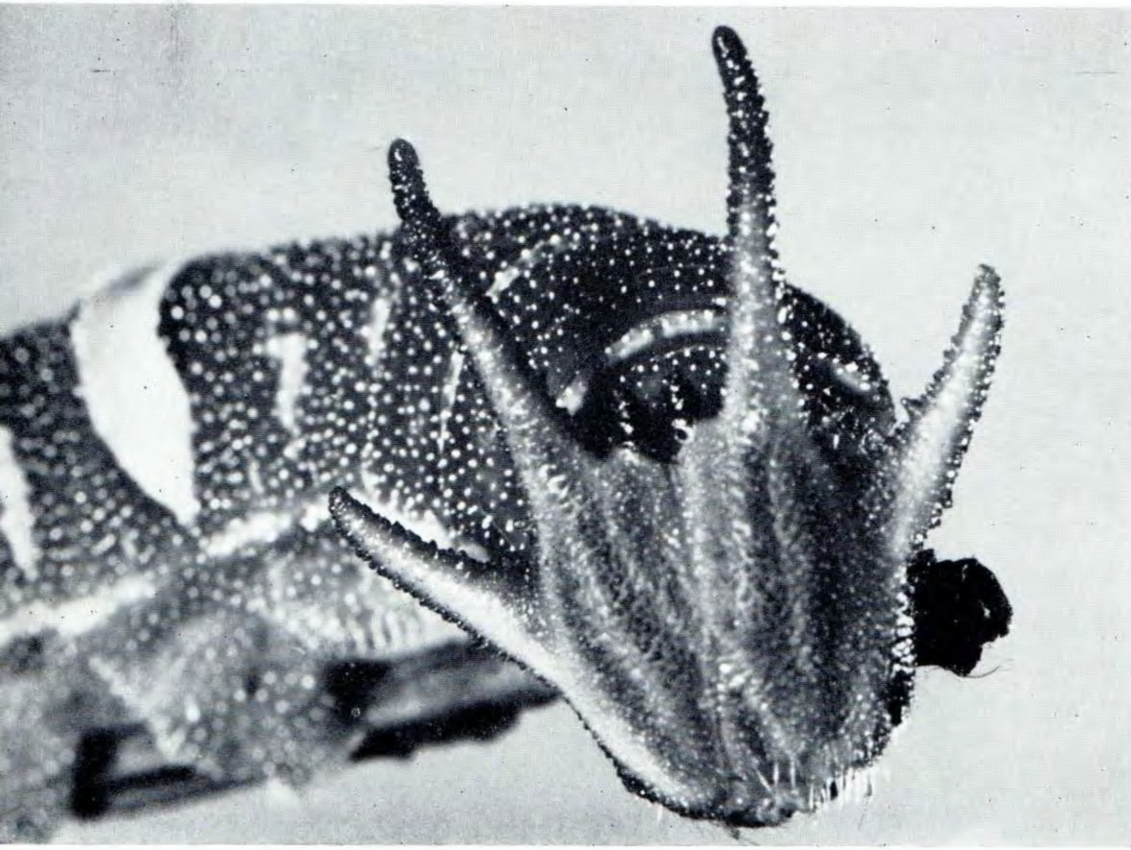
AUSTRALIAN NATURAL HISTORY



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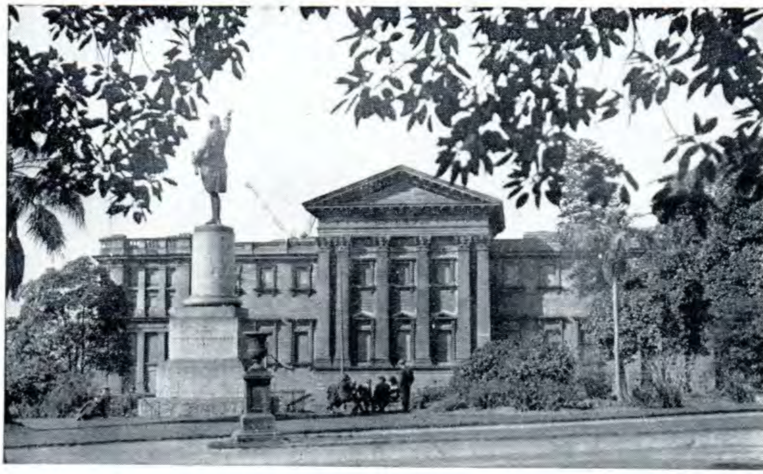

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(*Photography, unless otherwise stated, is by Howard Hughes.*)

● **FRONT COVER: Head of the caterpillar of the Tailed Emperor Butterfly** (*Eriboea pyrrhus sempronius*). **The "horns" do not appear to have any special function. The head is black in young caterpillars of this species and green in old ones. A full-length photo of this spectacular caterpillar is on page 192.**

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CUCKOOS

By H. J. de S. DISNEY

THE Order Cuculiformes contains two families, Musophagidae or Plantain-eaters confined to Africa, and the Cuculidae or Cuckoos with a world-wide distribution.

The Cuculidae are zygodactylous birds, in which the outer toe is reversible to the back. They have been divided into six subfamilies, the Cuculinae, Phaenicophaeinae, Crotophaginae, Neomorphinae, Couinae, and Centropodinae. Although members of some of the subfamilies are found in both the Old and New Worlds, there are no genera common to both.

Cuculinae are the true or parasitic cuckoos, which are not found in the New World.

Phaenicophaeinae are found in America and South-east Asia, with one species in Africa. They differ from the Cuculinae by making their own nests, which are usually flimsy structures made of twigs.

Crotophaginae or Anis and Guiras are a small American group which build large untidy stick nests. In the case of the Ani (*Crotophaga ani*) several females lay their eggs together in the one nest.

Neomorphinae, Roadrunners and Ground Cuckoos. These include the famous Californian Roadrunner, (*Geococcyx californianus*), which although it usually runs, can fly and makes its nest in a low tree.

Couinae. This subfamily is close to the Phaenicophaeinae, but is confined to the island of Madagascar.

Centropodinae. These are tropical birds found from Africa through south-east Asia to Australia.

Fourteen Species In Australia

In Australia we have fourteen species of cuckoos; thirteen of these belong to the parasitic Cuculinae. The remaining species, the Pheasant Coucal (*Centropus phasianus*) belongs to the Centropodinae. None of our species actually make the cuckoo call like the European Cuckoo (*Cuculus canorus*) but the Koel (*Eudynamis orientalis*) has a distintive "coo-ee" call and is sometimes called the Coo-ee Bird.

Cuckoos are mainly tropical and nearly all are migratory, although some of the Australian species do not appear to move

The Channel-billed Cuckoo, the largest parasitic cuckoo, is a migrant to Australia from the Malayan Archipelago. (Length, 24 in.).

very long distances. The Channel-billed Cuckoo (*Scythrops novae-hollandiae*) winters in the Malayan Archipelago, returning to breed in Australia in the summer months. The Pallid Cuckoo (*Cuculus pallidus*) comes south in August from the north to breed. The Oriental Cuckoo (*Cuculus saturatus*) on the other hand, is only a visitor in summer from the northern hemisphere winter, where it occurs as far north as Siberia. The European Cuckoo migrates to South Africa, while the Madagascar Lesser Cuckoo (*Cuculus poliocephalus*) migrates northwards to the African mainland after breeding. The Shining Bronze Cuckoo (*Chrysococcyx lucidus*), which breeds in New Zealand, has been recorded occasionally in eastern Australia, but its winter quarters are the Solomon Islands, a distance of about 2,000 miles of ocean, and only on Lord Howe and Norfolk Islands have a few stragglers been found. It is not known how the Shining Cuckoo does this amazing ocean journey or by what route.

The Australian Bronze Cuckoos were previously placed in the genus *Chalcites*, with the Black-eared Cuckoo (*Misocalius osculans*) in its own genus, but Dr. D. L. Serventy and H. M. Whittell ("Birds of Western Australia," 3rd edition, 1962) consider they all belong to the genus *Chrysococcyx*. This is the same genus as the Bronze or Didric Cuckoo (*C. caprius*) and Klaas' Cuckoo (*C. Klaas*) in Africa.

Insectivorous Birds Parasitized

In Australia the birds parasitized are all insectivorous; this may be because there are relatively few seed-eating birds in Australia. It has been stated that, as cuckoos are insectivorous, if their eggs were laid in nests of seed-eating birds the young would die. This, however, is not true for the Bronze Cuckoos. The Shining Cuckoo of New Zealand, although it generally lays its eggs in nests of the Grey Warbler (*Gerygone igata*), has been recorded using the nests of the introduced seed-eaters, the House Sparrow (*Passer domesticus*) and the Chaffinch (*Frigilla caelebs*). The Bronze or Didric Cuckoo and Klaas' Cuckoo of Africa regularly use the nests of weaver birds and other seed-eating birds, besides insect-eating birds. Weavers either feed their young entirely on insects, although they themselves are feeding on seed, or they feed their young for the first five days on insects, as in the case of the Sudan Dioch (*Quelea quelea*), and gradually wean the young onto green grass seeds. When in Northern Rhodesia in 1956 with Mr. C. W. Benson and Dr. D. L. Serventy I shot a young female Didric Cuckoo, which had recently left the nest. On examination, the stomach was found to be filled with grass seeds and a few hard parts of beetles. There were several weavers in the area, but none were seen attending the young bird. An adult Didric was seen nearby. Benson and Serventy reported this occurrence in "The Ibis," Vol. 99 p. 343, 1956. It is known that, unlike other parasitic cuckoos, the Bronze Cuckoos, both of Africa and New Zealand, may feed their own young after they have left their foster parents. I think the most likely explanation of the emergence of this habit is, as suggested independently by both Dr. A. J. Marshall and Mr. R. E. Moreau and stated in the above report, that response to a young cuckoo is vestigial in the adults of the Bronze Cuckoo and that it may have survival value where the young has been receiving seed.

All the parasitic cuckoos show definite preferences for particular species of birds and types of nests to deposit their eggs. The Pallid Cuckoo arrives in spring and lays its eggs in cup-shaped nests, usually honeyeaters'. The eggs closely resemble those of the honeyeaters in colour, being a pale flesh colour, marked with a few reddish spots. The Fan-tailed Cuckoo (*Cacomantis pyrrophanus*) seems to prefer domed nests and in particular in the Sydney distict the Rock Warbler's (*Origma solitaria*). The Brush or Square-tailed Cuckoo (*Cacomantis variolosus*), although very similar in appearance to the Fan-tailed Cuckoo and belonging to the same genus, prefers to lay in open nests, usually flycatchers', such as the Rufous Fantail (*Rhiphidura rufifrons*), and the Scarlet Robin (*Petroica multicolor*). All the species of Bronze Cuckoos (*Chrysococcyx*), both in Australia and Africa, prefer to use as hosts small birds which build domed nests—in Australia usually nests of warblers and thornbills and in Africa weaver nests, such as the Sudan Diochs, and I have several times seen them round the large colonies of the latter birds.

The Koel is unique among cuckoos for the very great difference in colour of the

The male Koel or Coo-ee Bird, which has glossy, blue-black plumage. (Length, 18 in.).

plumage of the male and female. The male is glossy blue-black, while the female has the upper parts and tail brown barred with white. The crown is black and the under parts are buffy-white barred with brown. This is a large cuckoo, much larger than the previous species, being about 18 in. long, including the tail. This cuckoo usually places its eggs in the nests of orioles and the larger honeyeaters, like the Friar Birds (*Philemon spp.*)

Largest Parasitic Cuckoo

The Channel-billed Cuckoo is also a remarkable cuckoo, and at a first glance appears very similar to some of the African hornbills, due to its large bill and size. It is the largest parasitic cuckoo, being 24 in. long. It lays its eggs in the nests of crows, magpies, and currawongs. Several eggs are laid in the one nest and some of the host's eggs removed. Like the Great Spotted Cuckoo (*Clamator glandarius*), found in southern Europe and Africa, which also lays its eggs in crows' nests, the young do not throw out the eggs or young of the foster parents; both sets of young are brought up together. This is presumably because the foster parents are nearly as large as, or larger than, these cuckoos, and they have no difficulty in feeding the whole brood, while in the other cases the foster parents are very much smaller.

There is much evidence to show that each breeding season the female cuckoo returns to the same area to breed. Although this may not yet have been proved by banding, many other birds have been proved by banding to return after long and complicated migrations to the same place and also by the same routes. After the female arrives she keeps a watch on intended foster parents and appears to find their nests this way, rather than by random searching. The female waits until the nest and clutch are ready before she lays her egg. If the nest and clutch are ready before she is ready to lay her egg, she may remove the eggs so that the host bird will continue to lay, or she may destroy the nest completely so that it has to be built again. When she lays an egg, she usually removes one of the owner's eggs. The cuckoo egg usually hatches first; the young cuckoo has a sensitive cavity on its back and, should anything touch this area,

New Subscription Arrangements

As from July 1, 1963, payments by post for subscriptions to "Australian Natural History" should be addressed to the Government Printer, Harris Street, Ultimo, Sydney, who prints this magazine, instead of to the Australian Museum.

This new arrangement is to facilitate handling of subscriptions, and will not, of course, result in any change to the magazine.

Visitors to the Museum will still be able to take out subscriptions there, and single copies of the magazine, both current and "back" numbers, will continue to be sold there.

it immediately tries to throw it out of the nest. A young European Cuckoo was seen to throw out all the young from a Redstarts' (*Phoenicurus phoenicurus*) nest, while the mother foster parent still brooded. After four days in the case of the European Cuckoo this sensitivity is lost and objects dropped on its back are no longer thrown out. In some cases the foster parents will not accept the cuckoo's egg and throw it out or even build it into the lining of the nest or abandon the nest altogether.

In general cuckoos' eggs resemble those of the main foster parent of the area, both in size and colour. The Black-eared Cuckoo (*Chrysococcyx osculans*) usually lays in the nest of the Speckled Warbler (*Chthonicola sagittata*). The eggs of both are a similar reddish-brown, but the cuckoo's egg is usually slightly larger and can be further distinguished from the warbler's egg by the fact that when it is rubbed some of the red colour comes off.

Laying Of Eggs

If the host nest is cup-shaped the female cuckoo lays directly in it, and if it has a side entrance the bird seems able to eject its egg into the nest. The old idea was that where the nest was domed or had a difficult

The Golden-bronze Cuckoo, which, like most Bronze Cuckoos, usually lays its egg in a domed nest, such as that of a thornbill or wren. (Length, 6 in.).

entrance the cuckoo laid her egg on the ground and carried it in her bill to the chosen nest. This has in fact never been observed and it is significant that when the cuckoo lays in a nest with a side entrance she is not always successful. If the egg should fall to the ground or rest on the edge of the nest, she makes no attempt to pick it up with her bill and put it into the nest. There is no difficulty for the small Bronze Cuckoos to enter weaver birds' nests in the same way as their owners. The Shining Cuckoo can push its way into the Grey Warbler's nest. Thus, unless the cuckoo can lay directly in the nest of a bird, that bird will not be parasitized.

It is well known that all cuckoos, both New and Old World, feed on insects, particularly hairy caterpillars and other obnoxious insects, which few other birds will eat. If the stomach of a cuckoo is examined, it appears to be lined with fur, but this fur is really the hairs from the caterpillars. The stomach of a Great Spotted Cuckoo I examined in Africa had several grasshoppers of the species *Zonocerus elegans*. These grasshoppers are fairly brightly coloured with what might be termed "warning" colours. They are evil smelling and tasting and few other creatures will touch them.

The Centropodinae or coucals can be separated from the other cuckoos by having a straight, lark-like claw to the inner hind toe. They are sometimes put into a separate family, but they are connected to the true cuckoos, which have a curved hind claw, by the African species *Ceuthmochares areus,* in which the hind claw is also curved.

The coucals are all fairly large birds, and the Australian Swamp Pheasant is one of the largest of the genus; it is nearly as large as the Channel-billed Cuckoo, being 23 in. long. It will eat more or less any animal food it can catch, such as mice, frogs, small reptiles and insects, also the eggs and young of birds.

The nest is a large round structure in tall grass, made by pulling the tops of the grass together. Mr. A. H. Chisholm recently reported in "The Emu" (Vol. 62, p. 197, Oct., 1962) that Mr. Bravery, of Atherton, Queensland, had informed him that if Swamp Coucals nested in a canefield and the nest was disturbed or likely to be cut down, the parent birds quickly made a nest in another part of the canefield and apparently transferred the eggs or young to the new nest. A coucal was seen carrying an egg in its beak. The White-browed Coucal (*C. superciliosus*) of Africa has also been reported transporting its young between its thighs like a Woodcock (*Scolopax rusticola*) when menaced by a forest fire or other danger.

An Aboriginal hunter preparing a kangaroo for cooking. The stones, ashes and sand with which the carcass will be covered are being heated in the fire behind him. An oven pit will be dug in the fireplace. [Photo: Author.]

Kangaroos and Wallabies in Aboriginal Life and Art

By FREDERICK D. McCARTHY

As the kangaroos (and some of the wallabies) are the biggest land mammals in Australia, they supplied the largest quantity of meat to Aboriginal hunters throughout the continent. One of the principal duties of the men was to obtain meat for their families and these animals became their principal game, the target of the magician's skill, the theme of camp-fire corroborees, and a subject of the deepest significance in legend, ritual and art. Quite appropriately, the kangaroo is paired with the emu on the Australian coat of arms.

There are three species of kangaroos—the Great Grey or Forester in the east and south-west, the Red or Plainie in the interior, and the Euro or Wallaroo, widely distributed but not all over the continent. In addition, there are two species of tree kangaroos in north Queensland, and in various parts of the continent about four species of rat kangaroos and over twenty of wallabies. The men of any local group or horde of Aborigines, comprising from thirty to forty persons, would be able to hunt one or two species of kangaroos, and from three to eight kinds of wallabies, in their own territory, depending upon the environment, there being more species of wallabies in the fertile eastern regions than elsewhere. Giant kangaroos were hunted by the ancestors of the Aborigines, but it is not known precisely how long ago these animals became extinct.

Methods Of Hunting

Kangaroos are often stalked while resting or sleeping in the shade of a tree during the heat of the mid-day. In the open plain and undulating country of the inland, a family will stalk a kangaroo, the wife signalling the movements of the animal to her husband. This is a gruelling experience for the hunter, who has to pursue the animal until it is exhausted, particularly in a hot summer temperature of over 100 degrees. In droughts and times of food shortage his success or failure is of vital importance to his family. After rain kangaroos are run down in the soft ground with the aid of dogs. It is common for a group of hunters to go out, led by their most skilful spearman, and when kangaroos are sighted several of the younger men act as beaters to drive them to a spot where the leader can spear one or two of them. Sign-language for quietness, and skilful co-operation, make this a highly successful method of hunting. Sometimes the men, women and children of a local group surround kangaroos or brush wallabies in a thicket, finally driving them into the spearmen's range. Burning-off was a common practice all over Australia, a co-operative effort of local group members who, in the sub-tropical north, burnt out areas of the tall wet-season grass, and elsewhere patches of scrub, killing the terrified animals as they attempted to escape.

Pit traps are widely employed. In some inland areas spikes are set in the bottom of the pit. Frequently a log is placed across a track to force the game to leap over it into the pit. Brush fences are erected along both sides of a track to guide the animals into the pit trap, and some keen hunters construct a zigzag line of fence with a pit at each apex. The fence, too, may be erected around a waterhole, with two openings, through one of which the kangaroo enters to drink; the hunters chase it into the other one, where it is caught in a net. In Queensland conical cane traps are set behind openings in the base of a bough fence, and the brush wallabies are trapped in them as they dart through the holes to evade the pursuing hunters. Wallabies are speared or killed with a throwing club.

In place of the fence the natives of the tablelands and plains of Queensland and New South Wales made a stout net (no longer in use) out of plant-fibre cord, $\frac{3}{8}$ in. thick, fashioned into a mesh of 12 in. by 9 in. These nets, 6 ft. to 7 ft. high, formed an open-sided barrier up to 120 ft. long. The ends were fastened to trees, and the nets supported by poles in between. They were erected across narrow ravines, tracks used by the game, breaks in the forest and similar places where kangaroos could be driven into them and killed with spear or club.

How Many Kangaroos Were Killed?

It is interesting to speculate about the numbers of kangaroos killed by the Aborigines. It is certain that they were, in pre-white-man times, scarce in the arid regions and abundant in the more fertile areas, the only restrictions on their increase being Aboriginal man, dingoes, droughts and fires.

A cave painting of hunters spearing a kangaroo. Note how the hunter, spear and kangaroo are joined together.

An "X-ray" cave painting at Oenpelli, western Arnhem Land, Northern Territory, of a dead kangaroo, showing the vertebral column and stomach organs, painted in red on a white ground. [Photo: Author.]

There were 600-odd Aboriginal tribes, comprising about 8,000 local groups, in Australia, of which one-third were coastal and estuarine dwellers whose principal food was fish and molluscs and for whom the hunting of kangaroos was not a daily task. In the other 400 tribes, the local groups living in the fertile areas would probably kill from six to eight kangaroos a week, and those in the arid regions from three to four. Thus, taking an average of five per week for 6,000 hordes, the number of kangaroos killed would have been in the vicinity of 30,000 per week, or 156,000 per annum, to which the 2,000 fishing hordes at two per week would add another 20,000 per annum. A similar figure is arrived at based on six kangaroos a week killed by ten people, as I witnessed in western Arnhem Land, relative to a total population of 300,000 Aborigines. With this kind of control eliminated, the dingo removed from vast areas of country, and better sources of water provided by pastoralists, it is probable that kangaroos have increased in numbers in post-white-man times.

Cooking And Sharing

The hunters carry the game back to camp, where the women have the firewood ready, or to a spot on the open plain where the group will camp or have its meal. In Arnhem Land it is an honour for the spearman, who is given a special status term in recognition of his skill, to carry his quarry, even though it may be a fully-grown buck, into the camp, where he prepares it for the oven. Other men may assist him. Sometimes the animal is cut into joints which are all cooked in the one oven. Usually, the fur is burnt off over a big fire. The entrails are baked, and with strings of fat and lumps of undigested grass from the stomach, are eaten while the carcass is cooking. The carcass is dumped on its back into the pit, and buried in the hot sand, ashes and stones scraped out of the oven pit, the body cavity being filled with hot stones. These ovens are covered with paperbark and soil in Arnhem Land.

Various parts of the body are given to parents, parents- and brothers-in law, hunting companions and other men, either before or after the animal is cooked. This compulsory sharing of kangaroos, irrespective of who was the spearman, and other food, is jealously administered in a local group, and evasions are punished severely. Sharing varies from the spearman losing the whole animal (in south-western Victorian tribes) to giving specific joints to certain relatives, and in some areas every family in the group receives a share. Shortage or abundance of food affects the proportionate shares. Another type of discipline was that of the Wotjobaluk tribe in Victoria, which forbade boys to eat kangaroo and other foods, in the firm belief that they would become sick if they broke this rule.

Other Uses For Kangaroos

All over Australia, the long sinews from the tail of the kangaroo provided bindings on spears and spearthrowers, the fur was twisted into an excellent twine, and the incisor teeth were fashioned into attractive necklets, forehead bands and other ornaments. Warm winter cloaks were made out of the whole skin in the southern temperate portion of the continent. In the eastern half of Australia the skin was sewn up, and the orinces sealed, to form a water bag, and in south-eastern Victoria the pouch was used for this purpose. In New South Wales and Victoria a rectangle of the furry skin was cut into a fringed pubic apron. The leg bones were commonly used as death pointers and awls, in Queensland as drills, and in the Kimberleys as pressure-flaking tools for the making of stone spear-points. The lower jaw incisor tooth formed a ready-made cutting and engraving tool. In Arnhem Land the shoulder blade is fashioned into a knife for slicing Macrozamia nuts.

Ritual

The Aborigines classify kangaroos and wallabies according to sex, size, colour, habitat and age as totems of clans and other social groups, examples being hill, female, rock, red, black, small and long-legged kangaroos. The kangaroo, because of its great economic value, is usually one of the most important totems among the hunting tribes, but the Kariera and other tribes of north-western Australia did not have a kangaroo totem. Although the eating of a totem animal or plant may be strictly forbidden or permitted only as a ritual by some tribes, in others it may be eaten at any time, exception sometimes being made in the case of a staple food. A representation of the totem is painted on a clansman's body during ceremonies, painted or engraved on his weapons to give them magical efficacy or in the rocks beside a waterhole, and the totem is represented in the sacred art galleries.

Few of the folk-lore tales about the long legs and tail and the hopping action of kangaroos have been collected. The Wiradjuri of New South Wales believe that the tail is a spear thrown into the buttocks of a man during a quarrel in mythical times. The Aranda kangaroo clansmen in central Australia relate that a party of kangaroo spirit men travelled from Ultainta to Karinga in the Dreamtime. One called Unburtja died but his spirit survived in a sacred stone, the *tjuringa*, and it is re-born in members of the clan generation after generation. In north and central Australia, and along the east coast, ceremonies were performed by the men of the cult-clans to increase the numbers of the totem animals and plants symbolically by clearing out holes, distributing dust, water and other things at the totem centres, or by retouching cave paintings (in the Kimberleys) accompanied by the singing of sacred chants, the perfomance of imitative dances and other rites. The Aranda clansmen pour blood from their arms over the sacred kangaroo rock at Undiara, and elaborately decorated men sing and dance about

A cave painting in red of a kangaroo in an unusually animated pose, at Oenpelli. [Photo: Author.]

the kangaroo and its mythical ancestors for several days, during which they eat a ritual meal of its flesh. At the famous ochre mine at Wilgamia, Western Australia, the blood of a kangaroo speared on a nearby hill in mythical times produced the red, his liver the yellow, and his gall the green pigments. A popular corroboree around the campfire is the kangaroo hunt in which the men imitate very skilfully the hopping, sitting, scratching and other postures of the animals.

The Kangaroo In Art

The kangaroo and emu are among the most important and widely distributed art motifs of the Aborigines, and in some areas dominate the art. They are shown in profile as a rule, in sitting, crawling, leaping and other postures, occasionally eating grass, and as single figures or in lines and groups. They are often depicted struck with a spear, club or boomerang.

In the outline engravings of the Sydney-Hawkesbury district are many fine life-size compositions illustrating the kangaroo, hunters and the tracks of both, and in this area figures up to 24 ft. long of kangaroos occur. In the linear design phase of engraving the compositions consist of the tracks of the kangaroos, hunters and sometimes their dogs, or of the tracks of the animals beside a pothole. Among the later pecked intaglios many excellent engravings of kangaroos and wallabies, up to life-size but also in miniature, have been found in galleries in western New South Wales and north-western Australia. The pecked tracks are often very big, up to 2 ft. long and several inches wide and deep, enlarged to represent gigantic mythical kangaroos. Hunting compositions in this phase range from those limited to tracks, or tracks and the speared kangaroos, to those in which the hunter, kangaroo, weapon and tracks are included.

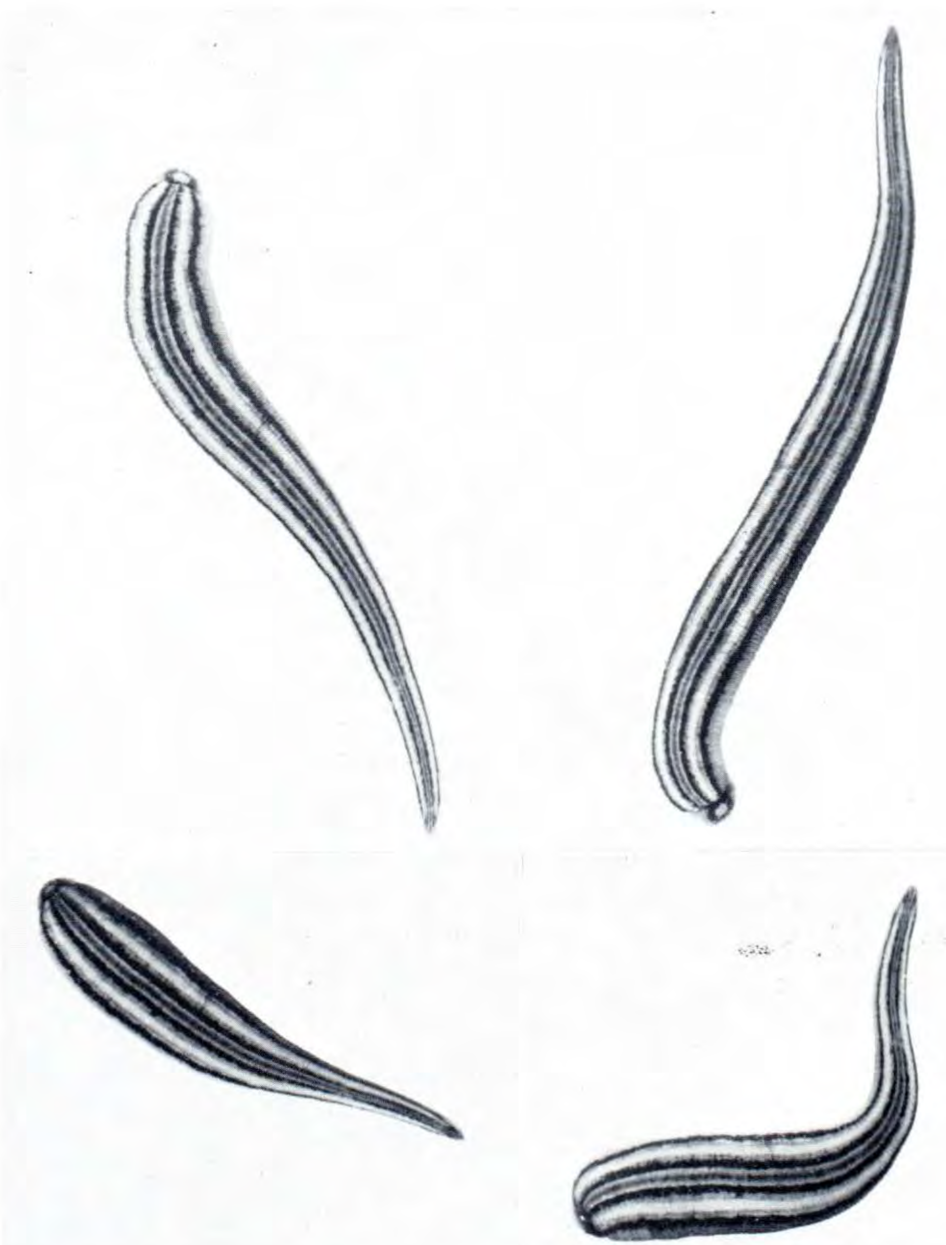
Aboriginal artists have produced their finest representations of kangaroos in the cave paintings. The dry pigment drawings of these animals, up to life-size, in eastern New South Wales, though somewhat stiff in style, possess a feeling of strength and bulk unusual in this subject. They are drawn in red or black, sometimes painted in red, yellow, white or black, mostly less than a foot long. They display a sensitivity in the postures, a realism in the groupings, and a keen appreciation of the anatomy not marred by the flat monochrome technique employed. In this area the hunting of kangaroos and emus, often depicted with the magicians performing a rite to render the animals easy to kill, forms the principal inspiration of the art. Another interesting style of representation occurs in the Groote and Chasm islands caves, where large-bodied, thin-legged kangaroos and wallabies, often lacking paws, but in many unusual and graceful postures, are painted in groups of considerable delicacy and animation. The magnificent X-ray figures portrayed in the caves and bark paintings of Arnhem Land are undoubtedly the most colourful and striking representations of these animals done by Aboriginal artists. On the bark sheets a kangaroo may represent a spirit man who has turned either into a kangaroo or into a painting, one is a kangaroo woman who plays a vital part in rain-making, and others are portrayed simply as animals of the countryside. These well shaped and posed kangaroos, painted in sets of fine red or black parallel lines over a white or yellow silhouette, form a striking contrast to the stiff, ill-proportioned animals portrayed in broken lines and dots by the Groote Eylandt artists where the totem and the legendary origin and travels of its clan ancestors give sanction to the cave and bark paintings.

Butterfly Tagging Programme

In an attempt to obtain an indication of the distances travelled by migrating butterflies in Australia a preliminary programme of observation, marking and release of specimens is being carried out by the Australian Museum with the co-operation of entomologists in several places in New South Wales.

The butterflies are marked by means of a small label attached to the underside of the hind wing, each label having the words "Return Museum Sydney" printed on it, together with a serial number. Of about 1,300 butterflies labelled and released so far, 16 have been returned, or reported found again. Eight of these were from one batch of 100 released at Turramurra, near Sydney. To date recaptures have all been close to the points of release, but they indicate that the techniques used are satisfactory and that the information on the label is sufficient to make certain that the specimens are returned to the Museum. So far most of the specimens marked have been Wanderers (*Danaus plexippus*), together with a few of the Lesser Wanderer (*D. chrysippus*) and some Caper Whites (*Anaphaeis java*).

Eventually it is hoped to extend the marking to other species and to mark in more localities.



These photos of a Common Freshwater Leech (*Limnobdella australis*), travelling by a series of looping movements, show its tremendous power of contraction and expansion. *Top left*: Anchored by the rounded posterior sucker (above), the narrow front end stretches out and attaches by another sucker, around the mouth, to the surface it is on. *Bottom left*: The posterior is then brought towards the head by a shortening and thickening motion of the rear end. *Bottom right*: With the posterior sucker now re-attached, the head end again reaches out, questing for a new place of attachment. *Top right*: The leech, now at maximum expansion, shows clearly one of the well-known colour patterns of this species—five dark brownish-black stripes on a background of creamy-yellow ochre. It was collected by a Museum field party at Lake Narran, near Brewarrina, western New South Wales.—E.C.P.

FOSSIL MARSUPIALS AND DRIFTING SANDS

By R. A. STIRTON

University of California, U.S.A.

MANY kinds of animals are restricted in their distribution to Australia, Tasmania and New Guinea. Most of these creatures are so different from those in other parts of the world that many questions have arisen concerning their origin, relationships and rates of evolution. These queries can be answered only when the fossil records of the groups are adequately known. It is obvious that most of the families, many of which are still living, have been isolated in the Australian Continental Region for not less than 70 million years, and some probably longer. Since 1953, the South Australian Museum and the University of California Museum of Paleontology have had six expeditions in the Tirari Desert to find fossils that would throw some light on these problems.

The Tirari Desert is a sand ridge country east of Lake Eyre and west of the Birdsville Track. In a north-south direction it lies between the Warburton River and the divide between Lake Eyre and the Frome Basins. As we have continued the excavations and the explorations, the results of each field trip have been more productive than the one that preceded it. The last one, from June to August, 1962, was no exception to this trend.

Our participation in this project has been at the invitation of the South Australian Museum. In the beginning the expeditions were primarily financed by Fulbright Awards, and the last three explorations by the United States National Science Foundation. Funds were also contributed by the South Australian Museum and by the Museum of Paleontology. The holotypes of the species described will be returned to Australia.

For many reasons, we have found it more profitable to include no more than five persons in our field parties. This past year there were four: Paul F. Lawson, of the South Australian Museum, and Richard H. Tedford, Michael O. Woodburne and the author, from the University of California. All were experienced prospectors and collectors of fossil vertebrates. Our work was greatly facilitated in having for the first time a McCormick International tractor for removing the overburden above the fossil-bearing beds. This machine was generously

Paul Lawson removes overburden at Lawson Quarry, while Richard H. Tedford collects fossils.

supplied by Mr. Vincent P. Keane, of Adelaide. It was furnished with a hydraulic back-acting hoe (back-acter) with a capacity of three-eights of a cubic yard. We also purchased a trailer to be pulled by the tractor.

The party left Adelaide early on the morning of June 18 in two Land Rovers, one pulling a trailer. The tractor and its trailer, six drums of fuel, our field gear and most of our provisions had been shipped to Marree by rail. We were thirty-four miles north of Adelaide before the morning light had broken to the extent that crows could be seen on posts and in paddocks along the highway. The countryside was green, but fruit orchards revealed the time of year in the southern hemisphere, with leaves fallen and left-over apples on the ground. Later large flocks of corellas, disturbed by the passing cars, arose noisily only to settle on the ground again and continue feeding. At Quorn the petrol station man told us there had been good rains farther north. Along the road to Hawker a flock of crows and a big Wedge-tailed Eagle circled away from the carcass of a Red Kangaroo that had been run into the night before by a car. 'Roos were common here nine years ago, but now they have been greatly depleted. Near Brachina Creek we saw the first live emu. To our right was the colourful blue Flinders Range showing a limb of the syncline that forms the spectacular Wilpena Pound. Nearer the highway the salt bush and open spaces over the rolling hills bore a remarkable resemblance to places in Wyoming and Colorado. Farther on a sandstorm, blowing out of Lake Torrens, crossed our path and thoroughly bathed us in dust for several miles. In the meantime a long coal train roared past on its way from Leigh Creek to Port Augusta. Soon, however, we were out of the wind and dust and everything was bright again. Camp was made for the night below the Aroona Dam, where a woolly euro came bouncing up the creek and was within 75 ft. of the cars before it took off up over a rocky slope in enormous leaps. As our fire splashed its light on the white trunks of the huge gum trees, the aroma of coffee and barbecuing lamb chops stimulated our anticipation of the evening meal. Later we contentedly zipped ourselves into our sleeping-bags and listened to the music of crickets and frogs. For a while I lay there watching a bright moon and even picked out the Southern Cross where its stars sparkled through the gum trees.

Next day we pushed on to Marree and arrived at noon. It was five o'clock before the tractor and our gear were off the flat car and the trailer was loaded. Then we were off up the Birdsville Track with Mike driving the tractor. Most of the time he made about twenty miles per hour. Next day we went by Lake Harry, across dry Clayton Creek, to Dulkaninna Station, past Blazes Well and at last reached Cannuwalkaninna Bore at noon. By 3.20 we had crossed a gibber plain and were eight miles to the north-west at our old camp site under the coolibah trees on the leeward side of Cannuwalkaninna Dune.

All of us were anxious to get to work in the Lawson Quarry where Dick Tedford and I had left a few fossil bones in place last year. Paul selected a slope with a reasonably modest incline and had little trouble driving the tractor over the big dune near camp. Dick, Mike and I followed in a Land Rover as Paul attempted to follow our old trail four miles across the desert to the escarpments along the west side of the Lake Palankarinna salt pan. The desert was in marked contrast to the dry, windblown condition so prevalent last year. Later we learned that there had been 6.2 in. of rain up to June. This was well above the average for an entire year in this area. The effect was apparent, with young plants popping through the sand everywhere. Even the bushes and coolibahs around camp had taken a new lease on life. Birds were singing everywhere and there were some species we had not seen before.

The discovery site of the Palankarinna fauna, known as the Woodard Quarry, was depleted in 1954. Then in 1957 another site, one-half mile to the north-east, was discovered which later was developed as the Lawson Quarry. The extinct macropodid kangaroo *Prionotemnus palankarinnicus* has been the dominant element in this fauna. We were particularly anxious to learn more about the other creatures in that environment, especially the large ground birds, diprotodonts called *Meniscolophus mawsoni* and the other smaller marsupials. With earth-moving equipment now at hand our possibilities were promising.

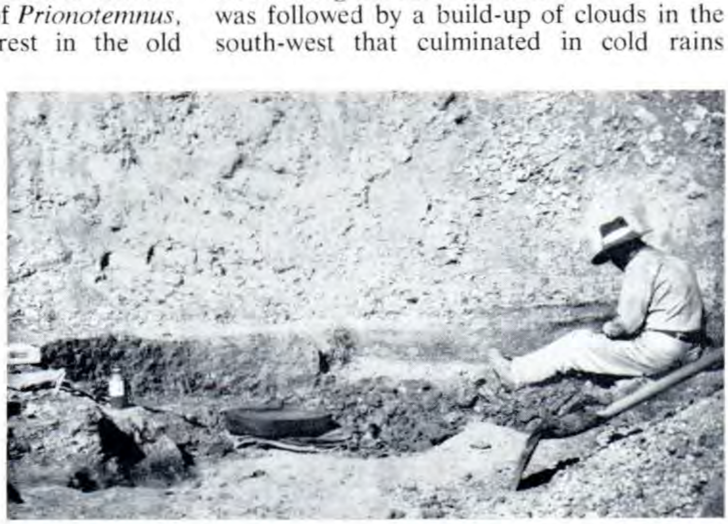
Last year was unusually dry, and consequently the quarry was full of windblown sand. Within a few hours this was cleared away with shovels, and the Mampuwordu channel sand relocated with its few exposed fossils. That was where we reluctantly stopped working last year. Paul inched the tractor up the slope and onto the floor of the quarry, where all fossils had been removed. Thus he was in a position to reach out with the back-acting hoe, cut through the tough, brick-red, argillaceous sand of the overlying Tirari formation without the weight of the machine on the fossil beds. In less than two days approximately 576 cubic feet of earth was moved out of the way and we were ready to locate and collect fossils.

Although a cold damp wind almost continuously swept across the lake for the next five days, we stuck tenaciously to our job. At times there was so much sand whipping and swirling through the quarry that our work stopped as we protected our eyes. When the wind subsided and the temperature ameliorated, bush flies moved in, truly making their annoying presence felt by crawling over our faces and even behind our glasses.

The Mampuwordu sand matrix was readily scratched away, but the bones and teeth were usually partly incased in sheet gypsum, requiring time, patience and skill to remove them. Jaws and limb-bones of *Prionotemnus*, where they had come to rest in the old stream channel several million years ago, continued to appear in abundance. Fortunately there also were parts of the diprotodonts and emu-like birds. Each specimen added some additional information. At every opportunity both Paul and Mike prospected elsewhere with the earth-moving equipment where there were traces of the Mampuwordu sands along the escarpments. Without the tractor time would not have permitted this exploration. After a few fruitless attempts they finally located bones within a stone's throw of the Woodard Quarry. There we uncovered associated parts and better preserved specimens of the diprotodonts than had been discovered at the other sites. This we called the Keane Quarry.

The days slipped by rapidly, and almost before we realized it was time to break our camp under the coolibahs and move on to Lake Ngapakaldi deep in the heart of the Tirari Desert. With our water containers refilled, a generous supply of fresh beef kindly given us by Brian and Cathy Oldfield, of Etadunna Station, and exhilarating baths in the warm water at Cannuwalkaninna Bore, we struck off to the north. Following our landmarks of previous trips, we passed the salt-pan lakes of Kanunka and Piticanta and finally pitched our tent back of a dune ridge half a mile east of Lake Ngapakaldi.

It has been said that every camp has its charm, but most of the time it was difficult to find any merit in this location. The wind blew, filling the air with sand and dust. This was followed by a build-up of clouds in the south-west that culminated in cold rains



Brown channel sands with bones and teeth, and overlying horizontally-bedded mudstone with leaves. A new locality at Lake Ngapakaldi.

Small diprotodont limb and foot bones in Ngapakaldi Quarry.

sometimes lasting for days. The desert was dripping wet. When the sun came out thousands of bush flies converged on us as if to make up for lost time.

Discomforts were diminished and even forgotten as the life-giving moisture stimulated growth. From the arid wastes of last year the interdune valleys metamorphosed into continuous flower gardens. Dominant were yellow daisies, white and yellow poached-egg daisies, and purple wild stock. These formed patterns of yellow, white and light purple that were less densely distributed up along the sides of the golden dunes. It was as though someone had designed this colourful display with pathways of fresh clean sand among the flowers.

Closer inspection revealed delicate deep purple blossoms of the "wandering lawyer," as it is called. It grows as a flattened vine on the sand. It was difficult to believe that such a precious little flower would in fact eventually produce such a nasty burr.

Birds, some of which we had only seen rarely in the desert, responded to the change in climate in number and kinds. Australian song-larks were everywhere, but each with its limited territory. The male would take off in a burst of continuous song. Moving through the air on fluttering wings and with landing gears down like a helicopter, it gave a cheerful song to the desert that had come to life. There were many interesting birds but those most likely to be remembered were the orange chats, the crimson chats, and the equally colourful, tiny, red-capped robins. Most charming, however, were the little blue wrens with white wing coverts; without them the desert would not be the same.

Small Diprotodonts

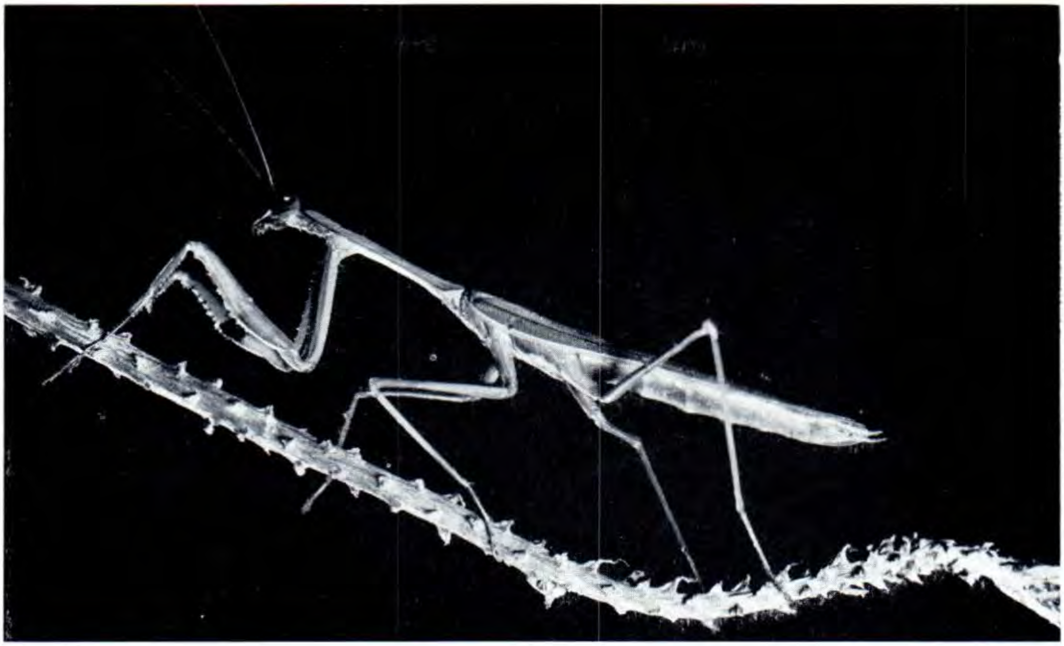
Rain or shine, day after day, we pushed on with our work. With the big tractor Paul and Mike removed the overburden, then cut through a layer of dolomitic limestone at the Ngapakaldi Quarry, exposing the green claystone unit in which we had found such excellent fossils last year. This was the oldest of our Tertiary faunas. Soon Dick discovered most of a small diprotodont skeleton. Both hind feet were clasped together, indicating that the animal had died on its back in the mud. Among the other bones were a left front limb and foot with every bone in place. Next day Mike found another individual. More than a week of the most painstaking work passed before these smallest of known diprotodonts were removed. The length of a skull was 9 in., a remarkable contrast to the big *Diprotodon* skull from Lake Callabonna which measured 32 in. Then we found some dasyurid jaws. Of even greater interest was part of what promises to be a small phalanger. Careful preparation will reveal its identity.

One day Paul came into the quarry with the news that he had found another promising site several hundred yards farther along the edge of the lake. Sure enough, there at the edge of a sand drift was evidence of an old stream channel that had apparently cut into the underlying Etadunna formation. Within an area of 10 ft. were the shattered carapaces and plastrons of five turtles. Fish bones, bits of fossil wood and gravel littered the surface. Again our big machine played an important role in getting into the channel deposit. Dick was the first to find a small mammal jaw. From that time on we worked almost from daylight until dark.

When we finally left the field we all agreed that this was the most interesting fauna we had encountered in Australia. It was next to the oldest in our stratigraphically controlled section east of Lake Eyre. Some of the genera were also found in the Ngapakaldi fauna, but the species appeared to be different. It was very much a forest stream and woodland assemblage. There were ringtail-like possums, bushytail-like possums, koala-like forms, the first known Tertiary wombat, and a jaw and teeth suggestive of a pig-footed bandicoot. As near as we could judge there were four or five kinds of macropodids. There was also a rather primitive diprotodont, but not like the one in the oldest fauna. The dasyurids, that assumed the role of carnivores and insectivores in other parts of the world, as usual were fascinating. One little fellow in this fauna appeared to be primitive and another resembled the spotted-tailed *Dasyurops*. Even more interesting was a mandible about the size of that in *Dasyurops*, but the fossil had an unusually large premolar. We also found five mammalian teeth that have us puzzled as to ordinal classification. There were also teleost fish, lung fish, turtle, crocodilian and bird remains. Of considerable importance was the presence of the first Tertiary leaves to be found associated with our faunas. They were remarkably like the coolibah leaves we had for comparison.

Each year we have returned to the Tirari Desert something new has been discovered, and more has been added to our knowledge. We realize that much more of the Cenozoic sequence of life can be found there and elsewhere on the continent, but it will require considerable determination and patience to get it.

[*Photos in this article are by the author.*]



The Praying Mantis, a well-known insect predator, and (below) its head and forelegs. The forelegs are specially adapted for seizing and holding prey.

CARNIVOROUS INSECTS

By C. N. SMITHERS

ONE of the most important factors contributing to the success of the insects, as a group, has been the ability to exploit food sources. Hardly a species of plant or plant product is immune to insect attack and with such versatility it is only to be expected that many species of insects would turn from a vegetable diet to investigate the other animals in their environment as a source of food. This has happened many times in the long evolutionary history of the insects and there are few orders of insects in which there are no predaceous species. We usually think of caterpillars as being typically leaf-eating insects and most of them are, but even amongst the caterpillars there are species which are carnivorous, feeding, for example, on scale insects and tree hoppers; others have formed a close association with ants and are found in ants' nests, where they feed on the ant larvae. Some groups of insects are entirely carnivorous, their ancestors having long ago ceased to be vegetarians.

Being such a successful group of animals and having the ability to reproduce at a rapid rate and thereby build up their populations rapidly, makes many insect species an ideal food source themselves and the predaceous insects have not been slow to take advantage of the food source thereby provided. With such a ready source of food and with large numbers of species which are carnivorous, it is inevitable that specializations should arise making for the more efficient capture of prey. Much depends, of course, on whether the prey is fast or slow moving; some of the most vulnerable species are those which are immobile. Aphids (plant lice) form the prey of many insects and, in general, their predators are not very fast-moving. Groups of aphids can usually be found in spring and summer on the new shoots of rose bushes or bean plants and such groups are nearly always accompanied by ladybird beetles and their larvae as well as by the carnivorous maggots of the hover flies; these predators move amongst the aphids without undue haste, eating as they go, and between them are capable of destroying entire colonies of aphids.

In the case of slow-moving prey the predators are often also fairly slow-moving or are capable of flying somewhat faster than the prey. Ground beetles are able to run at a fairly rapid rate and can overtake and attack the slaters, millipedes and insects on which they feed. For this they use their powerful jaws, seizing and chewing up the victim. The flying predators are more spectacular in action than some of the ground-dwellers, and the sight of a dragonfly flying over water in search of the flying insects which form its food is appreciated even by those least interested in natural history. The dragonfly's head is large, most of it being occupied by well developed compound eyes; this is to be expected, as the dragonfly hunts its prey by sight. The lower part of the head is occupied by the jaws, and the legs are so arranged in a forward position that when they hold prey it is brought close to the mouth; actual feeding takes place on the wing. The incessant to-and-fro hawking of the dragonfly is in strong contrast to the flight of the robber fly, which rests quietly on a grass stalk or a branch waiting for its prey; when a suitable victim passes nearby the robber fly flies at its prey, captures it, often taking it with an audible impact, and then lands on a convenient perch to eat its meal at leisure. Although both dragonfly and robber fly will take rapidly flying prey, they can usually find sufficient in the way of fairly slow-flying insects to satisfy their requirements without the need for any great turn of speed.

It is those insects which are themselves not very fast-moving that exhibit some of the more specialized means of capturing their food, the methods used usually involving lying in wait for the prey to come within reach or making some form of trap. Of all insects that lie in wait for their prey the mantids, of which all species are carnivorous, are perhaps the best example, for not only does the structure of their forelegs enable them to grasp and retain hold on relatively powerful insects but their behaviour patterns are such that they will find and occupy a suitable situation, one into which likely prey will come sooner or later. Also, they have the ability to remain immobile with their predominantly green or brown colouring making them relatively inconspicuous, to our eyes at least. The forelegs are so formed that they have the tibia and femur very well developed and these can be brought together edge to edge, the edges being spined and the spines fitting between one another when the femur and tibia are brought together. This arrangement results in a highly efficient grasping mechanism. In order to give an extended reach the coxa (basal section of the leg), which is usually quite short in insects, is greatly elongated. Mantids, like dragonflies, find their prey by sight, and they, too, have large eyes.

It is somewhat surprising that, despite the fact that insects parallel so many of the achievements found in other groups of animals, they have seldom evolved mechanisms for trapping their prey. The secretion of silk is widespread amongst insects yet we find little use of it in making snares. The most spectacular of the insect trappers is the familiar antlion, which makes its conical pitfall in loose, dry sand. The larva responsible for the pit rests in the sand at the bottom of the pit, often with its mandibles protruding, until an insect, frequently an ant, falls into the pit. The loose sides of the pit prevent the prey from scrambling to safety and it eventually comes within reach of the very effective jaws of the larva. When a potential victim disturbs the sides of the pit the antlion larva is sometimes stimulated into throwing sand from the bottom of the pit and this helps to prevent the escape of the prey.

Most carnivorous insects use their jaws in capturing and subduing their prey. In the wasps and some of the ants we find a fine weapon in the sting, but, being a modified ovipositor, an organ originally used for laying eggs, it is only found in the female. This presents little problem in practice as it is the female which is responsible for the formation of the nest, the provision of food and, in the species which are social in habits, the care of the young. In providing food for the colony the female makes full use of her weapon.

The size of predator frequently limits the prey available to it; many insects do not attack prey of anything nearly approaching their own size so that the larger the insect the less likely it is to fall prey to others. This limitation has been overcome, however, in the ants, because with the evolution of their social life there has been opened up to them the possibility of communal foraging, and prey very much larger than an individual ant will succumb to the attacks of several ants.

Probably the greatest enemies of insects and the most potent forces in reducing their numbers are to be found amongst the insects themselves.

This fossil trilobite was recently presented to the Australian Museum.

Trilobites form an interesting and important group of exclusively marine animals which lived only during the Palaeozoic Era. They form a compact group, distinguished by a hard shield-like covering which is trilobed longitudinally into a central and side regions and also differentiated transversely into anterior (head), middle (body), and posterior (tail) portions. The average length of trilobites varies from 1 to 4 inches. Minute forms, 5 to 15 mm. (one-fifth to three-fifths of an inch) are numerous while large forms measuring more than 8 inches are rare.

Trilobites belong to the class Trilobita of the phylum Arthropoda which also includes such well-known creatures as the prawns, lobsters, crabs, insects and spiders.

Trilobites were the dominant form of life in Cambrian seas, about 600 million years ago, and frequented the muddy and sandy bottoms in shallow water. They were bottom crawlers and slow movement was by means of paired legs on the underside of the body, but occasional fast spurts could be achieved by rapid movements of the tail flaps.

In early Cambrian time many complex families had already evolved and it is certain that primitive types ancestral to trilobites had been in existence in late Pre-Cambrian time, possibly 1,000 million years ago. Following Cambrian time trilobites steadily waned in number and variety until at the close of the Palaeozoic Era, in Permian time, they were represented by only a few genera and very soon became extinct. During the approximately 250 million years life-span of the trilobite group they evolved into many specialized and differentiated types with diverse ornamentation. A recent estimation of the number of trilobites which has been described is 1,500 genera with at least 10,000 different species.

Trilobites are well represented in rocks of Palaeozoic age in Australia and many species differ little from those found in rocks of similar age in other parts of the world. The illustrated specimen is a species of *Leonaspis* from rocks of Upper Silurian age at a locality about seven miles west of Forbes, New South Wales, and was recently presented to the Museum by Timothy Bradley, aged 12.

COPPER MINING AT COBAR

By E. O. RAYNER
Geological Survey of New South Wales

THE Cobar region in central-western New South Wales has been well endowed with natural mineral resources, and in the past has been the State's major copper producer. At the present time, new operations towards the large-scale mining of copper ores at and near one of the dormant mines, known as the C.S.A., has re-focussed interest on this mineral belt.

History

The name Cobar is said to be derived from an Aboriginal word meaning burnt or red earth, ochre or "raddle". A low hill with outcrops of this reddish oxide or ochre, on which a native rock-well existed, became a tribal meeting ground and the Aborigines used this "raddle" to paint themselves for ceremonial occasions.

Native guides showed this spot to a party of tank-sinkers (Campbell, Hartman and Gibb) in 1869 or 1870, and samples were collected from the outcrop at the waterhole, streaked green and blue by malachite and azurite, the carbonates of copper. At this site, what was to become the Great Cobar Copper Mine developed, and the township of Cobar grew alongside it.

By 1871, the Chesney, Occidental and C.S.A. ore-bodies and many other prospects had also been found, and shortly afterwards the Queen Bee, Peak and Fort Bourke (later called the New Cobar) were discovered. Probably all the main outcropping mineral deposits in a belt some twenty miles long comprising the Cobar mining field had been found by 1907.

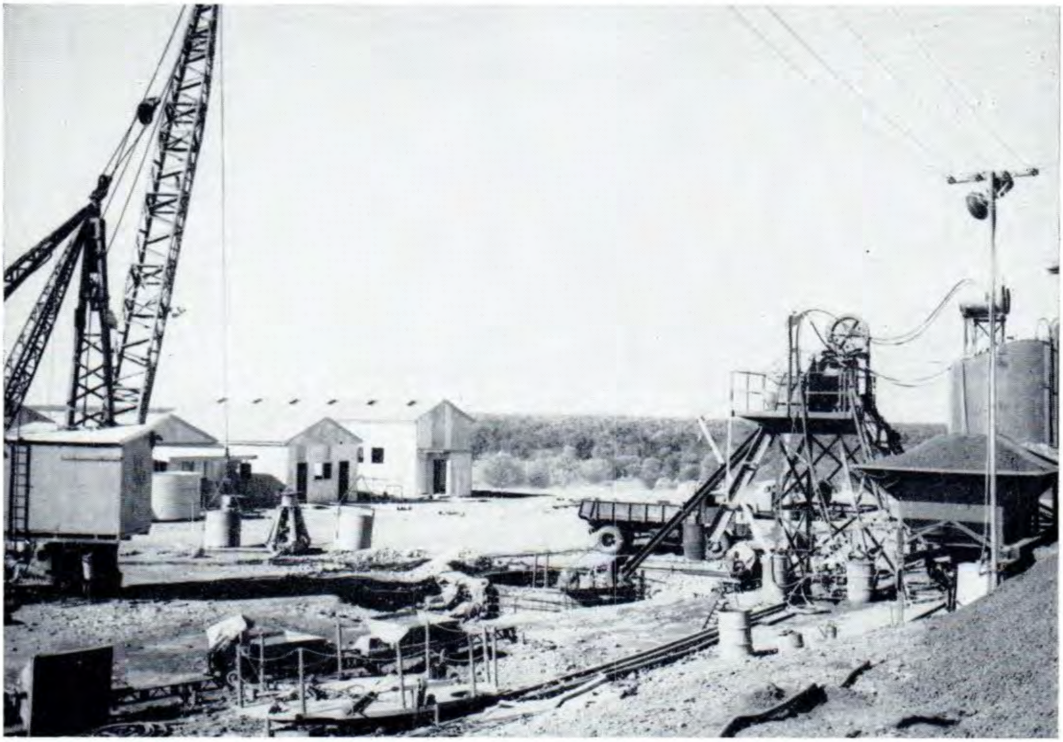
Water shortages hindered early mining. So did high freight costs, particularly before the railway was pushed this far west in 1892. Several of the earliest ore parcels had been taken by bullock train to Louth on the Darling River and thence by river-boat to South Australia.

Smelters were erected at the Great Cobar to treat its basic ore, which was mixed

Typical primary copper ore from the Great Cobar Mine, showing veins of chalcopyrite-pyrrhotite-magnetite and quartz in slate. [Photo: Author.]

(especially for fluxing purposes) with more acid, siliceous ores from several neighbouring and outlying mines. Over 4,000,000 tons of ore were mined and treated by the Great Cobar group up to 1919.

At first, because of the deep zone of oxidation and enrichment extending several hundred feet from the surface down to water level, as is characteristic of such semi-arid regions, all mines were able to exploit high-grade secondary ores (upwards of ten per cent copper). When the underlying zone of primary sulphides was reached, however, the recoverable grade dropped to between one and three per cent copper. This stage of lower-grade and costlier deeper mining had been reached in the major mines before the end of World War I. When there was coupled with this condition a world-wide



Above: The commencement last year of a new major copper mine at the site of the old C.S.A. Mine, seven miles north of Cobar. [Photo: Author]. *Below*: Mining on the Great Cobar outcrop in 1874. [Photo: Frank Lean.]

slump in copper prices in 1919-1920, most of the Cobar mines were forced to close, and there was virtually no activity on the field between 1920 and 1931.

Most of the Cobar copper lodes also contain and have produced some gold. Such mines as the Chesney, Fort Bourke and Queen Bee were at first worked only for gold, at the surface and in uppermost levels, and only later were they exploited for copper when copper mineralization either first appeared or increased in amount in subsurface positions. The New Occidental, two miles south of Cobar, has been essentially an important gold producer, the lode containing only minor amounts of copper.

In 1931, because of a sudden rise in the price of gold, the New Occidental mine was re-opened and commenced gold production by 1935, the metal being recovered by fine grinding and cyanidation. The New Occidental company also acquired the nearby Chesney and New Cobar properties to win copper and gold, producing copper-gold concentrates by the flotation process. Rising freight and mining costs were several of the factors which led to the closure of the mines again by 1952, after considerable production from this group. In recent years, subsidiaries of two large Broken Hill companies have explored the lodes from C.S.A. to Chesney and have disclosed significant amounts of low-grade copper ore by deep drilling beneath the known workings.

The Cobar mining field from C.S.A. in the north to Queen Bee in the south has produced several millions of tons of ore which have yielded about 135,000 tons of metallic copper, over 1,250,000 ounces of gold, and over 1,750,000 ounces of silver.

In what might be termed the greater Cobar region, bounded on the east by the Bogan River, on the north by the Darling River and on the south by the Lachlan River, other mineral deposits have been worked, particularly for copper and gold (e.g., at Nymagee, Shuttleton, Mount Hope, Mount Boppy-Canbelego, Hermidale, Girilambone, Bobadah, Mineral Hill, Condobolin, and Tottenham). In round figures, this greater Cobar region has produced about 200,000 tons of metallic copper and 2,000,000 ounces of gold. Deposits containing tin, lead, zinc, tungsten, bismuth, uranium, molybdenum, platinum, iron, limestone, magnesite and gypsum are also known in this region.

Current Operations

Recent investigations have resulted in Cobar Mines Pty. Ltd., in which Broken Hill South Ltd. holds a $76\frac{2}{3}$ per cent interest and Consolidated Zinc Pty Ltd. the remainder, commencing last year a new major copper mine at the site of the old C.S.A. mine seven miles north of Cobar. The name C.S.A. was originally bestowed on the old mine because the three men who first worked it were respectively Cornish, Scottish and Australian.

The operation will exploit not only the old western or footwall ore-body, on the upper part of which the former C.S.A. and Tinto workings were placed, but also a more recently discovered parallel hanging wall ore-body on the east, found by geophysical survey and diamond drilling. The drilling has indicated ore down to 3,000 ft. and the ore-bodies can be expected to continue some distance below this.

Disclosed ore reserves (chiefly for the C.S.A., but also including the Chesney) are 18,000,000 tons containing an average of just over three per cent copper. It is planned at the C.S.A. to win ore at an initial rate of about 325,000 tons per year by June, 1965, with provision for this rate to be doubled within twelve months from the start of production. A mechanized cut-and-fill method of mining, with hydraulic stowage, will introduce some features novel to mining practice in Australia. Copper concentrates produced in the milling and concentrating plant at the mine site will then be railed to Port Kembla for the production of metallic copper.

Two vertical, circular, concrete-lined shafts are now being sunk. The main shaft is for hoisting ore and handling men and equipment, and for a downcast airway in the ventilation system. It is 18 ft. in diameter, and initially planned to 2,100 ft. The second shaft, 14 ft. in diameter, is an upcast airway, and is being sunk first to 1,200 ft. and later extended to 1,800 ft. by raising, stripping and concreting from 1,800 to 1,200 ft.

A railway line is to be laid from the mine to the railhead at Cobar. Sufficient water will be available in the developmental stage by pipeline from the Cobar reservoir, but for an adequate permanent supply a pipeline will probably be necessary from the Darling River or, more likely, from the Bogan at Nyngan, some eighty-three miles to the east.

The Cobar Ore-bodies

The Cobar mineralized zones are strongly sheared and faulted belts, mostly trending north-north-west, which dip steeply and traverse a group of folded and slightly metamorphosed slates, siltstones and sandstones (or greywackes). The individual ore-bodies of economic grade within such zones have great vertical extent, commonly greatly exceeding their length and width, so that the ore is in steeply-pitching, pipe-like masses having the shape of a flattened spindle or carrot. Deep drilling in recent years has confirmed that for several of the lodes the mineralization is continuing down strongly below a vertical depth exceeding 3,500 ft.

The Cobar ore-bodies are chiefly made up of a great number of veins of ore and quartz, commonly aligned along cleavages and interleaved with the sedimentary host-rocks. The chief copper ore mineral in the primary sulphide zone (below water level) is chalcopyrite. Typically this is accompanied by abundant pyrrhotite and magnetite; these two iron minerals being magnetic, geophysical surveys by magnetometer are thus capable of detecting bodies of mineralization which contain them. Other metals and minerals present in the ore include gold, silver, bismuth, bismuthinite, pyrite, marcasite, sphalerite, galena, bornite, cubanite, valleriite, arsenopyrite, tetrahedrite, and cobaltite.

The gangue of the ore, in addition to cherty (metasomatised) slate, quartz, chlorite, and lesser calcite and siderite, in many cases is characterized by the comparatively rare dark-green to black platy iron silicate, stilpnomelane.

Zones of oxidation and secondary enrichment are well developed, in some cases (as at C.S.A.) down to nearly 500 ft. From the earlier mining of such zones, particularly at the Great Cobar, many beautiful specimens of green malachite and blue crystals of azurite now grace mineral collections in Australia and around the world. Native copper and cuprite were also fairly common in the oxidized zone, and masses of chalcocite were formed in the secondarily enriched sections of the lodes at and near water level. Secondary lead mineralization also occurs, particularly in the gossanous upper part of the C.S.A. footwall ore-body.

An observer in the Cobar field will note that most of the lodes which have been cut by the present land surface are on isolated low hills. This is because mineralization, and especially silicification, has stiffened the lode areas against erosion more than the surrounding country rocks.

Banded radiating malachite from the Great Cobar Copper Mine.

South of the Cobar mining field there are copper ore-bodies of similar form and mineral assemblage at Nymagee, Shuttleton and Mount Hope, so that this great copper-bearing belt is over 100 miles long.

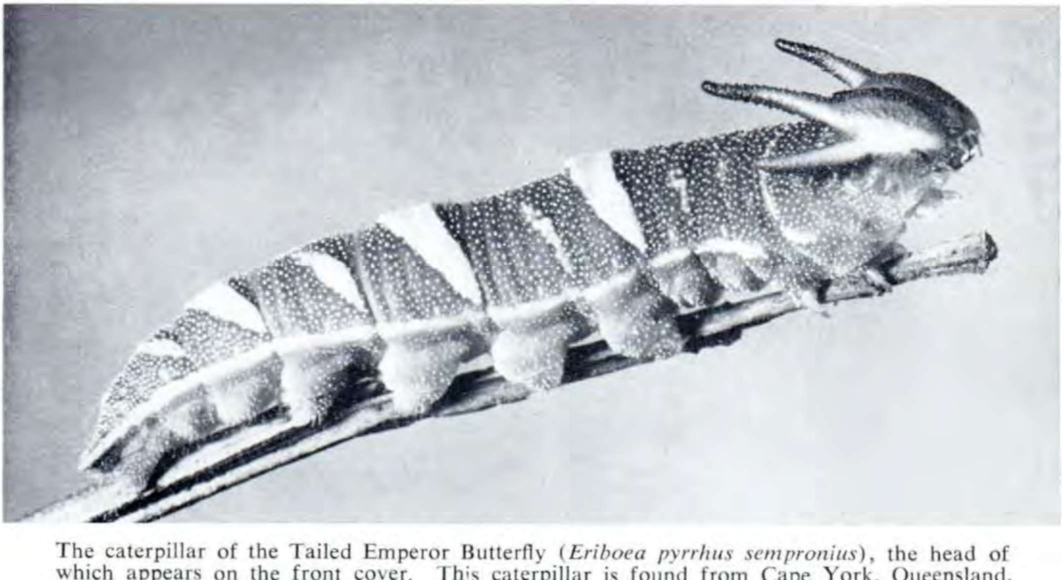
The Outlook

Although it started as a mining camp, Cobar has also developed as an important pastoral centre, surrounded by many sheep grazing properties. When the New Occidental mining group ceased operations in 1952, Cobar did not become a "ghost town". Indeed, the efforts of civic-minded townspeople, guided by a progressive Shire Council and supported by the pastoral community have greatly improved this western town in recent years.

The population of Cobar is about 2,300, and success for the new mining venture, with the ancillary developments it will bring about, could well see this population doubled in the next five years. Cobar is a railhead 469 miles westerly from Sydney, and also lies on the Barrier Highway which runs a further 290 miles west to the city of Broken Hill and its famous lead-zinc-silver lodes. Great progress is being made with the bitumen-sealing of this highway, and when this is completed Cobar will also become a stopping place for increased tourist and commercial road traffic. It is a point of interest that for the bitumen surfacing carried out in the Cobar district the aggregate consists of crushed slag from the huge residue dumps of the old Great Cobar smelter.

The mining operations envisaged at the C.S.A. are on a large scale, but will be conducted by deep mining on ore of low grade. Thus the mining method adopted, the cost structure, and the maintenance of good prices for copper, are critical factors. If the undertaking proves profitable, the way becomes open for similar large-scale mining at other localities in the Cobar belt, where reserves of low and marginal grade ores are already known and more may be expected from further prospecting and development.

Among prospective areas for further mineral discovery and production in New South Wales, the Cobar region may be rated highly.



The caterpillar of the Tailed Emperor Butterfly (*Eriboea pyrrhus sempronius*), the head of which appears on the front cover. This caterpillar is found from Cape York, Queensland, to Sydney. It feeds on *Acacia* (wattles), *Brachychiton* (flame trees) and *Albizzia*. It is bright green, the small raised spots are white and the bands across the abdomen, which vary in number from one specimen to another, are yellow. These colours and their arrangement make the caterpillar inconspicuous in the dappled light and shade of the foliage of its food plants.

Stranded in an ocean rock-pool at Norah Head, N.S.W., during an easterly blow is a Brown Jelly-blubber (*Catostylus mosaicus*). The sting seems to be localized in the fingers-like mouth arms, as the bell could be handled with no ill-effects. Out of water the mouth arms seemed to loose their power of stinging. [Photo: Patricia McDonald.]

Jelly-fish Stings In the Summer of 1962-63

During a field trip to Norah Head, New South Wales, in February, 1963, Miss Patricia McDonald and Miss Elizabeth Pope, of the Australian Museum, were able to establish the fact that the common Brown Jellyblubber (*Catostylus mosaicus*) can definitely sting if handled underwater. This species, which is common in harbours and estuaries all along the New South Wales coast, can apparently be handled by the umbrella-part with impunity, but, when the mouth-arms were allowed to brush against the softer skin of the inside of the forearm underwater, a distinct rash developed after a few minutes. Small, raised, red lumps appeared, scattered at irregular intervals over the skin, and were intensely irritating. The rubbing of wet fine sand over the affected area was sufficient to remove the stinging nettle-cells from the flesh and the itchiness soon died down.

The same sort of sting was also experienced when tiny pieces of jelly-fish flesh which were floating in the sea brushed against the less horny parts of the skin. Strong and continued easterly winds were causing mass stranding of *Catostylus* in the rock pools at the time, and many were being mashed up as they were battered against the rocks. The sea was full of floating fragments, some so small they could scarcely be felt when they brushed against the bare arm.

It is believed that the phenomenon erroneously attributed by newspapers and members of the public to "sea lice bites" in the surf is in fact due to stings resulting from swimmers coming in contact with such floating fragments of jelly-fish.

In the summer of 1962-63 three "waves" of complaints by surfers of "sea lice bites" were recorded, and these could be correlated with the occurrence of strong and continued easterly blows in each case and the presence of swarms of jelly-fish offshore. The first wave of stingings corresponded with mass visits of the Purple Stinger (*Pelagia panopyra*) and occurred in late November. The second outbreak of complaints occurred between Christmas and New Year, when the sea and harbour waters were full of Giant Blubbers (*Cyanea capillata*), and the third was in late January and early February, when *Catostylus mosaicus* swarms were present in the sea—at the same time as the observations described above were made by officers of the Australian Museum.

From this it would appear that the best first-aid treatment for stings of unknown origin, either in the surf or harbour waters, is to treat for jelly-fish stings—and the sooner the term "sea lice" is forgotten the better.—E. C. Pope.

Sponges — The First Republicans

By J. R. SIMONS
Department of Zoology, University of Sydney

IT comes as a surprise to most people when they learn that sponges are animals. Certainly, the rather dull, uninteresting looking objects of various shapes and sizes frequently found above the high tide marks on beaches, give few clues about their animal origin. These objects, generally dark brown or grey in colour, are rather brittle and "scratchy" to the touch, and close examination shows them to be formed by a tangled meshwork of threads. The threads, composed of a substance called spongin, chemically similar to silk, make up the greater part of the skeleton of the sponge, so that in life the meshwork is really the scaffolding which supports and protects the tissues and "body" of the sponge. In most sponges, other elements go to make up the skeleton, in particular thousands of minute needle-like rods called spicules which are usually siliceous in composition, although there are species of sponges in which the spicules are calcareous. It is the spicules which impart the "scratchy" quality to the sponges found on the beaches.

Some sponges lack spicules altogether and specialize in using spongin as the only skeletal material, and it is from among these types that the once-familiar "bath sponge" is prepared. In these days foam plastics have largely replaced "sponges" as a household and bathroom accessory, but nevertheless the natural product is, by a wide margin, the superior one, if only because of its greater durability.

Most sponges are marine, but there are some, belonging to the group Spongillidae, which inhabit fresh water. These freshwater sponges are world-wide in distribution and Australia has its fair share of them.

Some sponges show a definite form as they grow, resembling fans or vases, which may be quite large, but the majority do not have any definite form and come simply to encrust and spread over submerged rocks, pieces of wood or any other suitable substratum.

A specimen of the common Australian freshwater sponge, *Ephydatia multidentata,* encrusting a sunken branch. Gemmules can be seen as small whitish spheres on the wood below the sponge as well as in the sponge tissues.

[Photo: P. J. Stanbury.]

Although known and used by man from antiquity, it was not until the last century that the true animal nature of sponges was established. The mystery lasted so long largely because their method of feeding was not directly observable until the microscope revealed it.

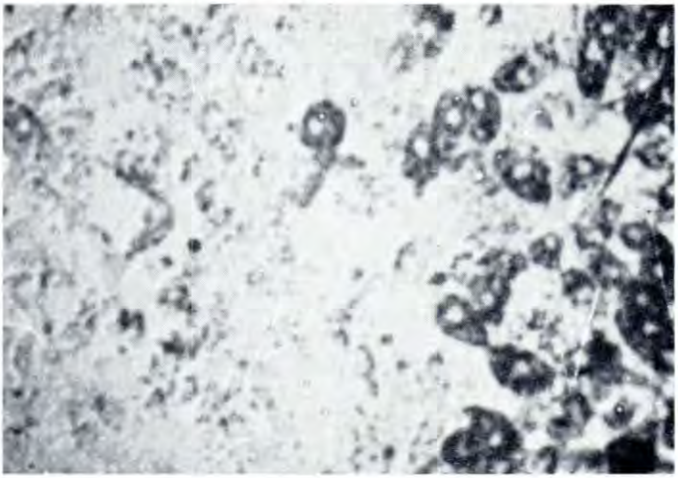
Unlike most other animals, sponges are sessile and do not move about in search of food: instead they cause their food to be brought to them. They do this by creating currents of water which pass in through tiny pores in the "skin" into fine canals in the interior of the body. In these canals, special cells called choanocytes, grouped together in chambers, cause the current of water to flow by the beating of small whip-like structures on the cell, the flagella. Microscopic particles of food carried in the currents are caught by the collars of the same cells and abstracted from the water. The water moves on past the chamber and into another system of canals to be exhausted finally through larger pores on the body surface. The food particles are digested and the products distributed throughout the sponge by other types of cells which are capable of moving about among the tissues.

From this brief description it is obvious that the sponge body is made up of many cells and that the cells are of different types —epithelial cells, for instance, which form the outer covering and linings of the canal systems, the choanocytes which are responsible for the creation of water currents and the removal of suitable food particles, the amoebocytes which move about the interior of the sponge and, of course, other types of cells which lay down the spongin fibres and the spicules of the skeleton. This differentiation of cells, each type specializing in some particular function, is, at first sight, very similar to the sort of thing we find in all other animals except the acellular protozoans. Although there is this similarity, sponges, however, differ very considerably in the way the cells are organized with respect to each other and in the way they are produced. Because they show a high degree of autonomy and even interchangeability the tissues and cells of sponges are of great interest to the biologist.

Sponges Nerveless

The vast majority of animals are noted for their ability to respond rapidly as a whole to stimulation. They are able to do this because they possess nerve and hormone systems which serve to integrate all the parts of the creature into a unity. Sponges do not possess nerves and probably do not have well-developed hormone systems, so their power of general response is very limited, and, where it does occur, very slow. (Indeed, there are some plants which react faster than sponges). This being so, we can see that the degree of integration within sponges is very low.

Again, in animals in general, once the early embryonic stages are passed through, cells which have become differentiated into their various categories—muscle cells, nerve cells, connective tissue cells and so on—cannot change into another type; they continue to produce cells like themselves. In sponges, however, it is possible for a choanocyte to change into an ameobocyte and for amoebocytes to become temporarily cells producing spicules or epithelial cells. There is also a special kind of large ameoboid cell in sponges which is capable of producing not only cells like itself, but also the other types as well.



A close-up view of some of the cells in living sponge tissue. The darker cells are archaeocytes; the other types present are more transparent and therefore do not show up so well.
[Photo: Author.]

A young sponge just emerged from a gemmule, which is seen as the "yolk" of this "fried egg". The young sponge's white area nearer the gemmule is formed by a thick concentration of cells; the more transparent outer region is formed by a thin layer of epithelial cells which gradually extend the perimeter of the sponge as it grows. [Photo: Author.]

In contrast, then, to the vast majority of the many-celled members of the animal kingdom with their great variety of fully differentiated, highly specialized cells dominated by nerve and hormone systems, sponges are organized, so to speak, as fairly loose federations or republics of almost equal cells capable of various activities at different times, depending, presumably, upon the particular demands being made on them at the time.

This "republicanism" is most evident in the events which occur after a sponge, or part of it, is fragmented. The aim of fragmenting the tissues is to obtain a yield of single isolated cells, and this is quite easy to do. The isolated cells immediately behave as amoebocytes and, crawling about on the substratum, eventually meet up with each other. Contacting cells immediately adhere together so that after a short time, say about ten minutes or so, clumps of dozens or even hundreds of cells come to be formed. The clumps become spherical and internally there is much rearrangement of protoplasm and nuclear material. Eventually, after about ten to twelve days, a miniature sponge begins to form. Now the important thing here is that if originally only amoebocytes and choanocytes are incorporated into the cell mass *all* types of cells are present in the young sponge, so they have been manufactured, as it were, by the original two types. In terms of some higher animal, it would be equivalent to, say, producing a puppy by taking a mixture of white blood cells and liver cells from a dog and allowing them to develop in some suitable medium. It could not be done, of course, although something similar has been done using the *embryonic* cells from chickens at about the fourth day of incubation. In these experiments a mixture of kidney and liver cells sorted themselves out to form recognizable kidney and liver tissues, but that is a far cry from building up a complete chicken.

Freshwater Sponge

All sponges, so far as is known, have this capacity to re-aggregate isolated cells and to re-form to a greater or less degree a miniature sponge; some more successfully than others. The species I have been studying most is the common Australian freshwater form, *Ephydatia multidentata*. This is a common encrusting sponge (see illustration) and like all the freshwater sponges has an interesting mechanism for surviving (as a species) over long periods, such as drought, which are inimical to the individual. As the water level of the pool or stream the sponge is living in begins to fall, and the water becomes more stagnant and polluted, the larger amoeboid cells begin to collect together in the body of the sponge to form little spheres. These are invested and sealed with a series of tough membranes and coatings by other amoebocytes from the outside. The main part of the sponge dies as the water dries away, and all that is left is the skeleton holding within its meshes the coated and sealed spheres which are called gemmules. In *Ephydatia multidentata* the gemmules are each about half a millimetre (about one-fiftieth of an inch) in diameter.

The gemmules are permeable to water and after a few days' dessication are completely dried out; nevertheless, the shrunken contents remain viable for at least three years with certainty, but are probably capable of surviving much longer than that.

On being returned to water the contents swell and in about ten days break through the sealed capsule to form a young sponge. The events which go on inside during the ten days are too complicated to describe here, but they are similar in some ways to the events which occur in the spherical mass of cells obtained by the re-aggregation of isolated cells. Once again we find that all the cell types are present, despite the fact that only one type of cell was originally enclosed in the gemmule.

From what has been related here, I think the reader will agree that far from being uninteresting and perhaps pitiable objects, sponges are most fascinating and possibly hold the secrets of much we would like to know about the ways cells come to be differentiated, organized and controlled in higher organisms. It would not be the first time sponges contributed to the understanding of higher organisms, for it was from watching the wandering amoebocytes in sponges that Metchnikoff, last century, got his ideas about the possible function of the white cells in the blood of vertebrates.

NOTES AND NEWS

ASSISTANT CURATOR

Mr. Douglas Miles, B.A., has been appointed Assistant Curator of Anthropology at the Australian Museum. Mr. Miles, a graduate of the University of Sydney, has lately been carrying out research work in southern Borneo.

INSECT-COLLECTING

The Director of the Australian Museum, Dr. J. W. Evans, spent two weeks collecting insects in Victoria in March.

VISIT TO MUSEUM

The Director of the British Museum (Bloomsbury), Sir Frank Francis, visited the Ausralian Museum in February.

METEORITE CRATERS

Dr. Brian Mason, Curator of Minerals, the American Museum of Natural History, New York, and Mr. E. P. Henderson, Associate Curator of Meteorites, United States National Museum, Washington, are examining meteorite craters in Australia, and meteorite localities, particularly in the arid inland regions. Mr. R. O. Chalmers, Curator of Minerals at the Australian Museum, is accompanying them for part of their trip.

ABORIGINAL IMPLEMENTS

Mr. Robert Turner, of Sydney, has presented to the Australian Museum a collection including 4,000 Aboriginal stone implements from campsites in New South Wales. Implement types particularly well represented are *Bondi* points, *elouera* and uniface pebble implements from the coast of N.S.W., where some of the camp-sites have been obliterated by municipal and other operations. Cylindro-conical stones from Queensland, a scraper made from opal, and pebble implements illustrated in early papers add to the scientific value of this collection in which the specimens were collected with great discrimination.

CONFERENCES AT MUSEUM

Two conferences were held at the Australian Museum in April, both sponsored by the Australian Institute of Aboriginal Studies. One was attended by archaeologists from all over Australia who discussed the typology and nomenclature of Australian stone implements and prehistoric cultures. The other was attended by representatives of the various State museums, who discussed co-operation between the museums and the Institute, and ways and means of filling gaps in existing collections and of building up a collection, for the Institute, of Aboriginal material culture.

ART DESIGNS ON BUKA CANOES

Dr. H. Spiegel, of Sydney, is making a study of the art designs on Buka canoes and paddles, of which the Australian Museum possesses a splendid series of specimens.

MUSEUM EXPEDITION

Mr. Rolf Lossin, an Australian Museum preparator, accompanied the British Museum bird-collecting expedition in New South Wales, Victoria and Queensland in March and April.

BAT BANDING

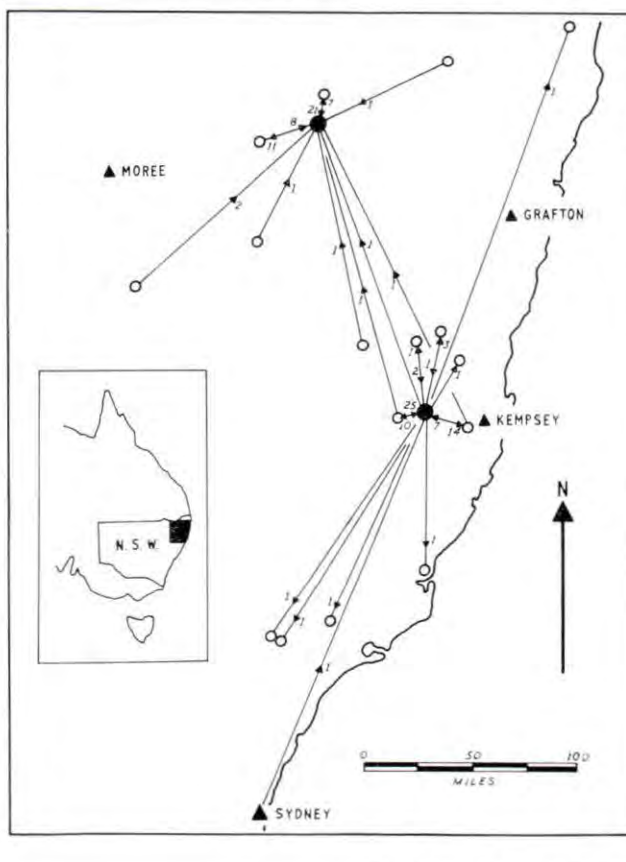
By P. D. DWYER

Zoology Department,
University of New England, New South Wales

IN Australia there are forty-five species of small bats, the Microchiroptera. Many of these are rare, but even for the common species which live in cave or mine colonies of thousands there is only fragmentary knowledge of their year-round biology. In 1957 the Australian Bird Banding Scheme extended its activities to include bats, and now bat banders are operating in most States. However, in Europe and the United States large-scale bat-banding programmes have been in existence for over thirty years and by these standards the study of bats in Australia is still in its earliest stages. The writer has been banding bats in north-eastern New South Wales since 1960 and the present article discusses results that have been obtained from this work. The purpose of the study is to determine the structure of bat populations, in terms of sex and age composition and social organization, and to discover how this structure contributes to the year-round population processes of births, deaths and movements.

10,000 Bats

So far just over 10,000 individuals of nine species have been marked. For most, the method used has been to place an individually numbered aluminium band around the "wrist" of the bat, about half-way along the leading edge of the wing. Here it does not impair flight and can be easily read if the bat is recaptured. Different sized bands are used for different species, and on the inside of the band is an inscription requesting the finder to forward it to the C.S.I.R.O. in Canberra. Banded bats that are recovered by the public often yield information of considerable importance.



Movements of the Bent-winged Bat.—The large map shows movements of breeding females and juveniles to and from maternity colonies (black circles). Females arrive at the colonies during spring and early summer; movements away occur during autumn. The number beside each arrow indicates the number of individuals known to have followed that route. The inset map shows the study area, shaded. [Map by the author.]

Bent-winged Bats massed 150 to the square foot on a cave roof. [Photo: C. Sourry.]

The nine species are by no means equally common. Only one individual of the large, handsome, white-striped Mastiff Bat (*Tadarida australis*) has been marked. This was caught, together with about fifty Broad-nosed Bats (*Scoteinus rueppelli* and *Scoteinus orion*), when these left their roost in a hollow eucalypt branch and flew into a net fixed under the entrance. By contrast to the scarcity of species such as these, some of the cave-dwelling bats are frequently available in tremendous numbers. The medium-sized Bent-winged Bat (*Miniopterus schreibersi*) occurs in colonies of hundreds or thousands of individuals. In the caves or mines that are used as daytime roosts it may be massed on the roof in dense clusters of 150 or more to the square foot. Its relative, the Little Bent-winged Bat (*Miniopterus australis*) is less abundant. Colonies of a few hundred are known from several caves and mines of the eastern Clarence River and Macleay River watersheds but previously this species was not recorded from New South Wales; in fact, it was not known south of Rockhampton, more than 500 miles to the north. These latter species are easy to catch, a powerful torch and a long-handled net being the only equipment needed. It is only necessary to get the net under a good-sized cluster to capture 100 or more squeaking bats—enough work for an hour of banding and recording data.

Recoveries of marked bats now number 1,425. These have included only four of the nine species marked and, in fact, more than 1,000 of them have been recoveries of the Bent-winged Bat. Although most of the bats recovered have been retaken only once, there are a number which have been taken two or more times, with a few being captured on as many as six different occasions. Most have been taken in the cave or mine where they were banded (no tree bats have yet been recovered) but over 400 have been retaken after moving from one locality to another. For example a Horseshoe Bat (*Rhinolophus megaphyllus*) has been recaptured after shifting fourteen miles from a summer cave colony to a winter colony in a mine tunnel and sixty-three Little Bent-winged Bats have been retaken after moving between caves. Most of these latter have travelled distances of less than twenty miles, with the longest movement being a flight of thirty-seven miles. Of course, the distances recorded as a movement are taken in a direct line between the banding and recovery sites and this may have no real relation to the distance "as the bat flies".

The interpretation of movements in relation to differing seasonal needs of the species and possible migratory behaviour depends upon having a large number of records. To date it is only for the Bent-winged Bat that a reliable picture is emerging. This is a fast-flying species which, in forested areas, usually flies well above the canopy. Distances travelled by banded individuals have varied from less than 100 yards between two caves to a record flight of 220 miles for a bat banded by Mr. D. Purchase, C.S.I.R.O., in Sydney and retaken when it flew into a mist net set up over the entrance to a cave near

Kempsey. Several individuals banded at one cave have been taken at another, forty-two miles away, after a single night's flight, and longer distances of seventy-six and 110 miles have been covered in less than a month. Certainly then the Bent-winged Bat is capable of ranging very widely. However, its movements are not haphazard. The ability to "home" is well developed and banded individuals released up to forty-five miles from their daytime roosts have frequently been retaken there within a few weeks.

Most individuals undertake seasonal movements between summer and winter roosting places so that some caves which are occupied by a few hundred or thousand bats in the summer may be deserted during the colder months. The distances between such sites may be as great as thirty or forty miles but are frequently much less. In coastal areas of northern New South Wales Bent-winged Bats move to lower altitudes in the winter, perhaps because their insect food is only available there. But, in addition, they seek out day-time roosts which are cool and are therefore suitable for "hibernation". In these bats, hibernation is not a very strict process and some individuals may be out feeding throughout the year.

The most spectacular movements made by Bent-winged Bats are the annual journeys of breeding females to and from special caves where maternity colonies are established. In the spring and summer, females from many localities converge upon these caves so that by early December there may be as many as 10,000 present. Flights of 125 miles, or more, may be made to reach the breeding caves. Often the journey is made in easy stages, with other caves along the route being used as temporary "stop over" roosts. The same breeding caves are visited year after year and during the months when large number of bats are present cave temperature increases from about 60°F to as much as 80°F. This temperature increase is caused by the bats' activity in the cave. High temperatures are the rule for maternity colonies of this species and appear to be necessary for the proper development of young. Extremely high humidities and an intensely ammoniated atmosphere are also characteristic. The deep deposits of guano covering the floor are infested with mites, and rats thrive in the constantly dark underground environment.

It is into these conditions that the young bats are born, blind and naked, during December. Here, too, they spend their first ten weeks hanging upside down from the cave roof while they learn to fly and eventually to fend for themselves. By autumn they are independent and the maternity colonies begin to decrease in numbers. Adult females are the first to leave and return to their original colonies but finally the young depart so that by early April no Bent-winged Bats remain. The young may travel individually or in loose groups of 100 or so which pass quite rapidly from cave to cave till a suitable locality is selected. Consequently in autumn many small caves usually unoccupied by bats may be temporarily colonized. These roving juveniles may travel similar distances to the adult females and by winter they are generally well dispersed through the area. Many of the movements of juveniles and adult females are shown on the accompanying map, which illustrates recoveries of Bent-winged Bats at, or from, the two known breeding caves.

Not all species have maternity colonies involving thousands of individuals. Nor do all require the extreme physical conditions of temperature and humidity, for juvenile development, that have been found for the Bent-winged Bat. A maternity colony of the delicate Pied-wattled Bat (*Chalinolobus picatus*) occupying an abandoned diamond mine has been visited several times during the last year. The colony was absent from the mine during the winter but re-formed in spring, when it consisted almost entirely of breeding females. In contrast to maternity colonies of the Bent-winged Bat, only thirteen females were present. These, with two adult males and the season's young, born in mid-November, brought the entire colony size up to only thirty-seven! The females and young were massed as a cluster in a small indentation of the ceiling. Mine temperature was only slightly above 60°F and the humidity was comparatively low.

The Pied-wattled Bat belongs to a group of true temperate bats, whereas the Bent-winged Bat is of tropical origin but has succeeded in colonizing southern latitudes. It is probable that the striking differences in breeding requirements of such species reflect this different ancestry.

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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.

Gifts of even the commonest specimens of natural history (if in good condition), and specimens of minerals, fossils, and native handiwork, are always welcome.

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.

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