the unfamiliar implements had to be shown in a recognizable manner in the time-periods to which they belong. In other words, we had to illustrate the archaeological horizons in a way that would arrest and interest the visitor and let him know how the archaeologist builds up the story of the prehistory of his country.

To do this, we showed a profile in cut-out board of three key cave-sites, painted a group of Aborigines living on the floor of each one, and below them attached sets of implements in their periods to sanded layers of board in different colours. Other open camp-site industries are shown on separate mounts on the floor. Cave paintings are shown where relevant. Thus, here at a glance may be seen how long we know the Aborigines have lived in Australia.



Models of huts and windbreaks show the different kinds of Aboriginal dwellings. With this exhibit are a painting of a camp scene and photos of life about the huts.

Photo.—Howard Hughes.

Following sections illustrate the enrichment of Aboriginal culture from foreign sources; they display the axes, picks and other advanced types of implements made with the Neolithic techniques of pecking and polishing, and the cultural importance of the visits of the Torres Strait islanders to Cape York and of Indonesians to Arnhem Land. Although a minimum of labelling is used in this exhibit, it is one that requires either some knowledge of archaeology or a willingness, on the part of the visitor, to study the material, and from this point of view the exhibit is difficult to reduce to visual standards.

Visitors look with a more personal interest in, and a quicker understanding of, exhibits which deal with material familiar to them in their everyday life. "Dress and Ornament" is one. In this display, on a frieze 9 ins. high and 16 ft. long, we have illustrated an extensive series of aboriginal men and women from different parts of Australia, contrasting their daily attire, or lack of it, with the striking and colourful patterns of their ceremonial dress. The relevant ornaments, grouped according to the part of the body on which they are worn, are shown on differently coloured backgrounds, while a rose-pink main label draws the attention at once.

Aboriginal Huts

The domestic and economic life of the Aborigines is also ideal material for visual presentation, as none of it is of a complicated and technical nature. As many people in Australia do not know that the Aborigines built huts of any kind, we have used models of the various types of windbreaks and huts, together with a painting of a camp scene and photographs of life about the huts.

The same approach has been followed with hunting and fishing traps, where the models are blended with background and action paintings of the traps used. These exhibits were designed also to emphasize the very restricted range of simple traps used by the Aborigines and the fact that the hunters must be in attendance, be patient and have an intimate knowledge of the game sought. The message of exhibits of this kind is imparted to the visitor almost at a glance.

A series of other exhibits, each one of a limited subject, made it possible to use a high proportion of specimens and illustrations to labels. In "Methods of Communication" two seated Aboriginal men (half life-size), one handing a message stick to the other, are painted in the middle of the exhibit and are surrounded by a wide variety of these sticks; sign language and smoke signals are explained by a label on which the subject is illustrated with a coloured sketch. Where possible specimens have been blended with action diagrams or paintings. The "Fishing Gear" exhibit displays hook, net, spear, harpoon and poison methods, but it relies on a shell-hook making sequence, and a cast fish transfixed on a spear, as features of a subject familiar to every visitor. "How Trees are Climbed" attracts the child at once, as Aborigines are seen half-way up large tree-trunks. "Twines" draws the eye with a life-size painting of an attractive young woman, rolling twine on her hip, from whom lines run to the hair on another woman's head, a possum and a plant—to represent the human, animal and vegetable sources from which the twines originate.

Tribal Boundaries

"Tribal Map" incorporates the strictly-observed territorial boundaries, important because many people do not realize that the Aborigines were confined to their own areas and could not wander at will according to their fighting prowess. The tribes are set out on a perspex sheet illuminated from behind, and photographs indicate the close economic and religious link between the Aborigines and their country. Visitors enjoy finding out the name of the tribe in whose territory they are now living.

Two of the exhibits dealing with spirit concepts in Aboriginal life are set out on the closed circle principle. The Aborigines believe that a spirit lives in the body of each person, and that death is due to this spirit either leaving the body or being captured by a sorcerer. Thus, in "The Spirit Concept", a line, the circle of life, extends from a mother and her new-born babe to an outcrop of rock in which a huge shadowy culture-hero has deposited a stock of spirit-children, who emerge to fertilize the mother, to whom the line returns. The circle encloses a series of spirit boards.

"LIFE THROUGH THE AGES"

"Life Through the Ages", a coloured chart showing the progress of life through geological time, has just been published by the Australian Museum.

The chart (34 in. x 24 in.) relies on illustrations more than on wording, and is designed for hanging in schools so that it may be seen by all children, whether they are studying the biological sciences or not. It can also be used as an aid in the teaching of science, and will be of value to lay people interested in biological subjects.

The chart illustrates the kinds of life that have existed from the primitive invertebrates of more than 800 million years ago to the present. It shows the geological periods and their durations.

It is on sale at the Museum, price 6/- (6/9 posted).

"Death in Arnhem Land" illustrates the same theme from another angle. Here the skulls, bark coffins and graveposts, with totemic designs painted on them, are combined with sketches of the many stages of delayed disposal of the dead, from mourning to the final passing of the spirit, and the throwing of the skull into the sacred waterhole of the clan. The various steps in this prolonged rite progress easily from one to the other, the specimens are colourful, the skulls are personal and death is an important theme. For these reasons hardly a visitor passes by this exhibit.

Medicine And Magic

"Medicine and Magic" offers a strong contrast to all the other exhibits because its technical procedures cannot be explained in a few words. Its basic theme is to demonstrate how magic penetrates every aspect of the life of the Aborigines. The exhibit begins by explaining the instruction and initiation of a medicine-man and the source of his magical powers. The treatment of sickness is then described, followed by magic in hunting, fighting, divination, totemism, love and rain-making. Bone-pointing, Kurdaitcha shoes and other well-known methods of sorcery are illustrated, and some rare specimens shown. Pictures in a frieze painted in grey and white (running the full length of the exhibit) illustrate each section of the exhibit, which as a whole flows smoothly from section to section, though each part may be studied separately. It was found impossible to deal adequately with an ingredient of Aboriginal life which has such wide ramifications without what we consider to be too high a proportion of labels, and people must read the labels if they wish to understand the subject.

We followed a general principle of using as much illustration as possible to explain the material and subject to the visitor. Colour has been used as part of the design rather than as a feature in itself. Thus, in "Medicine and Magic", muted colours are used to blend with the solemn nature of the subject, and light grey serves well where the illustrations and specimens provide adequate colour and variety. In "Dress and Ornament" we found blocks of different colours necessary to give life to the exhibit as a whole. Colour has been used in the lettering and labels to add to the attractiveness of the exhibits.

CORAL SEA COLLECTIONS

For two weeks in August and September last year, the Museum's Curator of Molluscs, Dr. D. F. McMichael, was the guest of the Royal Australian Navy aboard H.M.A.S. Gascoyne during a survey cruise to some outlying islands of the Coral Sea.

Mr. K. Hindwood, the Museum's honorary ornithologist, and Dr. D. L. Serventy, of the C.S.I.R.O., also made the trip, to study the bird-life of the islands.

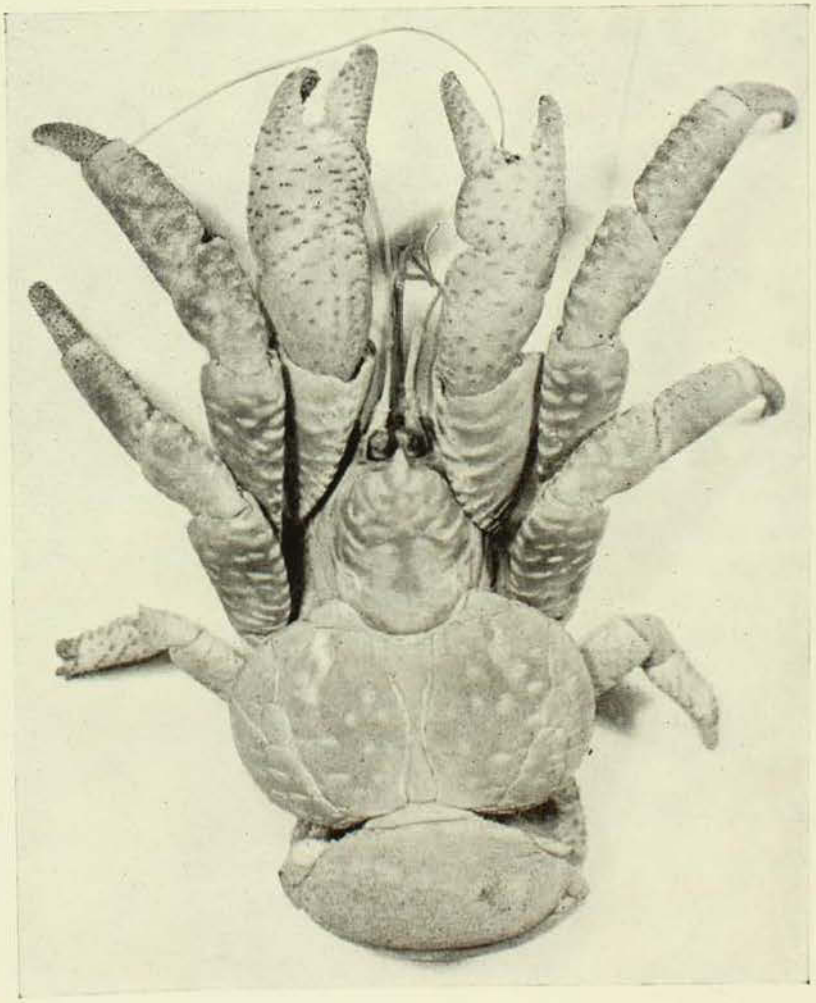
Dr. McMichael brought back many specimens of fishes, shells and other marine invertebrates, which will be added to the Museum's collections. He obtained 456 specimens of fishes belonging to some 80 odd species, which are still being identified. Noteworthy amongst these are a series of Surgeon Fishes (one of which wounded a man with the spine on its tail), some beautifully coloured coral fishes, many pomacentrids, and several smaller kinds new to our collections. One species at least may be new to science.

THE ROBBER CRAB—A CRUSTACEAN MYSTERY

By FRANK McNEILL

HISTORY records that, in the latter part of the 16th century, Sir Francis Drake visited an island in the southern Celebes during his famed circumnavigation of the globe in the ship Golden Hynd. It was there he observed a remarkable land-dwelling crustacean which has since become known as the Robber or Coconut Crab. This was probably one of the first reports of its kind to reach the countries of Europe. An earlier reference to the same crab enigma appears to be a report by an Arab merchant of the ninth century, who noted the strange habits of the crustacean on an island of the Indian Ocean. Since those early days a mass of information has become available on this still intriguing subject but of such a controversial nature that it is now difficult to sort fiction from fact.

The very uniqueness of this strange species, *Birgus latro*, is probably the reason why so much circumstantial evidence about its unusual ways of life has been both reported and repeated by numerous authors. If a subject is intriguing, there is always a tendency to exaggeration, and this appears to be the case with much of the available data on the Robber or Coconut crab, which



A young example of the Robber Crab in the Australian Museum's collection.

Photo.—Howard Hughes.

is found on many widely-scattered tropical islands eastwards from the Indian Ocean to the mid-Pacific region.

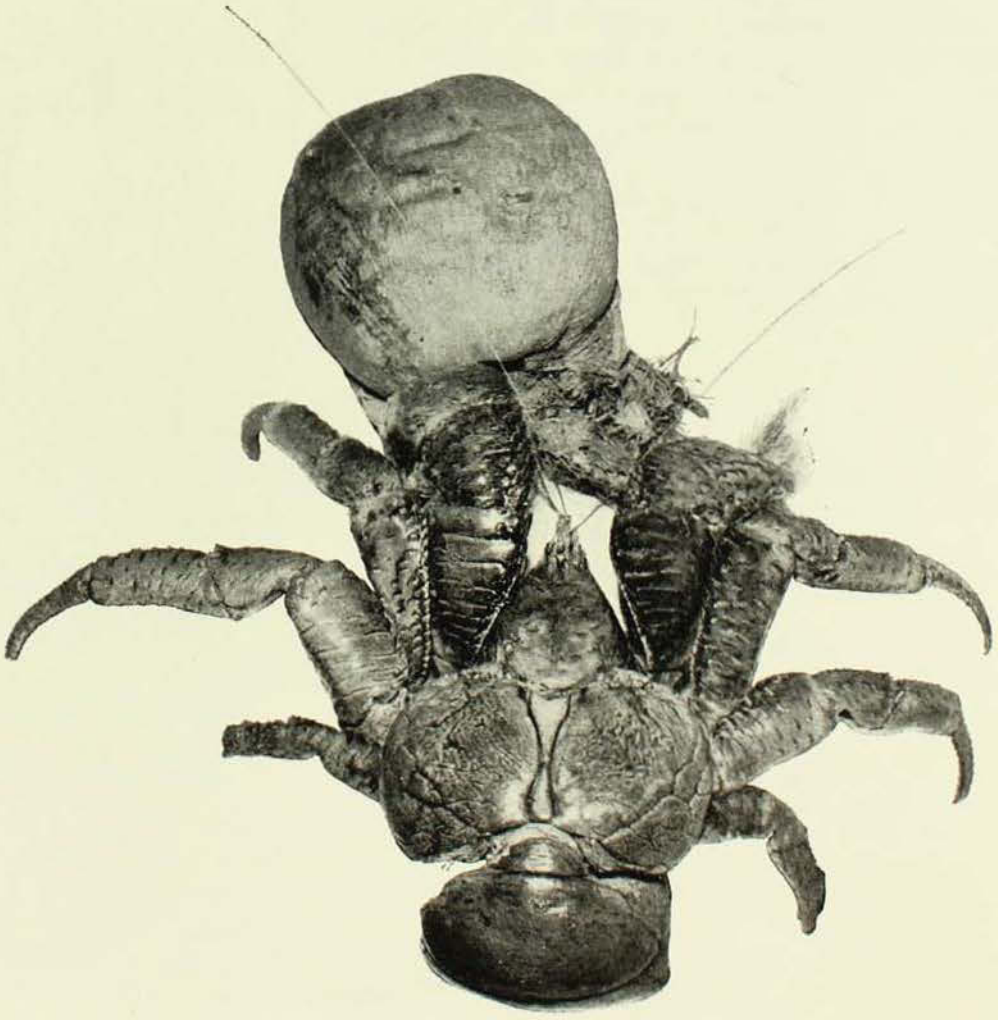
Crab Climbs Coconut Palms

An author named Rumphius (1705) published the first detailed description and account of the Robber Crab. It was also he who first claimed that it ascended coconut palms to dislodge the nuts, and later descended the palms to feed on the kernels after tediously husking and breaking open the nuts with its claws.

The latter part of the crab's technical name, meaning robber, has reference to the foregoing claim, and its application by the scientist Linnaeus in 1769 was influenced by what Rumphius had published. The great naturalist, Darwin, in his Narrative of the Voyage of the Beagle (1845) was even moved to state: "I think that this is as curious a case of instinct as ever I heard, and likewise of adaptation in structure between two objects so remote in the scheme of nature as a crab and a coconut tree." Darwin doubted, however, if the crab could actually climb trees.

Nevertheless, this ability to climb has since been firmly established, and the habit is not confined to coconut trees, for these do not grow in some places where the crab is found. No irrefutable evidence exists which supports the claim that the crab can dislodge nuts, and the more feasible and more acceptable explanation is that the climbing is done to drink the sap or the water accumulated in the leaves, or to consume soft fruits and berries. The crab's return journey to the ground is a far more difficult operation than the ascent. A climber has more than once been seen to solve this problem by loosening its hold and falling anything from 12 ft. to 15 ft.

Modern investigators have belied the frequently published claim that the Robber Crab can husk and break open coconuts.



Robber Crabs can sometimes break open coconuts and eat their internal flesh. This Australian Museum exhibit shows an adult crab tearing husk aside to gain access to the inside of a nut.

Photo.—Howard Hughes.

While there is no denying that the creature has been seen in the wild state eating the fleshy interior of coconuts, some competent observers of very recent years have been convinced that these were nuts that had fallen to the ground and were found by the crabs in a condition where access to the interior was easy. While the present writer has not observed Robber Crabs in their natural state, he has noted that, on islands where fallen coconuts receive the attention of rats, these rodents are able to gnaw through the husks and inner shells to reach the edible interiors. Being inveterate scavengers, the Robber Crabs would naturally take advantage of such readily-available food, either by driving off the industrious rats or by simply feeding on their leavings.

The account of the Robber Crab's coconut-eating habit given to us by Darwin is worth repeating here. It is only one of a number of similar accounts to be found in the literature of the last century which, it now appears, were not fully substantiated. Darwin records that "the crab begins by tearing the husk, fibre by fibre, and always from that end under which the eye-holes are situated; when this is completed the crab commences by hammering with its heavy claws on one of these eye-holes till an opening is made. Then, turning round its body, by the aid of its posterior and narrow pair of pincers, it extracts the white albuminous substance." Admittedly there is great strength in the crab's two front claws, and this alone could give rise to all sorts of suppositions. However, there seems little doubt that the enlarging of a hole found in a fallen coconut would prove a comparatively simple task.

This is borne out by the story told to the writer by the late Charles Hedley, of the Australian Museum staff. In 1898, when he was a member of a Royal Society (London) expedition to Funifuti Island, Ellice Group, in the western Pacific, he placed a captured Robber Crab in a light metal biscuit tin, securely tying down the lid. Overnight, the captive managed to escape by first punching a hole in a wall of its prison and then enlarging this by literally tearing the metal aside. The formidable strength of the claws, thus demonstrated, accounts for the respect natives have for the crab when capturing it for food on those islands where the crustacean's main diet is coconut. This is usually a nocturnal operation, for it is mainly at night that the crab ventures from its hiding-places to feed. The main attraction to the hunters is said to be the abdomen or hinder body of the Robber Crab, which is classed as an epicurean treat. This part is a compact oily mass which will yield as much as a quart of oil. Most museum specimens have the same oiliness permanently present, and it gives off a rancid odour.

In some places the Robber Crab has been reported as living quite long distances from the sea, as much as 30 to 40 yards above the shoreline. One author stated that he had seen specimens in the Solomon Islands at an elevation of 300 ft. In such places they have been known to make their homes or hiding-places in the vacated burrows of large conventional land crabs. Nearer the shoreline they commonly hide by day in crannies and crevices among tumbled coralline limestone boulders, among the roots of mangroves or in burrows which they excavate at the base of coconut trees. The last-named type of habitat is shown in the group exhibit of Robber Crabs on display in the Australian Museum.

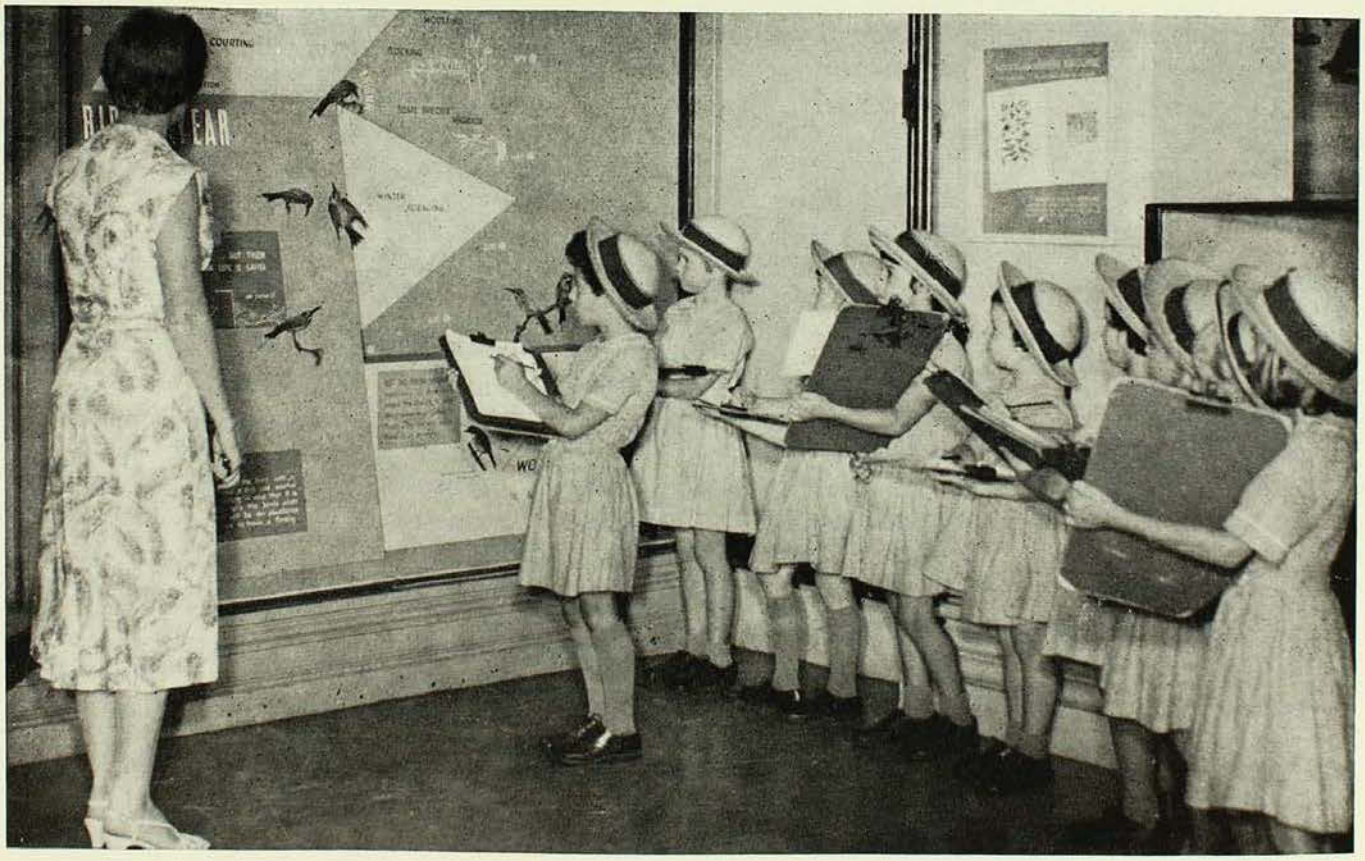
Robber Crabs 18 ins. Long

Large examples of the Robber Crab grow to 18 ins. in length and weigh as much as 6 lb. They are, strangely enough, a giant type of Hermit Crab, but do not occupy the shells of molluscs as do all other Hermit Crabs found so commonly on every shoreline and in every sea.

Their closest relatives are several species of Land Hermit Crabs (*Coenobita*) which infest practically every tropical island shoreline in the same area of distribution. A problem of the Robber Crab's origin that will always confound zoologists is whether it has evolved from a shell-living type of Hermit Crab by dispensing with such an encumbrance at some period in a past age, or at no stage in its development ever occupied a shell. Other more simple problems than this have yet to be solved concerning this enigma of the crustacean class. It appears obvious that much of the confusion and wide divergence in published

accounts of the crab's habits is due to variation in the pattern of behaviour at different localities in the wide range of distribution. Never have its habits or its life history been investigated with any degree of completeness. As is common practice with other kinds of land crabs, it is obvious that at least the females of the Robber Crabs enter the shallow edge of the sea for short periods either to hatch their eggs or release already-hatched larvae. Although apparently no observer has ever seen them go into the water, this is probably done at night. If they did not enter the sea there would be no explanation for the scattered occurrence and wide range of the species.

SCHOOL CLASS AT THE MUSEUM



This school class has come to the Australian Museum for a lesson on birds, and is here seen studying the exhibit "The Bird's Year," under the guidance of Museum Education Officer Miss Patricia McDonald. Lessons for school classes of all ages, on all subjects illustrated by gallery exhibit, are a regular feature of the Australian Museum's educational work. Teachers wishing to bring classes should apply to the education officers by telephone or letter.

THE BLUE WREN

By IAN ROWLEY

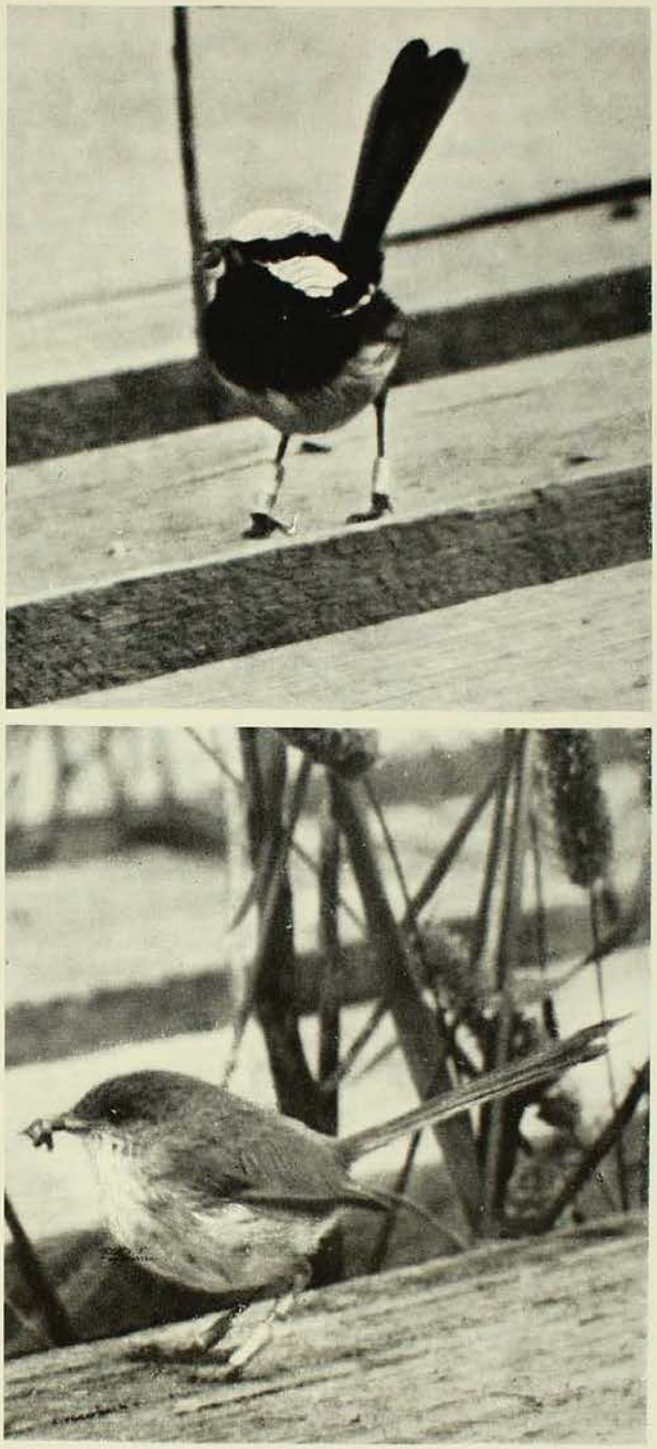
Wildlife Survey Section, C.S.I.R.O., Canberra.

BLUE Wrens belong to the genus *Malurus*, which comprises some 14 species, all except one of which are confined to Australia, the exception occurring in New Guinea. These wrens are characterized by their cheerful song, small size, long legs and long tail, which is carried nearly upright; the males are all brightly coloured, while the females are usually brown.

Between them these species cover the entire continent of Australia. The Superb Blue Wren (*Malurus cyaneus*), to give it its full title, or Blue Wren as it is commonly called, is certainly the most widely known of the 14 species. Its distribution coincides with the area of densest human settlement and stretches from South Queensland down the eastern seaboard through New South Wales and Victoria to Tasmania, where a distinct sub-species occurs (see fig. 1), and South Australia. The species covers an area of country stretching 100 to 200 miles from the sea throughout this range and a narrow strip along the Murray River from its mouth to Kerang in Victoria, broadening to include the western Riverina. Whether this inland population is the relic of a former more widespread one, or whether the species is spreading, is at present unknown.

Blue Wrens have adapted themselves to the changed environment following settlement far better than any other member of the genus, and are now common residents of our city parks and gardens. In contrast, *M. splendens*, the West Australian counterpart species, has failed to colonize, or remain in proximity to, human habitation; the same applies to *M. melanocephalus* and *M. lamberti*, both of which occur near Brisbane, the latter also near Sydney.

In their natural setting Blue Wrens inhabit the damper sections of the bush where there is shrubby growth providing nesting sites and cover from predators, interspersed with clearings, over which they search for food in



Top: A male Blue Wren banded 18 months ago. Some wrens have carried their bands 4½ years. Bottom: A female Blue Wren carrying food for her nestlings. The two upper bands on the left leg are her individual colour combination (green and orange), and the lower band is a numbered aluminium one supplied by the Australian Bird-banding Scheme. The coloured celluloid bands are duplicated on the right leg in case they are lost.

Photos.—Author.

a series of hops, propelled by their long thin legs; tea-tree-covered creek banks are favourite places. It is easy to see the similarity between this environment and man-made gardens; since Blue Wrens tolerate the presence of humans and survive the added predators, such as cats and small boys, the advent of settlement has probably favoured the species as a whole by providing more suitable habitat than was previously available.

Plumage

During the breeding season male wrens assume their full plumage; with the Blue Wren this is chiefly in shades of blue and black, the pale blue feathers looking almost as though they were enamelled by some Oriental craftsman and the whole effect, both in colour and intensity, being one rarely found in birds. Once breeding ceases (usually January-February) all the adults enter a moult from which only the older males (more than three years old) emerge with full blue plumage; younger males remain in eclipse and closely resemble the females, except that the bill, the lores and the area around the eye are dull brown, whereas in the female they are bright orange-brown. This eclipse plumage, and the young birds' habit of remaining with their parents throughout their first winter, give the impression that the cock is herding a harem of females, and in consequence the name "Mormon Wren" became firmly established, although ornithologists proved it to be without foundation many years ago.

Banding

For the past few years a number of people have banded Blue Wrens in connection with the Australian Bird-banding Scheme. About five years ago all the wrens in an isolated population near Canberra were trapped and given different combinations of coloured celluloid bands, so that they could easily be recognized as individuals and their life-histories recorded by repeated observations. All the nestlings were banded too, and so gradually a quota of known-age, pedigreed birds was built up in the population, which enabled plumage changes and social relationships to be documented. It soon became clear that, far from maintaining harems, males outnumbered females, and the latter were often attended by two or more consorts—an imbalance confirmed by similar studies in Sydney.

Territories Defended

From watching these wrens as individuals it was clear that they were intensely territorial, inasmuch as they maintained a defended area of about two and a half acres from which others of the same species were repulsed and outside which the territory-owner became a trespasser in a neighbouring

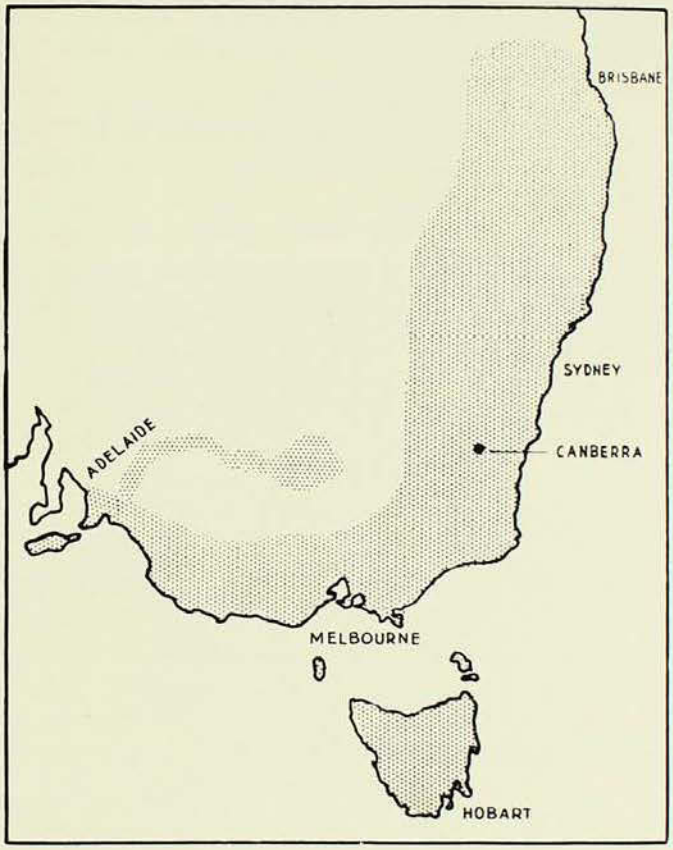


Fig. 1: Shaded areas show the distribution of the Blue Wren (*Malurus cyaneus*).

domain. Within these territories wrens may satisfy all their requirements—breeding, feeding and roosting—and some individuals spend their entire lives, from hatching to ripe old age, within the confines of the same acre or two of shrubs and lawn.

Over the years the locations of territories remained remarkably constant (see fig. 2), although the inhabitants changed as natural losses occurred and were made good. Some changes in boundaries occurred with season,

probably in response to food supply; this growth was amoeboid in nature, spreading where resistance was least, e.g., into an open paddock not usually frequented.

Movements within the populations were small and such dispersal of young as occurred chiefly concerned females, one of which travelled four miles to nest outside another C.S.I.R.O. laboratory in Canberra; this was the greatest distance a wren is known to have moved.

Nesting

Around Canberra nesting usually starts in September and finishes in January, varying with seasonal conditions. The nest itself is a small ball of grass with a side entrance and lined with softer materials, such as feathers, wool and horsehair; it seldom measures more than 4 in. across by 5 in. in height, and may be placed from one to 20 ft. above the ground (average 3 ft.) in a moderately dense bush, grass tussock or pile of brushwood. Three or four eggs are laid and incubated by the female for about 14 days; both parents then feed the young, which remain in the nest for another 12 days. For 10 days after leaving the nest the fledglings remain in dense cover being fed. After this they venture into the open and can fly quite strongly, by which time the female is usually sitting on her next clutch of eggs so that the care of the young falls largely on the males.

Social Organization

Blue Wrens have interesting and unusual social habits. With most species of small passerines the offspring leave their parents soon after they are able to fend for themselves, especially if the species is multi-brooded. Wrens nest several times in a season but no such family break-up occurs. During winter the family group moves and feeds as a unit, roosting together at night; it is not until the spring and the breeding season return that any dissension arises, and this is mainly confined to young females who wander off to fill vacancies in other groups nearby or farther afield.

Young males appear to mature later than the females, and therefore do not evoke parental jealousy during their first year of life. By the time they mature the parents are again engrossed in nest-building and have other things to worry about. As a result of this greater tolerance, our observations have shown that it is quite common for a breeding pair to be attended by a male from one of their previous season's broods, and that bird (in full plumage by now) would help feed the nestlings and later might even undertake the complete care of an early-fledged brood while the parents attended a second clutch. In all cases where this development was fully documented these "supernumerary" males were invariably offspring from the same group; sometimes such relationships continued for several years. Occasionally the male parent

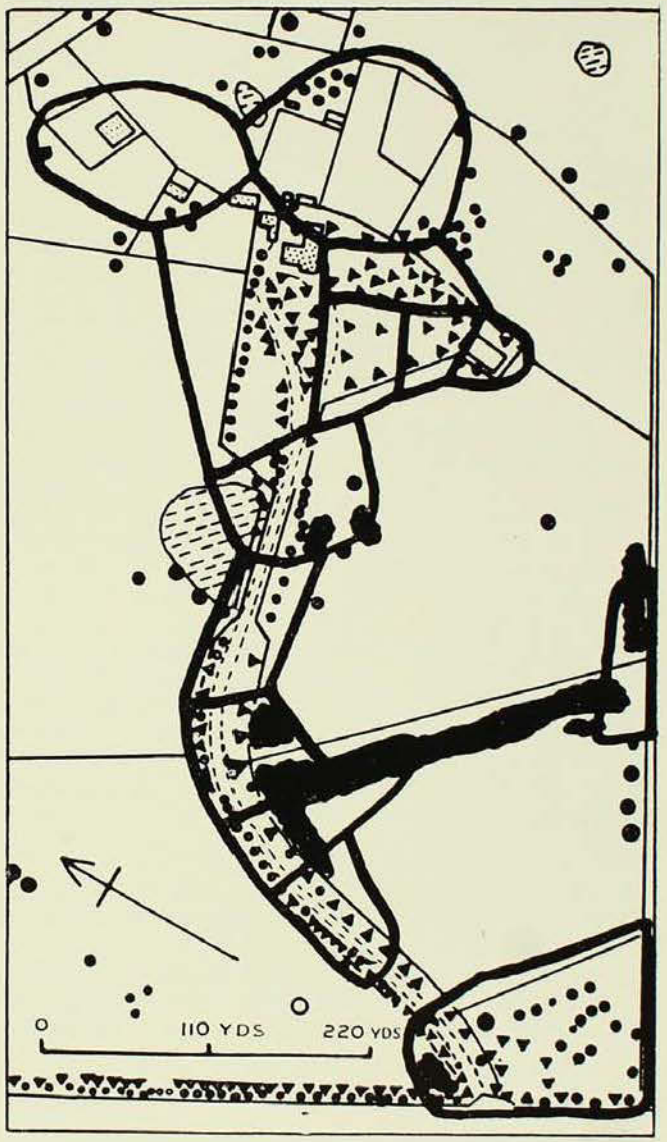


Fig. 2: The boundaries of Blue Wren territories at Gungahlin, Canberra, in the spring of 1956.

might disappear (?dead) and then the supernumerary would take his place, so that a measure of inbreeding must occur with this species.

As mentioned above, breeding lasts for three or four months, and the resulting young remain in the family group even after they become capable of independent life. Towards the end of the season it often happens that the offspring of the earlier broods take part in the feeding of their later-hatched brothers and sisters. Observation of banded nestlings at Gungahlin, Australian Capital Territory, the headquarters of the C.S.I.R.O.'s Wildlife Survey Section, has frequently confirmed that such behaviour—almost unique in ornithology—is of common occurrence in this species.

Individual colour-banding of Blue Wrens has uncovered many interesting facets of their life; perhaps it may also enable the public to gain still greater pleasure from the company of these colourful birds in our parks and gardens.

Book Review

ENCYCLOPAEDIA ZOOLOGICA. Illustrated in colour. Volume IV. Hokuryu-Kan Publishing Co. Ltd., Japan; 317 pp. 7½ in. x 10½ in. Price, $25.00.

This volume, which is the fourth and last in its series, deals with Arthropoda, Annelida, Nemathelminthes, Trochelminthes, Nemertini, Plathelminthes, Ctenaria, Coelenterata, Porifera, Mesozoa and Protozoa. Its first part consists of 45 pages presenting an account of the structure of each of these 11 groups as represented by various types. In this introductory part there are line drawings of external morphology and key sections; these illustrations carry numbers placed adjacent to structural features which are named, in Japanese and English, in the legend.

The main part of this work is a set of 123 colour-plates, each illustrating from three to as many as 30 forms in natural colours; interleaved with these plates are notes on each form, in Japanese, with scientific names in Roman script. Thus, the notes on each form are in the main inaccessible to a non-Japanese reader. However, the illustrations are magnificent, and although some specialist might conceivably consider, for his group, that there are inaccuracies of structure or colour, and it would require specialists to declare, from close examination of the illustrations and of translation of the text, whether the nomenclature were satisfactory, nevertheless the work is a wonderful collection of colour-illustrations of some 1,300 or more forms.

There are indexes in both Roman and Japanese scripts; the former gives entries for both genera and species, and clearly shows the number of the text page on which the species is described, together with plate and illustration number.

While a non-Japanese reader (unless he can read Japanese) cannot use or appraise the text, and while specialists might have reservations about arrangement, nomenclature and details of the illustrations (the reviewer is not implying that he has found matters on which he believes that reservations should be made), the work is of considerable value for students and amateur naturalists.

G. L. KESTEVEN.

Uses of Radio-Activity in Entomology And Insect-Pest Control

By M. F. DAY, S. W. BAILEY and K. R. NORRIS
Of the Division of Entomology, C.S.I.R.O., Canberra.

AMONGST the many examples of the uses of atomic radiation its applications in entomology may seem small. They are, however, diverse and significant. Only three of the more spectacular examples can be mentioned in this brief report. These are the control of insects by the release of males sterilized by radio-activity, the control of pests in stored grain, and the use of radio-active tags for tracing marked insects.

An entirely new concept of insect control was developed by the entomologists of the United States Department of Agriculture when they discovered that populations of the screwworm *Callitroga*, which develops in wounds in livestock, could be effectively reduced by the release of males sterilized by atomic radiation. When native female flies mated with the sterile males they produced eggs which failed to hatch and the population declined rapidly.

The screwworm was introduced into south-eastern U.S.A. about 1933, and by 1958 was estimated to be costing the live-stock industry 20 million dollars annually. The pest was eradicated in 15 months at a cost of less than 10 million dollars.

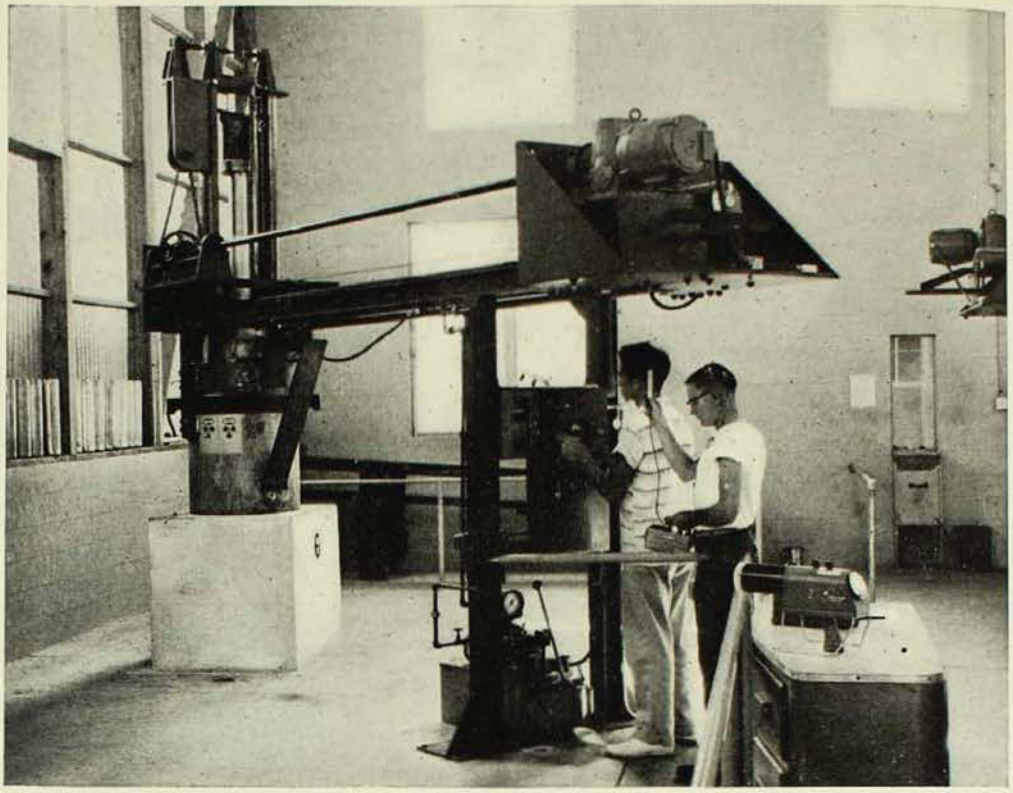
3,000 Million Flies Sterilized

Field trials began in 1956-57. Four hundred sterile males per square mile were released each week from July, 1958, to November, 1959, finally covering an area of 85,000 square miles. No screwworms were found after June, 1959. The problem of raising and sterilizing the 3,000 million flies required for this job involved insect-rearing on an unprecedented scale. An airplane hangar at Sebring, Florida, was converted to a factory for the mass-production of flies. Each week about 40 tons of meat and 4,500 gallons of blood provided food for the larvae, and the adult flies consumed 35 gallons of honey a week. About 40 workers each eight-hour shift were required to produce the insects.

Wheat weevils in pill boxes being prepared for experiments to determine their sensitivity to irradiation.

Photo.—U.K. Atomic Energy Research Establishment.

Extraordinary and entirely successful precautions were taken to stop the escape of flies from the building. Five-day old insects were sterilized by exposure to 5,000r (roentgens) of gamma radiation from a 70 curie cobalt-60 source (see photo on the next page). This was housed in a concrete



Equipment in Florida, U.S.A., for the irradiation of screw-worm pupae by cobalt-60.

Photo.—U.S. Department of Agriculture.

shed separated from the main building, and all operations were carried out by remote control.

The sterilized flies were packaged in cartons, about 1,000 of which could be carried by small aircraft. The cartons were automatically opened when released from the plane. Twenty-eight planes flew five to six hours every day during the campaign. Eggs from infested cattle and goats were examined, and weekly patrols of 400 fly-traps throughout Florida gave indications of fly activity.

The phenomenal success of the campaign is attributable to several factors. The population of flies in the field was not high, so that an excess of sterile males over the native population was achieved. The area was isolated, and could be protected against re-invasion by the pest. The insect could be reared in large numbers and the irradiation did not reduce the mating efficiency of males. Another characteristic which assisted in the eradication of the screwworm is the fact that females mate only once.

Whether useful control can be achieved with other pests is uncertain, but, whatever the future may hold, the screwworm eradication campaign will remain a landmark in the fight against insect pests.

Unlike the sterile-male-release technique, which was a new concept in insect control, the possible use of irradiation against insect pests of grain and other stored products was an obvious application. However, it has nowhere fulfilled its promise, although, very recently, the outlook has become much more favourable.

Research has shown that doses as high as about 500,000r are required to kill insects quickly (see photo on the previous page). A dose of 100,000r causes sterility and death within seven days; 20,000r causes this in about three weeks. Even this lowest figure is many times the dose that is lethal to man, so extensive shielding of the source is required. Radioactive isotopes cannot be switched on and off, and so provision must be made to handle them by remote control. All this means a large and expensive permanent installation that is most economically used on a 24-hour basis.

Even with lower costs of by-products of atomic power, like cobalt-60 or caesium-137, the costs of a unit big enough to treat grain at normal handling rates is very high, and in Australia not more than one unit per State would be possible; hence all grain requiring treatment would have to be channelled through it, and this would cause

considerable dislocation of the normal handling procedures. As treatment would have to be limited to major handling centres, such as terminal elevators, much of the potential insect damage would have already occurred. To be really effective all grain should be disinfested before storage; this would call for many low-cost units or a smaller number of portable units that could serve different localities of the State's country elevator systems. Radio-active isotopes would suit neither of these requirements.

Very recently a new family of electrical particle accelerator machines has been developed. These produce a beam of intense radiation and require far less shielding than a source that radiates in all directions. No radio-active materials are built into these machines, and so they are perfectly safe when switched off. Thus, they might become portable. One of the most promising instruments is the "insulating core transformer", and it may be the prototype of machines that will enable irradiation to take a useful place in storage technology.

The inherent limitations of irradiation must not be forgotten. Although it may effectively rid grain of any insect pests present at the time of treatment, there is no residual effect. It is essential that treated grain be put into clean, insect-free silos or the work is wasted. Thus, the introduction of this technique would in no way reduce the maintenance standards required at the storage silos.

Although irradiation would be a very useful tool, it cannot, by itself, solve our grain-infestation problems.

Marking Insects In Dispersal Studies

The technique of marking insects has long been employed in studies of their behaviour and dispersal. Formerly paints, dyes and dusts of various sorts were used, but in many modern studies of this type the insects are marked with radio-active isotopes. The chemical element which is most generally suitable for this purpose is phosphorus, which can be readily prepared in a highly radio-active state. The isotope of phosphorus, ^{32}P, has a half-life of about a fortnight—that is, a sample exhibits only about half its radio-activity after the lapse of this period. Some is also lost in the excretions of the marked insects, but, provided a dosage of high enough activity is applied initially, insects may be detectable for a few weeks after marking, which is sufficient for many purposes.

Insects may be "tagged" with radiotracers by incorporating ^{32}P in the larval diet, whence it is readily assimilated in the course of normal phosphorus metabolism. Otherwise, adult insects may be given a radio-active meal before liberation.

Tagged insects are detected with a counting apparatus which transforms energy from radio-active disintegrations into impulses which can be counted. There is a continuous "background radiation" which makes such counting devices register at a slow rate all the time, but when a radio-active insect is brought close to a detector there is a marked increase in the response of the counter. Insects may be detected alive in the field with a portable Geiger counter—or, more usually, samples of trapped, killed insects are spread out and exposed to the more complicated laboratory counting devices.

Employing radio-isotope marking methods, much valuable research has been carried out in the United States, Russia and elsewhere on the habits and dispersal of pests. A large part of this research has been concentrated on insects which transmit human diseases, such as mosquitoes and other blood-sucking flies, blowflies and houseflies.

Mosquitoes, made radio-active by rearing the larvae in solutions containing ^{32}P, or isotopes of other elements, have been found to disperse usually up to a mile or less from the release point, though one exceptional record of 20 miles was obtained for *Aedes taeniorhynchus* in Florida. Houseflies have also been recorded up to 20 miles from the release point, and, although the usual range of travel is three to four miles, they have been shown capable of spreading rapidly through residential areas, visiting kitchens and privies indiscriminately. The possibility exists that odd houseflies and mosquitoes may "hitch-hike" in cars or other forms of transport, but this is less likely to have been responsible for the movement of the strong-flying blowfly *Phormia regina*, which has been recovered 28 miles from its release point in Oregon after 13 days of wandering.

Fossil Insects

By J. W. EVANS

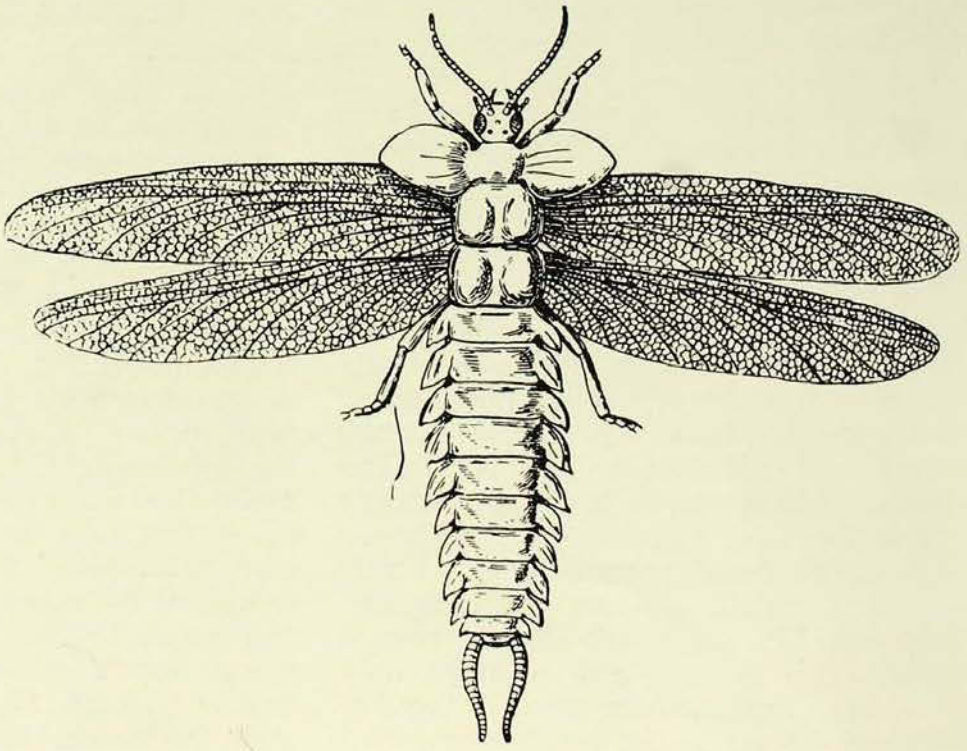
IN a gallery of the Australian Museum is displayed one of the most remarkable fossil insects ever discovered anywhere in the world. This fossil (which is illustrated in "The Handbook of the Australian Museum") and those of a few other insects on display in the public galleries represent only a very small part of the magnificent study-collection of fossil insects which the Museum possesses.

The study of these fossils, as well as assisting in the understanding of the evolution of insects, helps fill in a few of the many gaps in our knowledge of past geography and past climates.

The earliest known fossil insects are Springtails (Collembola). These fossils were found in Middle Devonian strata in Scotland, and the insects of which they are the remains lived some 300 million years ago. Although most people have never noticed the existence of Springtails, these insects are, though small, very abundant, and live mostly in damp situations. One, an introduced species, is well known to farmers in some parts of Australia as a pasture pest, the "Lucerne Flea". Springtails lack wings, and the earliest insects were wingless. Nevertheless, Springtails are not ancestral to any group of winged insects.

Earliest Winged Insects

The next geological period after the Devonian is known as the Carboniferous, and during this the first forests came into existence, although there were some tree-like plants growing during the Middle Devonian. It was during the Carboniferous that the earliest winged insects appeared. We know from the fossil record that wings in insects developed from lateral flaps on the three first segments of the body, behind the head—that is to say, on the thorax, which also bears the legs of insects. These flaps enabled gliding or, anyhow, acted like a parachute when an insect jumped or accidentally fell. Needless to say, until the advent of trees, insects were ground or water dwellers and so had no need for such gliding flaps. Hence, the correlation of the beginnings of forests and winged insects.



A reconstruction of a Palaeodictyopteron from Carboniferous strata in Europe. Note the lobes on the first segment of the thorax.

The earliest known winged insects belonged to an order now no longer in existence, known as the Palyaedictyoptera. Like present-day dragon-flies, these were unable to fold their wings backwards over their bodies when resting and had to keep them open at right-angles or folded upwards.

It has been mentioned that wings developed as gliding flaps on the front part of an insect's body and that there were originally three pairs of such flaps. Insects, however, only have two pairs of wings as the flaps on the first segment of the thorax never developed into wings. They were, however, retained by some of the Palyaedictyoptera and by insects in other Carboniferous orders.

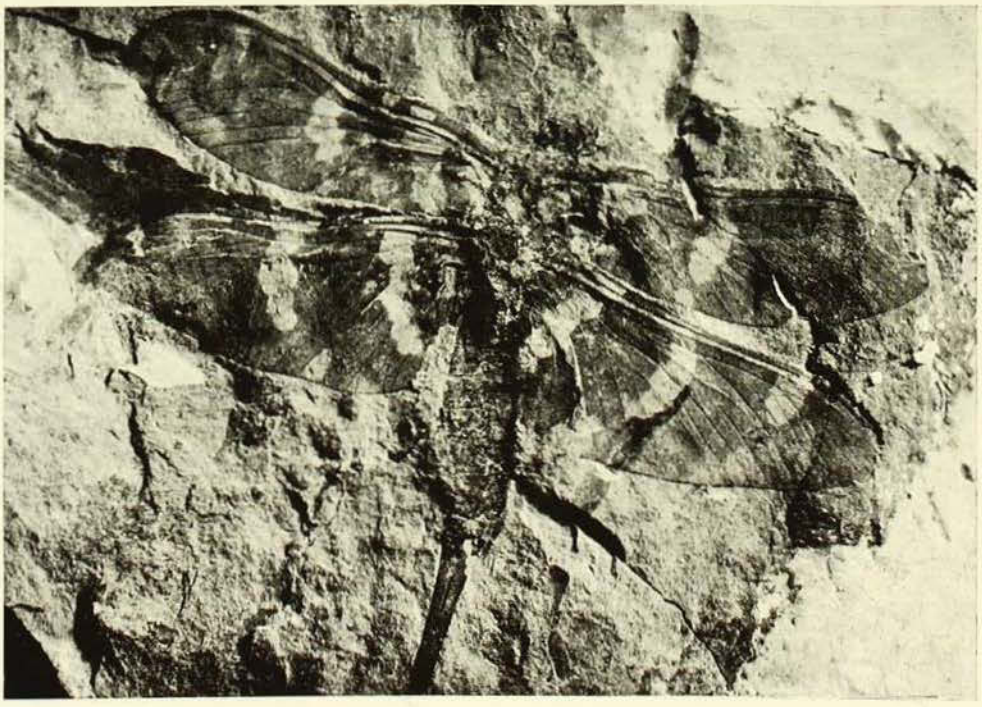
Although the rise of the Palaedictyoptera was associated with that of forests, many of these insects must have lived in open conditions, as some were of a very large size, measuring as much as 3 ft. across the extended wings.

We know from the fossil record that during Carboniferous times insects appeared which were able to fold their wings so that they could lie flat over their bodies. This would have enabled them to frequent places from which the Palaedictyoptera were excluded and to take shelter under stones and in crevices. Moreover, the wings, when at rest, could serve as a protective cover for the folded hind wings and the soft abdomens. As an example of such a Carboniferous insect may be mentioned cockroaches, and present-day representatives of this group are little-changed descendants from their ancestors which lived some 250 million years ago.

While abundant remains of Carboniferous insects have been found in Europe none are known from Australia.

The next geological period is known as the Permian. While the Carboniferous was a time of high rainfall (since without rain the lush forests which were the origin of the European coal measures could not have flourished), the Permian in the Northern hemisphere was a time largely of desert conditions, although contemporaneously there were extensive glaciations in the Southern hemisphere. However, in neither hemisphere were conditions everywhere at any one time so inhospitable as to prevent insect life flourishing.

A rich assemblage of Lower Permian insects has been found in Kansas, U.S.A. These occur in argillaceous limestone which was laid down in shallow water, doubtless bordered by forests. Many of the contained insects are splendidly preserved, and their wings, as is always the case with insect fossils, are the most abundant of the remains. Some complete bodies have also



A Palaeodictyopteron from Lower Permian strata in Kansas, U.S.A., showing the preservation of the wing pattern.

been found. A point of particular interest is the fact that, as well as the structure of the wings being preserved, in a few instances so also is their colour-pattern—though, of course, no trace of actual colour remains.

It is in the Kansas beds that the first representatives of the order Hemiptera occur. This Order comprises insects known as sucking bugs, and includes today such creatures as cicadas, scale insects, aphids and water bugs.

In most present-day Hemiptera the hind wings are larger than the front ones and the two pairs are locked together by hook-like structures. However, the Kansas fossil bugs had fore and hind wings which were similar in size and shape and which were not coupled together during flight. Consequently, compared with modern bugs, they must have been very weak fliers.

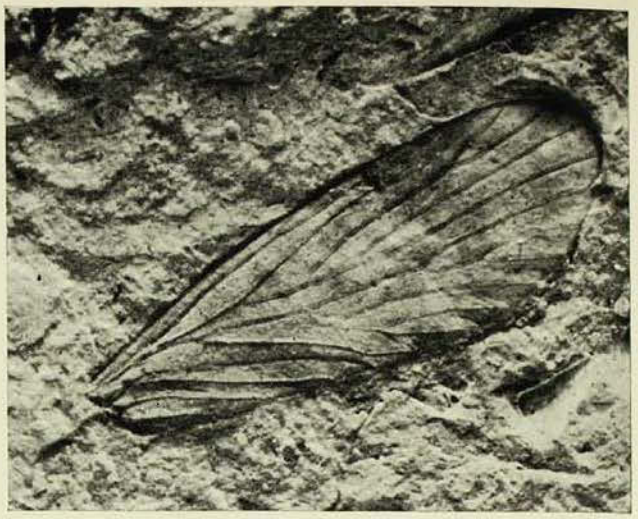
In a recent issue of this magazine mention was made of a fossil-insect reserve near Warner's Bay, New South Wales. The beds which outcrop on this reserve belong to the Upper Permian geological period and are especially rich in bugs and Scorpion Flies (Mecoptera) and, to a somewhat lesser extent, Lace-wings (Neuroptera) and beetles.

Bugs (Hemiptera) are divided into two sub-orders—the Heteroptera, comprising such insects as stink bugs, bed bugs, assassin bugs and water bugs, and the Homoptera, which includes cicadas and aphids. Representatives of both sub-orders have been found at Warner's Bay, and this indicates that, even as long ago as 200 million years, the two groups had a separate existence.

Although, as has already been mentioned, most fossil insects consist of wings only, in Upper Permian strata in Russia many complete insects have been discovered.

Large Fossils

In Triassic strata, which is next in sequence to the Permian, insect fossils have been found at Brookvale, near Sydney, and near Ipswich, Queensland. Unlike the Warner's Bay insects, those from Brookvale are very large, though remains of only a few species have been found. These include the insect referred to at the beginning of this article, which had a ridged oval area on the wing, presumably associated with stridulation. Another large fossil from Brookvale is a cicada-like insect (*Fletcheriana triassica*). Like present-day cicadas, these were doubtlessly able to produce sound, and as birds had not been evolved by Triassic times one can suppose that sound production was not the hazard to the safety of cicadas that it is at present. Were it not for the fact that the greater part of cicadas' lives are spent underground, they might have been exterminated by birds well before now. Some closely-related, cicada-like fossils have been found in Jurassic strata in Central Asia. This suggests that Australia was not then at all times separated by sea from the Northern hemisphere.



The wing of a fossil scorpion fly from Permian strata near Newcastle, New South Wales.

Among the many insects discovered in the Triassic beds of Queensland are the first recorded moth and the first recorded aphid.

A great many remains of fossil insects are known from Tertiary strata in different parts of the world. These consist mostly of insects which are very similar to those living at present, and, while of little evolutionary significance, they are of importance from the point of view of distribution. The best preserved of any insects known as fossils are those contained in Baltic amber, which is a plant resin. Large quantities of such insects have been discovered, and several represent species which now live only in the Southern hemisphere.

TRIGGER PLANTS

By DAVID K. McALPINE

TRIGGER PLANTS (*Stylidium*), with their erect stems of numerous bright pink flowers, are familiar objects of the Australian bush, being particularly abundant in the open eucalypt forests. The stem arises from a tuft of short, grass-like leaves and bears flowers up to half an inch in diameter.

Apart from their decorative appearance, there is something else that attracts attention to the flowers. This is the trigger mechanism, a remarkable pollination device, which gives the plants their name. To understand this it is necessary to consider the structure of an individual flower.

There are five petals, but, as one of them is diminutive, only the four large rounded ones are at first apparent. A long, slender, bent column arises from the centre of the flower, and bears the male and female organs at its tip. The column is sensitive to touch, and, when irritated, bends quickly across to the other side of the flower. An insect alighting on the flower is likely, therefore, to receive a dab of pollen on its back from the male organs. At a later stage the stigma, the female portion at the tip of the column, ripens. If an insect which already carries pollen grains visits a flower with a ripened stigma some of the pollen from it may adhere to the stigma when the "trigger" is set off. The column regains its sensitivity a quarter of an hour after being sprung, and the process can be repeated until the flower is fertilized.

Not every kind of insect is capable of pollinating the flowers of the trigger plant. It has been shown that a small bee (*Exoneura humulata*) is an important agent and that larger bees may fail to fertilize them.

A trigger plant.

From Curtis' Botanical Magazine.

Similar Mechanism In Orchids

There are other plants besides trigger plants which have sensitive moving parts to ensure pollination. Certain of the orchid family (Orchidaceae) may be cited, Australian representatives being the Duck Orchid (*Caleana major*) and the Greenhoods (*Pterostylis*). In these, however, it is not the column which moves but the front petal or labellum, upon which the insect alights.

There are over 100 species of typical trigger plants of the genus *Stylidium* and, though most of these are Australian, the genus also occurs in southern Asia, the extreme south of South America and in New Zealand. In New South Wales there are only seven kinds of trigger plants, but Western Australia has, according to one authority, 93. In the latter State there are yellow forms in addition to the usual pink to white ones. This is an example of the richness of the flora of Western Australia as compared with the east. *Banksia* provides another example, for 40 of the 48 known species occur in Western Australia.

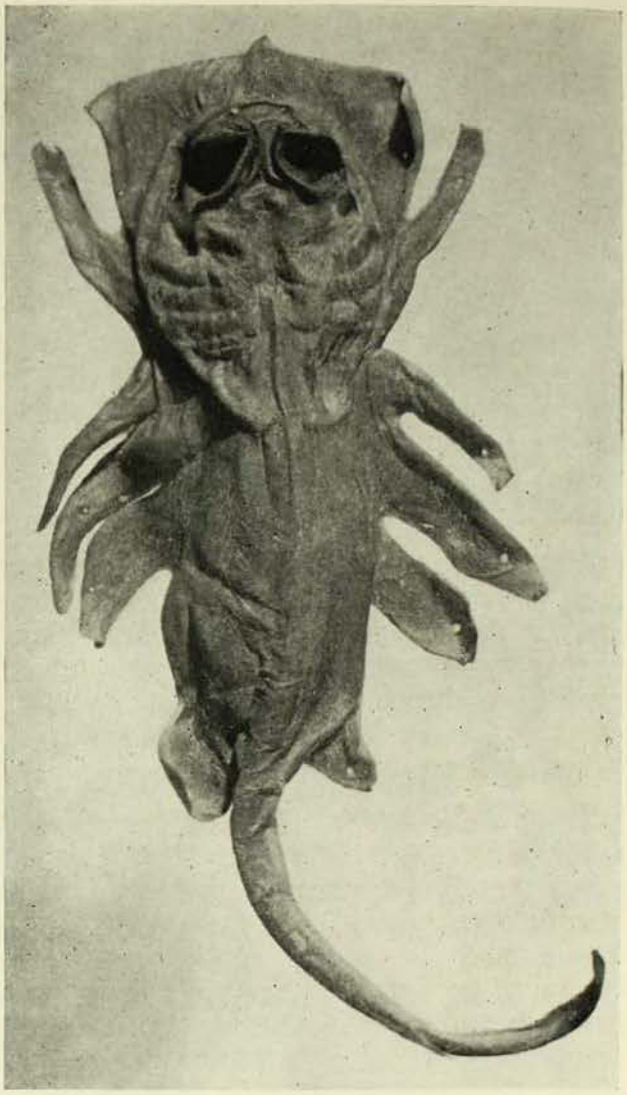
FREAK FISHES

By G. P. WHITLEY

A striking feature of most fishes is their uniformity. The individuals in a school are as alike as peas, and even if they are looked at under a microscope their variations appear very slight. Fishes caught nowadays not only agree with old published accounts of their species, but are scarcely different from their fossil allies or ancestors in deposits laid down millions of years ago.

Yet, during years spent in examining specimens, one comes across occasional odd ones which stand out because of some remarkable variation. Some of these "sports" are due to freak food or water conditions. Other variations are due to injury or disease or to artificial conditions in fish hatcheries, and others to some little-understood deep-seated causes, interesting to students of evolution and genetics. Hundreds of cases of freak fishes have been described in a vast and scattered literature over the last 400 years. The earliest records have been discussed by E. W. Gudger in "The Scientific Monthly" of September, 1936; Bashford Dean's "Bibliography of Fishes" refers to many published before 1923 while recent accounts are to be sought annually in the "Zoological Record" and in the files of angling journals and newspapers. Modern students often cannot be bothered to do the tremendous amount of reading entailed in research into these cases so, to lighten their labours, I have given more citations than usual in this article.

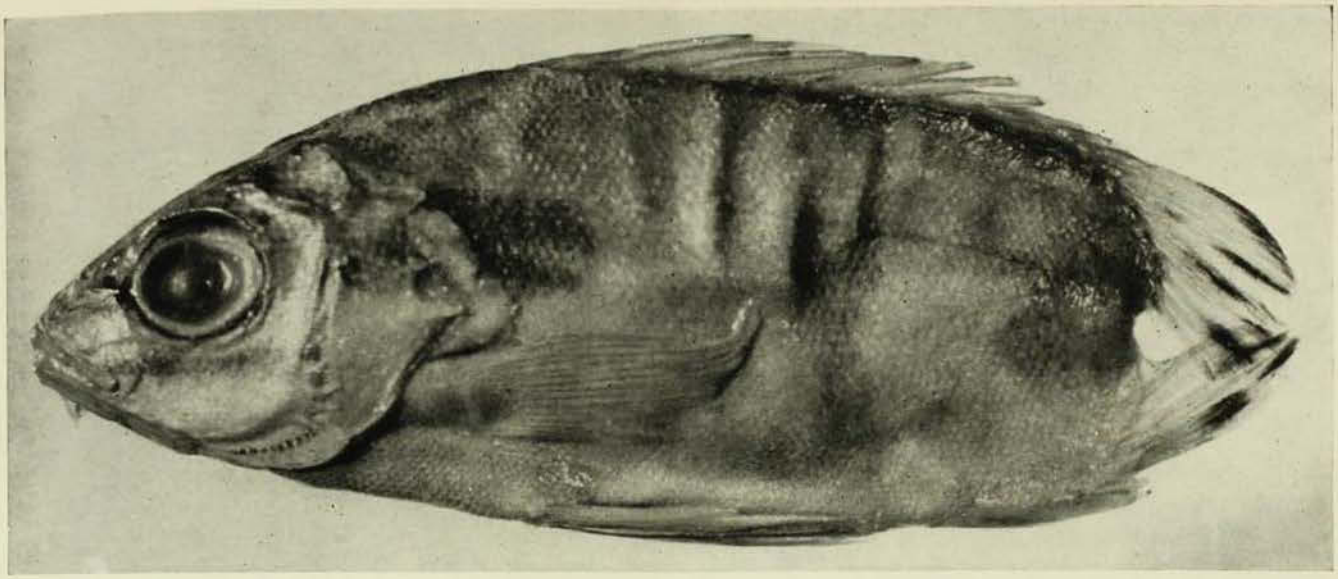
In the space available here, I can only mention a few interesting Australasian cases. Abnormal flatfishes have already been dealt with in "The Australian Museum Magazine" (Vol. IX, No. 11, 1949, p. 381), and so have two-mouthed fishes (VII, 5, 1940, p. 179), two-headed fishes and sharks (VI, 5, 1937, p. 154 and VI, 12, 1939, p. 432), pugheaded abnormalities (VIII, 6, 1944, p. 200) and abnormal spines in leather-jackets (III, 12, 1929, p. 423). Unusual markings on fishes were considered in "The Australian Museum Magazine" (VII, 10, 1941, p. 339).



This stingaree (*Urolophus sp.*), with its disc in strips, was trawled in 20 fathoms in Victoria. Because of its appearance it was nicknamed Dracula's Ghost.

Certain localities in Australia produce unusual fishes: yellow luderick are caught almost yearly off Malabar, near Sydney, and pugheaded Murray Cod have been taken from time to time in the Murrumbidgee River from the 1880's until recently. This indicates that abnormal conditions may be inherited and fishes having them can survive in competition with their normal neighbours. In popular opinion and in newspaper accounts such freak fishes are assumed to be new species, but this is not the case; they take the same scientific names as their more normal brethren.

Australia has so far not produced any examples of fishes with reversed scales or cyclopean (one-eyed) fishes, though such have been found elsewhere. Internal



The tail of this grunter (*Pelsartia humeralis*) is missing, probably bitten off by a fish or shark, and the fins have partly grown around where it was in an effort to replace it.

abnormalities are harder to trace (e.g., mirror-image viscera in which the organs normally on the left are on the right, cases of more than two ovaries, etc.), yet a number of hermaphrodite specimens (having both male and female organs) have been found, and hermaphroditism is indeed normally the case in the young of some fishes.

Fish fanciers have long admired the beautiful Veil-tailed Goldfish in aquaria, yet Nature, on very rare occasions, produces a veil-tail in a marine fish. A snapper so adorned was illustrated in a New Zealand newspaper ("8 o'clock", Auckland, October 19, 1957, p. 12).

In skates and rays the pectoral fins occasionally fail to join up with the head to form a disc, but one extraordinary little stingaree (*Urolophus sp.*), trawled in Victoria, was nicknamed Dracula's Ghost, it looked so strange. Its disc was split several ways and, unless the condition was due to mutilation, cannot be accounted for.

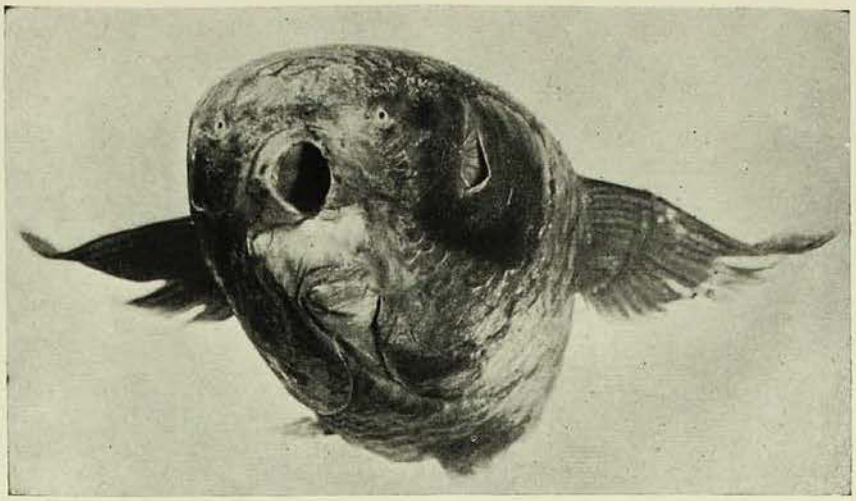
Leather-jackets may have their tails bitten off by some other fish or chopped off by propellers of boats. The wound heals into a stump and the fish may re-grow fins round the tail-end. Quite a few cases of these freaks have been featured* and one, "Mr. Nobody", was for 15 months in Taronga Park Aquarium, Sydney, dying in August, 1950.

Ventral fins may be lacking entirely in fishes whose species usually have them. A snapper (*Chrysophrys guttulatus*) from off Merimbula, New South Wales, trawled in April, 1949, lacked them as also did a garfish (*Euleptorhamphus*) from the Noosa River, Queensland.

In Argentina, it has been shown that vertebral deformity in atherines (silversides or hardyheads) can be caused by malnutrition—the fishes cannot get enough weeds, so turn to animal food, and their brains become heavily infested with larval trematode worms (*Diplostomulum*) which cause malformation of the spine and give a switchback appearance to the fish (de Plaza and Boschi, 1957, Republ. Argent. Min. Agric. Ganad. Dept. inv. pesquer., pp. 5-26, illustrated).

The Australian Museum has several swaybacked fishes, viz., a Murray cod, a hunchbacked whiting, a dumpy or foreshortened mullet, a butterfly bream (*Nemipterus*) and a luderick. In November, 1934, some Coogee fishermen caught a snapper with the tail curved sharply downwards almost at a right angle to the axis of

*Pope, "The Australian Museum Magazine," VIII, 11, 1945, p. 383; "The Daily Telegraph," February 8, 1945; "The Daily Mirror," May 19 and 20, 1949; "The Sun," May 31, 1949; "Truth," June 12, 1949; "Tight Lines," II, 4, 1950, p. 6; "The Daily Mirror," January 2, 1950; "The Daily Telegraph," January 6, 1950; "The Daily Mirror," November 10, 1950.



A mullet (*Mugil dobula*) with "O-mouth," probably caused when its jaws were pulled out by a fisherman's hook.

the body. However, investigations have not yet been made to see if the conditions of these fishes were caused by worms.

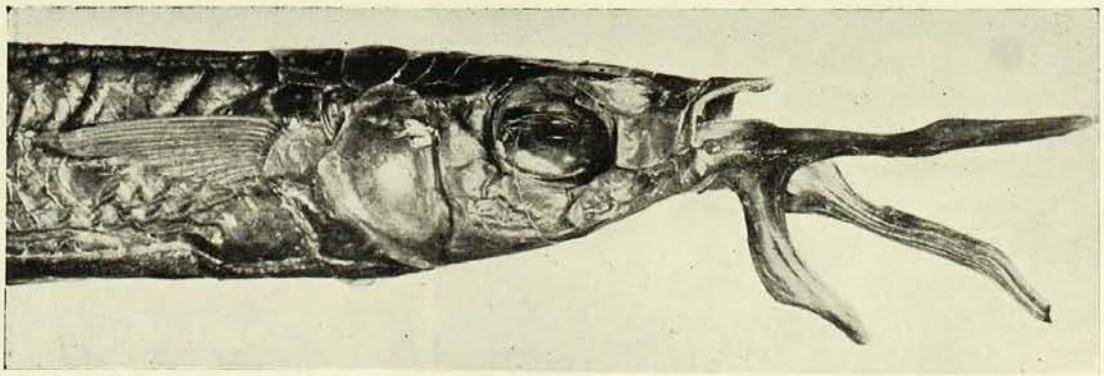
Marlin swordfishes sometimes damage their snouts when ramming their prey or colliding with ships. Cases of marlin without swords have appeared in New Zealand (Morrow, 1951, "Copeia," p. 303). A marlin with two swords, from Townsville, Queensland, was illustrated in A. D'Ombrain's "Game Fishing Off the Australian Coast", 1957, (plate opp. p. 63) and a twin-beaked Striped Marlin from New Zealand in "The Daily Telegraph", Sydney, on March 12, 1948; see also "Outdoors and Fishing", Vol. 5, 1950, p. 163. The Shovel-nose Ray (*Rhinobatos*) usually has an acutely pointed snout, but some examples have a semicircular outline as if the shape of the snout had been altered by bumping.

A four-inch herring with three eyes, from Greymouth, New Zealand, was reported in "The Sunday Sun," Sydney, April 3, 1938, p. 13.

The Port Jackson Shark is occasionally beetroot coloured or partially red, instead of brown, through feeding on purple sea urchins.

Members of the blackfish (luderick) and drummer families are notably prone to freakish bumps on the head or body or to abnormalities of colour. A special exhibit of these fishes is being prepared for the new Fish Gallery of the Australian Museum to help spearfishermen and others to recognise the various kinds.

We have xanthistic luderick (i.e., fishes with a greater or lesser preponderance of yellow in the usually bronze or grey colouration) from several parts of New South



A garfish (*Reporhamphus australis*) with a three-pronged, instead of a single, beak.

Bird - Identification Exhibit

An exhibit of Australian birds, specially designed to enable members of the public to identify the birds they see in their gardens, in the bush and at sea, has been opened at the Australian Museum.

Four hundred and sixty of the 670 *species of Australian birds are represented in the exhibit, and the others will be added as soon as specimens come to hand. Many of those not yet represented are to be found in the main bird gallery, and are specially indicated.*

The new exhibit is in the upper gallery, above the reptile gallery.

Wales, but notably from off Malabar. One canary-yellow example is shown in our Fish Gallery (Melleuish, "Anglers' Digest," March, 1959, p. 7; Whitley, "Proc. Roy. Zool. Soc. N.S.W.," 1950-51, 1952, p. 29). A xanthistic drummer (*Segutilum gibsoni*) from Point Lookout, Queensland, was recorded by Ben Cropp ("Anglers' Digest," December, 1958, p. 7). A semi-albino Rock Blackfish and an albino and abnormally deep drummer (*Kyphosus fuscus*) have also been noted.

An unusual luderick was caught in the Hawkesbury River, New South Wales, in November, 1957: it was reported to have measured 12 ins. long, 6 ins. deep and 2 ins. thick. Another, from Greenwell Point, New South Wales, lacked a tail.

Osteoblastitis is the term given to an excessive growth of bone, probably due to excess lime in the fish's diet. The bumps on the skull of the snapper and the "arthritic" bones of the batfish (*Platax*) are cases in point. Diners sometimes encounter bulbous bones in the backbone or tail of leatherjackets; there is nothing unsavoury about these. Similar exuberance of bone-production is found also in threadfins and mulloway or jewfishes (Polynemidae and Sciaenidae).

"O-mouth" is a strange condition which seldom occurs. The mouth is round like a letter O, probably due to the jaws having been pulled out when the fish was previously hooked. Sometimes teeth grow in the new O-shaped mouth-opening. A luderick and a mullet exhibiting this condition, both from New South Wales, are in the Australian Museum.

The Museum also has a garfish (*Reporhamphus australis*) with a three-pronged mandible instead of a single beak and another garfish with a deformed mouth. A snapper with malformed jaws was exhibited by Miss E. Pope, of the Museum's scientific staff, before the Linnean Society of New South Wales in 1936.

And so the sad list of misfits might be considerably extended. Unusual specimens should be preserved for further study; the actual fish is better than a photograph, for some persons seem to have succumbed to the temptation to add a bit here and there when "retouching" a photograph of a freak fish for publication. Museums in the past placed too much stress on monstrosities; interesting as they are in their wayward way, we are nowadays more interested in the marvels of Nature in the normal state.

[*Photos in this article are by Howard Hughes.*]

Handbook of South Australian Fishes

Mr. T. D. Scott, Curator of Fishes at the South Australian Museum, Adelaide, spent several weeks at the Australian Museum in November studying specimens in connection with a handbook of South Australian fishes he is preparing.

Land and Freshwater Invertebrates of the Sydney District

By E. C. POPE and D. F. McMICHAEL

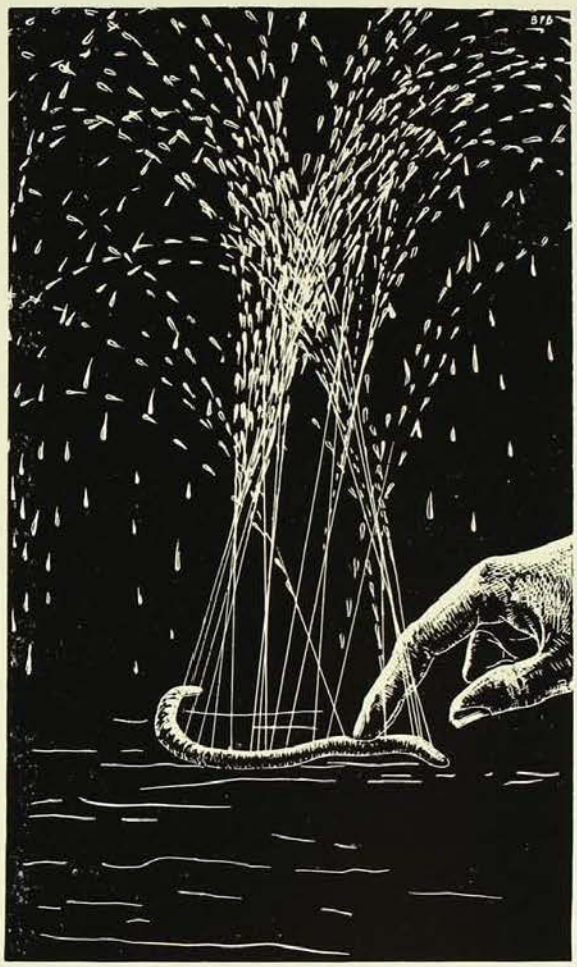
MANY people are interested in the natural history of the sea-shore, and quite a lot has been written about sea-shore animals in recent years. But practically nothing has been written recently about the invertebrates of the land and fresh water, which are almost unknown to many naturalists. Most terrestrial invertebrates, apart from insects, spiders and a few garden pests, are rather small, and often they are nocturnal or so secretive in habit that they pass unnoticed by casual observers.

Probably the best known are the molluscs, especially the garden snails and slugs. Among the introduced snails, the common species *Helix aspersa* is almost universal in suburban gardens, while a second species, *Bradybaena similaris*, seems to be spreading rapidly in recent years. Less common is the glassy, flattened Cellar Snail (*Helicella cellaria*), while another small, pointed soil-snail, *Subulina octona*, is found commonly throughout the world.

Snail Helps Gardeners

One native snail, *Strangesta capillacea*, has managed to survive the invasion of man and introduced snails, and it appears occasionally in suburban gardens, especially if there are bush areas nearby. It is carnivorous, preying on *Helix aspersa*, slaters and, regrettably, earthworms. On the whole it is beneficial to gardens and should not be destroyed.

A few small species of native snails may still be found among humus and leaf-litter in bush areas in suburban Sydney, but most of the larger species have retreated into the uncleared bush as settlement has advanced. The patches of residual rain-forest along some of the streams in the Royal National Park are the home of the large *Meridolum marshalli*, the dead shells of which are used by bower birds for decoration of their bowers. Several other smaller species of *Meridolum* occur in bush around Sydney,



The Squirter Worm (*Didymogaster sylvaticus*) ejects jets of fluid from pores on its back when handled.

Drawn by B. P. Bertram.

including *M. middenense*, which is found in sand-dune country along the coast.

A number of introduced slugs occur commonly in the Sydney area, principally the yellow-brown *Limax flavus*, the grey-black *Agriolimax agrestis* and the great Grey Slug (*Limax maximus*), which reaches the enormous size (for a slug) of nine inches or more. This last species is spotted with black and is omnivorous, feeding on garbage, humus and similar fare. One native species of slug, *Triboniophorus graeffii*, is often found in the pockets of brush left

around Sydney and in adjacent gardens. It is strikingly marked, being yellow-green in colour, with a narrow red or orange border right around the foot, and a red diamond or triangle on the back, near the respiratory opening.

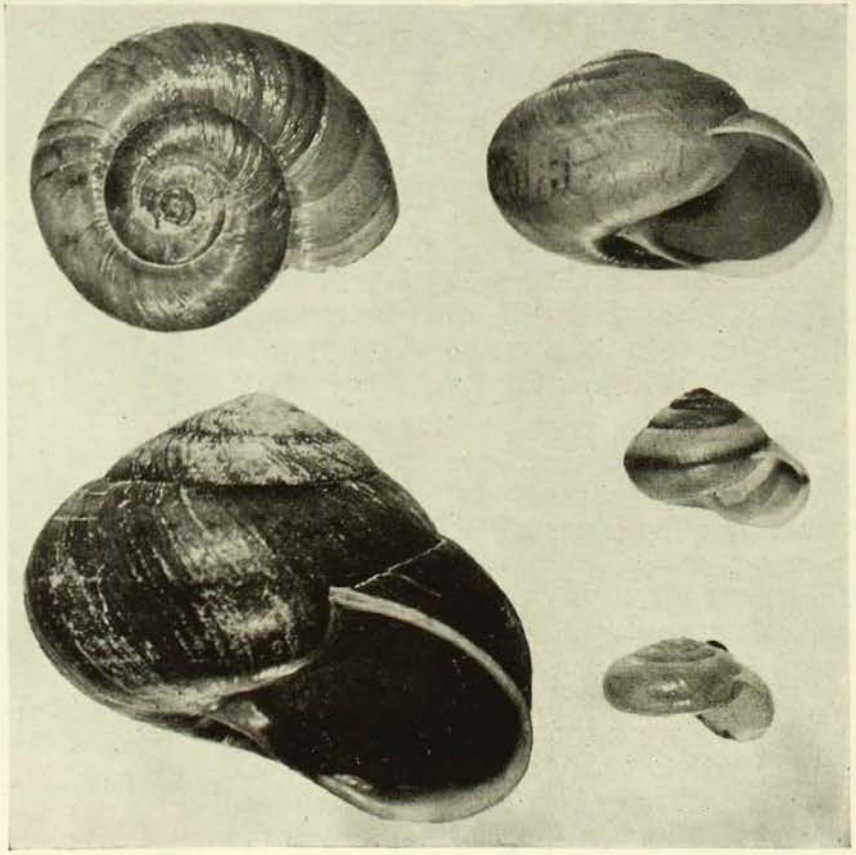
Quite a few snails are found in the freshwater creeks and ponds around Sydney, as well as a number of bivalves. These have been described in earlier issues of this magazine, and space does not allow their inclusion here. The most interesting of them are the freshwater mussels *Velesunio ambiguus*, which is found in muddy streams, and *Hyridella australis* and *Hyridella depressa*, which live together in clear sandy streams, like the Woronora River.

Freshwater Crustaceans

A few crustaceans also occur in fresh water; these include two species of fresh water crayfishes or yabbies, *Euastacus nobilis* and *Euastacus serratus*, while freshwater shrimps are represented by *Paratya australiensis*, which occurs commonly in the Sydney water reservoirs, and *Atya striolata*, which occurs only sporadically. Other interesting crustaceans found occasionally in local rivers are the Long-Armed Prawn (*Macrobrachium novaehollandiae*), in which the first pair of legs in the male is enormously elongated, and the small freshwater crab *Halicarcinus australis*.

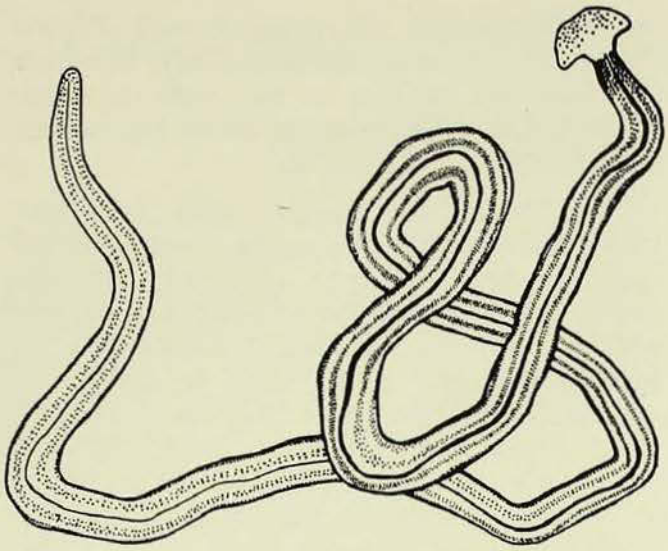
Still smaller crustaceans, such as Water Fleas (*Daphnia*), Copepods (of several species), Seed Shrimps (*Cypris*) and the peculiar little shrimp-like *Estheria packardi*, which is almost completely encased in its horny bivalved "shell", may be found by careful searching with a fine net. The almost stingray-shaped little Shield Shrimp (*Lepidurus viridis*), which seems to prefer to swim upside-down, may also be seen in small pools in swampy areas west of the city. It is keenly sought by aquarists as fish-food. A recent addition to Sydney's freshwater fauna is the dainty little jellyfish *Craspedacusta sowerbyi*, the discovery of which was recorded in an earlier issue of this magazine.

Most of the other invertebrates are essentially land-dwellers, but they are nevertheless very dependent on the amount of moisture in their environment; consequently, they generally hide away by day in damp places, such as among leaf mould or under



Top left: *Strangesta capillacea*, the Carnivorous Native Snail. Bottom left: *Meridolum marshalli*, a large native snail from Royal National Park. Top right: *Meridolum middenense*, an inhabitant of coastal country. Centre right: *Bradybaena similaris*, a common introduced species. Bottom right: *Helicella cellaria*, the Cellar Snail, a widespread introduced carnivorous species. All about natural size.

Photo.—Howard Hughes.



The Shovel-headed Garden Worm (*Placocephalus kewensis*).
Drawn by B. P. Bertram.

logs. While some, such as the introduced common slaters *Porcellio scaber* and *P. laevis*, may emerge almost nightly and forage around, others, like the *Geoplana* flatworms, usually only move about freely in the open after long periods of rain or during very humid weather. At such times they may appear in suburban gardens, especially those adjacent to bushland.

Crustacean Invades Kings Cross Flats

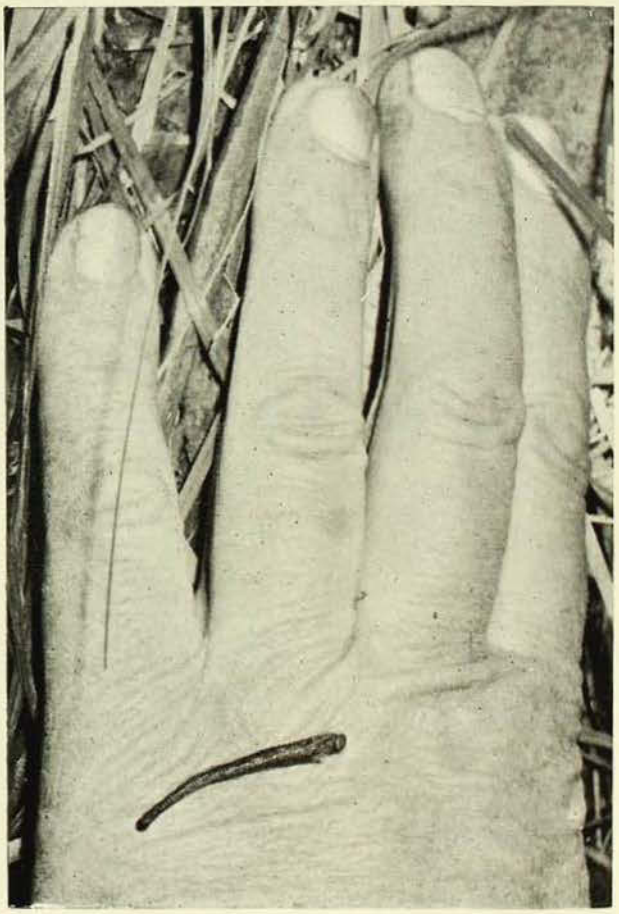
Some land invertebrates have managed to penetrate into highly populous and built-up areas in the heart of the city. The tiny crustacean amphipod *Talitrus sylvaticus*, which normally lives among and feeds on rotten leaves in forest litter or in compost heaps, has on several occasions invaded flats in Kings Cross during prolonged wet periods, when it has been found snipping off the carpet pile in its search for food and shelter.

Three kinds of planarian flatworms turn up in Sydney gardens during prolonged damp weather. All are flattened, brightly coloured on the upper surface, and exude a copious mucus. The commonest, *Placocephalus kewensis*, is from 8 ins. to 12 ins. long when extended, and has a flattened shovel-shaped head. Its long ochre-yellow body bears five longitudinal brown or black stripes. Only 2 ins. or 3 ins. long and pointed at both ends are *Geoplana caerulea*, which is dark navy blue on its upper surface with a central white longitudinal stripe, and *G. sanguinea*, which is dark red. The blue worm is sometimes found curled up in a hole eaten out of a strawberry, but is not guilty of damaging the fruit. It is there to try and capture the small beetles which have eaten out the hole.

Another interesting local worm is the long, thread-like Gordian worm (*Gordius* sp.), which often appears mysteriously in kitchen sinks or buckets of water. The worm spends part of its life as a parasite inside the body of an insect or spider. When ready to breed, it bursts out of its host's body, enters the water of a pond or stream and, after pairing, the female lays eggs. These worms are quite harmless to humans.

Earthworms

Earthworms must be counted among the more prominent of Sydney invertebrates. Again, introduced species seem to be most successful, so that *Allolobophora caliginosa* (the commonest kind), *Eisenia foetida* and *E. rosea* (the pinkish worms in compost



When engorged with blood, this leech will be four or five times the size shown here.
Photo.—Howard Hughes.

Increase in Price of Magazine

As has previously been announced, the price of "The Australian Museum Magazine" is increased to 3/- *a copy* (3/6 *posted*) *as from this issue. The subscription rates* (*posted*) *will therefore be* 14/- *a year and* £2/2/- *for three years* (*the full volume*).

This has been made essential by rises in the costs of printing, paper and process-engraving in recent years.

heaps) and a species of *Lumbricus* are those most frequently encountered by gardeners.

However, at least seven species of native earthworms can also be found. The most interesting of these is the squirter worm *Didymogaster sylvaticus*, which is found under rotting logs in the Royal National Park rain forests and other bushy areas. These worms are tough and solid, with a diameter of half an inch or more, and may grow up to 18 ins. in length. When disturbed or handled they often emit a series of jets of fluid from a line of pores along the middle of their backs. These fountains of fluid may rise up to two feet in the air, but they are relatively harmless, though the fluid will sting if it gets in one's eye.

Another type of segmented worm which occurs in the Sydney district is the Five-Striped Leech (*Hirudo quinquestriata*). It is common in the damper parts of the Royal National Park and in the Blue Mountains valleys. Sometimes these worms attach themselves to unwary bushwalkers, and, after painlessly making a wound with their sharp jaws, proceed to suck blood which they store and use for food. Not only are they difficult to dislodge, but the wounds go on bleeding owing to the chemical hirudin which the leech introduces into the wound to prevent coagulation. Attached leeches may be induced to let go by holding a lighted match or cigarette-end near them, or by the application of insect repellants. The best way to avoid leech bites is to apply plenty of insect repellant (such as dimethylphthalate or benzyl benzoate) before entering the bush, and to keep an eye open for these pests.

In as short an article as this it is possible only to mention a few of the more prominent invertebrates found in the Sydney district. In all, more than 300 species occur in the area, and there are probably quite a few more species as yet unknown to science. The list of articles which follows will give further information on various invertebrate groups.

FURTHER READING

Allan, Joyce: "Land Shells of Australia" (parts 1 and 2), Aust. Mus. Mag., Vol. 10, No. 2 and No. 3. "Aftermath of Rain," Aust. Mus. Mag., Vol. 10, No. 6. "The Introduced Grey Slug," Aust. Mus. Mag., Vol. 11, No. 6.

Brereton, J. Le Gay: "The Way of Life of the Slater," Aust. Mus. Mag., Vol. 13, No. 3.

Francois, D.: "Freshwater Crayfishes," Aust. Mus. Mag., Vol. 13, No. 7.

McMichael, D. F.: "Shells of Rivers and Lakes" (parts 1, 2 and 3), Aust. Mus. Mag., Vol. 10, Nos. 11 and 12, and Vol. 11, No. 1. "The Freshwater Aquarium," Aust. Mus. Mag., Vol. 12, No. 11.

McNeill, F. A.: "Deserters from the Sea," Aust. Mus. Mag., Vol. 9, No. 8. "An Elusive Jellyfish from Freshwater." Aust. Mus. Mag., Vol. 11, No. 7.

Pope, E. C.: "When the Rains Come." Aust. Mus. Mag., Vol. 9, No. 12. "Earthworms and Soil Building in Australia," Aust. Mus. Mag., Vol. 10, No. 3. "Squirter Earthworms." Aust. Mus. Mag., Vol. 11, No. 12.

Australian Museum Leaflets Nos. 15 (Planarian Worms), 30 (Gordian Worms) and 45 (Earthworms).

William Holmes, the Australian Museum's First Custodian

By GILBERT P. WHITLEY

'It was under the administration of Governor Darling, that a Museum was very judiciously founded in Sydney, and the situation of Colonial Zoologist was given to Mr. W. Holmes, who died at Morton Bay in August, 1830."

This brief quotation from Dr. Johann Lhotsky's "Journey to the Australian Alps" (1835) was for many years all that we knew about the establishment of the infant Australian Museum and its first custodian, and it seemed impossible to find out much more. However, an editorial in The Australian Museum Magazine in 1927, the Museum's centenary year, gave a few more details.

Now, unexpectedly, at this late date, more information can be added since Mr. A. E. Holmes, of Manly, a collateral descendant of William Holmes, has supplied me with a history of the family and a paper by W. J. Goold in the "Newcastle and Hunter District Historical Society Monthly Journal", 5 (10), 1951, which bears on the matter. We still have no portrait of William Holmes, but the facts which have emerged about him are worth brief record here towards a more detailed history of the Australian Museum which is now being compiled.

William Holmes was probably born in Lancashire at about the end of the 18th century (certainly before 1803). He emigrated from London in 1826 in the barque "Elizabeth" (Captain Collins), arriving in Sydney on April 7, 1827, to take up his post as colonial zoologist at the Museum. A fellow-passenger was the Rev. C. P. N. Wilton, M.A., appointed to St. Ann's Church, Ryde, New South Wales, who is of interest to us because he published "Suggestions for the Establishment of an Australian Museum" in his "Australian Quarterly Journal of Theology," i, January, 1838, and who later became the first man to discover vertebrate fossils in Australia.

Holmes lived in Castlereagh Street, but in 1828 returned to England, where he applied successfully for an order for a grant of land in New South Wales. On May 16, 1829, he arrived back in Sydney on the "Elizabeth" and, at a salary of £130 a year, continued his employment at the Museum, then situated in the Old Post Office, Bent Street. He did not take up the land to which he was entitled as he evidently wanted to look around for a good spot when travelling for specimens. But he was fated not to live long, for in August, 1830 he was accidentally shot while collecting specimens at Moreton Bay, in what is now Queensland.

This reference to his work in the "Sydney Gazette" of August 31, 1830, was unconsciously posthumous, probably having been delayed before publication: "The public are not generally aware that a beautiful Collection of Australian curiosities, the property of Government, is deposited in the Old Post Office. This Museum is under the superintendence of Mr. Holmes, who, between the hours of ten and three, politely shows the same to any respectable individuals who may think fit to call. It is well worthy inspection."

William Holmes was undoubtedly the first man to mould the Australian Museum into being.