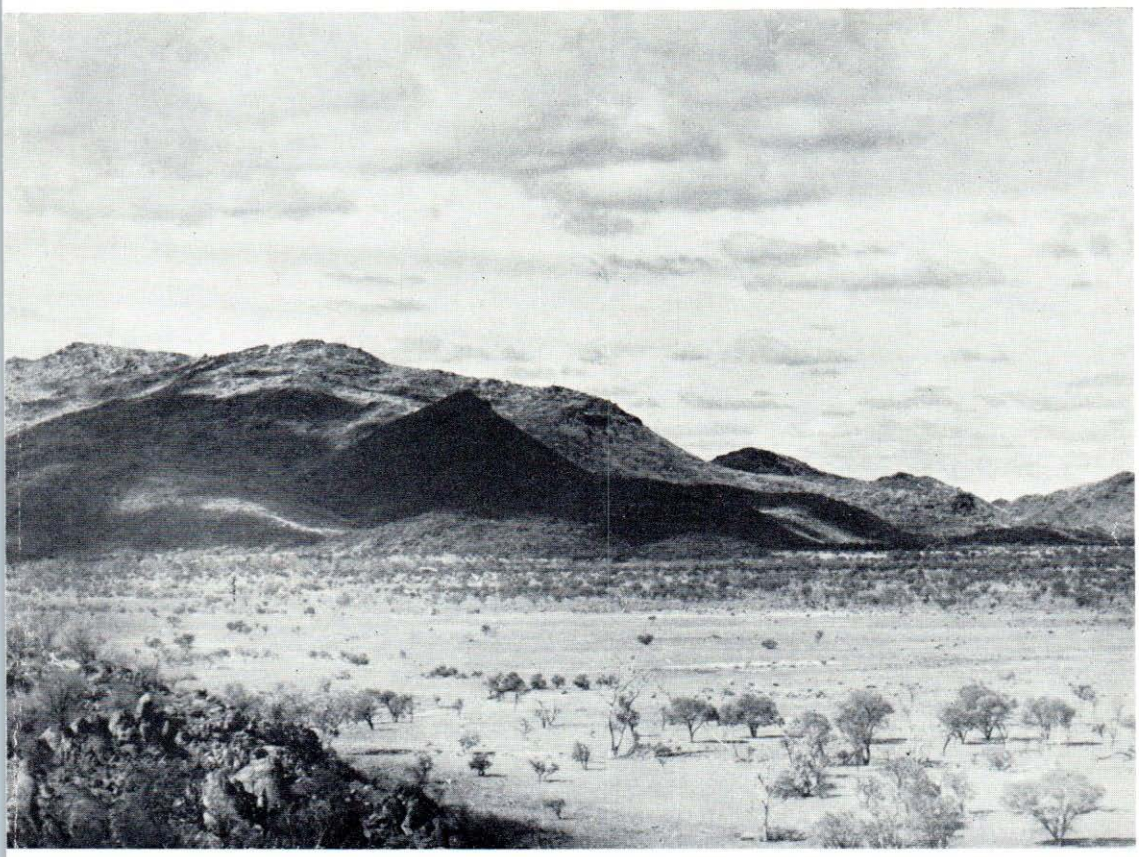
AUSTRALIAN NATURAL HISTORY



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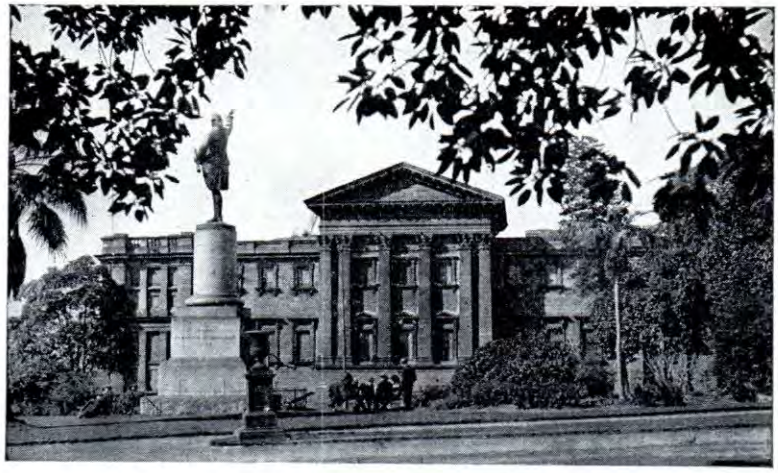

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• **FRONT COVER: Part of the Musgrave Ranges, Central Australia. This was the site chosen for most of the work of an Australian Museum expedition which studied desert reptiles last year (see article on page 51). The Musgraves reach a height of more than 5,000 ft. (3,000 ft. above the surrounding country), and studies were made of the changes which occur in reptiles between the surrounding desert and the tops of the ranges. The photo was taken by Howard Hughes, a member of the expedition.**

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CRABS OF THE SYDNEY FORESHORES

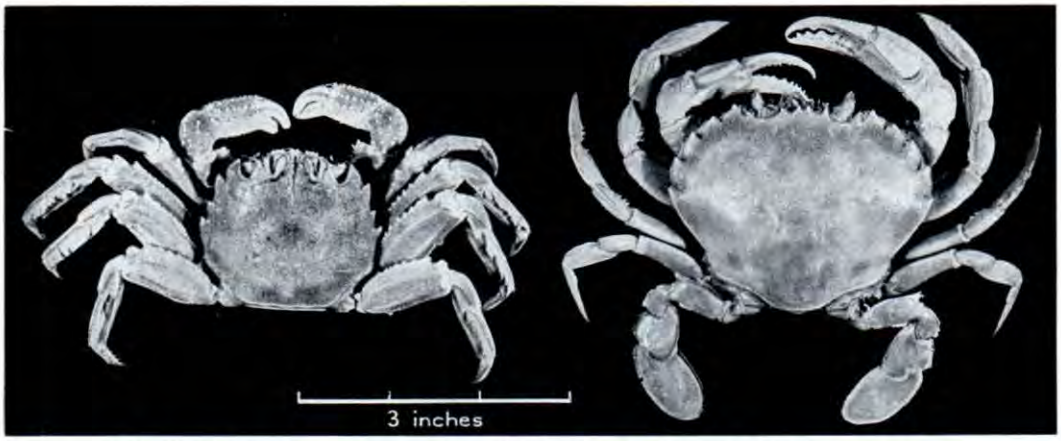
By FRANK McNEILL

Honorary Zoologist, Australian Museum

AMONG the seaboard cities of the world, Sydney has received wide acclaim for its scenic beauty. This is but one of the natural endowments of the same great maritime port, for its surrounding waters support a fauna probably richer in variety than that of any other comparable populated area. Within a short distance of the city's centre there is to be found every type of foreshore, and each provides a source of inexhaustible study for the naturalist. Bordering the coast is the line of surf beaches, interspersed by headlands and cliffs towering above rocky platforms that dip beneath the waves. Within the quieter waters of the port itself the numerous wide bays and inlets present a marked difference from the ocean front. Then there are the deeper reaches of two small rivers (Parramatta and Lane Cove) penetrating to parts where mangrove patches and muddy flats are features of their shores. To the south, suburbia embraces similar environments at Botany Bay and Port Hacking, while in the adjacent north are shallow coastal lakes encompassed by a continuous settled area reaching as far as Broken Bay at the mouth of the Hawkesbury River.

When the subject of an article is introduced in such deservedly glowing terms the writer is tempted to expand it far beyond the limits required. Many interesting aspects of Sydney's marine fauna have already been dealt with in past issues of this magazine, but many more still remain to be introduced to the reader. For the present, however, we must confine ourselves to the conspicuously numerous members of just one small group—the crabs.

Crabs never fail to arrest the interest of those who visit the foreshores. They have always been regarded as among the quaint inhabitants of the marine world, and in Museum life the professional zoologist is constantly answering queries concerning them. As the most highly developed of all crustaceans, they are classified in an order known as the Decapoda, a name which implies the possession of five pairs of limbs. The larger kinds can readily be distinguished by their characteristic limb count, and also by the well-developed shell (carapace) covering two united underlying body parts termed head and thorax. All of the true crabs, too, have no extended hind part (abdomen) as found in their other 10-



Left: Red Crab (*Plagusia capensis*). Right: A swimming crab *Ovalipes punctatus*.
Photos.—Keith Gillett

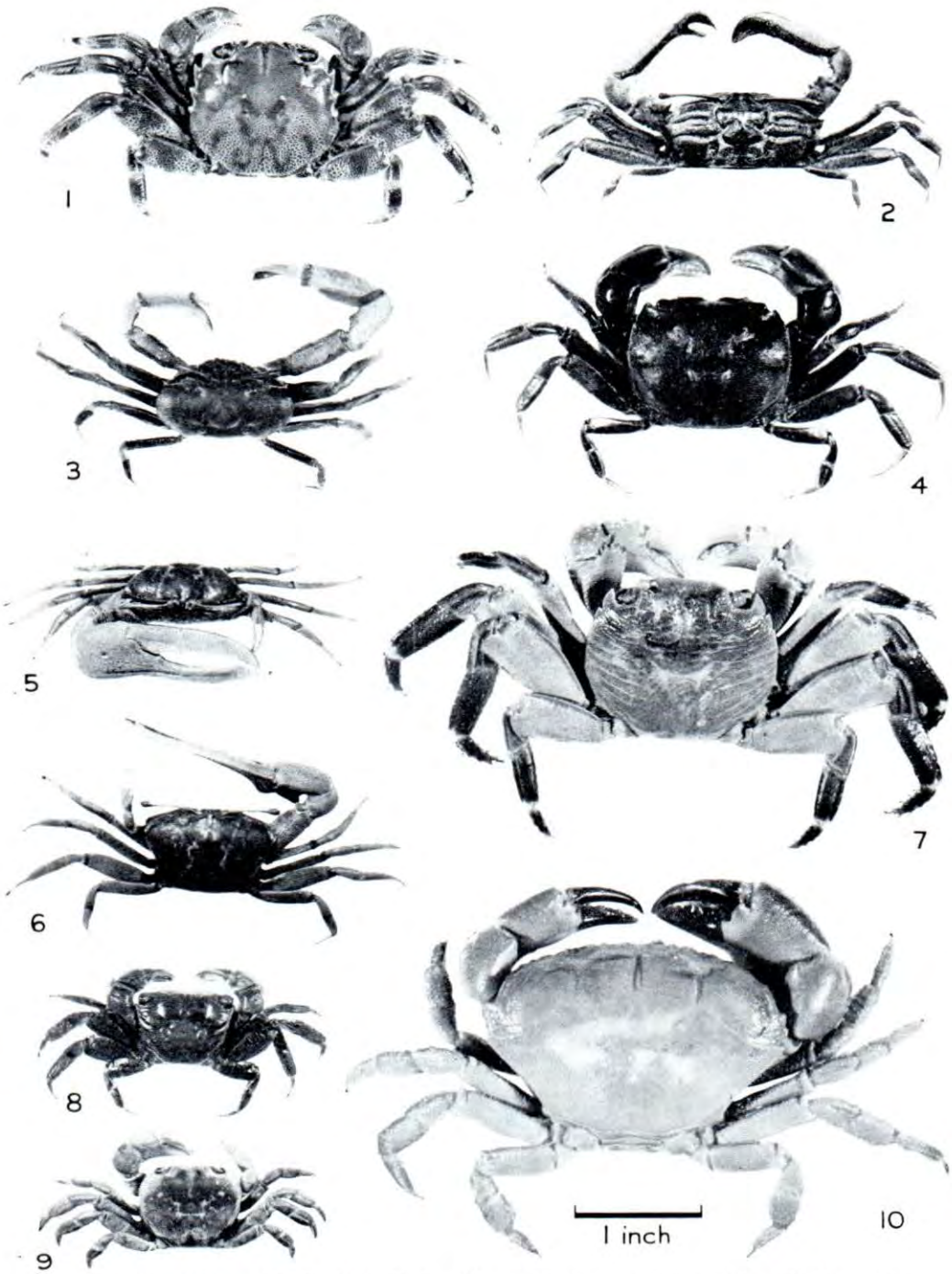
footed relatives, the prawns, crayfishes and hermit crabs. The hind part, instead, is reduced to a mere flap (pleon), and this is snugly folded against the underside of the body.

Coastal Rock-Platforms and Beaches

Most of the crabs inhabiting the open coast spend a hardy life contending with the buffeting of the waves. This applies particularly to the more active rovers among their ranks, but even those that constantly seek the meagre shelter of their habitat are sturdily built, and all are provided with specially strong or modified terminal joints to the walking legs which ensure a safe foothold.

The most prominent of the rocky platform species is the so-called Steelback Crab (*Leptograpsus variegatus*), one that a visitor never fails to notice when tidal waters recede. Its general colour is somewhat variable, but usually a dark olive-green or slaty with some lighter flecks over the back, where many fine, curved, nearly-parallel lines cross from side to side. The claws (chelae) are constantly white and purple, a feature clearly seen on the more bulky pair borne by the males. Of all local crabs, the Steelback is the most agile, and can retreat with great speed to the shelter of a deep gutter or crevice on the slightest provocation. It is the scavenger of the rocky shoreline, and turns to good account the period between the falling and rising of the tides. Rock fishermen shun it as bait, but this is not the case with another less conspicuous roving species commonly called the Red Crab (*Plagusia capensis*). This is one that is assiduously hunted low down on the tide line. It remains at these moister levels, often actually submerged, and frequents patches of seaweed under rock ledges. An unmistakable feature is the deeply-notched front edge to the shell, and a back clothed with short, densely-packed hairs (tomentum). The fishermen who seek Red Crabs use either thin, barbed steel spears or quest for their often hidden quarry with bare hands. They find them to be succulent bait for the capture, with hook and line, of the local reef-dwelling fish known as Blue Groper. Contrasting with the Red Crab is a smaller closely related species, *Plagusia glabra*, lacking a common name. It, too, lives at or near low tide level and, while similar in shape to the Red Crab, its shell has a glossy smoothness. Colour again is different and tends to greyish hues with darker flecks.

The Reef Crab (*Ozius truncatus*) grows to a larger size than any other crabs of the rocky ocean front. Fully adult examples may measure 3 in. across the back, and appear quite formidable. The species is, however, less active and far more docile than the roving kinds already discussed. Adults are usually found quietly sheltering in restricted spaces under ledges and large boulders, and must be keenly searched for. More often than not the young are found to be most abundant where they hide under



(1) *Plagusia glabra.* (2) Sentinel Crab (*Macrophthalmus carinimanus*). (3) Semaphore Crab (*Heloecius cordiformis*). (4) *Paragrapsus laevis.* (5 and 6) Fiddler Crab (*Uca marionis*). (7) Steelback Crab (*Leptograpsus variegatus*). (8) *Sesarma erythrodactyla.* (9) Smooth Shore Crab (*Cyclograpsus audouinii*). (10) Reef Crab (*Ozius truncatus*). (Nos. 1, 3, 4, 6, 8, 10 photographed by Keith Gillett, the others by Howard Hughes.)

Little Seaweed Crab (*Naxia tumida*)—natural size.
Photo.—Howard Hughes.

accumulations of tumbled stones anywhere between mid- and low-tide marks. They are almost invariably an insipid dingy-white shade, and it would appear that the gradual change to a final rusty brown or dark brick-red colour is in some way influenced by light as the creatures grow and emerge more into the open. Dense brownish-black cutting fingers are a feature of the claws of adults, and one claw is always conspicuously larger than the other.

A diligent search deep among heaped boulders and stones in places at and above the highest limit of the tide will be rewarded by the discovery of the Smooth Shore Crab (*Cyclograpsus audouinii*). This is a retiring species, never seen in the open during daylight hours, and comparatively inactive. The borders of the shell are rounded, and unbroken except for the cavities where the eyes are accommodated. No excrescences whatsoever are to be found on either body or limbs, which carry a sheen that enhances the general deep cream to light ochre colouring. Among all of its kind along the rocky coastline, the Smooth Shore Crab can survive on the least amount of moisture, and will live for a remarkably long time after capture.

Often when questing with the hands among patches of soft and yielding seaweed growths a compact hard body will be detected. This will almost invariably be identifiable as a specimen of the Little Seaweed Crab (*Naxia tumida*), a completely harmless creature that lies inert when captured. Upon close examination the small brownish-green body will be found clothed with wisps of the weed amongst which the crab lives. These are the prunings deliberately placed in position by their wearer and secured by means of strong curled hairs to effect an almost complete camouflage. Two short, downwardly-directed spines form a fork at the front of the nearly oval body, and the terminal joints of the four pairs of limbs behind the claws are modified as strong anchoring hooks.

No account of the prominent crabs of the open coastline would be complete without mention of a lone inhabitant of the seemingly inhospitable beaches and dunes far above the reach of the tides. This is the Ghost Crab (*Ocypoda cordimana*), with a general colour perfectly matching the varied shades of the sands. Burrow holes of this crab are to be seen in elevated dry areas, and sometimes in their vicinity a lone little corpse, dry and brittle under the sun, betrays the ownership of the strange homes which penetrate deep through moisture-free surface levels to damper parts where breathing gills can function normally through the hours of daylight. For it is in the twilight and darkness that the Ghost Crabs emerge to forage right down to the water's edge. Anyone who cares to wander at night over the damp sands of an ocean beach will not fail to note the wraith-like forms of these agile crustaceans as they scamper ahead in erratic flight. Although they have partly abandoned a marine life, they still cling to the margin of the sea, and in their nightly forays will actually enter the fringe of a spent wave. As their metamorphosis, from

Ghost Crab (*Ocypoda cordimana*)—approximately three-fifths natural size.
Photo.—Keith Gillett.

minute larvae to an ultimate crab-like form, is passed through in the sea, the females must, by natural law, enter the water to hatch out their eggs.

On quiet nights in mild weather, surf fishermen are attracted to the ocean beaches, but this is the very time that their enthusiasm is dampened by a local crab menace—this time a swimming crab, *Ovalipes punctatus*. Like other crab swimmers, the terminal joints of the back pair of legs are flattened in the form of paddles, and the usual 3-inch-wide shell bears on its hinder part two clearly defined, round purplish spots. While the species is also commonly found in clear water just inside the inlets, it is particularly common along the ocean front, and takes such tenacious hold of baited hooks that it allows itself to be drawn on to the moist sands lapped by the waves. More than once a surf fisherman has been startled by a bite on bare feet from this same crab when he has waded into the water to cast his line.

Sand-floored Tidal Flats

The more typical of the crab inhabitants of tidal flats are to be seen in greater abundance at localities away from the busy waters of the port (Port Jackson). In the quieter seclusion of Botany Bay and Port Hacking there are expansive areas of sand with a bare admixture of silt which support a bounteous marine fauna. Patches bared by receding tidal waters are interspersed with barely submerged areas of weed, and beyond are the shallow water stretches reaching to the edge of permanently deep channels. In such places low tide is feeding time for perhaps the most spectacular of Sydney's foreshore crabs—the Soldier Crab (*Mictyris longicarpus*). At a certain stage in the ebb of the tide smoothed surfaces of the flat become broken by eruptions of tumbled sand. This first sign of sub-surface activity is soon followed by the appearance of great numbers of Soldier Crabs, which then congregate in closely-packed companies like armies on the march. In many ways they are quaint and unusual crustaceans, not only in the erect carriage of their high and almost round bodies, raised on stilt-like legs, but also in the striking blue to mauve colouring of their shells. Then, too, the peculiarity of the crabs' forward gait immediately attracts attention—a gait so different from the sideways progression of other crabs, whether walkers or swimmers. When the period of surface wandering and feeding ends, the subterranean retreat is a marvel to behold. Each Soldier Crab vigorously works the limbs of one side down into the yielding sands of the flat, and with the most unusual of spiral motions soon disappears from sight to await the coming of the next low tide.

A summer frequenter of the sand-floored flats is the Blue Swimming Crab (*Portunus pelagicus*), which foregathers for mating from the surrounding deeper waters. At low tide numbers of this species are often seen isolated in small pools or are stumbled upon resting quietly on the bottom in the extensive shallows. Because of its edible qualities, the "Blue Swimmer" would be the best known of all local crabs. Great numbers are netted every year by fishermen and sold to the public. The shells of adult males are commonly 5 in. across, and the rather ponderous front limbs bearing the claws far exceed the length of those that follow. The two most unmistakable features, however, are the distinctive variegated blue colouring attained by the adults, and an elongated spine springing from each side of the shell midway along its length.

Soldier Crab (*Mictyris longicarpus*)—three quarters natural size.
Photo.—Howard Hughes.

A comparatively flat-bodied, sluggish crab, *Macrophthalmus carinimanus*, usually makes its home in the weed patches; it has a nearly rectangular shell which is at least twice as wide as long. Because of the

peculiarity of its eyes, an appropriate popular name would be that of Sentinel Crab, as these organs are mounted at the extremities of exceedingly long stalks occupying almost the entire width of the front. They can be raised erect and lowered at will, and thus function usefully when their owner is partially or wholly submerged. The colour is uniformly drab, with no specially distinguishable features, and suspended fine grains of silt have a tendency to cling to limbs and shell to obscure small details of body sculpture.

Another Sentinel Crab (*Macrophthalmus setosus*) prefers the far more silted areas of the mud and mangrove shores, next to be discussed. It differs from its close relative of the sand-floored tidal flats in that the shell is squarer in outline and the limbs are clothed with a noticeably thick covering of hairs. Again, the colouring is of an uninteresting drabness, and the upper surfaces of body and limbs are usually coated with a heavy deposit of silt.

Mud and Mangrove Foreshores

Up-river locations and the far reaches of a number of arms of inlets are where the right conditions prevail for crab dwellers of mud and mangrove foreshores. Here along the margins of barely ruffled waters they enjoy a somewhat quieter and more secluded existence than so many others of their kind. Some occupy deep burrows that become regularly flooded by tide waters, while others living a freer life are able to shelter at will when not foraging for food.

In ideal situations the exposed surface of a mud flat is seen to be literally perforated with burrow holes. These often extend right from the water's edge to more shady parts deep in a fringing line of mangrove trees. One common occupant of this area is the Semaphore Crab (*Heloecius cordiformis*), which has received its popular name from the quaint habit of holding the claw-bearing limbs outstretched while the body is being raised and lowered in a manner simulating signalling. Normal colouring of the shell is the darkest of purple shades, sometimes in a mottled pattern. Eyes are carried on long purple eye-stalks, which are usually seen raised fully erect. Perhaps the most characteristic feature of this crab is the conspicuous light-purple colour of the claws of the adults. While the general colouring of the adults could never be confused with that of other mud-flat crabs, the light orange-red hue of the claws of younger examples could cause some temporary confusion in the recognition of another equally abundant species, *Sesarma erythrodactyla*, sharing the same habitat. In this crab the claws are a bright orange shade, making their owner a most conspicuous object against its background. The nearly square outline of the shell of this particular mud-dweller at once distinguishes it from

Blue Swimming Crab (*Portunus pelagicus*)—one-third natural size.

Photo.—Howard Hughes.

Mud or Mangrove Crab (*Scylla serrata*)—one third natural size.

Photo.—Keith Gillett

the almost transversely-oval shape of the body of the Semaphore Crab, and its shell is a blackish-green to almost black. A striking variation occasionally exhibited by adults is a shell of brilliant iridescent green or pale-blue colour, sometimes even a mixture of both these shades.

A discovery of very recent years has been the appearance of a species of Fiddler Crab (*Uca marionis*) in small communities on mud-flats at widely scattered places. The reason for this reference is that the various kinds of Fiddler Crab are by far the most ornate of all mud-dwellers in northern tropical parts, where their crowded presence along a shoreline creates the impression of a garden of gaily coloured flowers. In its ornateness, the local visitor from further north along the coast is no exception. As with all Fiddler Crabs, it is one prodigiously large claw of the adult male which bears the orange-red colour that arrests an observer; this stands out against the sombre dark hue of the rest of the crab. The lesser claw of the male is ridiculously small and weak, and comparable in size to the pair always borne by the female.

Close to the highest limits of the tide line along muddy foreshores the comparatively large roving species *Paragrapsus laevis* is to be found sheltering under stray logs or slabs of stone. This is a crab particularly partial to localities where mangroves occur, and is not given to foraging during the daylight periods of low tide. One unmistakable feature is a pair of noticeably swollen claws of about equal size. These are a purplish-brown to a purplish-red above, but almost white below. The ground colour of the shell is commonly a much darker hue, often with scattered flecks of grey or yellow.

The most elusive of all crabs of the mud zone is, incidentally, the largest of its kind frequenting local waters. This edible species, *Scylla serrata*, has been named the Mud or Mangrove Crab. It is not a plentiful crab at this near southern limit of its range, and normally spends the daylight periods of low tide hiding deep in a burrow among the mangroves. The occasional captives mostly fall prey to fishermen who draw their nets at night. Unlike the "Blue Swimmer", this mud-dweller has a swollen, bulky body, and the claw-bearing limbs are thick, heavy, formidable weapons of offence. The general dark brown or greenish-brown colouring of the body and limbs may be broken by some light reticulated markings on the upper side of the swimming legs. Across the front and well down each side-margin of the shell there is a continuous set of evenly spaced teeth.

PARENTAL CARE IN INSECTS

By C. N. SMITHERS

IN most insects parental responsibilities end with the deposition of eggs. Once they have been laid the female goes on her way and only by chance will she encounter either eggs or progeny again; this gives the impression that the well-being of the next generation is left to chance. This, of course, is not quite true; few species of insects would survive in the highly competitive conditions of life in the wild were there not at least some provision made for ensuring that the young had a reasonable start in life.

In most species the greatest mortality occurs in the immature stages, and an investigation of the habits of insects usually brings to light some action by the parent which helps the young to survive. This may merely consist of making sure that the egg is deposited in a suitable place. The female dragonfly flies over a pond or stream and drops her eggs into the water; here the young have a chance to survive, which they would not have if the eggs were dropped on land. This is the simplest of provisions for the young, making sure that they hatch in an environment to which they are suited. An egg drifting freely in the water is open to all sorts of hazards, and the damselflies, close relatives of the dragonflies, take things a little further by inserting their eggs into the tissues of plants below water level, so giving a measure of protection to the eggs. Adult antlions drop their eggs in sandy situations where the larvae, on hatching, will be able to make their well-known conical pits for trapping the ants on which they feed.

Selection of Plants

In species which have evolved a close association with a single species of plant, such as those in which the larva will feed only on leaves of one species, the adult has the task of selecting the correct plant species from amongst all those which it encounters in its wanderings. The caterpillars of some of the species of Lycaenid butterflies (the "Blues") will feed only on certain species of mistletoe and female butterflies must seek out the right species on which to lay if the larva is to survive. The hover flies (Syrphidae) usually lay their eggs near a colony of aphids and the hover fly maggots feed on them; the adult fly itself has no more interest in aphids as a food than the Blue Butterfly has in mistletoe leaves. Making provision for the following generation, in this simple way, is common amongst insects; it is relatively easy for an insect to seek out a suitable plant if it is within reach.

The female water bug (*Sphaerodema*) lays eggs on the back of the male; he carries them until they hatch.

Photo.—Howard Hughes.

A somewhat analogous method of providing food and protection for their larvae is adopted by the parasitic wasps of the families Braconidae and Ichneumonidae. Here it is necessary for the parent to find a "host" insect (some species of parasitic wasps must find a certain species of host and no other, others have a wider choice) in which its young can develop. The female wasp seeks out a host, often a caterpillar or other insect in the larval stage, and attacks it by inserting her ovipositor, which is a modified sting, into its body. Through this most efficient egg-laying instrument an egg is forced well into the body of the host. The host may go on leading an apparently normal life, with the wasp larva feeding on its

internal organs. Eventually, of course, the host succumbs, but by that time the parasitic larva has eaten sufficient food to enable it to complete its development. Here the wasp has taken steps which ensure that its offspring will hatch and be surrounded by food as well as be protected.

Storing of Food

The solitary wasps, of which there are many species in Australia, have evolved the habit of accumulating a food supply for the larvae and of storing this in special ways, such as in hollow stems or in specially constructed mud cells. *Sceliphron laetum*, a yellow and black mud-dauber wasp, makes mud cells in protected situations, often visiting houses in search of suitable nesting sites. The cells, or chambers, are made of compacted mud, and each is stocked with spiders which have been paralysed by stinging. An egg is also deposited in each cell and the resulting larva feeds on the store of paralysed spiders. In this case, too, the larva hatches to find a food supply available, its food in this case being alive but paralysed. Provision by the parent for the well-being of the progeny is made before the young have hatched; the female moves on, making one cell after another.

In none of the insects mentioned so far is there any contact between parent and offspring. Opportunity for helping the following generations is increased immensely if the two generations have contact with each other. This happens in many groups of insects, and the closeness of the contact varies from one to another; this contact can be regarded as an essential condition if true parental care is to be exercised. In some species of earwigs the female constructs an underground chamber in which she stays with her eggs for some time after they have hatched. The young may derive some measure of protection from enemies by the presence of the female, but the association seems to be a rather loose one and not of very great duration. This is certainly so with the species of shield bugs which stand over their egg-masses until the eggs hatch. The female is very easily disturbed and moves from the egg mass on the slightest provocation. Incidentally, egg-protection is not always the prerogative of the female insect; in the water bugs of the genus *Sphaerodema* the female glues her eggs on to the back of the male, and they are carried about by him until the young have emerged.

Colonial Species

It is in the species which live in colonies, the ants, bees and social wasps, that parental care in the insects reaches its most highly developed condition. In these insects the female stays with her young after they have hatched, through their larval and pupal periods of development, and is associated with them after they have become adult. Also, instead of merely providing a bulk of food to see them through their larval

An adult Bull-dog Ant (*Myrmecia gulosa*) feeding its larvae on Sugar Ants (*Camponotus* species).

Photo.—D. Trengrove.

development, the female provides food for the larvae from time to time as required. She becomes closely associated with them for a long period and their well-being is her responsibility throughout their period of growth. She must find food for and feed the larvae individually, at least until the colony is established; in the honey bees the female takes with her a large number of workers from the old colony to form the new. The association of female and offspring gives opportunity for care over and above mere feeding. The female can give active protection to the young and can make sure that they are kept in the most suitable environment; the larvae and pupae of ants, for example, are moved from place to place in the nest, being placed in the parts of the nest in which the most congenial conditions are to be found. The social wasps, such as *Polistes*, bring their prey, which consists mainly of caterpillars, back to the nest and these are fed to the larvae, each of which is housed in a cell of the suspended paper nest.

"Reward" From Larvae

There is one aspect of this contact between parent and offspring which is peculiar and important to the proper understanding of parental care in insects. When the adults have contact with their larvae and take care of them, cleaning and feeding them, they obtain from the larvae a "reward". This is in the form of small quantities of a substance secreted by the larva of which the adults are very fond. The care and attention given to the larvae are, therefore, only one side of an arrangement which is, in fact, a mutual one in that the adult receives some individual benefit from it. This reciprocity of feeding has been developed to such an extent in the social insects, and has been extended to mutual feeding amongst the adults of the colonies as well as between adult and larva, that it has come to form the basis of the social structure of the colony. The fundamental nature of true parental care, which is closely linked with social structure in its most highly developed form, has a different basis from that to which we are accustomed. In the non-colonial species a certain behaviour pattern is gone through by the female, who then moves on to repeat the activity; whether or not the young survives because of her action she will never know. In the highly developed social colonies there is a reciprocal arrangement whereby the young become of interest to the adults for reasons other than that they are their own offspring; this reciprocal feeding arrangement maintains the whole colony as an entity.

The ways in which insects provide for their young vary; some do little, by means of comparatively simple instinctive actions, others have evolved elaborate behaviour patterns to ensure that losses in the next generation are minimised.

Death of O. le M. Knight

The Museum records with deep regret the death of one of its honorary correspondents, Oscar le Maistre Knight, B.E., A.M.I.C.E., A.M.I.E.Aust., on December 17, 1961, at the age of 73.

Mr. Knight's connection with the Museum started when he became interested in geology in the middle 1930's, and as a result he took courses in geology and mineralogy at the Sydney Technical College. He put his studies to good use by undertaking a detailed survey of the outcrops of fossil insect horizon in the Permian rocks of the Belmont-Warner's Bay district, near Lake Macquarie, N.S.W. During this work and by diligent collecting he accumulated almost 1,000 beautifully preserved fossil insect wings which he later presented to the Museum. He was also largely instrumental in obtaining for the Museum the Malcolm Stanley collection from the same area, and these two collections form the basis of the Museum's outstanding collection of Permian insect wings.

Apart from his interest in palaeontology, Mr. Knight devoted a great deal of time to minerology and gem-cutting. He also designed and built a new type of direct specific-gravity balance of great use in the identification of gem-stones. His collection of cut gem-stones and his specific gravity balance were presented to the Museum.

In his later years he took a great interest in Aboriginal stone implements, and the Museum collection has been enriched with material he collected from many localities in New South Wales and Central Australia.

On numerous occasions, Mr. Knight accompanied members of the Museum staff on official field trips, making his vehicle and camping equipment freely available. All members of the staff who travelled and worked with him invariably formed a warm and lasting friendship.

Mr. Knight suffered ill-health for the last few years of his life and in the last few months he knew he had not long to live. This situation he faced with the courage one would expect from a man of his outstanding character. He will be sadly missed.—R.O.C.

This poker-work picture of the Taungurong Aboriginal tribe in battle was done by Caroline Le Souef, wife of Albert A. C. Le Soeuf, on the lid of a wooden box in which are kept models, made by her husband in 1867, of the weapons formerly used by this tribe.

Central Victorian Aboriginal Weapons

By A. MASSOLA

Curator of Anthropology, National Museum of Victoria

THE illustrations for this article are from photographs of a set of models of the weapons formerly used by the Taungurong, a large Aboriginal tribe once inhabiting the valley of the Goulburn River, in Central Victoria.

The models are, perhaps, the only complete record of the weapons of this tribe, as no systematic collecting had ever been done amongst them. The early contacts between the Taungurong and the white colonists proved disastrous for the former. Whereas in 1850 they were a well-organised tribe, by 1860 not many of these unfortunate people were left. The discovery of gold, with its attendant influx of thousands of gold-seekers, soon reduced the Taungurong to a negligible number. The gold-seekers, of course, were not interested in the Aborigines as such, and nobody thought, in those feverish days, of studying them or of forming collections of their material possessions. When the importance of collections was realised it was too late. Hence the great value of this set of models.

Made in 1867 by Albert A. C. Le Souef, they are perfect minatures of every type of weapon known by him to have been used by these Central Victorian Aborigines. He had every opportunity to handle and examine the originals. He was the son of Assistant Protector of Aborigines W. M. Le Souef, who, in 1840, founded the Mission Station at Murchison, on the Goulburn River. There the Assistant Protector took all his family and lived in a very primitive way amongst the natives, many of whom had never before seen a white man. Young Albert thus had ample opportunities to mix with them. This knowledge of the natives was of great advantage to him when, in 1858, in partnership with Sherbourne Sheppard and W. N. Atkins, he took up Tallygaroopna Station, consisting of 160,000 acres on the right bank of the Goulburn River, just north of, and adjoining, Shepparton. Here he continued his friendly relations with the natives, and left for posterity a number of published descriptions of their way and manner of life, while his wife, Caroline, a gifted artist, painted camp scenes and corroborees. Albert A. C. Le Souef died in 1902.

As seen by the illustrations, the models in this set were made with care, and, we can believe, are exact copies of the originals. They are, therefore, extremely useful as a guide for the student of the weapons used by the natives of this region. It must be borne in mind that the following description of the implements and the use to which

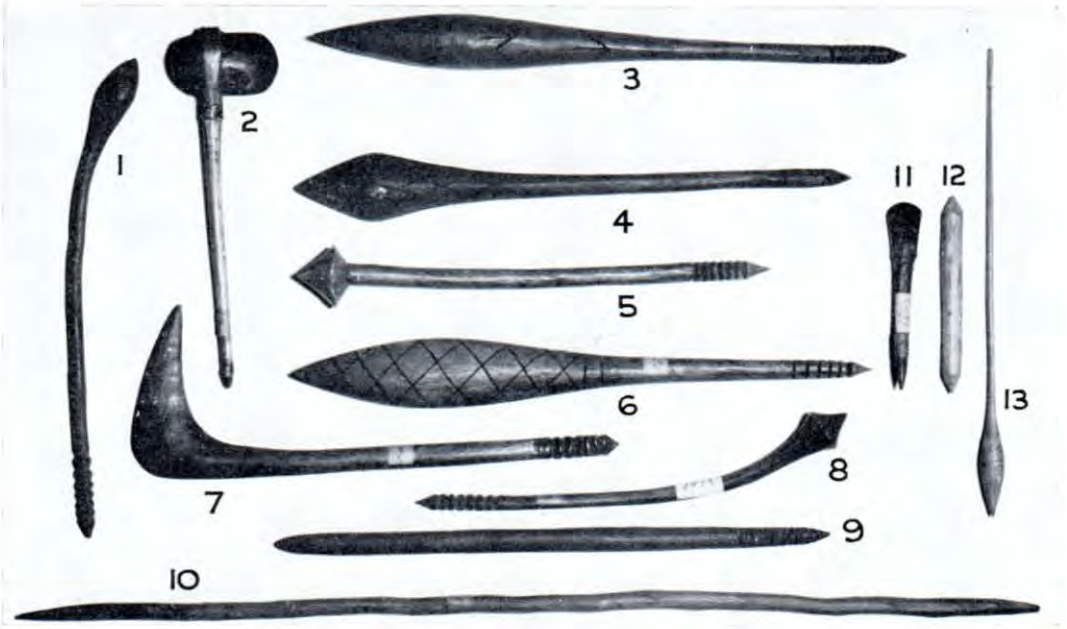


Plate 1.

they were put naturally refers to the originals from which these models were taken, and not to the models. The native names given are mainly in the language of the Yarra tribe, the Woewurong, the immediate southern neighbours and allies of the Taungurong. Woewurong appellations are used because, in most instances, the Taungurong name for the implements has never been recorded.

Plate 1

Beginning from the left:—

No. 1: *Worra-worra*, a throwing stick used in fighting and also for hunting game. It was generally made from the root of a sapling of the tea-tree (*Melaleuca ericifolia*).

No. 2: *Karagik* (in Taungurong), stone-headed axe; the stone used for the head was usually of metamorphic rock. The handle was a length of tough sapling, split, and bent around the head. It was tied near the head and at the distal end with the fibre of the stringy-bark tree, or the sinews of the tail of the kangaroo, and further secured by vegetable gum.

No. 3: *Kudjeroong*, a club, or waddy, with a bulbous round head, used most commonly in single combat, when both combatants protected themselves with the wooden shield (mulga). Blows were only aimed at the head, and it would have been deemed unfair to strike at any other part of the body.

No. 4: Another form of *Kudjeroong*. In this variety the head is oval in cross-section.

No. 5: *Yeamberrn*. This weapon was usually used in hand-to-hand combat, although it was sometimes thrown at an enemy. It could also be used as a stabbing weapon, and the sharp point would then inflict a dangerous wound. Red gum or box was preferred for its manufacture.

No. 6 is another form of *Kudjeroong*. In this variety the bulbous head was flattened to the extent of producing two blunt cutting edges.

No. 7: *Leonile*. A good *leonile* was made of hard, heavy wood, and, in order that it might stand a heavy blow without splitting, a root with a curve in it was chosen. The weapon was employed in single combat in the same way as the *Kudieroong*, but it is said to have been more dangerous, as the curvature enabled the point to get over the protection of the shield.

No. 8: *Yeamberrn*, the throwing form of No. 5, only differing from it by the curved shaft. It was sometimes thrown in a way that caused the sharp point to enter the

body of the enemy, thus inflicting a severe wound.

No. 9: *Konnung*, fighting stick, sharpened at both ends, employed in close combat, when it was held by the middle and used for stabbing.

No. 10: *Kannan*, woman's digging stick. This stick, sharpened at both ends and hardened over a fire, was made from any suitable sapling. It was principally used by the women for digging roots and small animals from the soil, but could also be used for fighting.

No. 11: *Stone chisel*. The head was an edge-ground flake of hard stone, such as basalt, or diabase, set in a cleft stick, held in position by a ligature of native string. Used in manufacturing wooden implements.

No. 12: *Koorngoon*. The illustration shows one of a pair of models of sticks made from a sonorous wood. These were used by the Aborigines during corroborees and sing-songs. One of these sticks was held in each hand and one struck against the other, thus keeping time or emphasizing the dance steps or the words of the song.

No. 13: *Wit-wit*, a plaything. When properly thrown to skim along the ground, it could be made to leap from spot to spot for over 200 yards. It was made from a suitable sapling, the head being part of the root.

Plate 2

Top centre: *Mulga*, a strong wooden shield used for warding-off blows given with the *Kudjeroong* or *Leonile*. In these shields the section through the middle is diamond-shaped, the inner and outer face of the shield therefore being angular.

From top left down:—

Drunmung, another form of Mulga. It is wedge-shaped, or a flattened diamond in cross-section, thus presenting a very sharp edge to the incoming blow.

The next shield shown is a third form of the *Mulga*. In this specimen both the outer and the inner surface lack the typical angle, therefore presenting a convex-concave appearance.

Burngeet. War boomerang. The *Burngeet* was thrown straight at the enemy, who, if hit, would receive a severe cut. It was parried with the shield. Sometimes the thrower could cause it to strike the ground, rebound, and hit the person towards whom it was aimed. When thrown this way it was much more difficult to parry. The *Burngeet* did not return to the thrower.

Wonguin. This is the play boomerang which, when properly thrown, came back to the thrower. It was not used in fighting.

From top right down:—

Geeam. This shield was used as a protection against spears. It was most commonly made from the inner bark of *Eucalyptus viminalis*, the Manna Gum. Two types of this shield exist, the difference being in the handle. In one this part is cut from the solid, while in the other the handle is made of a separate piece of green wood, thrust in two holes, expressly bored for the purpose of receiving it. When dried it is almost impossible to take this handle off.

Murriwan (Goulburn tribe) or *Kurruk* (Yarra tribe). This is the spear-thrower, the implement with which spears could be thrown with much greater force and accuracy. Spear-throwers were furnished with a

Plate 2.

barb which fitted into the hollow at the butt end of the spear. Two types were used by the Aborigines of this region. In one the barb was cut out of the solid, while in the other, as in the present model, the barb was made from a fragment of bone, lashed on with native string smeared over with vegetable gum.

Murriwan. Spear-thrower, as above, except that the barb at the top of the implement was carved out of the solid.

Murriwan. Spear-thrower, similar to the last.

Plate 3

From top:—

Wormegoran, a two-pronged spear used for catching fish. The spear-thrower was not used with this implement.

Koy-yun. Hunting or war spear. This weapon was fashioned with great care. It had to be very straight and the point had to be very smooth and sharp. This spear was not barbed. It was thrown by hand

Mongile, the jagged spear. These war spears were greatly feared because of the nature of the wound they inflicted. In making them, a groove was cut on each side of the point, and continued for a foot or more along the shaft. In this groove were embedded a number of sharp chips of quartz. These were further fastened on by coating the grooves with vegetable gum. In the model shown the chips of quartz have unfortunately been lost. This spear was thrown by hand.

The next implement shown was made from two long wooden rods, each fitted to a central section of reed. The reed ensured great flexibility. A noose of native string was fitted to one end of the rod. The hunter, hidden behind some bushes, would contrive to slip the noose over the head of a bird, when, with a quick jerk, it would be secured.

Tirrer. The upper part of this spear consisted of a shaft of hard, heavy wood, with a series of barbs cut along one side of the point. The heavy wooden shaft was inserted into a reed, where it was securely fastened with native string and vegetable gum. This spear was thrown with the spear-thrower.

Nandum. War spear. A spear similar to the last, except that it was made from a single length of hard wood and was not fitted to a reed base. This spear was not thrown with the spear-thrower.

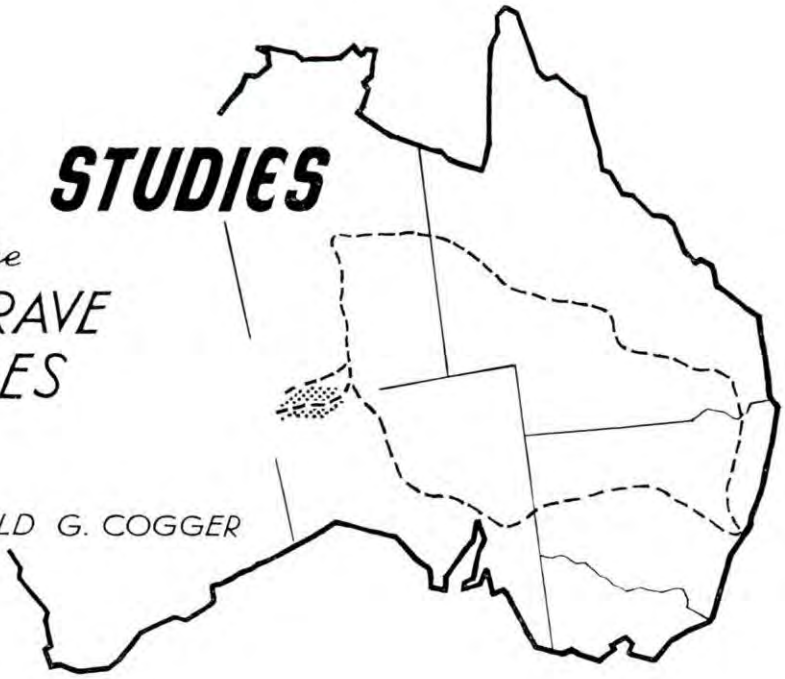
Tare. This spear is similar to the second-last, except that it is not barbed. It was thrown with the spear-thrower, and mainly used in warfare.

These models are kept in a wooden box ornamented on the four sides and on the lid with scenes of Aboriginal life done in poker work by Caroline Le Souef. It is not the purpose of the present article to describe this European art. It is sufficient to say that, as can be seen by the battle scene illustrated, it is a faithful representation which adds to our knowledge of the life of the Taungurong.

Plate 3.

REPTILE STUDIES

in the MUSGRAVE RANGES



by HAROLD G. COGGER

TO study adaptation is to study evolution in action. Perhaps this is the principal reason why desert faunas have always attracted so much of the attention of biologists, for animals and plants have evolved a wide variety of complex structural, physiological and behavioural adaptations to enable them to survive the rigid and extreme conditions of arid regions. Temperature extremes, low and unreliable rainfall, and high evaporation rates are just some of the more obvious factors which make life in the desert more hazardous than in many other environments.

Such an interest was instrumental in prompting the author to choose Central Australia as the site for field work on reptiles in May, June and July of 1961.

Our party consisted of the author (herpetologist), H. D. Hughes (photographer) and R. D. Mackay (preparator). We travelled nearly 7,000 miles through four States in a one-ton Willy's Jeep. The route taken is shown in the map above.

To most people the central portion of Australia is rather indefinable "desert", or, as frequently described on maps, an even more obscure "semi-desert". This confusion arises largely because the arid parts of the continent consist of a wide variety of environmental types. Stony or sandy plains, forests of mulga or gidgea, spinifex-covered sand ridges, mallee, salt lakes and claypans, and high, bare mountain ranges all intergrade to present a complex and confusing picture of the "desert".

Low Rainfall

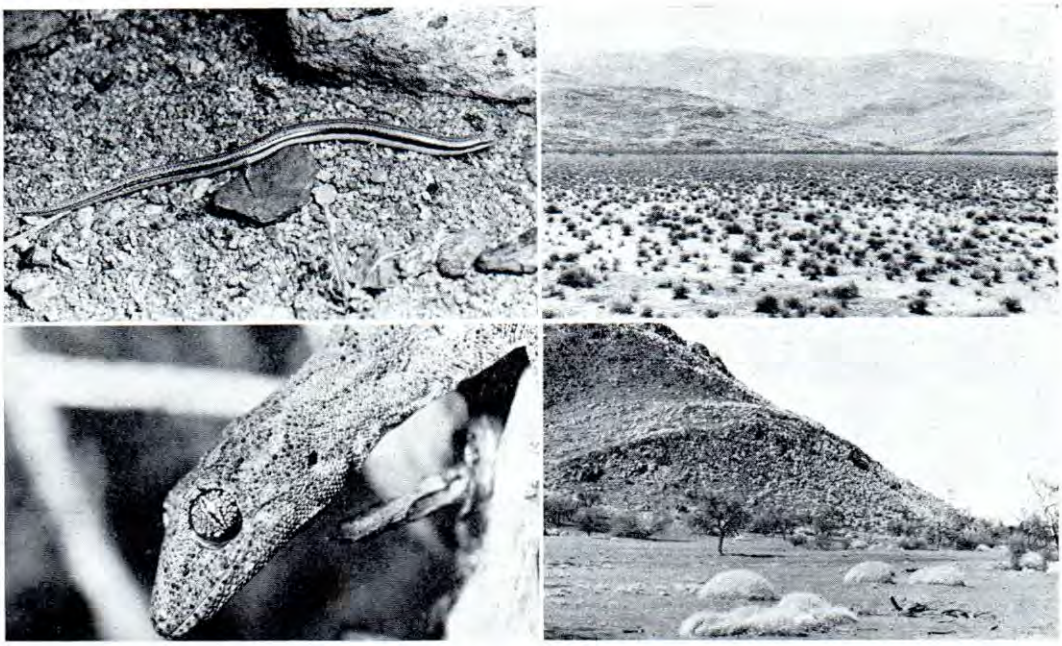
The common factor, however, is low rainfall. The greater part of the Centralian region receives an average of less than 10 inches of rain each year. Rainfall is unpredictable and spasmodic; large areas may fail to receive any rain for a year or more. Hence, although growth may be extensive immediately following rain, this is soon reduced to a sparse xerophytic vegetation which may be considered to be more or less permanent.

However, two of the points just mentioned—the unique adaptations of the desert flora and fauna, and the wide variety of environmental types—serve to emphasize one of the most popular misconceptions concerning the Central Australian region,







OPPOSITE PAGE (left to right from top): (1) The Musgrave Ranges, viewed from the east. They are approached through open mulga forests and low rocky hills. (2) The Shingle-back or Sleepy Lizard (*Trachydosaurus rugosus*), a common diurnal lizard often found foraging in the open. (3) A broad valley in the heart of the Musgrave Ranges. (4) A Pigmy Goanna (*Varanus gilleni*), essentially an arboreal species and usually found in close association with mulga trees. (5) A clump of porcupine grass or spinifex (*Triodia sp.*) on a sand-ridge near the Musgrave Ranges. Spinifex constitutes a major habitat for reptiles in Central Australia. Note the lighter-coloured seeding heads. (6) The Beaded Gecko (*Diplodactylus elderi*), a lizard usually found intimately associated with spinifex, through the interlacing spikes of which it moves easily and rapidly. (7) View from a rocky peak near Mount Woodruffe (4,970 ft.), showing the barren appearance of the ranges. The vegetation consists almost entirely of spinifex clumps scattered over a tumbled and broken rocky surface. (8) A Rusty Dragon (*Amphibolurus rufescens*) which is found in the rocky habitat shown in the previous photo. **THIS PAGE:** (9) A degenerate-limbed skink, *Rhodona bipes*, a burrowing species found in many parts of Central Australia. (10) View, from the south, of a central portion of the Musgrave Ranges. Note the three distinct zones—the foreground plain of saltbush and bluebush, the thin line of mulga forest at the base of the ranges, and the rocky, spinifex-covered mountains. (11) Head of a Spiny-tailed Gecko (*Diplodactylus strophurus*), a species which is equally at home in spinifex and in trees. The intricately-patterned eye is a bright golden or silver colour in life. (12) A low hill in the Musgrave Ranges, showing the patchy distribution of the spinifex and its occurrence both on the rocky hills and on the flat, sandy areas. The scattered corkwood trees are characteristic of the Centralian environment. (Photos 5 and 12 by Howard Hughes; others by the author.)

that it is monotonously homogeneous. Indeed, to the traveller, Central Australia presents a confusing array of contours and colours, and many people have confused the boredom of satiation with the boredom of monotony.

On leaving Sydney our principal destination was the Musgrave Ranges, a chain of mountains running in an east-west direction for about 90 miles, and averaging five or six miles in width. The Musgraves are located just a few miles south of the South Australia-Northern Territory border, and about 120 miles east of the Western Australian border.

Rugged Ranges

Despite the general conception of Central Australia as an extensive plain, the Musgraves rise to a height of 5,000 ft. (3,000 ft. above the surrounding country). In appearance they are barren and rugged, in

most parts the starkness of their rocky contours being broken only by an occasional tree. There is no common central dividing ridge, the Ranges consisting merely of a morass of individual rocky peaks separated by narrow ravines or wide valleys. Many of these valleys are but extensions of the surrounding desert, and at times extend deep into the heart of the Ranges.

Permanent water is found only in occasional isolated rock-holes scattered throughout the Ranges. Such rock-holes are usually the result of an extensive drainage basin, and a non-porous substratum, and are usually in such a position as to be protected from excessive evaporation. For this reason we chose as our camp site a rock-hole known only by its Pitjandjara tribal name of "Erliwunyawunya", on the southern side of the Musgraves. Here we set up our tent on a sandy patch beneath the shade of a River Gum, a short distance from the waterhole, and below a series of towering peaks from the slopes of which Erliwunyawunya receives its life-giving water. Unfortunately, our visit took place towards the end of a prolonged drought, with the result that only a small quantity of soupy green water was to be found in a few isolated crevices.

Relict Species

Apart from the availability of water, there were a number of reasons for camping at the foot of the mountains. Firstly, it has been suggested by biologists working on certain groups of animals and plants that the Centralian ranges, due to particular climatic differences, act more or less as "oases" in the surrounding desert, and in this way are refugees for certain species which otherwise could not withstand the harsh conditions of the desert. In this way various animals and plants, which were more widespread when the country was more humid, have been able to survive in these pockets in the ranges, even though such pockets may be little more than small valleys, ravines or rock-holes. (See article by J. A. Keast in "The Australian Museum Magazine", Vol. XIII, No. 3, 1959.)

Although this is certainly true of a number of animals, we were anxious to study the reptiles of the Musgraves (and subsequently other Centralian ranges) in an attempt to determine whether any such "relict" species occurred.

We were also anxious to study the changes occurring in the reptilian population between the ranges and the surrounding desert. Is there any basic change in the numbers and kinds of reptiles when one moves from the desert sandhills into the mountains? One would naturally expect to find certain species restricted to one habitat or another, but is this restriction due to basic and absolute differences between the two environments or does it merely reflect minor habitat variations?

Hence, by setting up our work camp at the foot of the ranges, we were able to study the transition between these various habitats, and their effects on reptilian distribution.

Evolution of New Species

Another important aspect of this problem concerns the development of new forms. If certain species were to be restricted to particular habitats associated with the mountains, the isolation of the mountain ranges from one another results in the isolation of pockets of the same habitat and hence the isolation of one population of a particular species from another. This is a basic requirement for the evolution of new species, and the differences (if any) between such populations are indicative of the period and degree of isolation. This question is, however, particularly complex, and attempts to over-simplify such cases have resulted in many erroneous conclusions.

The reptile fauna of the Musgraves (and the surrounding country) is rich and varied. On the basis of their habitat or way of life, these reptiles can be placed in four basic categories—

(1) Spinifex (*Triodia*)-dwelling forms.

(2) Rock-dwelling forms.

(3) Arboreal forms.

(4) Burrowing forms.

So far as the lizards are concerned (the reptiles in which the author was most interested), the first group is the largest. When one considers that various species of porcupine-grass or spinifex (*Triodia*) cover

enormous tracts of Central Australia, ranging from the desert sandhills to the very summits of the mountain ranges, and that in most places it constitutes the only permanent and extensive ground-cover, this fact is not surprising.

However, it should be stressed that these habitat differences are not always clear-cut, and a number of species occur in two or more categories. Much of our time was taken up with exploring these different habitats in an attempt to determine the principal factors governing the microdistribution of species within the area.

As a total of more than forty species of lizards were found in these various habitats, there would be little point in attempting to list or describe them in this article. Some of the more interesting are illustrated in the photographs.

Apart from these broader problems, however, studies were made of the individual ecology and behaviour of desert lizards, and their adaptations to their rigorous environment.

Desiccation Problem

One of the greatest difficulties facing any animal, including man himself, in desert regions, is that of desiccation. Without water, animals simply cannot survive. In the area in which we were working, surface water was virtually non-existent, except for isolated rock-holes in the mountains, many miles apart.

This problem has been overcome in a number of ways by desert lizards. Some of them burrow deep into the sand where conditions are relatively moist, and where they can regain the moisture lost when they forage above ground. The majority of species are nocturnal in habit, and are therefore not subject to such extreme desiccating effects of low humidity and high temperatures as are diurnal lizards. Others feed on certain insects, such as ants, which have a high water-content, and this supplies the lizards' total needs. Some of these ant-eating lizards, only 3 in. or 4 in. long, might eat as many as 600 or 700 ants in the course of a day. Another means of water conservation has been the development of a thick horny skin which is more or less impervious to moisture.

There are, of course, other complex physiological ways in which water can be conserved (such as increased re-absorption in the urodaeum or kidney), and such mechanisms often achieve their greatest development in desert species.

Another problem is temperature. Summer temperatures in inland Australia may go as high as 110° to 120°F.; at such times the ground temperatures may be in the vicinity of 120°F. to 140°F., and this is from 15° to 35° above the lethal temperature for most lizards that are active during the day. How, then, can lizards survive in temperatures that are so high? How do so-called "cold-blooded" animals maintain their body temperatures some 20° below their surroundings? We've found that they do this in a number of ways; for example, they raise their bodies and tails from the ground to leave an insulating layer of air between their bodies and the hot sand. Diurnal desert lizards almost invariably have an immaculate white belly which reflects the heat from the hot ground. When they get too hot many lizards pant, which results in a respiratory heat loss that reduces their body temperature. Burrowing is another method of avoiding excessive temperatures. These are just a few of the many adaptations that may be observed in desert reptiles.

Not only are high temperatures a problem. Our coldest night was 15°F., a temperature at which reptiles would quickly die if they did not take shelter in well-insulated surroundings, such as burrows, hollow trees, rock crevices, or under vegetation.

Food Supply

Food supply is also subject to considerable fluctuation in the arid parts of the Australian continent. Droughts, with their resultant effects on vegetation, may extend for years, and this imposes a serious drain on food resources. It has been found that, to offset this, many desert reptiles have developed means of fat storage within their bodies which will allow them to survive prolonged periods without food. For example, in laboratory experiments, small nocturnal gecko lizards, only a few inches

long, have been able to survive for about a year without any food whatsoever. The precise physiological mechanisms whereby this fat storage takes place are not fully understood.

Expedition's Importance

I have attempted to describe, briefly, the nature of our work in the Musgrave Ranges, and our reasons for choosing to work in the area. It will be some time before the full results of our efforts are known. It should also be stressed that only those aspects with which the author was personally concerned have been discussed. Apart from the work on reptiles, a large number of other animals were collected for study by biologists in Australia and overseas, ranging from tiny snails to kangaroos. Films were taken which will be used by the Museum for educational purposes. Expeditions of this kind, where animals are studied in their natural environment, are not only helpful, but are vital supplements to work in the laboratory.

Anton Friedrich Bruun, 1901-1961

On December 13, 1961, Dr. Anton Fr. Bruun died suddenly on the eve of his 60th birthday. He had been lecturing to students in the zoological laboratory at Copenhagen University, where he was Professor of Oceanology. The night before, at the Christmas celebration of the Danish Adventurers' Club, he had received an ovation when he made the speech of the evening.

With his passing many in the Australian Museum feel they have lost a dear friend and a valued colleague. Dr. Bruun's association with this Museum began when he visited it in 1929 as a youthful zoologist assisting Professor Johannes Schmidt on his famous eel investigations aboard the "Dana" during the Danish Oceanographical Expedition around the world in 1928-30. He briefly visited the Museum again in 1949, and later returned with another Danish deep-sea expedition when the "Galathea" visited Sydney in 1951. On this occasion he was the scientific leader of the expedition. In between these periods he had become an eminent marine zoologist attached to the Zoological Museum in the University of Copenhagen, had been scientific leader of the Danish "Atlantide" Expedition to the coast of West Africa in 1945-1946, and had represented Denmark, and the University of Copenhagen, at many international scientific congresses. At the invitation of the University of California, he led the Scripps Institute of Oceanography's Expedition to the South China Sea and the Gulf of Thailand.

—E. P. and G.P.W.

Book Review

MINES IN THE SPINIFEX. THE STORY OF MOUNT ISA MINES, by Geoffrey Blainey; Angus and Robertson, 1960; pp. 233, pl. 24. Price, £1/7/6.

More space than is available would be required to do justice to this remarkably fine account of the discovery and development of Mount Isa, and the history of the whole Cloncurry mineral field from the time when Burke, in 1861, only 200 miles from the Gulf of Carpentaria, named the Cloncurry district.

The story is long and complex. The whole history of most of the numerous copper mining ventures in the Cloncurry field prior to the discovery of Mount Isa is one of almost unrelieved failure. The author aptly describes Cloncurry as "the scene of more unfulfilled promises than any other town in Australia". Difficulties that at the time seemed insurmountable were encountered time and time again for many years after the first discovery of the Mount Isa ore bodies. The area is extremely remote, formidable technical problems had to be overcome in the milling and smelting of the low-grade silver-lead-zinc ore, and the development of the mine took place in the depression years, when local capital was unavailable and overseas capital hard to get. Mount Isa was no get-rich-quick proposition, and many were the vicissitudes until it finally became Australia's biggest copper producer, second greatest lead producer, a major producer of zinc and silver, and Queensland's biggest single industrial concern.

The early attitude to the field which persisted for many years is well illustrated by the story of one Mullavey, part owner of the Rio Grande lease, who, back in 1924, was alarmed that his partner was asking too much when he stuck out for a modest £5,000 when asked by prospective purchasers to give a four-month option on the leased. Said Mullavey, "This is no —— Broken Hill. If you'd been sensible (i.e., asked for less) we might have got to Camooweal for a week on the whisky".

In the hands of a less skilled writer, the account of the financial history of the mine, necessitating the quoting of many facts and figures, might have become monotonous. At all times the author handles his material most ably and gives an absorbing account. His flair for presenting mining history in an accurate yet readable form is most apparent, this being his second successful book of this genre.—R.O.C.

BOWER-BIRDS

By A. J. MARSHALL
Dean of the Faculty of Science, Monash University, Victoria

BOWER-BIRDS, like Phar Lap, Les Darcy, the Man from Snowy River and that dog that helped MacDougal (if that was his name) Top the Score, have become part of the folklore of Australia. Like most people, I heard about bower-birds from my parents (both of whom came from "The Bush") long before I saw one.

The countryman's story is simple and limited, as is his appreciation of most natural phenomena around him. Bower-birds collect bright and colourful objects indiscriminately, and play with them at "playgrounds"; also, they eat garden fruit and therefore may be legitimately shot on sight. This pattern of folk belief is common to coastal dairy-farmer and inland sheep-farmer alike.

The evolution of knowledge and ideas about bower-birds is in itself an interesting subject. As far as I am aware, nobody has yet asked tribal Aborigines or Papuans what they believe to be the functions of the bower, but at least some of the early explorers have left their speculations on record. Thus, Sir George Grey thought that a bower of the Great Grey Bower-bird was the nest of a kangaroo rat when he first saw it in March, 1838, and in the following year Captain J. Lort Stokes, of H.M.S. "Beagle", conjectured whether bowers of the same species were "some Australian mother's toy to amuse her child". Later, he was invited to inspect a bird's "play-house" where he saw the bird "amusing itself" by carrying shells through its archway. This idea that bowers were essentially playgrounds was followed by our pioneering forefathers who washed gold and established "sheep-runs", as they were then called. Bower-birds, too, were said to build "runs", and to play at them.

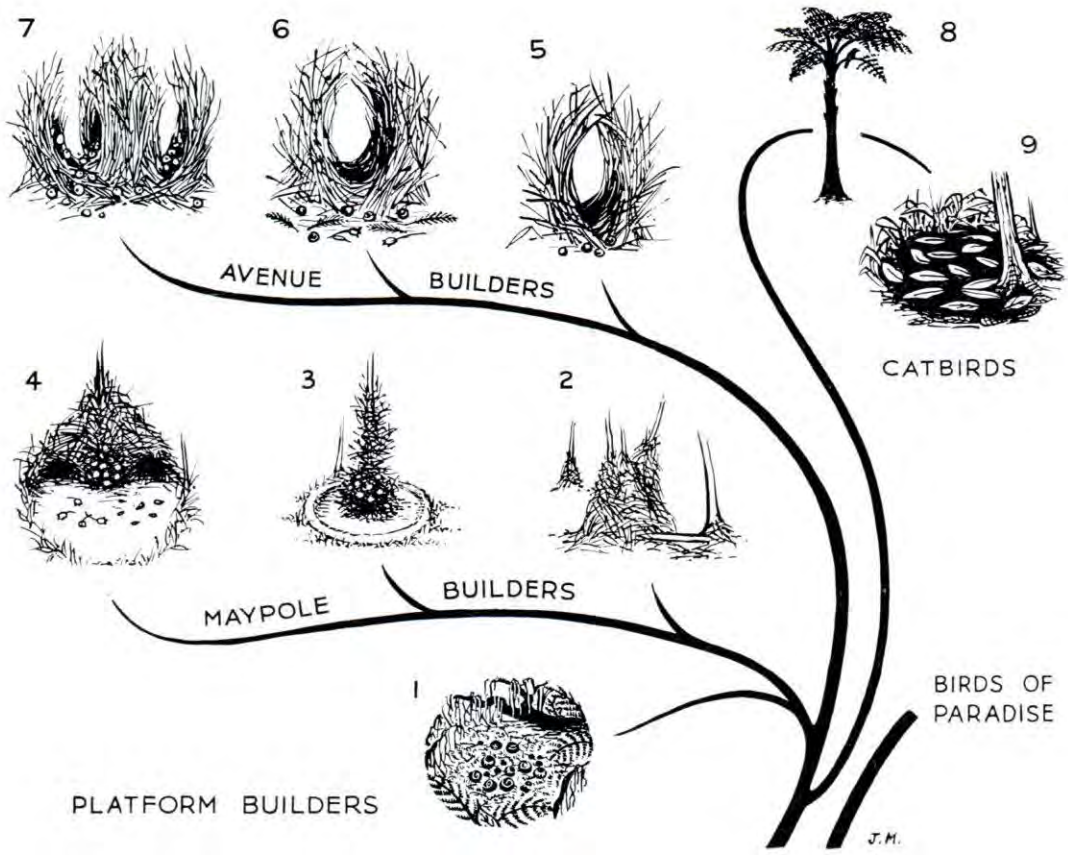
Gould's Views

John Gould began the era of the recording naturalist when he arrived here in 1838. It was Gould who first brought before the general public the poetic name *bower-bird*, but he was not taken in by settlers' stories of play-theatres and play-things. "These constructions . . . are used by the males to attract the females," wrote Gould tersely. They are, he said further, "perfectly anomalous in the architecture of birds". Fifty-three years later, Alfred Newton, Professor of Zoology at Cambridge, and the leading ornithologist of the day, was to say that "this statement, marvellous as it seemed, has been proved by many subsequent observers to be strictly true".

In Victorian England there was an even greater interest in natural history than there is there today. Many gifted amateurs, like Dr. Gideon Mantell, who discovered the first-known dinosaur, pursued their hobbies to a fastidious, almost professional, degree. So there was aroused in England far more excitement about the "new" bower-birds than there was among the sheep-farmers and gold-diggers who were building New Holland into Australia, or lamentably, than there is today among their inheritors. Soon, the term "bower-bird" became affectionately applied to anybody, often little girls, who indiscriminately accumulated colourful rubbish. In 1878, Trelawny, in his "Memoirs of Shelley", reports himself as having said, not later than 1822, that "you too have built your nest [sic] after the fashion of the Australian bower-birds". This, incidentally, is a near classic case of inaccurate memory. It would be more than two decades before Gould brought the name "bower-bird" before the English public.

"Anthropomorphic Nonsense"

Gould's surmise that the bower has a utilitarian, sexual significance was largely ignored by the emergent school of Australian naturalists. During Victorian and Edwardian times, local ornithologists indefatigably collected, first, bird-skins, and next, now almost phrenetically, egg-shells, carefully drilled and blown with one hole only! This was a natural pioneering phase. In most countries it was succeeded by a period



THE EVOLUTION OF BOWER-BUILDING

Bower-birds and birds of paradise almost certainly have a fairly close common ancestry, the true bower-birds and catbirds branching one way and the birds of paradise another. The most simple arenas are the fern and shell-strewn platforms made by the black bower-birds (*Archboldia*) (1), which are probably a primitive offshoot from the maypole-building or gardener bower-bird stock—for example, the Golden (2), Yellow-crested (3) and Orange-crested (4) Gardeners, which show an increasing architectural elaboration. The second major stock is the avenue-builders—for example, Regent (5), Satin (6) and the *Chlamydera* group, the last-named exemplified here by the Yellow-breasted Bower-bird (7), which adds two extra walls and so achieves three avenues instead of two. Of the three catbirds, two green species stay in the trees (8) and make no display ground. The third, the brown Stage-maker or Tooth-billed Catbird (9), spends much of its time near the ground, clearing a display arena which it constantly replenishes with freshly-cut leaves. This species shows a fascinating example of convergent evolution with some of the true bower-birds and birds of paradise.

—Drawing by Jane Marshall.

of solid scholarship applied to basic problems relating to avian ecology, physiology and so on. In Australia, on the other hand, it was succeeded by the camera and a piece of string. So there arose here a school of bird photographers who produced admirable pictures, but only occasional and incidental information of any biological significance about the creature photographed. The picture, not the bird, was the thing. Some new information of value was gained about bower-birds; but at the same time problems of their bizarre bower-building and associate activities were clouded with a romantic literature full of anthropomorphic nonsense. Ornithologists wrote solemnly of bower-birds with "thoughtful" looks in their eyes: they claimed that the birds built theatres, and at them performed essentially for aesthetic reasons; and they ascribed to birds an intelligence comparable with that of higher mammals, including specifically

Man. One writer credited the Satin Bower-bird with the power of deductive reasoning.

It will be agreed that there must be something extremely special about a group of birds possessing attributes that evoked statements that seem something like pure lunacy in terms of biological scholarship. And, as Newton maintained long ago, bower-birds *are* extremely special. Furthermore, during the past 25 years we have come to at least a broad understanding of the significance of the bower, its miscellaneous paraphernalia and the grotesque activities that take place nearby.

The bower is an extreme elaboration on the display ground which is the focal point of the cock bird's *territory*. The males of most birds, some fishes and mammals and other creatures establish territories at the start of the breeding season when sex hormones begin to flow through the bloodstream. All kinds of birds—as widely unrelated as pheasants and manakins—make display grounds on their territories and defend them vigorously against rivals. Bower-birds differ chiefly in that they put a building on the display ground, and bring to it embellishments that are exhibited to the female during display. The male builds his bower, gathers the display objects that are characteristic of his kind, gyrates noisily and soon attracts a female with whom (in the species that we know best) he mates. The hen then goes away and builds a nest, lays and hatches her eggs, and later feeds her young without help from the male, whose attentions have become so canalized into the bower area that he will desert it only after the hen and chicks appear at the end of the sexual season.

Three Types Of Display Grounds

The display grounds of the different species of bower-birds fall into three distinct types, and one of the closely related catbirds builds a fourth kind, as shown on the accompanying diagram. I have called these three different sorts the *platform*, *avenue* and *maypole* types. Each is superimposed on the simple display arena that is made by so many widely different birds. The platform type is constructed by two little-known New Guinea species of the genus *Archboldia*. On the platform the owner puts snail shells and other display objects. The avenue type is basically twin rows of sticks, sometimes arching overhead, and is built by the flashing blue male Satin Bower-bird of eastern Australia, the lilac-crested Spotted and Great Grey Bower-birds of the dry areas, the Fawn-breasted Bower-bird of north-eastern Queensland and New Guinea, the Regent Bower-bird of the wet rain-forests of eastern Australia and probably by its close relatives in New Guinea. Finally, the Yellow-breasted Bower-bird of the New Guinea grasslands adds yet another wall at each end and so achieves four walls and three avenues. Within the avenues, or on the display ground outside, each species accumulates characteristic displaying materials.

Of the maypole builders or gardener bower-birds only one, the Golden Gardener, occurs in Australia. It lives in the heavy rain-forests of the Atherton Tableland and weaves a great fabric of vegetable material, sometimes 9 ft. high, around a sapling. The other maypole bowers are elaborations of this basic plan, and two of them take the form of huts, even though an abbreviated central cone is always retained beneath the shelter. Either the cone or the immediate surroundings is decorated with colourful beetles' wings, flowers or fruits.

Functions of the Bower

I see the construction of bowers as a form of displaced nest-building. This activity on the part of the males (which do not assist females in building the nests) has become ritualized and genetically "fixed", and seems to be under the influence of sex hormones. A castrated bower-bird does not make a complete bower.

Experiments have shown that the male Satin Bower-bird chooses decorations in the image of competitors of its own sex and species: the blue flowers and feathers that it tosses about so ferociously match the eye-colour of its rivals, while the selected lemon-yellow objects match the colour of the adult male's beak tip. The savage intensity with which the bower owner displays with these objects effectively keeps marauding rivals away from his bower, and from his female, as long as he remains strong and healthy. The aggressive bower "dance", too, is partly a displaced threat

drive. Sometimes the male is so carried away that he attacks the hen savagely during the height of the mating season.

The mysterious painting ritual of some of the bower-birds can be explained in the same way. It is probably a displacement of courtship feeding, a common avian practice involving the passing of chewed food from one bird to another. The avenue-building bower-birds apparently have projected this activity onto the bower, transferring chewed fruit, charcoal or dried grass to the twigs which form its walls.

Bower-birds take up territory and build bowers early, and, during the many weeks when the male is secreting sex hormones and waiting for the watching female (whose seasonal development lags behind) to come into reproductive condition, the bower and its embellishments occupy the male's physical attention. So have evolved the weird specializations of the avenue-building birds. (The behaviour of the maypole-builders, buried deep in the tropical rain-forests of New Guinea and northern Australia is still not known in detail.) For up to four months the female may ignore the male. She awaits stimuli from the environment that will herald the arrival of the appropriate season for reproduction, when the forest becomes rich with flying insects of the kind that she will catch and carry to her young. Only then will she exhibit the special *sign-stimulus* that will reflexly transfer the physical attentions of the male from the display-objects to herself. In brief, she now adopts a special crouching position. Then, and *only* then, mating occurs.

As for intelligence, the Satin Bower-bird has not enough sense to scratch aside a piece of bark to search for a hiding beetle that has run under it. The bird's selection and placement of decorations in its bower seem to be essentially mechanical. A species that habitually chooses blue and lemon-yellow never changes to, say, red and white, nor even, in fact, to very pale blue and gold.

Notes and News

CURATOR APPOINTED

Dr. J. C. Yaldwyn, who has been appointed Curator of Crustacea and Corals at the Australian Museum, was born and educated in New Zealand.

After graduating at the Victoria University at Wellington in 1950 he was employed for a period in the Department of Zoology of the University. Later, he joined the staff of the Dominion Museum, and he recently spent a year at the Allan Hancock Foundation, University of Southern California, Los Angeles, U.S.A.

Dr. Yaldwyn, whose principal interests lie with the Crustacea, has had a wide zoological experience and has taken part in several field expeditions, including the Chatham Island 1954 Expedition and the Cook Strait Deep Water Faunal Investigation.

IDENTITY OF BALER SHELL

In the article on Baler Shells published in the last issue of "Australian Natural History", a species from Moreton Bay, Queensland, was regarded as an unnamed form. The identity of this species has now been ascertained; it is *Melo georginae*, which was previously thought to have come from Western Australia. This information was obtained through the study of specimens in the British Museum by the Australian Museum's Curator of Molluscs, Dr. D. F. McMichael, who has recently returned from six months' study-leave in Europe.

VISITOR TO MUSEUM

Dr. Victor G. Springer, of the United States National Museum, Washington, visited the Australian Museum in March to examine types of sharks, parrot-fishes and blennies. By courtesy of the Anatomy Department, University of Sydney, he was able to obtain X-ray photographs of certain sharks in order to study their vertebrae.

DINGOES

By B. J. MARLOW

THE most primitive living family of placental flesh-eating mammals, or carnivores, is the Canidae, which includes dogs, wolves, jackals, foxes and several other aberrant dog-like genera. This family is widely distributed throughout all the main zoo-geographical regions of the world in a variety of habitats and climatic conditions. The only regions where indigenous wild dogs are lacking are the island of Madagascar and the Australian region, two areas which have a long history of isolation from the land masses of the rest of the world.

The Origin of the Dingo

Much controversy has raged concerning the origin of the dingo in Australia and this problem is not one that is easy to answer. Some of the earlier workers on Australian mammals maintained that the dingo was truly indigenous and cited the fossil evidence of the existence of the dingo in Pleistocene deposits in association with marsupials which are now extinct, such as the large herbivorous *Diprotodon* and the marsupial lion, *Thylacoleo*.

The mammal fauna of Australia is characterized by the relative scarcity of terrestrial placentals, since bats and rodents are the only representatives of this group and both are believed to have arrived here by adventitious means after the separation of Australia from the main land-mass of Asia during the Cretaceous. Apart from the dingo and introduced animals such as dogs, cats and foxes, there are no terrestrial carnivores in Australia either living or fossil, and thus there are no progenitors from which the dingo could have evolved indigenously.

Under these circumstances it is much more likely that the dingo is not native to Australia but was brought here as a domestic animal by the Aborigines and has since become feral.

The Relationship Of The Dingo To Other Canids

The origins of domestic animals are extremely difficult to determine due to the complex implications which are involved in the crossing of different races of animals and their transport by man to many parts of the world. This problem is particularly acute with regard to the domestic dog, and both the northern wolf and jackals or an admixture of the two have all been suggested as possible ancestors.

The head of an adult dingo.
Photo.—Howard Hughes.

Although some wolves and jackals may look superficially alike, an important difference exists in the teeth which enables these two groups to be distinguished readily. In the jackals, there is a horizontal ridge, called a cingulum, at the base of the outer surface of the first upper molar tooth, and this structure is absent in the wolves. Moreover, it is also absent in the domestic dogs and in the dingo as well. This absence of a cingulum in the domestic dog makes it unlikely that there has been much contribution from a jackal-like ancestor in its origin. On the other hand, Tate cites two examples of a jackal-like cingulum in the dentition of dingoes that he examined, but it would appear that this was an aberrant condition, since in general the teeth of dingoes conform to the wolf and dog-like type in their absence of a cingulum. The most likely ancestor of the dingo and other domestic

dogs of south-eastern Asia is the plains wolf of India (*Canis lupus pallipes*), which was made famous in the "Jungle Books" of Rudyard Kipling. Neither the Asiatic jackal (*Canis aureus*) nor the wild dog (*Cuon alpinus*), which are the only other possible ancestors, can be seriously considered in this light.

The Characteristics of Dingoes

Dingoes resemble the larger breeds of domestic dogs both in their external form and in the structure of their skulls. The only feature whereby the skulls of these two forms can be distinguished is in the relatively larger size, in the dingo, of the upper last premolar tooth.

The general body colour is normally a tawny yellow with a paler belly, while the feet and tail tip are often white. The tip of the muzzle varies from pink through brown or black, and the ears are always carried erect. Several colour varieties are known which may vary from black through reddish-yellow to white, and these abnormal colours have given rise to the erroneous idea that dingoes which are not of the normal reddish-yellow colour must be crosses with domestic dogs. It is probable that hybrids between dingoes and domestic dogs do occur, but they are not nearly as plentiful as is generally believed. Contrary to public opinion, dingo populations still exist which contain a high proportion of pure-bred animals. In view of the differences in behaviour and temperament between dingoes and domestic dogs, it is unlikely that crosses between these two forms occur with great frequency under natural conditions.

The Distribution of the Dingo

Dingoes are widely distributed over most of mainland Australia with the exception of central New South Wales and the mid-coastal region of Western Australia. They tend to be absent from the more highly developed regions of the continent. They have never occurred in Tasmania or New Guinea. In conjunction with its wide distribution, the dingo is found in a variety of habitats which include eucalyptus forest and woodland as well as the more open plains country. The latter comprises such associations as mallee, mulga and spinifex grassland, and it is in these habitats that dingoes are more common.

It has been suggested that the presence of dingoes on the Australian mainland caused the extinction there of the thylacine (*Thylacinus cynocephalus*) and "devil" (*Sarcophilus harrisi*), which are now found only in Tasmania.

The Biology of Dingoes

Like most other canids, dingoes are fast-running carnivores which hunt in packs and feed on medium to large sized mammals. They are at least partly diurnal, and normally live in small groups which consist of an adult male and female together with a varying number of yearling pups. The average litter, which is born in late winter or early spring consists of about five pups. In addition to small mammals such as rats, dingoes also feed largely on wallabies, kangaroos and rabbits. They are destroyed whenever possible by pastoralists because of their depredations on domestic stock, particularly sheep and calves. Unlike domestic dogs, dingoes do not bark, but rather utter

Typical dingo habitat on Cooper's Creek, South Australia.

Photo.—R. D. Mackay.

a series of mournful howls. Their sense organs are well developed, and smell, hearing and sight are all extremely acute.

Before the numbers of an animal can be successfully controlled, it is essential that the general biology of the species, and in particular its ecology, should be well understood. There is still much to be learnt concerning these aspects of the life of the dingo, and at the present time the Wildlife Survey Section of C.S.I.R.O. is engaged on a long-term study of the ecology of this animal.

Control Methods

Methods of dingo control may be divided into two categories—those such as poisoning and trapping, which kill the animal, and those such as the erection of fences, which prevent its access to specific areas.

Poisoning is normally carried out by aerial baiting, which involves the dropping of pieces of brisket fat, wrapped in cellophane, each containing a pellet of strychnine. This method is very costly, and its results are difficult to assess. It has the advantage that it is possible to tackle dingoes in rugged country where overland travel is difficult. On the other hand, the widespread use of poison is a very unselective method of dealing with a particular pest species, and the grave risk of killing harmless native fauna, which should be protected, is very great indeed. Some graziers have suggested that national parks and reserves are breeding grounds for dingoes, and have advocated the use of aerial baiting over these areas. Such a practice would be most undesirable, since many native carnivorous mammals and birds would also possibly be destroyed.

Large numbers of dingoes are killed either by trapping or shooting, often by professional "doggers", and a bounty is paid on their scalps. The younger animals are easy to obtain in this way. Dingoes can be whistled or squeaked within range of gunshot in a similar manner to that used for foxes. Some of the older dogs, on the other hand, become very wary and are often difficult to kill. If such an animal becomes established in a particular district it may do a great deal of damage to stock and a special bounty may be declared for its scalp.

Doubts have been expressed concerning the efficacy of a bounty system for the destruction of pest species, since the system becomes liable to malpractices. Moreover, the bounty system induces people to kill pests only at a time when they are easy to obtain. Once the population density has dropped below a certain level, the labour involved no longer justifies the reward, and the resultant slackening of effort allows the pest to achieve its former numbers.

Large sums of money have been spent in Australia in the erection of dog-proof fences which restrict the entry of dingoes into areas where they are relatively scarce. Such a fence exists along the western part of the border between New South Wales and Queensland. The mammal faunas on either side of the fence are quite distinct. In the south, there are many red kangaroos and foxes and relatively few dingoes and rabbits. On the northern side of the fence, red kangaroos are uncommon and foxes are practically absent, but dingoes are common and rabbits are present in prodigious numbers. The ecological factors in this situation may be complicated by a change of vegetation in this region from the gibber desert of northern New South Wales to the mulga of southern Queensland.

An ecological study of these transition areas would help to elucidate the complex inter-relationships of the pest species involved. Thus, it might be found that dingoes replace foxes in a given area, and yet are less efficient in reducing the numbers of rabbits.

Barriers in the form of fences against pests can thus be an efficient method of control, but they should be considered as temporary measures only, rather than the final answer to the problem.

It cannot be over-emphasised that the secret of the control of the density of animal populations, both in conservation and destruction, lies in a sound and thorough knowledge of the ecology of the species in question. This point is well illustrated by this feral domestic dog, *Canis familiaris dingo*, which is well adapted to the rigorous environment into which it was introduced. In spite of the fact that it is persecuted and destroyed by humans everywhere, it continues to persist in adequate numbers over most of its range and much intensive study of its ecology will be needed before adequate control measures can be devised to limit its numbers.

Life Histories of Two Australian Insects

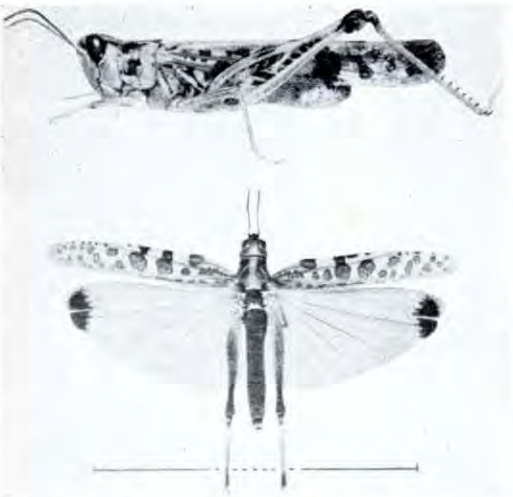
By DAVID K. McALPINE

IT is the purpose of this article to explain the transformations which typical insects undergo during their lifetime and to suggest how the student may observe these developmental stages. For this purpose, two well-known Australian species have been chosen as illustrations—the Australian Plague Locust and the Macleay's Swallowtail Butterfly.

The Australian Plague Locust

The Australian Plague Locust (*Chortoicetes terminifera*) is a common species through most of the Australian mainland and is sometimes found in Tasmania. The term "locust" is often incorrectly applied to the large, tree-living cicadas in Australia, but it is now considered that it should be used only for those kinds of grasshoppers which develop swarming populations, following conditions suitable for their rapid multiplication. The Australian Plague Locust develops these swarms at times in many areas west of the Great Dividing Range, but, except in the Hunter Valley, swarms do not develop in coastal districts, though the insects may be common.

A fully grown example of this locust measures up to about 1 in. in body length. The wings are well developed and, when folded, extend well beyond the tip of the body. The hind legs are much longer and stronger than the front and middle pairs of legs and are used for hopping. The colouring is light-brown or green, with darker-brown markings which form conspicuous blotches on the fore-wings. The antennae or "feelers" are short and thick compared with those of some other grasshoppers, for the Plague Locust is one of the many species of Short-horn Grasshoppers. Important characteristics for distinguishing this species from other grasshoppers of similar appearance are: (1) The hind wings are clear, but with a conspicuous blackish spot at the tip; (2) The tibiae or "shanks" of the hind legs are red fading to cream towards the base, with only one small brown mark at the extreme base. These points apply only to adult locusts and cannot be used for distinguishing the young stages.



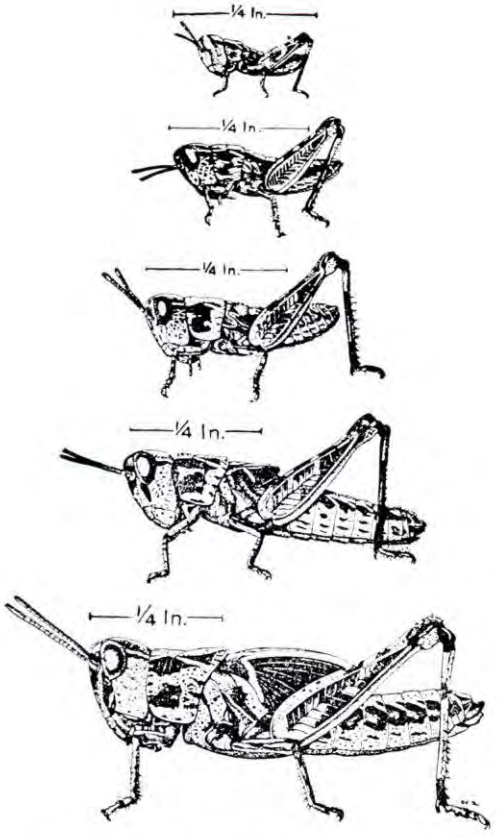
Adults of the Australian Plague Locust (*Chotoicetes terminifera*): male (above), female (below).
—After K. H. L. Key.

The female locust lays its eggs in an excavation in the soil made with the abdomen. The insect remains on the surface of the soil and uses the hard valves at the end of the abdomen to bore into the ground. The abdomen is extended to several times its normal length during the process. The eggs, which are laid in clusters of 30 to 40, are about one-sixth of an inch in length, narrow, and shaped like bananas.

The young locusts which hatch from the eggs, though at first very pale, soon acquire the blackish-brown colouring characteristic of all the immature stages. There is no trace of wings in these very young individuals, which otherwise resemble the adults in appearance.

After feeding for some time on grass and other herbage the hopper grows so much that its cuticle or "skin" become distended,

for it cannot grow at the same pace as the insect. At this stage the cuticle splits open and is shed completely. The locust which emerges from the old cuticle has a new, loose-fitting cuticle with room for further growth. Now the wings are visible on each side of the body as two pairs of small pads. The wings in these immature stages are mere useless rudiments or buds. After another



The five nymph or hopper stages of the Australian Plague Locust, showing the development of the "wing-buds."

—After Swan.

period of feeding and growth the cuticle is moulted once more. After each successive moult the wings become larger in proportion to the rest of the insect. There are five of these immature stages or instars, as they are called, before the insect becomes mature. The locust is called a nymph during these five stages, as contrasted with the adult, or imago. The term "hopper" is often also applied to the immature flightless stages of grasshoppers.

At the end of the fifth instar the cuticle splits for the last time and the adult crawls out. At first the wings are small and folded, but they rapidly expand to their full size. The wings are still too soft for use, but on exposure to the air they become hard and dry. If undisturbed the locust remains motionless during this hardening period, after which it is capable of normal activity, including flight.

The period from the hatching of one generation to the hatching of the next is 10 to 12 weeks during the warmer months of the year. Eggs laid in the autumn generally do not hatch until September or October. Those laid in summer may hatch within two weeks if the soil is suitably damp.

The Macleay's Swallowtail Butterfly

The Macleay's Swallowtail (*Papilio macleayanus*) is one of the most widely distributed of the Swallowtail Butterflies in Australia, as it extends from the Atherton Tableland in North Queensland to Tasmania and Lord Howe Island. It does not occur outside Australia.

The butterfly is most often seen in hilly or mountainous country, where it may be caught when attracted to the flowers of lantana or blackberries. Its food consists of the nectar of these and other flowers for, like all butterflies, it can take only liquid food. The insect measures up to 3 in. across the outstretched wings. The colouring consists of black and varying tones of green on the upper-side of the wings with, in addition, brown and a little red on the under-side. Each hind wing is produced into a tail-like appendage. The male differs from the female in having a patch of very long, fine, greyish hairs near the hind border of the hind wing.

Eggs are laid singly on the young leaves of certain plants. The small, round, pale-greenish egg is less than one-tenth of an inch in diameter. The young insect which hatches from the egg is totally unlike the parent, in sharp contrast to the young nymph of the locust described above. It is called a larva or caterpillar and is a very small, blackish, grub-like creature with the body slightly swollen or humped at the front end. There are three pairs of hard, claw-like legs near

Egg, larvae, pupa and adults of Macleay's Swallowtail Butterfly. The egg is visible as a small round object on one of the upper leaves on the left.

—After Scott.

the front end and five pairs of soft stumpy legs, called prolegs, along the rest of the body. The prolegs have numerous very small hooks which enable them to cling to rough surfaces. These are too small to be seen clearly without a microscope, even in a fully grown larva. The surface of the larva has a number of conspicuous wart-like tubercles near each end which give rise to bunches of hairs. The head is harder than the rest of the body and has a pair of hard jaws or mandibles, one on each side of the mouth. Thus the larva, unlike the adult, can chew solid food. The food of the larva consists of the leaves of the plant on which the parent laid the egg. In the case of the Macleay's Swallowtail, this may be the introduced Camphor Laurel Tree or, in the bush, Brush Wilga (*Geijera salicifolia*) or *Drimys*, a native shrub related to *Magnolia*.

As the larva moves about it spins a fine web over the leaves and stems, which is produced by a silk gland just below the mouth. This web enables the larva to cling firmly to the smooth surface of the plant. When suddenly disturbed the larva protrudes a long, forked process, resembling a pair of dark-red tentacles, from a slit on the back just behind the head. This structure is called an osmeterium and is considered to produce an odour which deters enemies.

As the larva grows it moults its "skin" periodically in much the same way as the locust nymph. The appearance of the larva changes somewhat with each moult, as it loses the haired tubercles and becomes paler in colour. The fully grown larva is $1\frac{1}{4}$ in. long, green, usually with a yellowish stripe along each side, and nearly smooth.

After it has finished feeding, it spins a small pad of silk on the stem of the food plant and attaches itself to this by the hind pair of prolegs. Then it spins a strand of silk which encircles the middle of its body and fixes it in an upright position to the plant stem. The larva is now ready to enter the next stage of its life, the pupa. After some hours, or even days, in this position the larval skin splits and is moved down as a crumpled mass until it reaches the end of the abdomen, revealing the newly formed pupa. Finally, the tip of the abdomen is lifted momentarily from the pad, the old skin falls away and the pupa attaches itself by a new set of hooks. Sometimes pupation takes place on a leaf instead of a stem.

The green pupa is just under 1 in. long and nearly smooth, without obvious legs, antennae, wings, or eyes, but the mouldings of the cuticle encasing these developing parts may be seen on closer examination. There is a conspicuous, outwardly projecting spike at the head-end. The only movement of which the pupa is capable is a slight twitching of the abdomen. In spite of its outward inactivity, the pupa is undergoing great changes within, for the entire structure of the larva is breaking down and becoming reorganised as the adult structures are formed. When the process is complete the pupa becomes darker in colour and the wing pattern of the adult is visible through the encasing cuticle. Finally, the pupa splits open and the adult butterfly emerges. As with the locust, there is a quiescent period while the wings expand and harden, after which the mature insect takes to the wing.

In the warmer months the complete life cycle of this species lasts about two months. Near Sydney and southwards larvae which pupate in the autumn do not emerge as adults until the following October so that the life cycle is greatly extended over the winter.

The life cycle of such insects as butterflies is seen to consist of four stages—egg, larva, pupa, and adult. This complex series of changes is described as a complete metamorphosis. The locust is, on the other hand, an insect with incomplete metamorphosis, as its life consists of but three stages—egg, nymph, and adult. All the oldest groups of insects have an incomplete metamorphosis with a life history resembling that of the locust to a varying extent. In these forms the changes which the insect undergoes after hatching from the egg are comparatively slight and often consist of little more than the development of wings. The insects with complete metamorphosis, though still very ancient, appeared later than the other forms from which they undoubtedly evolved.

Insects In Captivity

Many kinds of insects may be reared and observed in captivity if adequate food of the right kind can be provided. A simple box with a wire gauze top is a suitable container for many of them. The box should allow plenty of space for newly emerged adults to

spread their wings, or deformation will result. Leaf-eating insects should be fed at least once a day on the kind of plant on which they were originally found, as some insects will not change easily from one food plant to another. Pupae should not be detached from their supports or removed from their cocoons, as this often prevents adults from emerging. Some insects pupate in the soil, and clean sand or sawdust should be provided for these. Numerous interesting and useful observations can be made, as there is a vast amount yet to be discovered about Australian insects—even the common ones. Accurate notes made on kind of food plant, locality of capture and dates of hatching, pupation and emergence of adults may be of considerable value later when viewed in the whole scheme of the biology of the species.

THE "CRAB'S EYE" SEED

By K. KENNEDY

Townsville, Queensland

When going through the Australian Aboriginal section of a museum one notices that some of the gum caps protecting the ends of North Queensland fire drills are decorated with what appear to be red beads, but are in reality seeds. The seeds are obtained from a bushy twiner botanically known as *Abrus precatorius*, fairly common on the tropic coast and adjacent islands. In the Townsville district, the seed is known as "Crab's Eye" because of its bright red colour and black spot. The plant is not confined to Northern Australia, for it grows in several tropical regions, and in South America, where it is said to have been introduced, it is called jequirity. The specific name *precatorius* was given by Linneus because the seeds were once used in some of the church missions to make rosaries. They are exceptionally hard, and to bore holes in them must have taken a considerable amount of perserverance.

Being a legume-bearing plant, *A. precatorius* belongs to the order Leguminoseae, one of the largest orders of the botanical world. This order is divided into three families: Mimosaceae, to which belong the wattles; Caesalpiniaceae, to which belong the bauhinias and cassias, and Papilionaceae, which comprises the butterfly-like flower group. It is the latter family to which *A. precatorius* belongs; it has such varied company as the giant forest tree the Black Bean (*Castanospermum australe*), and lowly herbs a few inches high.

As it is a twiner it needs something to twine around or rest on, such as rocks or shrubs, and, although sometimes growing to a length of 15 feet, it is often contracted and resembles a bush. The inflorescence is a small raceme about 1 in. in length, and the very small flowers are a light pink. What gives the plant its distinctive appearance is the legume, which, when ripe, splits open and reveals the glossy red seeds, each with its black spot where it is attached to the placenta. The seeds are said to be poisonous, but, as they are conspicuous, they evidently are meant to attract some animal that eats them. What eats them must be immune to their poison and have very strong digestive powers, because of their hardness.

Like that of the wattles, the testa, or outer covering of the seed, is too hard to allow the embryo to germinate in the ordinary manner, so the seed must lie in the ground until a grass fire or bush fire passes over. This cracks the testa and the seed can sprout. The writer has germinated seeds by placing them in a tin container and pouring boiling water over them. The hot water cracks the testa, and then the tin absorbs the heat, which prevents the embryo being killed. If left in the water overnight the seeds can be planted the next day with a fair chance of success.

When not in flower or bearing legumes *A. precatorius* can be identified by its pinnate leaves, which have an odd leaflet at the end. This kind of leaf is called impari-pinnate, meaning unequally pinnate.

In his "Native Tribes of Northern Australia", Baldwin Spencer mentions that on Melville and Bathurst Islands very decorative ornaments were made out of masses of beeswax studded with *Abrus* seeds. The ornament consisted of a central mass of beeswax, moulded by hand to the desired shape, and the seeds were then pressed in.

W. E. Roth, in his North Queensland Ethnography Bulletin 9, wrote that ornaments constructed of gum-cement studded with *Abrus* seeds were worn by the relatives of a dead man among natives of the Middle Palmer River as a reminder that the deceased had to be avenged. The ornaments were club-shaped, about 6 in. long, with the handle covered with soft yellow fur, and with a string for suspension. The seeds were pressed into the gum and their red colour was an emblem of mourning and vengeance.

The Australian Museum

The Museum is open free, daily, at the following times : Tuesday to Saturday, and public holidays, 10 a.m. to 5 p.m.; Mondays, 12 noon to 5 p.m. (during school holidays 10 a.m. to 5 p.m.); Sundays, 2 to 5 p.m. It is closed on Good Friday and Christmas Day.

To students and pupils of schools and colleges special facilities for study will be afforded if the Director is previously advised of intended visits. A trained teacher is available for advice and assistance.

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The office is open from 9.30 a.m. to 1 p.m. and 2 to 4.30 p.m. (Monday to Friday), and visitors applying for information there will receive every attention from the Museum officials.

College St., Hyde Park, Sydney

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