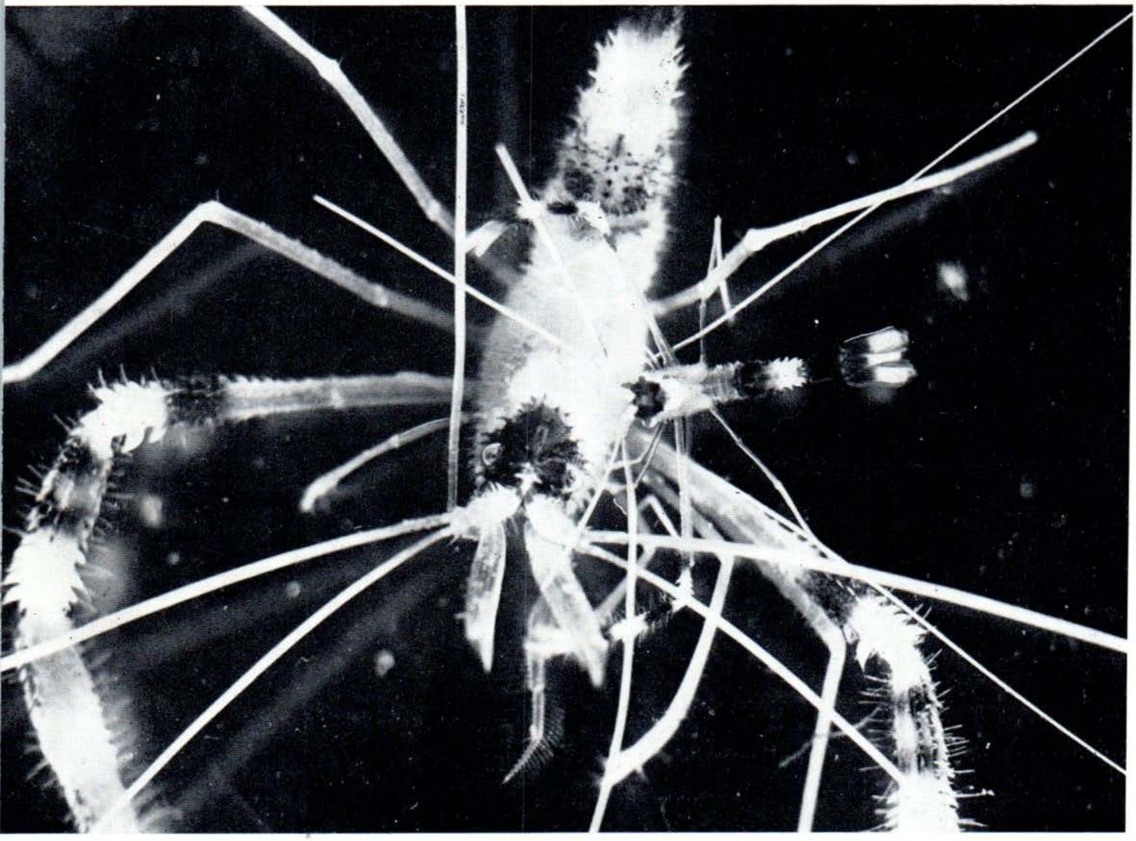
AUSTRALIAN NATURAL HISTORY



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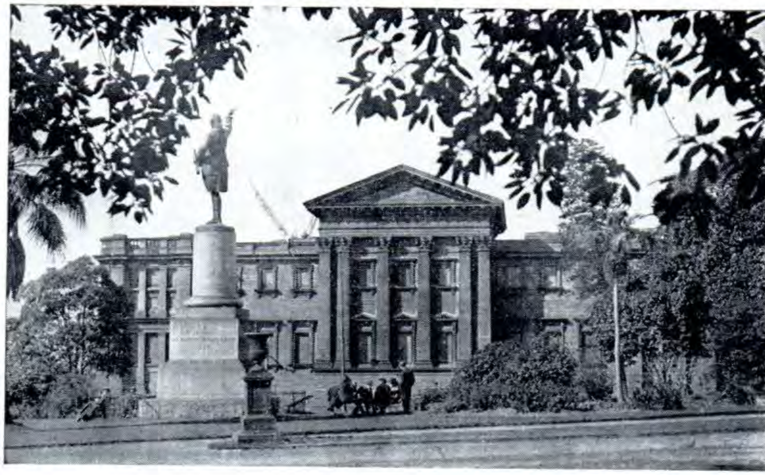

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[*Photography is by Howard Hughes, unless otherwise stated.*]

● **FRONT COVER: A pair of Banded Coral Shrimps (*Stenopus hispidus*) caught in Botany Bay, Sydney, by a skin-diver. The diminutive male is perched across the back of the 2½-inch-long female. An article on this pair-association is on page 286.**

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THE AUCKLAND ISLANDS EXPEDITION 1962-63

By JOHN C. YALDWYN

SOME 200 miles south of the New Zealand mainland lie the isolated Auckland Islands, the largest of a scattered grouping of islands somewhat loosely called the Subantarctic Islands of New Zealand. The Aucklands, or the Lord Auckland group as they were originally named, with the even more isolated Campbell Island, occupy much the same position in the minds of New Zealanders as Macquarie Island does in the minds of Australians. (See "The Wildlife of Macquarie Island", by Robert Carrick, *Australian Museum Magazine*, Vol. XII, No. 8, page 255, December, 1957.) That is, they are looked upon as bare, windswept outcroppings of rock and peat in the cold southern ocean, suitable only for seals, penguins and other sea birds, but with semipermanent occupation by meteorologists and other scientists vaguely associated with more adventurous expeditions to the Antarctic Continent itself. The description is partly true, but these subantarctic islands in general are important biologically in their own right for the very fact of their remoteness and inaccessibility. As the famous botanist Sir Joseph Hooker said of them in his *Flora Antarctica*, 1845, "it will appear that islands so situated furnish the best materials for a rigid comparison of the effect of geographical position and the various meteorological phaenomena on vegetation, and for acquiring a knowledge of the great laws according to which plants are distributed over the face of the globe." It was to study more of these effects on the vegetation, on the insect fauna, on the marine animals, as well as to continue the survey of breeding and nesting places of southern wildlife, especially Hooker's Sea Lion and the Royal Albatross, that the New Zealand Department of Scientific and Industrial Research (D.S.I.R.) combined with the Dominion Museum, Wellington, in sending an expedition to the Auckland Islands in December, 1962.

The Auckland Islands were discovered by Captain Bristow of the *Ocean* in 1806, just four years before the discovery of Macquarie Island. Bristow was employed by the whaling firm of Samuel Enderby and Sons, of London, and for the next 15 years

Several extended harems of Hooker's Sea Lion at Sandy Bay, Enderby Island. This beach is one of the main breeding colonies of the species and the sand dunes in the background contain abundant subfossil remains of previous breeding populations. At left is pasture induced by the browsing of cattle and rabbits. [Photo: John Moreland, Dominion Museum.]

or so these subantarctic islands were vigorously exploited for sealskins and oil, much of which passed through Sydney, the centre for sealing in New Zealand and the southern islands. By about 1820 the sealing potential of the Aucklands was virtually exhausted and little was heard of these islands until they once more came into prominence through being visited by three major scientific expeditions in the course of the same year.

In 1840 a French expedition under Admiral Durmont d'Urville, with the naturalists Hombron and Jacquinot, visited the Auckland Islands in the corvettes *Astrolabe* and *Zélée*. Earlier in the same year the United States Exploring Expedition under Commodore Wilkes had made a short stay, and later the British Antarctic Expedition under Sir James Clark Ross in the *Erebus* and *Terror* spent some time in Port Ross at the northern end of the main island. The naturalists Sir Joseph Hooker and Dr. Lyall made extensive investigations on the natural history of the group and later publications of this expedition, together with those of the French and American, laid the basis of our knowledge of the plants and animals of the Auckland Islands.

Disastrous Shipwrecks

After an ill-fated attempt at permanent settlement, sponsored by Samuel Enderby and Sons in 1849-52, the islands were ignored for many years. However, from the 1860s to the early 1900s there were a series of disastrous shipwrecks as the Aucklands lay on the shipping route between eastern Australia and Cape Horn. These wrecks, including that of the *General Grant* with gold from the Victorian fields in 1866, introduced a new period of periodic visits by New Zealand Government ships, often with scientists, and the establishment of a series of castaways' depots on all the New Zealand subantarctic islands.

With the opening of the Panama Canal the Auckland Islands were once more left virtually unvisited until World War II. The New Zealand Government, realizing that enemy vessels might well use the Auckland and Campbell Islands as landfalls and refuelling bases, established coastwatching stations on both islands in 1941 under the code name of the *Cape Expedition*. The personnel of these stations were deliberately chosen to include a number of botanists, zoologists and geologists, and much valuable work was done on the natural history of these islands. In addition, the first regular meteorological observations from this area were made and these proved so valuable that after 1945 the Campbell Island station was retained as a permanent meteorological observatory and has remained in full operation ever since. However, the two Auckland Islands stations, No. 1 in Ranui Cove, Port Ross, at the northern end of the main island, and No. 2 in Carnley Harbour, at the southern end, were closed down at this time. It was the huts of station No. 1, abandoned and virtually unseen since 1945, that the combined D.S.I.R.-Dominion Museum Expedition hoped to occupy in December, 1962.

Expedition Meets Bad Weather

The expedition consisted of 14 people under the leadership of Dr. R. A. Falla, Director of the Dominion Museum. Dr. Falla has done extensive work on antarctic and subantarctic wildlife and, being in charge of the Cape Expedition for two seasons during the war, had spent some time at station No. 1 as well as visiting all other stations then in operation. The executive organizer was Dr. E. J. Godley, Director of Botany Division, D.S.I.R., and the rest of the party included botanists, entomologists, marine biologists, a geologist, a Government Wildlife Officer, a carpenter and a cook who was also a forest ranger.

The party left Lyttleton on the New Zealand Antarctic supply vessel H.M.N.Z.S. *Endeavour,* an ex-U.S. Navy tanker, on her first voyage to McMurdo Sound on December 22, 1962. Winds up to 40 knots were encountered and the expedition's 14-foot launch was smashed to pieces by high seas on the foredeck where it had been stowed. After this mishap, the *Endeavour* made an unscheduled stop at Dunedin, where two dinghies (14 and 16 feet long) with outboard motors were borrowed. The same bad weather caused a privately-owned fishing vessel, sailing independently to the Auckland Islands to act as the expedition's seagoing transport, to turn back and this deprived us of a chance to carry out a marine programme of dredging and trawling around the islands' shelf.

The *Endeavour* sailed into Port Ross on December 25 and landed the Auckland Islands party, our stores and boats at the Ranui Cove camp site during the next day. The Cape Expedition huts were found to

Part of a sea lion harem, Sandy Bay, Enderby Island. The harem bull is the large dark animal in the centre; beside and beyond him are other dark bachelor males. The light-coloured animals in the foreground are females, and several can be seen suckling pups. Other pups are in the extreme right foreground. This photo was taken late in the season, when the rigid harem structure was beginning to break up. [Photo: John Moreland.]

The characteristic coastal Southern Rata forest of Ranui Cove, Port Ross, with *Olearia*-covered Ewing Island in the left background. The expedition's 16-foot sailing dinghy is tied to the partly submerged Cape Expedition stone jetty in the foreground. [Photo: John Moreland.]

be in fair order, though somewhat overgrown and lacking windows. Our party slept in Army tents and used the huts for living quarters, radio room and laboratories. Weather conditions were not good for the type of work planned as the heavy rain, high winds and high humidity made extensive work away from the base camp difficult and uncomfortable. The scattered fine, clear days, however, allowed a fairly thorough survey to be carried out on the northern portion of the main island, Port Ross and the northern off-shore islands, Enderby, Ewing, Ocean and Rose.

Fine Harbours

The main Auckland Island is some 23 miles in length from north to south, with a greatest width of about 15 miles. It rises to a height of over 2,000 feet and there is a main ridge running north and south, the backbone of the island. The whole of the west coast is formed of high precipitous cliffs, while the east coast is less rugged and indented by several fine harbours and inlets. The vegetation is distinctive, and characteristically and unexpectedly vigorous. To quote Sir Joseph Hooker again (Hooker in Ross's *Voyage to Antarctic Regions*, 1847):—

> "Possessing no mountains rising to the limits of perpetual snow . . . the whole land [the Auckland Islands] seemed covered with vegetation. A low forest skirts all the shores, succeeded by a broad belt of brushwood, above which, to the summits of the hills, extend grassy slopes. On a closer inspection of the forest, it is found to be composed of a dense thicket of stag-headed trees, so gnarled and stunted by the violence of the gales as to afford an excellent shelter for a luxuriant undergrowth of bright-green feathery ferns and several gay-flowered herbs. With much to delight the eye, and an extraordinary amount of new species to occupy the mind, there is here a want of any of those trees or shrubs to which the voyager has been accustomed in the north."

The coastal forest is mainly formed of the Southern Rata, *Metrosideros umbellata* (Myrtaceae), rising in sheltered areas to a height of about 40 feet and clearly shown in the photograph of Ranui Cove reproduced here. It is this forest, with its abundant red flowers in season, which is so distinctive of the Aucklands, as all other subantarctic islands are characterized by the total absence of trees of any kind, the tallest vegetation being low scrub and tussock. Under this forest and in more open places near the shore can be found the Macquarie Island Cabbage, *Stilbocarpa polaris* (Araliaceae), a large-leaved plant whose "copious bright-green foliage and large umbels of waxy flowers, often nearly a foot in diameter, have a most striking appearance" (Hooker). This is an antiscorbutic well-known to sealers, but now largely eaten out in accessible areas by introduced mammals such as pigs and goats on the main island and sheep (now removed), cattle and rabbits on certain of the off-shore islands.

The scrubland (mainly *Dracophyllum* and *Suttonia*) above the coastal rata is thick and difficult to penetrate, but progress through this and the tussock grassland (*Danthonia* and prostrate *Coprosma*) and peat bogs of the open uplands is fairly easy if advantage is taken of the so-called "clears". These are long lanes of open tussock parallel to the prevailing wind but often interconnecting and forming a natural route from one landmark to another. One of the main objectives of the D.S.I.R. botanists was to map the distribution of the various vegetation types represented on the island and much time was spent above the scrub line mapping and collecting herbarium specimens.

The entomologists, under Dr. J. L. Gressitt, of the Bishop Museum, Hawaii, were especially busy; as well as making extensive general collections with light-trap, sweep-net and Berlise funnel, they paid special attention to the several different orders that had both wingless and winged representatives on the islands. Wingless Diptera and Lepidoptera, as well as semi-apterous ichneumons, were already known from the Aucklands but wingless species of other orders were found. This work was part of the Bishop Museum programme on Pacific insect distribution, which included using aerial plankton nets in the rigging of both the *Endeavour* and the U.S.S. *Durant* for catching wind-blown insects at sea during the voyages to and from the islands. The first orthopteran from the group, a new wingless cricket (Raphidophoridae), was taken abundantly on the smaller-offshore islands at night, and this as well as many other new records will greatly increase the Auckland Islands list of 151 previously recorded insect species.

Marine Biology

Professor G. A. Knox, of the University of Canterbury, made a detailed study of intertidal zonation on rocky shores to compare with other widespread subantarctic areas. Thus Auckland Island zonation can now be directly compared with that on Macquarie Island or that found in southern South America visited by Knox and Godley during the Royal Society Darwin Memorial Expedition, 1958-59. The supralittoral was a clearly defined and obvious white lichen zone abruptly changing into a mid-tidal zone of predominantly bare rock. Scattered limpets occurred here, and in the more exposed portions an irregular barnacle band could be found. This "bare" zone abruptly changed into a lower-tidal zone of encrusting coralline algae and the giant kelp *Durvillea antarctica*. An extensive zone of red and brown algae was found in the sublittoral. On boulder beaches and in intertidal rock pools a cryptic fauna of small gastropods, fish and worms was found as well as large numbers of the small circum-subantarctic crab *Halicarcinus planatus*, the only intertidal crab on any subantarctic island. A small hermit crab swarmed immediately below low tide level, while nets and traps took several small fish, including pipe fish, and the bright red shrimp *Nauticaris*, from sublittoral algae.

Mr. J. Moreland, ichthyologist at the Dominion Museum, and the writer spent much time, between periods of working on unreliable and recalcitrant outboard motors, trawling and dredging from the expedition's dinghies both inside Port Ross and in a shallow bay on the outer eastern coast. The shallow-water area of Port Ross is characteristically a sand bottom with scattered, but extensive, patches of mixed red algae. The large red spider crab *Jacquinotia* (see photograph) dominated this bottom. It was caught by every type of gear used at this depth—baited trap, set net, hand line, dredge and small trawl, some of the overnight nettings yielding well over 100 specimens. Two species of nototheneid fish were taken by hand line and trap from this area and from the *Macrocystis* kelp beds off rocky headlands. Other crabs from these shallow waters include the large *Leptomithrax australis* and the edible *Cancer novaezealandiae*. Trawling in deeper waters down to about 15 fathoms in Port Ross and outside on the eastern coast demonstrated a sandy bottom or a distinctly different sponge bottom, with extensive dead shells of several species, the swimming crab *Nectocarcinus*, sand shrimp *Pontophilus*, "squat lobsters" *Munida subrugosa* and several small fish including sand-burrowing species.

The most spectacular aspect of subantarctic biology is the seal and sea-bird

A large Southern Spider Crab (*Jacquinotia edwardsii*), abundant in shallow waters around the Auckland Islands. The body, excluding the legs, can grow to eight inches in length. [Photo: F. O'Leary, Dominion Museum.]

populations on most islands. The Aucklands were no exception. Hooker's Sea Lion (*Neophoca hookeri*), restricted to the New Zealand area, were present in every sheltered bay and inlet examined and our initial landing in Ranui Cove was vigorously opposed by a large male. The large and famous breeding colony on the sandy beach of Enderby Island was crowded with hundreds of animals during our visit (see photographs) and the continual clamour and growl of fighting males and active harem life could be heard on the main island across Port Ross at any time of the day or night.

Yellow-eyed Penguins (*Megadyptes antipodes*) were nesting under coastal shrubs and other cover throughout Port Ross during our visit, and schools of crested penguins, *Eudyptes* species, from colonies at the foot of the west coast cliffs were "porpoising" and feeding in the harbour during fine weather. Auckland Island Shags (*Phalacrocorax campbelli colensoi*), Red-billed Gulls (*Larus novaehollandiae*), Antarctic Terns (*Sterna vittata*), Giant Petrels (*Macronectes giganteus*), Sooty Albatross (*Phoebetria palpebrata*) and the pugnacious scavenger, the Southern Skua (*Stercorarius lonnbergi*), were nesting in the open at different points in the Port Ross area. Burrowing petrels were mostly restricted to offshore islands due to the activity of introduced cats and pigs on the main island, thus

A Royal Albatross (*Diomedia epomophora*) on its nest on Enderby Island. The nesting site is in low scrub at the edge of open tussock moorland on the central part of the island. [Photo: John Moreland.]

Prions (*Pachyptila desolata*), Diving Petrels (*Pelecanoides urinatrix*), Sooty Shearwaters (*Puffinus griseus*), White-headed Petrels (*Pterodroma lessoni*) and others were examined and banded on Ewing, Ocean and Rose Islands. Of special ornithological interest was the study of quite large numbers of the elusive Auckland Island Flightless Duck (*Anas aucklandica*) on both Ocean and Ewing Islands.

Magnificent Albatrosses

The highlight of the expedition for the writer was a visit to the breeding colony of the Auckland Island population of the southern race of the Royal Albatross (*Diomedea epomophora*). This race is apparently the biggest of all the albatrosses, averaging a little larger than the Wandering Albatross (*D. exulans*), though popular literature has the latter as the largest of all flying birds. These two great albatrosses can have wing spans of up to 11½ feet and can weigh up to 25 lb. (See also "The Wandering Albatross" by M. D. Murray, *Australian Natural History*, Vol. XIV, No. 3, page 75, September, 1962). The Royal nests only on Auckland and Campbell Islands (larger southern race), Taiaroa Head on the South Island of New Zealand and on the Chatham Islands to the east of New Zealand (smaller northern race). On the Aucklands it appears to be restricted to the tussock and scrub uplands in the centre of Enderby Island and at the time of our visit about 10 nests were found. These magnificent birds made no objection to gentle handling, though sitting in each case on a single egg, and were readily photographed and banded by our party.

Shortly after completing observations on the Royal Albatross, but before work had finished on Enderby, a message from New Zealand on the expedition's radio recalled all our field parties. Our relief vessel, the U.S.S. *Durant*, was due in earlier than expected from weather picket work half-way between New Zealand and Antarctica. The *Durant* arrived on January 20, picked up our party, gear and collections and made a fast return run to Dunedin in 24 hours.

The "Glory of the Seas"

By DONALD F. McMICHAEL

THE Australian Museum was recently presented with a fine specimen of one of the world's most highly-prized sea-shells. It is *Conus gloriamaris* Chemnitz, which is generally known, by the translation of its specific name, as the "Glory of the Seas". The shell was found some years ago by Mr. George Edwards, a planter from the Duke of York Islands, north of Rabaul, New Britain, while beach-combing near his home. Although occupied by a hermit-crab it was in almost perfect condition, having only two minor chips in the outer lip of the shell, and still retaining most of its original colour. Just where the hermit-crab obtained the shell remains a mystery, for the species has not been found living on the coral reefs nearby, even though these have been thoroughly searched by a number of collectors. We can only surmise that the shells normally inhabit the deeper water beyond the edge of the coral reefs, and this may be one of the reasons why *Conus gloriamaris* is such a rare species. The species has, on occasions, been collected alive on coral reefs, the most notable find being that made by the famous English collector Hugh Cuming in 1838 on the island of Bohol in the Philippines. On discovering three live specimens under a rock, Cuming was so overjoyed that he later wrote "I almost fainted with delight!"

The species has been known for a long time, as it was described as early as 1777, the original specimen now being preserved in the Zoological Museum at Copenhagen. Over the years, the shell has always been the most prized of all sea-shells, and many collectors have paid large sums to acquire specimens. Some years ago, Mrs. W. S. S. Van der Feen, the conchologist at the Amsterdam Museum, made a survey of the scientific literature and estimated that some 22 specimens were known to exist in the collections of the world, although as many as 11 additional specimens which had been recorded could not be located or were known to have been destroyed. Since then, about six more shells have been reported, some being new discoveries, while some were old specimens located in collections in various parts of the world. The most recent living specimen was found near the island of Corregidor, in the Philippines, in October, 1957, while other recent finds have been of dead shells. Until quite recently all known specimens came from the eastern islands of Indonesia and the Philippines, with one exception. This was a dead and broken shell found on the reef at Yap Island in the Caroline Group.

About a month ago, a Rabaul collector, Mrs. A. Appleton, found a specimen of the "Glory of the Seas" on a beach near Rabaul, and the find received much publicity. This resulted in Mr. Edwards producing his specimen, which he had found about five years previously, and through the agency of Mr. Paul Savelieff, who was collecting in New Guinea on behalf of the Australian Museum at the time, Mr. Edwards agreed to present his specimen to the Museum, even though he had received very high cash offers for the shell.

The "Glory of the Seas" Cone Shell recently presented to the Australian Museum.

The specimen measures $4\frac{5}{8}$ inches long (117 mm.) by $1\frac{3}{4}$ inches wide (44 mm.). It is in good condition, with a slightly eroded apex, though the early whorls are all present. The colour is yellowish-brown, with very fine cream to white triangular markings, surrounded with fine dark reddish-brown lines. It has been registered as No. C. 64204 in the Australian Museum Mollusca collection, and will be placed on permanent exhibition in due course.

A litter of four Long-nosed Bandicoots (*Perameles nasuta*) which have just emerged from the pouch for the first time at seven weeks after birth. They are completely covered by a short smooth coat, and their eyes have opened. [Photo: T. C. Dagg.]

Australian Bandicoots

By A. G. LYNE

C.S.I.R.O., Division of Animal Physiology, Ian Clunies Ross Animal Research Laboratory, Prospect, New South Wales

THE bandicoots (Family Peramelidae) are among the most interesting of the marsupials and are unique to the Australian region. They have anatomical features that link them with the two major groups of marsupials. Their dentition is like the insect- and flesh-eating families, yet they possess certain peculiarities of the hind-foot, seen in the herbivorous kangaroos, wallabies and Australian possums. The fourth toe is enlarged and the second and third toes are bound together, or syndactylous, so that they appear as one, only the top joints and claws being free. One of the functions of these curious combined toes is that of a comb for freeing the hair from dirt and parasites.

The popular name "bandicoot" was originally applied to a genus of large rats which are found over much of southern Asia. It is derived from the Telugu language, spoken in southern India, and means "pig-rat".

The marsupial bandicoots comprise a large number of species belonging to eight genera and they have been described from Australia, New Guinea, and nearby islands. The general appearance and approximate distribution (past and present) of the four principal Australian genera [*Perameles* (1), *Isoodon* (2), *Chaeropus* (3), *Thylacomys* (4)] are shown on the accompanying map. There appear to be about six species of *Perameles* and seven species of *Isoodon*. *Chaeropus* is represented by only a single species and *Thylacomys* by three species. A single specimen of a typical New Guinea genus (*Echymipera*) was described from north Queensland in 1948 but it is not considered in this article.

Bandicoots range in size from a rat to a rabbit. Though an elongated snout is characteristic of all bandicoots, the head is stouter and the muzzle correspondingly shorter in the genus *Isoodon*, the members of which are known by the popular title of

Short-nosed Bandicoots. The ears are short and rounded in the genus *Isoodon*, more elongated and pointed in the genus *Perameles*, the Long-nosed Bandicoots, and greatly elongated in the Rabbit-eared Bandicoots (*Thylacomys*) and the Pig-footed Bandicoot (*Chaeropus*).

Two distinct types of hair, an outer coat of coarse spines and an inner coat of soft underfur, are characteristic of both the Short- and Long-nosed Bandicoots. In *Isoodon obesulus*, for example, the individual spines are flattened and grooved on one side and rounded on the other side. In the Rabbit-eared Bandicoots the hair is long, soft and silky whereas in the Pig-footed Bandicoot it is more coarse. A barred pattern on the rump is characteristic of the genus *Perameles*. *Perameles nasuta*, however, is supposed to be without markings or stripes anywhere but juvenile specimens showing a faint barred pattern on the rump are common.

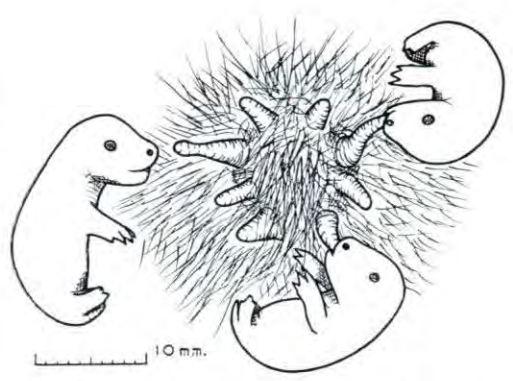
The great interest attached to the Pig-footed Bandicoot lies in the modification of the feet; the forefoot has only two functional toes and the hind-foot only one. The forefoot is therefore assuming the condition of the cloven-hoofed ungulates and the hind-foot that of the solid-hoofed ungulates.

Food And Nesting Habits

Both Long- and Short-nosed Bandicoots are nocturnal and omnivorous, or mixed feeders, with a preference for a meat diet. In the wild they are known to eat snails, slugs, caterpillars, earthworms, insects (larvae and adults) and small lizards. Vegetable matter taken from their stomachs includes grass, wild passion fruit, sugar cane and cranberry seeds. Some of the plant material is probably swallowed accidently in the search for insects, etc. In captivity they readily accept minced meat, earthworms and mice in preference to vegetable matter.

Rabbit-eared Bandicoots also appear to be mixed feeders. Termites, insect larvae, mice and other small mammals have been found in their stomachs. The few reports on the Pig-footed Bandicoot suggest that it lives mainly on a vegetable diet.

The conical holes dug by the forefeet of bandicoots in their search for food are a common feature of some gardens. Although



This diagram shows a litter of juvenile pouch-young of the short-nosed species *Isoodon obesulus* and the typical arrangement of the teats in the bandicoot family. A teat with an enlarged tip is shown beside the unattached young. [Drawn by A. G. Lyne.]

these diggings may be disturbing to the gardener, the bandicoots are probably assisting considerably in the control of mice, snails, slugs and other destructive pests.

During the daytime both Long- and Short-nosed Bandicoots hide in a well-concealed nest which they usually make beneath a mound of grass or leaves. No permanent hole is left in the nest, for they burrow in and out on any side. The entrance is completely closed after they enter. In captivity, males often fight but a number of females can be kept with a single male, and they usually occupy the same nest.

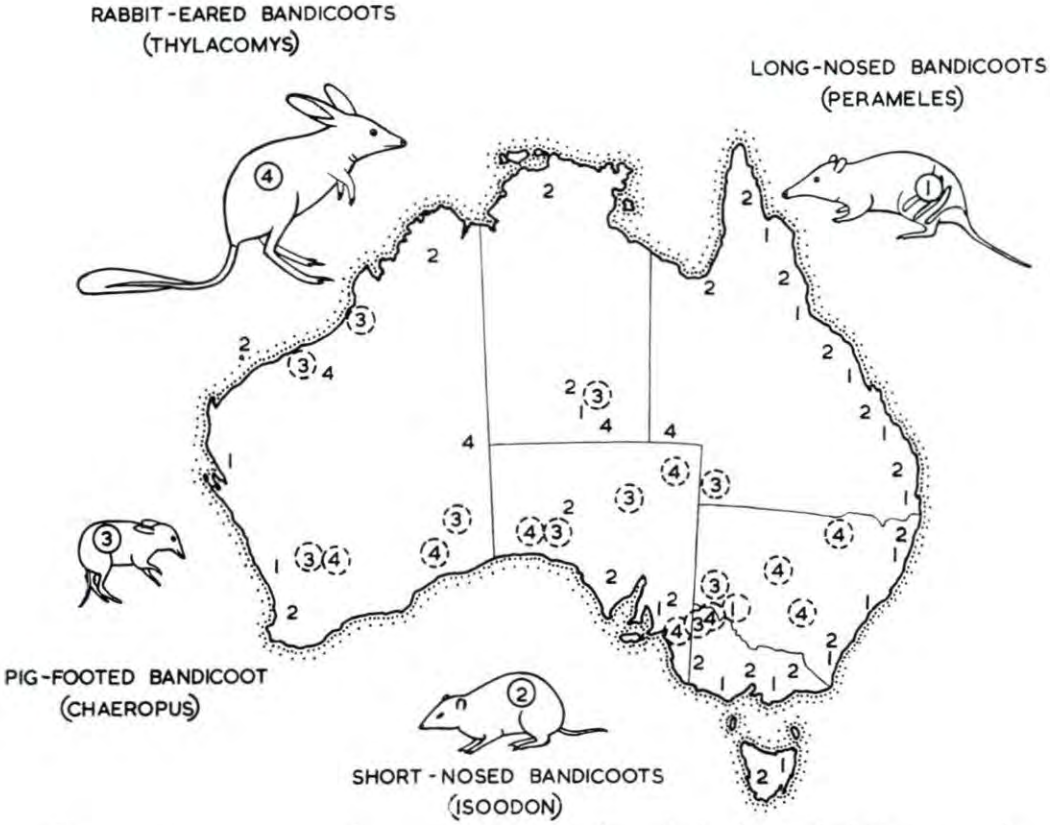
The Rabbit-eared Bandicoots are unique in that they live in burrows from three to six feet deep (see article by A. E. Newsome, *Australian Natural History*, Vol. XIV, No. 3, pp. 97-8, September, 1962).

Pouch

Bandicoots are typical marsupials in that the young are born at a very early stage of development and they are reared within a pouch. This pouch, which opens downwards and backwards, usually contains eight teats arranged in two curved rows of four (see diagram showing teats and juvenile young of the short-nosed species *Isoodon obesulus*). Only six teats have been reported in some bandicoots. Each teat is associated with a separate mammary gland.

Breeding

The long-nosed species *Perameles nasuta*,



The general appearance and approximate distribution of the four principal genera of Australian bandicoots. The numbers surrounded by broken circles refer to past distribution records, mainly of the last century. The range of the Rabbit-eared Bandicoots has shrunk considerably since European occupation, and the Pig-footed Bandicoot is now possibly extinct. [Drawn by A. G. Lyne.]

found only in eastern Australia from north Queensland to Victoria, is probably one of the best-known bandicoots. Near Sydney this common bandicoot breeds all the year round, with no indication of any peaks of breeding activity. The number of litters per year has not been determined but it is known that some animals become pregnant when they are still suckling a litter.

The short-nosed species *Isoodon macrourus*, found in northern New South Wales and Queensland, breeds all the year round in the vicinity of Brisbane [see M. J. Mackerras and R. H. Smith (1960), *Australian Journal of Zoology*, Vol. 8, pp. 371-382]. Limited observations on the bandicoots in Tasmania, *Perameles gunnii* and *Isoodon obesulus*, also suggest that they breed throughout the year.

In *Perameles nasuta* and *Isoodon macrourus*, females start breeding when only half grown. To date, the breeding of bandicoots in captivity has not been very successful. Cannibalism is one of the major problems of rearing bandicoots in captivity. Mother bandicoots often kill and eat their young, even when they are covered with hair at six to seven weeks of age.

The gestation period, or the period of development before birth, is about two weeks in the two species for which information is available (*Perameles nasuta* and *Isoodon macrourus*).

New-born Young

New-born specimens of *Perameles nasuta* are about 13 mm. ($\frac{1}{2}$ inch) long and weigh about $\frac{1}{4}$ gram (less than 1/100th oz.). The mother usually weights about 900 grams. In other words, the mother is usually about 3600 times heavier than the new-born baby.

At birth, the young resemble other marsupials in that they are provided with strongly developed fore-limbs and the fore-feet are equipped with three well developed claws which are shed soon after the young reach the pouch. These deciduous claws are curved in towards the centre of the palm and, no doubt, help the new-born to take hold of the mother's hair on its way to the pouch. Although the birth of a bandicoot has been witnessed, the passage of the young to the pouch has not been described.

Growth Of The Young In The Pouch

Eight is the maximum number of young that can be accommodated in the pouch but litters greater than seven have not been reported. Litters of two or three young appear to be the most common.

The new-born young sucks a teat into its mouth and remains firmly attached during most of its pouch life. The sucked teats enlarge and elongate during this period; they act not only as milk ducts but also to help to hold the young within the pouch. At no time is there any union between the teat and the young, which can always be removed by pulling gently. The specimens in the photo on this page are still firmly attached to the teats; the eyes are closed

A litter of three pouch-young of the Long-nosed Bandicoot (*Perameles nasuta*) about 25 days after birth. The young, which are still unable to let go of the teats, have been taken out of the pouch for photographic purposes. They are about two inches long. *Below*: Three Longnosed Bandicoots reared in captivity. The centre specimen is about 17 months old and the others about 11 months.
[Photos: T. C. Dagg.]

and they are still naked except for the whiskers, which are conspicuous on the muzzle and below the eye.

In *Perameles nasuta* the lips of the pouch-young are fused at the sides until they are about five weeks old, when they release the teats for the first time. Hair appears on the body at about six weeks after birth, and about a week later (see photograph) the pouch-young are completely covered by a short smooth coat. At nine weeks the coat is similar to that of the adult. The eyes usually open at 44 to 48 days and the young first venture out of the pouch several days later. When they first emerge they are unsteady on their feet. At 65 to 70 days after birth the young have become too large to return to the pouch. Weaning is at about 75 days.

Perameles nasuta, in common with the short-nosed species *Isoodon macrourus*, shows the fastest development of any marsupial so far investigated. The growth of the Brush-tailed Possum (*Trichosurus vulpecula*), for example, is only about half as fast as it is in these bandicoots.

Plea For Preservation

In general, bandicoots are disappearing over the whole of continental Australia. For example, the extraordinary Pig-footed Bandicoot (*Chaeropus*), which once had an extremely wide distribution (see map), has apparently disappeared from all former areas, and it now appears to be one of the unique marsupials threatened with ultimate extinction, if it is not already extinct.

The reasons for the disappearance, or decline, of some Australian mammals, particularly some of the species living in the sparsely settled areas, are unknown. It has been suggested that some mammals were on the way out due to long-term environmental change before Europeans occupied this country.

Information on various aspects of the natural history of all but a few bandicoots is sadly lacking. In view of the unique zoological position occupied by these marsupials and the comparative rarity of many species, it is hoped that they will receive wider public interest and the species which remain will not be added to our growing list of extinct mammals.

MUSEUM FILMS AVAILABLE

The following Australian Museum films are available for purchase by educational organizations:—

"The Black Swan": 16 mm., colour-sound, seven minutes.

"White Clay and Ochre": 16 mm., colour-sound, 15 minutes; shows Aboriginal cave paintings in western New South Wales and a method of scientifically recording them.

Prices and information are available on application.

NOTES AND NEWS

VISITOR FROM U.S.A.

Dr. Ernest A. Lachner, a curator of fishes at the United States National Museum, Washington, visited the Australian Museum in December. He had flown from Karachi, where he had been a member of the International Indian Ocean Expedition. He studied the Australian Museum's cardinal fishes, gobies, sucking fishes and other types for comparison with species of fishes obtained by American ichthyologists during "Operation Crossroads" at Bikini Atoll, Marshall Islands.

BARK CLOTH

Dr. Simon Kooiman, Curator of the Oceanic Department of the National Museum of Ethnology, Leiden, Holland, recently spent 10 days at the Australian Museum examining the large collection of bark cloth from Melanesia and Polynesia.

MUSEUM ASSOCIATE

Mr. L. Courtney-Haines has been elected an Honorary Associate of the Museum.

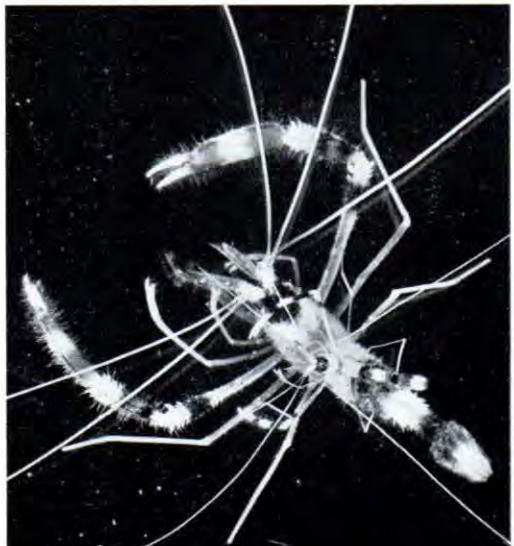
TEKTITES FROM THAILAND

When Dr. J. W. Evans, Director of the Australian Museum, visited Thailand last November, he acquired a number of tektites from north-eastern Thailand. These are, on the average, larger than australites and have suffered a considerable amount of corrosion. None the less they still retain, quite clearly, primary shapes such as the "drop" and the "dumb-bell". These are the first Thai tektites this Museum has received. They were made available by Dr. Kaset Pitakpaivan, Chief of the Geology Section, Department of Mineral Resources, Thailand.

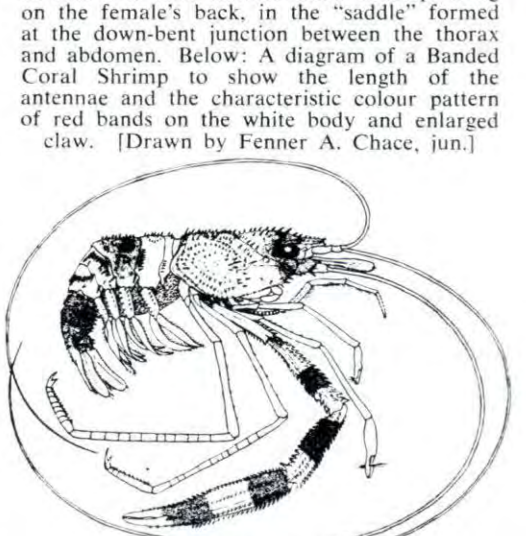
Pair Association in the Banded Coral Shrimp

The unequally matched pair of shrimps shown on the front cover and this page were first observed by Mr. Clarry Lawler while skin-diving during August, 1962, in Congwong Bay, near the mouth of Botany Bay, Sydney. The waving of long, white antennae from a crevice, at a depth of about 18 feet, attracted Mr. Lawler's attention to what appeared to be a single animal with a striking colour pattern of red bands on a white body. After keeping the shrimp under observation in the same *Ecklonia* (large brown seaweed) surrounded rock crevice for eight months, Mr. Lawler brought it into the Australian Museum alive in April, 1963. As suspected from the underwater description, this was a fine record of the Banded Coral Shrimp (*Stenopus hispidus*), long known as a prominent and abundant coral reef animal throughout the tropical waters of the Indo-Pacific and western Atlantic regions, but rarely recorded as far south as Sydney. Elsewhere in the Australian area it is often seen along the Great Barrier Reef and at Lord Howe Island, while illustrations and descriptions of its colour pattern have appeared in several books on our tropical marine fauna. Sydney is probably its extreme southern limit in our waters and it is possible that it can establish itself here only during years of favourable, warm-water conditions.

After bringing the shrimp to the surface in a hand-net and examining it in a glass container of sea-water, Mr. Lawler found that there was a small male riding on the back of what proved to be a much larger female. The pair were photographed extensively by Howard Hughes at the Museum, but these disturbances did not break up the association. The shrimps were then placed in the aquarium of the Honourable Mr. Justice Myers, an Honorary Associate of the Museum, where they were under daily observation until the death of the male three months later, in June, 1963. During this period the pair separated and fed on small brittle-stars and other aquarium scraps. They moulted (the male three times and the female twice) and at various times exhibited a wide range of behaviour, from mutual hostility, through a distinct courting "dance", to the characteristic "saddle" riding as illustrated here. Mr. Justice Myers made photographs of, and detailed observations on, all aspects of behaviour and feeding observed during this period, and these records will be published elsewhere.



Above: The male Banded Coral Shrimp riding on the female's back, in the "saddle" formed at the down-bent junction between the thorax and abdomen. Below: A diagram of a Banded Coral Shrimp to show the length of the antennae and the characteristic colour pattern of red bands on the white body and enlarged claw. [Drawn by Fenner A. Chace, jun.]



Recently it has been shown by overseas workers that the Banded Coral Shrimp is one of a small group of tropical shrimps and fish that have the habit of cleaning other fish. Fish are attracted to such obvious features as the waving white antennae and remain still while the shrimp picks with its smaller claws at parasites and fungal growths on their bodies and fins. The coral crevices in which *Stenopus* may be found apparently become known to fish and they congregate around them in numbers waiting to be cleaned. It is recorded that juvenile shrimps appear to pair and grow up together, and that pairs attempt to stay together when disturbed, but this appears to be the first record of a pair of grossly unequal size and the first record of "saddle" riding.—*J. C. Yaldwyn.*

A baby Crested Port Jackson Shark, 6¾ inches long, from the egg in the background, at Taronga Park Aquarium, Sydney, in 1938. Eleven years later this shark itself laid its first egg. It died in 1950. [Photo: A Jacups.]

SHARKS

By G. P. WHITLEY

IT is a pity that most people are afraid of sharks, because they are very interesting animals, well worthy of study: the majority of them are small and harmless, they have remained as "living fossils", unchanged for millions of years, and some of them have developed elaborate structures to protect their unborn young in a way superior to many other vertebrates.

Sharks are not only usually larger and fiercer than ordinary fishes but they differ from them in having five (or sometimes six or seven) gill-openings on each side of the head instead of only one, their skeletons are of gristle or cartilage instead of the fish's bone, and their tails tilt up at an angle to the axis of the body. The body, instead of having scales, is covered with small rough denticles, the shagreen, and these denticles become enlarged as teeth in the jaws. Every species of shark has characteristic teeth, suited to its food. Many have shearing teeth for slicing the flesh of their prey; in the Port Jackson Shark the front teeth are pointed and the hinder ones are flattened grinders; the Basking Shark has hundreds of small conic teeth. In some species, the teeth in the front of the jaws, when broken off or worn out, are replaced from the rows behind.

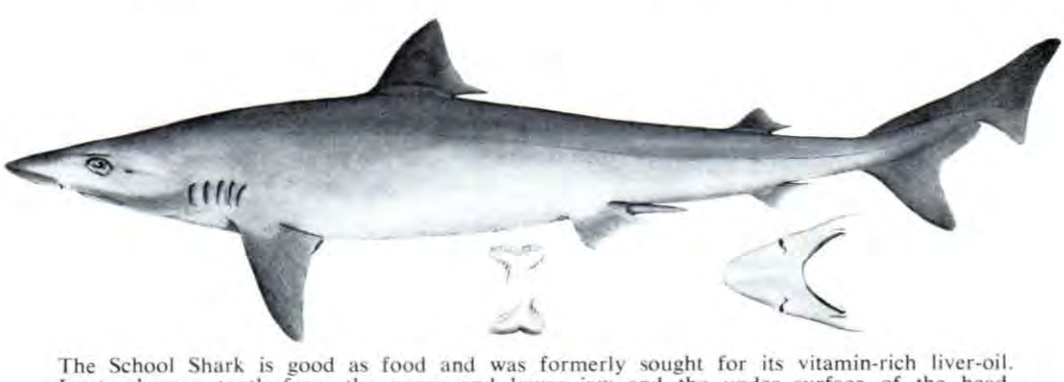
Sharks do not have to turn on their backs before they bite and usually approach their food upright; they do not always show the dorsal fin above the water level. Their usual food is fish or crustaceans and other sea-animals, but black men as well as white are sometimes attacked.

100 Species

There are 100 different species of sharks known from Australia. Some of these (notably the Whalers) are very difficult to distinguish from one another. However, certain kinds are readily identifiable. For example, the Seven-gilled Shark has seven gill-openings on each side of the head. Port Jackson Sharks have bumps over the eyes, teeth pointed in front, grinders behind, and a spine in front of each dorsal fin. Cat-sharks have a long, cylindrical body, often with spots. In the Wobbegong there are fringes of skinny flaps around the mouth and ornamental brown skin-markings. The Tiger Shark has the snout broadly rounded, cocks-comb-shaped teeth, and the body striped. In the Blue Shark the pectoral (side) fins are long and scythe-like, the colour is brilliant blue and the front dorsal fin is nearer the ventral fins than the pectoral fins. Teeth are blunt, like stones in a pavement, in the Gummy Shark, but in the School Shark the teeth are acute and serrated and the tail fin has two somewhat triangular lobes. The Hammerhead Shark has eyes at the ends of side-extensions of the head, which is hammer-shaped. Pointers have a conical snout, awl-like teeth, and extensive gill-slits. The White Shark has triangular and serrated teeth; its hinder dorsal fin is very small. The Thresher has a tail longer than the rest of the animal. The Basking Shark is up to 36 feet long; its gill-arches have comb-like rakers and it has very extensive gill-slits. The Grey Nurse has long pointed teeth, each with two very small cusps, eyes without eyelids, and a front dorsal fin slightly in advance of the level of the ventral fins. The Dogshark or Dogfish is a small shark, generally with a spine in front of each dorsal fin; it has no anal fin. The Saw Shark has a long blade-like snout armed with teeth and with two feelers. The Angel Shark is flattened like a ray, but has gill-slits at the sides of the head.

Reproduction

Some sharks lay eggs and others produce living young. In some related genera, both types of reproduction may be practised. Eggs have tough, horny envelopes, usually brown or black, which may be spirally flanged and pear-shaped in Port Jackson Sharks, or flattened and quadrangular "mermaids' purses" typical of some Dog-sharks; some have tendrils for anchorage to seaweeds. All have a central chamber in which the ovum goes through its development and from which the young shark emerges through a slit at the top of the egg-shell; the period of embryonic development varies in different species and may be more than a year. Usually a pair of eggs is laid at a time, unlike the thousands or even millions of eggs laid by true fishes. The larger sharks (e.g., Tiger, Whaler, Hammer-head, Pointers) do not lay eggs but produce young ones which are miniatures of their parents. These are sometimes nourished by yolk-sacs, but in some a structure rather



The School Shark is good as food and was formerly sought for its vitamin-rich liver-oil. Insets show a tooth from the upper and lower jaw and the under surface of the head. [Drawn by A. R. McCulloch.]

Aborigines with a large Hammerhead Shark at Broome, north-western Western Australia. [Photo: After Whitley.]

like a placenta is developed. A family may number only two babies (as in the Grey Nurse) or sometimes more than 50 (as with a large female Tiger Shark). Fin-spines of embryo Dogsharks are capped by knobs and the teeth of foetal Saw Sharks are laid against the sides of their snouts to prevent lacerating their mothers at birth. Male sharks can always be distinguished from females by their two rod-like "claspers" extending from the ventral fins each side of the anus.

Sharks probably live for many years; a Port Jackson Shark took 11 years to mature and some large sharks have been kept for 16 years in captivity without showing much increase in size. The largest species of shark is the Whale Shark, which has been recorded as reaching 60 feet in length.

Sharks belong to an ancient group of animals and most of them qualify for the term "living fossils". Fossilized fin-spines, teeth and other parts of sharks have been found, even fossilized eggs. Teeth exactly like those of modern Nurse and Tiger Sharks have been found in a fossil state in rocks of Eocene age (some 50 million years old). The Port Jackson Shark's relatives existed, much as they appear to-day, in the Carboniferous seas, over 255 million years ago. Curious shark remains from the Jurassic and Cretaceous periods, 130 to 150 million years old, have been found, but the remote ancestry of the group is still not clear.

Shark Attacks

There have been more than 390 cases of sharks attacking human beings (white and coloured), horses, dogs, boats or surf-skis in Australian waters during historical times: about 118 persons were killed, many recovered, though shockingly wounded, whilst others were bitten only when handling captured sharks. The eastern seaboard of Australia has probably had more tragedies due to sharks than any other part of the globe.

Since the sharks responsible for killing bathers are rarely caught and identified accurately, it is not possible to say with certainty which is the most dangerous of the various kinds involved. From data available, however, it seems that Whaler Sharks of several species are the most guilty, followed by the Tiger, Grey Nurse, and White Shark, and, perhaps, in rare cases, the Blue Pointer and Hammerhead. Very few sharks less than six feet in length have been reported as attacking man.

Sharks have been proved to take their food at any time of the day or night, on the ebb, flow or slack of the tide. Human beings have been attacked at various hours, but most commonly between 3 and 6 p.m., and in depths ranging from "ankle deep" to open sea (though most usually in about four feet of water, and between 10 and 25 yards off shore). Attacks have occurred under all sorts of sea and beach conditions. Solitary bathers are more often attacked than groups, but the "shark baiter" farthest off shore is not necessarily the one selected. The first attack is usually on the legs or buttocks, but one or both arms may be severed as the victim struggles and flesh wounds are caused by the shark's rough hide and fins. When shark-bite occurs, the mortality rate is about 80 per cent amongst whites and very much less amongst natives.

Apart from in the surf, attacks are likely in creeks and harbours, especially where rubbish such as offal has been dumped. Sharks ascend fresh water for long distances at times and could attack persons in fresh water, but there have been no cases in Australia so far. Dull or clear weather, calm or rough water, wind, air-temperature and bottom formation seem to have little or nothing to do with likelihood of attack, but a water temperature over 70° F. may indicate danger. Careful study of many cases has not revealed any method of determining when an attack may be expected. However, it has been noticed that attacks tend to occur more than once in a given area (of about 10 miles of coast) over a period of days, months, or even a year or two, so that evidently a "rogue" shark is usually responsible and, until that one is caught, further attacks may happen. The worst areas for shark tragedies are the Sydney, Newcastle, Townsville and Cairns districts and in Torres Strait. This may be due to the warm water and the greater number of bathers from the city areas, whilst pearls and trochus cause divers to take risks in north Queensland. Spear fishermen trailing wounded crustaceans and fish are very liable to be attacked, and in southern Australian waters fatal attacks have occurred during aquatic competitions. The most dangerous months for all types of shark attacks are December to March (especially January) in New South Wales, and November or January in Queensland. North of Mackay, Queensland, there have been attacks in all months of the year. Only sporadic attacks have occurred in other States and there have been very few in Tasmania.

Native divers recommend keeping still when a shark is around, but it is doubtful if this is a complete safeguard, since sharks sometimes bite dead bodies. Frogmen recommend swimming towards a shark and shouting under water. The best prevention is to swim in a shark-proof enclosure; nets are erected across some Australian bays and many baths are made safe by strong fencing. A shark may be seen on a clear day from a height if the water is not too rough, so towers on our surfing beaches have proved valuable, a man on the lookout sounding a bell or siren to warn bathers to leave the water. Aeroplanes, flying at about 300 feet or less, can also spot sharks effectively. Since 1937, meshing nets have been hung, curtain-like, overnight, off Sydney beaches in regular rotation. Sharks entangled in these are destroyed ashore. This meshing has evidently greatly reduced the risk of attack, since few persons have been molested off Sydney beaches since meshing began, whereas in nearly every year before, there had been at least one attack.

A chemical shark repellent normal copper acetate, $Cu(C_2H_3O_2)_2.H_2O$, mixed with a dye which stained the water black, was tested in Western Australia in 1944 and found to be 95.2 per cent effective in repulsing dangerous sharks. What attracts sharks is most probably unusual movement or the smell of food, as their colour-blind eyesight is of restricted range (though seemingly efficient in murky water) and they often swim hesitantly around a bait before taking it. The olfactory nerves are very well developed, forming a "brain of smell", and when there has been blood in the water, sharks have been observed (from the air) approaching from a mile or more away. Repellent irritates the shark because of its pungency, but even repellent may be ignored when a school of sharks has worked itself into a frenzy and there is blood and commotion in the water; at that stage, sharks operate by sight rather than smell.

For lists of all kinds of aggression by sharks in Australia, see G. P. Whitley's *Fishes of Australia* (1940) and *The Western Australian Naturalist* (1951). A medical and statistical analysis appeared in *The Medical Journal of Australia*, November 4, 1950, but the definitive work on the subject is the second edition (1962) of Sir Victor Coppleson's book, *Shark Attack*.

Interesting Queensland Specimens

An Australian Museum expedition returned to Sydney from Queensland last November after two months in the field. Members of the expedition were Mr. Basil Marlow, the Museum's Curator of Mammals, Mr. John Disney, Curator of Birds, and Mr. Rolf Lossin, preparator. The main collecting areas were at Normanton and Burketown on the Gulf of Carpentaria and Camooweal, Boulia, Bedourie and Birdsville in the extreme west of the State. The mammal specimens collected included an interesting series of bats and several hopping desert rodents, *Notomys* species, one of which is shown in the top photo. The carnivorous marsupial *Dasyuroides byrnei* (lower photo) and the jerboa marsupial *Antechinomys spenceri* were obtained in the stony desert country near Bedourie. A pair of jerboa marsupials was captured alive and brought back to Sydney for further study. Mangrove Robins (*Quoyornis leucurus*) and a Pygmy Goose (*Nettapus pulchellus*) were collected in the Gulf country, and Gibber Birds (*Ashbyia lovensis*) near Bedourie. This latter species was not previously represented in the Museum collection.

PRE-CAMBRIAN FOSSILS

By M. F. GLAESSNER
University of Adelaide

IN our geological time scale, the present, or the time of man, is included in the Cainozoic, the era of mammals, which was preceded by the Mesozoic, the time of dinosaurs. Before this came the Palaeozoic, in which there were no mammals and no dinosaurs. As we go back in Palaeozoic time we come to a period when fishes were the only existing vertebrates, and this in turn is preceded by a period without vertebrates. This is the Cambrian. Modern work on radioactive minerals dates its end at about 490 million years before the present and its beginning at about 570 million years. As we go back in Cambrian time, through the study of Cambrian strata from their top to the bottom, we find the invertebrate fauna changing in a more subtle way which is obvious only to the specialist. The oldest strata accepted as Cambrian still contain many of the major groups of invertebrates: trilobites and a few other arthropods, snails, worms, brachiopods (lamp shells), sponges. It is most significant that the subtle change in the composition of the fauna was accompanied by a slight change in the composition of the hard skeletons which are preserved in the rocks. The shells of early Cambrian animals are mostly thin, partly phosphatic or chitinous, and the sponge spicules are siliceous, but there are no thick calcareous shells in any of the various groups present, though the descendants of some of them were in later times able to produce such shells and skeletons. The only organisms building large calcareous cup-like skeletons at that time, the Archaeocyatha, must have made some "mistake" which robbed them of their chances of survival: they became extinct by mid-Cambrian time.

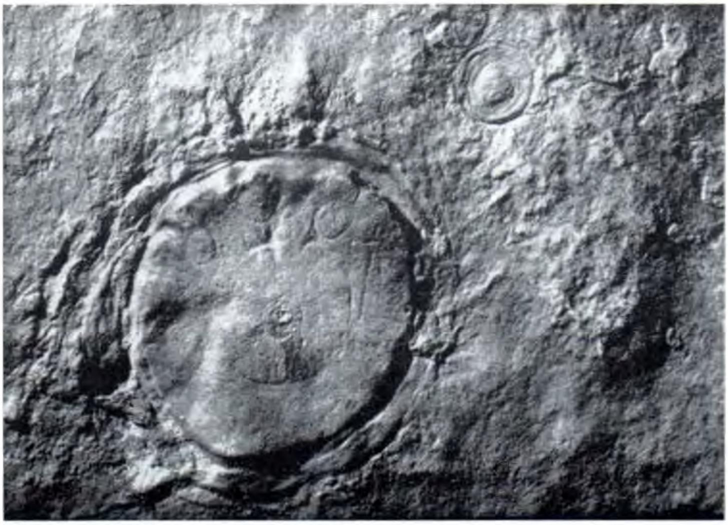
Descending below the lower boundary of the Cambrian we have still the greater part of the journey to the beginning of sedimentation on the earth's crust before us. Having gone back 600 million years, we still have at least another 3,000 million years to go before we reach the oldest rocks.

Tribrachidium heraldicum Glaessner (about twice natural size. [Photo: M. Wade, University of Adelaide.]

Almost inexplicably, the record of life is suddenly very nearly blotted out when we cross the boundary between Cambrian and Pre-Cambrian. Many hypotheses have been advanced to account for this strange fact. They range from cosmic catastrophes to the postulate of an interval of time without sedimentation; from the assumptions of a limeless or a life-less ocean to the thought that all organisms may have lived on the surface of the sea and none on its bottom, or all in the deep sea and none on its shores, or all on the seashore where they were destroyed by waves and shifting sands.

South Australian Fossil Jelly-fish

We do know remains of very ancient Pre-Cambrian algae and other lower plants. Some structures made by algae date back



Beltanella gilesi Sprigg. Cast of a jelly-fish. Half natural size. [Photo: G. Tomlinson, University of Adelaide.]

over 2,500 and some microscopic plants about 1,900 million years. But where are the remains of the ancestors of the half-dozen or more phyla of animals which are found well developed and fully differentiated in Lower Cambrian strata? The hypothesis that they were soft-bodied, without shells that could be preserved, seems the most reasonable one. Fossil remains of soft-bodied creatures are found occasionally, including worms, soft sponges or jelly-fish. When it is considered that their bodies consist of little more than water it is surprising to find the well-preserved impressions of fossil medusae in the rocks. They occur, however, in rocks of various ages. In 1947 a number of different kinds of fossil jelly-fish was described from sandstones which were then considered the lower strata of the Cambrian, at the old Ediacara mines near Lake Torrens in South Australia. The great number of different forms occurring together attracted considerable attention. The Australian geologist R. C. Sprigg, who discovered the first of those fossils and described them, concluded that they dated from the beginning of the Cambrian and that they were the remains of pelagic animals floating or swimming in the sea and stranded on sandy tidal flats or beaches. Their occurrence supported current views on the reasons why the immediately preceding Pre-Cambrian is almost devoid of fossils; it had been termed the age of jelly-fishes.

The desire of local private collectors to add some of Sprigg's fossil jelly-fish to their collections led to sensational new discoveries. The private collectors, Ben Flounders and Hans Mincham, found not only large numbers of presumed fossil jelly-fish and plant-like fronds, but also segmented worms, worm tracks, and strange impressions of animals unlike any known organisms, living or fossil. They made their finds known to the South Australian Museum and to the University of Adelaide, which soon afterwards commenced joint scientific investigations of the locality with the aim of obtaining answers to the following questions: What kinds of fossils occur in the rocks at Ediacara? What are their relations to other fossil faunas? How did they live and how were they fossilized? What is the age of the fossiliferous strata? The answers proved even more sensational than could have been anticipated.

Many Specimens Collected

About 1,000 fossil specimens have been collected, making this in all probability the richest fauna of its age. The fauna includes not only jelly-fish (see illustrations) representing at least six and probably more extinct genera, but also soft corals related to the living sea pens, segmented worms with strong head shields, many odd bilaterally symmetrical animals (*Dickinsonia*, see photo) resembling certain other types of living worms, tracks of bottom-living worm-like animals, and two or three different types of strange soft-bodied creatures which had never been seen before. Fossils similar to the soft corals and some of the jelly-fish from Ediacara have also been found in South Africa, England, North America, and Siberia, in strata considered as Pre-Cambrian. All the animals lived in the sea, some fixed to the bottom, some crawling and many others free-floating or swimming. The fossiliferous rocks were well below the lowest fossiliferous Lower Cambrian strata with Archaeocyatha, and their age is now considered as Late Pre-Cambrian. This is the first rich and varied assemblage of fossil animals of that age which gives us a glimpse of the marine life of that time, not only of a single type of animal but of an association of creatures living together in the sea.

Spriggia annulata (Sprigg). Cast of a jelly-fish. Four-fifths natural size. [Photo: G. Tomlinson.]

New Forms Of Life

There are, in addition to the abundant jelly-fish and worm remains, two new forms of life in the South Australian Pre-Cambrian fauna which deserve a closer look. One (illustrated) has a shield- or kite-shaped body with a ridge shaped like an anchor. It was named *Parvancorina minchami*. The first specimen was very small but later more than 30 others, up to one inch long, have come to light. Some of them show faint oblique markings within the shield on both sides of the midrib, as if the creature had paired legs or gills underneath. Here again folded and distorted specimens occur on the

Top: *Dickinsonia costata* Sprigg (about twice natural size). Bottom: *Parvancorina minchami* Glaessner (about four times natural size). [Photos: M. Wade.]

flat bedding planes. This proves that their bodies were soft.

The other kind of entirely new creature is even stranger (see photo). It was named *Tribrachidium*, as it has three equal, radiating, hooked, and tentacle-fringed arms. Nothing like it has ever been seen in the organic world among the million known species of animals. It recalls nothing but the three bent legs forming the coat of arms of the Isle of Man. The fixed three-rayed spread of tentacles of this strange animal can be considered a lophophore, similar to an organ used for plankton-fishing in living brachiopods (lamp shells), bryozoa (lace corals) and some worms. If that is correct, it may have been bottom-dwelling, possibly sitting on a circular flat base of which a few impressions have been found.

The sand from which the embedding quartzite was formed shows ripple marks and current bedding. How could the evenly coarse grains transported by currents of considerable strength preserve imprints of delicate soft-bodied creatures? Only very few of the animals which are preserved came to rest on the shifting sand. Most of them were deposited on mud-flats or patches of fine clay which settled out of the muddy water between the sand ripples during calmer periods. Some of the mud patches dried out, possibly between tides, and cracked deeply. The next high tide or shifting current covered them with a layer of sand. The lower surfaces of such sandy layers formed perfect moulds of the clay surfaces, showing now in some places the casts of drying cracks and wrinkles of the clay, in others the form of the bodies of animals that had stuck to them. In the transformation of the soft sediment to hard rock the sand grains were cemented by silica solutions to quartzite but the clay lenses were altered to thin slate-like streaks of the mineral sericite, and compacted almost beyond recognition. As these lenses were small and irregular the rock no longer splits along their surfaces as slates would. Only the slow natural weathering in the arid climate of the area is able to open up the rock along the sericitic partings of former clay lenses which disappear altogether in the process. Larger and smaller slabs of flaggy quartzite remain in place projecting from the hill-slopes until they break off and often turn over when moving down the hill. Their lower surfaces when exposed to the infrequent rain then reveal their wonderful riches of Pre-Cambrian animals until they, too, weather away or are worn off by the drifting sand of the adjoining desert.

Cafeteria Opened at Museum

A cafeteria was opened on the roof of the Australian Museum's new wing in December.

It seats 100, *and is open to the general public as well as to visitors to the Museum. It commands a magnificent view of the city and of the harbour from North Head to the Sydney Harbour Bridge.*

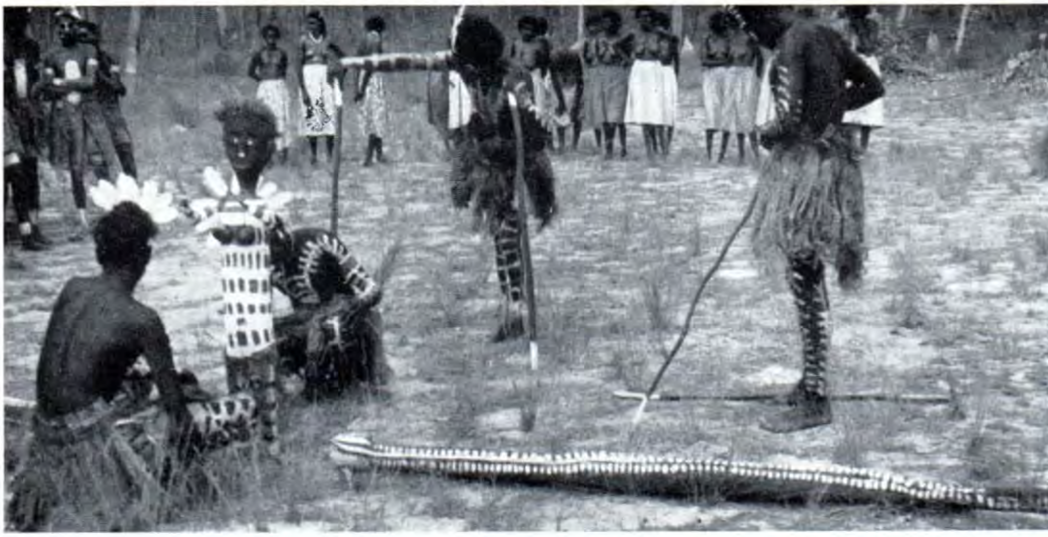
NOTES AND NEWS

AUSTRALITES PRESENTED TO MUSEUM

From 1928 to 1953, Mr. V. C. W. Nicholls, then owner of Pindera Downs, 30 miles east of Tibooburra, New South Wales, collected some 115 australites while working on his property. The majority of these showed regular shapes. In 1945 he presented three perfect flanged-button shaped ones to Mr. H. O. Fletcher, of the Australian Museum's staff, who was then on a field trip to that part of the State. In May, 1963, Mr. R. O. Chalmers, Curator of Minerals at the Museum, visited Pindera Downs and met the son of Mr. V. C. W. Nicholls, Mr. Frank A. Nicholls who now works the property. Over the last 10 years Mr. Frank Nicholls has collected a further 30 australites. Because of this Museum's interest in australites, Mr. V. C. W. Nicholls, now living in retirement in South Australia, has kindly presented 35 of the best specimens from the abovementioned collection of 115 to the Museum.

NEW ZEALAND VISITOR

A recent visitor to the Australian Museum's Department of Molluscs was Dr. A. W. B. Powell, Conchologist and Assistant Director of the Auckland Institute and Museum. Dr. Powell was studying the literature concerning his special research field, the family Turridae.



A dance illustrating an incident in the story of a Taipan Snake man who stole the wife of a Blue-tongue Lizard man. The two principal dancers represent a man and his wife who turned into snakes, and the two stick carriers are pelicans, another totem of the clan. [Photo: Author.]

The Dancers of Aurukun

By FREDERICK D. McCARTHY

THE Aborigines of Australia are famous for their corroborees. A popular entertainment in the early days of Sydney, corroborees performed on Brickfield Hill and in Hyde Park were witnessed from 1790 onwards by high officials and colonists who rewarded the performers with tobacco, food and liquor. Throughout Australia's history, celebrated visitors have seen corroborees arranged in honour of their visits to various parts of the continent.

The ability of the Aborigines to imitate the movements and postures of animals and to mime the mannerisms of the white man has always been recognized but I doubt whether their real talents as dancers have been adequately appreciated. The wide range of steps, the perfect timing of action with music, the lithe and rhythmic movements, the intensity with which the men dance, and the interesting themes expressed give these dances an exceptional interest to the student of dancing. Inspired by motifs from their daily life, religious beliefs and folklore, accompanied by music produced in the simplest possible ways, and performed in bush settings with a fervour and devotion of unusual intensity, Aboriginal dancing has to be witnessed to feel its full emotional impact.

The children absorb the rhythm of the music from babyhood, and they are taught dance steps at an early age by their parents. The boys practise their steps assiduously because dancing is an important facet of the men's life. The women, in general, dance on the side of the corroboree ground, limiting their steps to a shuffle or trot in one spot, but in some areas their dances, from which men are excluded, express special themes. The names of composers of good corroborees, and of outstanding dancers in any area, become bywords in all the camps and their skill is freely and openly admired.

The curlew dance, in which the central figure portrays most gracefully the movements and postures of the bird. [Photo: Author.]

Why Aborigines Dance

The Aborigines dance for a number of purposes. Entertainment is an important one. There are the simple evening camp dances, mimes of hunts and other incidents, in which complete freedom of expression is the rule and good compositions and performances are acclaimed. In these camp-fire corroborees elaborate set tableaux may be performed either of a local traditional kind or of dances learnt from other groups. In the latter type the meanings of the songs and even of the dance itself may not be understood by the performers. The exchange of corroborees between visitors and hosts is a common feature of inter-group gatherings. Love, mourning, hunting and fishing dances illustrate the extent to which dancing has become an expressive art in Aboriginal life.

Dancing is allied with magic in the protection of the warriors. There are war dances in which the men are sung with magic by the medicine-men to make their weapons potent and protect their bodies from the weapons of the enemy. Dances are a feature of peace-making ceremonies, and mock war dances are often performed when the hosts are welcoming visitors to an inter-group gathering.

Totemism, an integral part of Aboriginal religion, is an important inspiration of Aboriginal dancing, especially in central and northern Australia and along the east coast, where increase rites for the totem species constituted an annual ritual for the various clans. Totemic beliefs are usually blended with the mythology of the ancestral spirit-beings of a clan or, as in Arnhem Land, of a cult group. The members of the clans perform the ceremonies, which illustrate the lives of the ancestral beings, as recorded in the myths. Dancing is an incidental part of the ritual, the essential core of which is the life of the ancestor, the display and handling of sacred objects, and the singing of ritual songs.

The initiation ceremonies in many parts of Australia and the numerous ancestral cult ceremonies in central and northern Australia, some of which take months to perform, consist of a mixture of traditional dances and dramatic sets in which little or no virtuosity is permitted because departure from the patterns laid down by the ancestral beings would nullify the aim and purity of the ritual.

Aurukun Beliefs

In western Cape York an unusual type of dance ceremony is performed annually by

Above: The dance of Muipaka, who killed a plover man for stealing his wife. Below: A dance in which two poles represent plover men who helped their wife-stealing clansman fight Muipaka. The dancers are also plover men. The barred board on the ground represents a shield with which Muipaka struck the young plover man on the back of the neck and killed him. [Photos: Author.]

the clans. Here a child joins his father's clan. Each clan has a number of totems and a sacred place on the coast or in the bush in which its totem centres are situated. The totems are the animals and plants supplying food and raw materials, the weapons and implements used to secure and prepare food, and other things, like blood. Several coastal tribes have a limited number of marine (mostly) totems in their small territories, while an inland tribe, the Wikmunkan, occupying a very big area, has many more totem centres. These and neighbouring tribes share a common mythology and recognize their respective totem centres as part of it. Certain totem centres are linked in stories like the one of the carpet snake who defeated the whale in a duel and forced him to retire to the coast to make his totem centre.

The myths of these tribes recount how the ancestors of the clan searched the countryside to find a good place in which the habitat was ideal and food supplies abundant for the totem animal or plant. At such a place the ancestor(s) went down into the ground, usually in a hole, or down into the water of a lagoon, river or the sea. This going-down place is the sacred totem centre, the Auwa, of the clan, where its members perform their ritual dances.

The myths, or stories, of the various clans explain the origin of each totem. In one story a spirit-being named Sara walked from the tip of Cape York down the west coast through various tribal territories. He established a sacred totem ground called Aneiyam, at the mouth of the Embley River, for the crow, wren, gecko lizard, and the spear tree. He then travelled far southwards into Yir-Yiront territory where his further exploits are recorded in the myths of this tribe. He is one of the few true ancestral spirit-beings spoken of in the mythology of this area. He taught the people how to fish, hunt and find other food, how to protect themselves and many other things.

It is difficult to distinguish man from spirit in these stories but today the natives say that the clan ancestor(s) were actual people and not spirits. Thus a shark man saw a fairy girl sitting on a rock in a big lagoon and thought he would capture her to make her his wife. He plastered himself with clay to suppress the odour of sweat on his body and crept up behind a leafy branch which he held. He speared her but she took him down into the water, where together they made the Auwa of this shark. The barramundi fish ancestor was a man who was speared, and who, as he died, went down into a hole on the Kirke River. On the other hand, a big mob of peewee bird men speared one another in combats which went on for several days on a salt plain near the Watson River, after which they all went down into the Auwa hole. When a white ibis ancestor, a man, killed another man of the same totem in a fight the latter's body was carried to the place where the totem centre was established.

The ancestral men and women just appeared—there is no explanation of how they originated. They lived in the same way as the Aborigines have always lived in their country, and some of them had superhuman powers. They became the totem animal or plant after they went down into

The dance of the crow and gecko clansmen. The three principal dancers wear headbands and carry wands decorated with white cockatoo feathers. [Photo: Author.]

the Auwa, and one of their most important functions was to imbue the Auwa with a reproductive life force whose continuity is ensured by the performance of the annual increase rites. The totemic ceremonies re-enact the dances taught to the people by the clan ancestors before they died and went down into their Auwa. In this way the living clansmen sustain the link between the living generations of people and their ancestors.

At the totem centres the clansmen clean out the Auwa hole, at some they sweep the ground clean around lumps of ant heap or stones arranged in special patterns, at others they strike the trees on the site or stamp the ground with their feet. Seeds and corms of the water-lily are cooked in ovens and left to be scattered about the countryside by the wet-season floodwaters. In this way, the life force of the totem, or an actual part of it, is distributed, and the clansmen request the ancestors to provide an ample supply during the next year. Most of the totems are of economic importance but a special series is concerned with human baby spirits.

Totemic Dances

The dances at these Auwa vary considerably in theme. Many of them simply mime the movements of the totem animal—the crawl of the snake, the hop of the kangaroo, the quick run of a bird, together with its characteristic body movements and postures. Thus the elbows of the dancer are moved up and down to represent the flutter of the stingray's fins, the body is raised from the ground on the toes and hands, and the performer looks about on all sides, as a crocodile does when it decides to move about. A similar idea is expressed in a dance epitomizing the searching, finding and collecting of honey in a tree. These naturalistic dances are beautifully performed.

Some dances illustrate an episode in the myth. Thus, the Flying Fox dance depicts two brothers of this totem killing large numbers of these animals, carrying them back to camp on rods and attempting to cook them. They failed in the cooking because men of the same totem should not kill one another. The peewee and ibis dances demonstrate the same lesson to the young initiates present. Myths about the stealing of wives are expressed in dances to demonstrate to the initiates and other men that this practice is against the law of the tribe. Thus, the Taipan Snake stole the Blue-tongued Lizard's wife and was bitten in two by the lizard in a subsequent fight, and the echidna died after he stole the Black Snake's wife.

From two to twenty or so men perform the dance. The women dance in a separate group close to the men and by holding their hands in various positions indicate their kinship relationship with the principal dancers. These tribes have no musical instruments but provide the melody and rhythm by clapping, singing and a series of noises such as "ooh", "aah", "ugh", interspersed with bird calls in relevant dances.

Wide Range Of Steps

The dancers employ a wide range of steps. They trot, jump or hop on one or both feet, shuffle sideways, stamp the ground with one foot, twist one or both feet, move the knees in and out in sitting, bending and upright positions. These steps and movements are done slowly or rapidly, the dancers move quickly into various formations, assume a great variety of body postures (such as weaving, twisting, bending and kneeling), sit, kneel, or stand back to back, and imitate the movements of the animals they are portraying.

An unusual feature of these totemic dances is the use of wooden sculptures of the totem animals and of the ancestral beings. The animals are life-size, the human figures up to four feet high. They are chopped out of kerosene and messmate woods with steel tomahawks and knives, and painted in bright reds, whites, blacks, yellows and greens. They are absolutely naturalistic in shape but the colours have no relationship to those of the living species. Just how long these carvings have been made is not known. The natives say that they have made them in wood only since steel tools became available from the white man, but careful observers of Aboriginal customs who visited these tribes over long periods between 1890 and 1934 did not mention these sculptures.

INSECTS AND ARTIFICIAL LIGHT

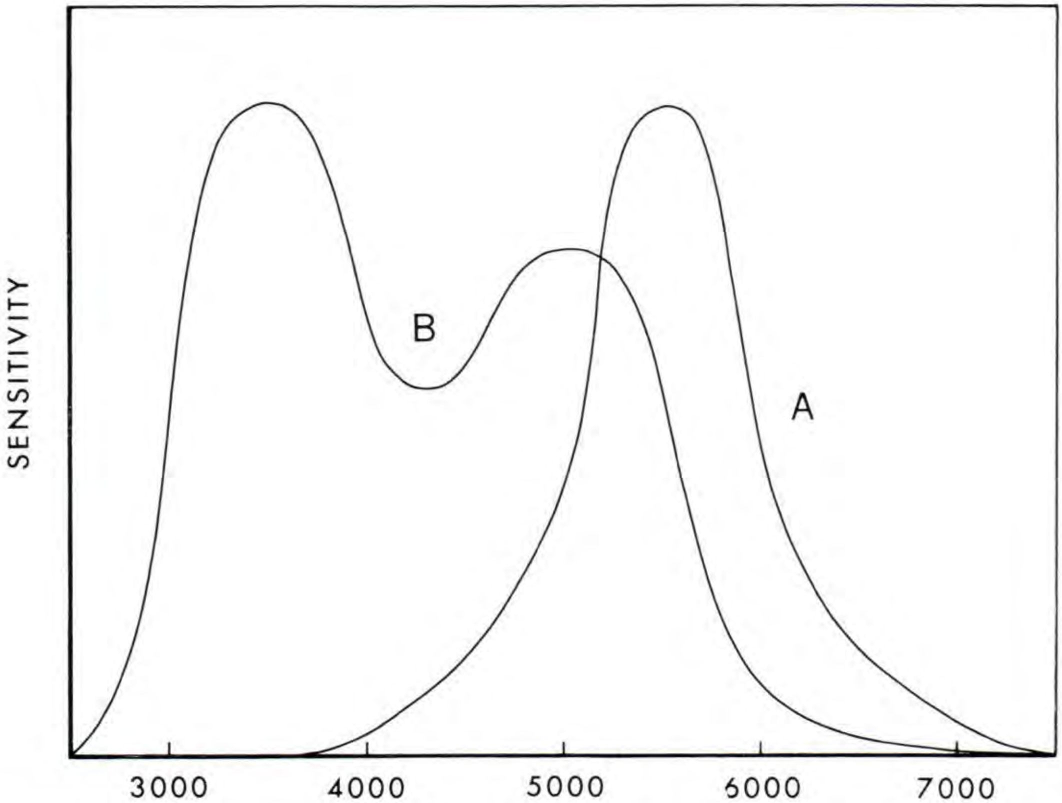
By I. F. B. COMMON

Principal Research Officer, Division of Entomology, C.S.I.R.O., Canberra

EVERYONE has noticed how insects are "attracted" to a lamp on a warm night. The idiosyncrasy of moths to fly into the flames that destroy them was proverbial among the ancient Greeks, and such writers as Aeschylus, the Greek dramatist, and later Shakespeare, John Gay and Shelley refer to the fascination that flames or lights have for moths. Until quite recently, however, no convincing explanation was offered for this behaviour. Even late last century Romanes wrote that the habit must be attributed to mere curiosity or the insect's desire to examine a new and striking object.

Sensitivity To Light

Light as we know it represents one part of a great spectrum of radiant energy. The various radiations which constitute this spectrum move in a wave-like manner at the incredible speed of 186,000 miles per second. Light waves, measured in Angström units (A), range from about 2000 A



The sensitivity of the normal human eye (A) and the compound eyes of insects (B) to light of various wave-lengths from 3000 to 7000 Angstrom units. [Chart by the author.]

at the ultra-violet end of the light spectrum to about 50,000 A at the infra-red end. The human eye is sensitive to a restricted central part of this spectrum, with wave-lengths ranging from about 3800 A at the violet end to about 7600 A at the red end. Light of wave-lengths shorter than 3800 A are filtered out by the lens of the human eye.

The sensitivity to light of the eyes of insects often differs greatly from that of the human eye. Wave-lengths of 2500 A to 7000 A may produce responses of various kinds in insects, although few species are sensitive to wave-lengths exceeding 6000 A. The firefly is one of the few exceptions, and reacts to flashes with wave-lengths of between 5600 and 6900 A produced by its fellow fireflies. Most insects are strongly stimulated by light of the shorter wave-lengths. Many show a maximum sensitivity at about 3600 A, while others are most sensitive at about 5000 A. In experiments, the Pink Bollworm of cotton (*Pectinophora*) showed both of these peaks of response, wave-lengths of about 5000 A being the more stimulating when the light had a low intensity, while the lower wave-lengths produced a greater response when the light was of a higher intensity.

Eyes Of Insects

The compound eyes of insects are made up of a very large number of facets, or ommatidia, well over 10,000 having been recorded for the dragonfly. Light falls upon the retina of the eye simultaneously through each of these ommatidia, producing a composite image made up of a large number of tiny contiguous images. The more numerous the ommatidia, the better the vision. Compared with higher animals, however, insects have a low level of visual acuity, but the compound eye is well suited to the perception of movement.

The function of the pupil in the mammalian eye, which adapts the eye to light or darkness, is performed in the compound eye of the insect by special pigment granules in the cells surrounding each ommatidium. In persistent bright light, these granules become clumped together around the ommatidium, preventing all but perpendicular rays from entering and reaching the retina. As darkness increases, the granules disperse, thus permitting both perpendicular and oblique rays of light to enter each ommatidium. In moths the change from the light-adapted to the dark-adapted condition normally accompanies the natural change from light to darkness each evening and takes about 60 minutes. Adaptation can be induced much more quickly, however, if a light is switched on or off suddenly.

The eyes of an insect that has suddenly come to a light usually show a rich red glow. This is a luminous reflection from the tapetum deep within the eye which, in the dark-adapted state, is visible through several ommatidia at once. In the light-adapted eye, this reflection is visible through only a single ommatidium at a time and therefore is not noticed.

Response To Light

The movement of an insect towards or away from the physical stimulus produced by a light is known as a phototaxis, either positive or negative. The eyes, of course are the photosensitive receptors. Since these are paired, the biologist Jacques Loeb maintained that the insect is forced to move towards or away from the light by reflex muscular responses of different intensity on the two sides of its body. If it is forced to turn in the direction of the eye that receives the greater stimulus, a positive reaction of the insect as a whole results, and it spirals towards the light. If it is forced to turn in the direction of the eye that receives the lesser stimulus, a negative reaction results, and the insect moves away from the light. It has been shown more recently that the ommatidia of the insect eye are not of equal sensitivity to light. Differences in the intensity of the light stimulus received by each part of the eye produce reflex responses of different strength in the muscles on each side of the body. Thus an insect still orients itself to light when one eye is blinded, although some difficulty is experienced at first.

In the presence of artificial light, most insects are positively phototactic only when the eyes are in the dark-adapted condition. While the eyes remain dark-adapted, the insect circles the light or flutters nearby but, when the eyes have become light-adapted, it will often settle in the area of light and remain quiet for several hours or until the light is extinguished.

Factors Which Influence Response

Few insects can be classified simply as either photopositive or photonegative. Not only does light sensitivity and response vary between species, but also between individuals of the one species, and at different times in the one individual, depending upon their stage of development, their physiological state and various factors of their environment. The European Potato Beetle (*Leptinotarsa*), for example, is normally photopositive and feeds on the potato foliage. However, should it become desiccated, it becomes photonegative and hides in the soil until rain falls, when it once more becomes photopositive and climbs up the plants to lay its eggs.

Generally speaking, weather factors which stimulate activity in nocturnal insects also tend to increase the numbers of insects around lights. Warm evenings, especially when the sky is overcast, are very favourable. Even though they may not be strong enough to discourage activity, slight winds tend to reduce the number of insects at light. It has been shown experimentally that fewer insects come to lights during the week of full moon, but the cause of this is not clear. An artificial light may be less conspicuous on moonlight nights and its stimulus therefore less effective. On the other hand, moonlight may affect behaviour by decreasing the activity of insects or increasing the height of their flight.

Light-traps

Most collectors of nocturnal insects have taken advantage of insects' phototactic responses, and those species which show a positive response are often much better represented in collections. Occasionally useful specimens were taken even at the relatively dim yellow lights of candles and kerosene lamps. The development of acetylene lamps, lamps with incandescent mantles, and later the brighter tungsten-filament electric lamps, which produce a much whiter light, greatly increased the effectiveness of this kind of collecting. More recently, the discovery that insects were more sensitive to the ultra-violet and shorter visible wavelengths of mercury and argon gaseous discharge lamps has been exploited by the collector, with surprising results.

The use of traps which automatically collect the insects attracted to lights began late last century. The introduction of electric lights about 1907, however, improved the results enormously. Modern insect traps, utilising mercury vapour and similar light sources, have proved so effective that they are now accepted as an essential piece of entomological equipment, with a wide variety of uses.

Light-traps vary greatly in design, but most consist of a light source and a collecting chamber, which may contain a gas to anaesthetize or kill the insects that are caught. The light is usually set in a funnel-shaped opening, leading to the collecting chamber, which readily admits insects but makes their escape difficult. In traps designed for collecting mosquitoes and other

A transparent plastic light-trap designed to collect mainly soft-bodied insects, such as moths. The diameter at the base is 18 inches. The hood is only used during rain to protect the mercury vapour lamp. [Photo: C. Lourandos, C.S.I.R.O.]

tiny insects, a suction fan is sometimes mounted in the entrance funnel to ensure that those insects which come to the light are in fact drawn into the collecting chamber.

The actual design of the trap depends on the kinds of insects to be caught and the conditions under which the trap is to be operated. It may be unidirectional, catching insects which approach it from one direction, or multidirectional, with the light visible from more than one direction, or from all points of the compass. It has been shown that a trap which permits the light to be seen from above as well as from all points of the compass captures more insects than one which has an opaque roof. If vertical baffles are arranged around the light, fast-flying insects tend to strike them and drop into the collecting chamber beneath. A trap provided with an opaque funnel, which casts a dense shadow beneath the trap, catches heavy-bodied scarab beetles freely. One with a transparent funnel tends to exclude the hard-bodied beetles and thus reduces the damage caused to moths and other softer-bodied insects in the catch.

Uses Of Light-traps

In addition to the obvious use of light-traps to collect insects for taxonomic study, they are also used for studying the geographical distribution and seasonal occurrence of insects, for detecting the presence of introduced insect pests, for anticipating pest attack upon crop plants, for studying fluctuations in insect populations and, less commonly, for controlling insect pests.

For collecting insect specimens, light-traps have many advantages over manual collecting at light. Perhaps the most important is that they can be operated every night and throughout the night, under conditions in which manual collecting would be out of the question. It is known, for example, that many nocturnal insects show a strong tendency to come to light during a restricted period of the night. Some noctuid moths are taken most freely in traps between 1 a.m. and 3 a.m.

In recent years light-traps have been used effectively in Tasmania to indicate large seasonal increases in the abundance of Armyworm moths (*Persectania*). Probable Armyworm attacks on pastures and field crops may thus be forecast, and insecticides applied early enough to destroy the young caterpillars before significant damage is done.

The use of light-traps to study insect populations presupposes a knowledge of the many factors which influence the positive response of insects to artificial light. If these difficulties are recognized and due allowance is made for them, light-trapping can provide a useful adjunct to other sampling methods in quantitative ecology. Such factors also impose serious limitations upon the use of light-traps to destroy insect pests. The number of insects destroyed would be greatly reduced during moonlight, windy or cool periods. Moreover, pest damage would not be greatly affected if the majority of those insects caught were males, or females which had already deposited their eggs. The cost of providing electric power in the crop to be protected or of installing sufficient traps throughout the crop may itself be prohibitive.

Our knowledge of the phototactic responses of insects can be used to reduce the nuisance effect of insects around street and other lights. There is no such thing as an insect-repellent lamp, but it should be remembered that insects are much less responsive to yellow or red lights than they are to white, blue or violet lights. If filament lamps, therefore, are used for outdoor illumination, rather than mercury vapour or fluorescent lights, the numbers of insects at light will be reduced.

Unfortunately there is little worthwhile information about the effect large-scale light-trapping might have on rare or useful insects. It can be reasonably assumed that a light-trap will catch only a proportion of those insects which are naturally active within a distance of some 50 yards of the trap. A light cannot "attract" insects from any great distance. Dr. C. B. Williams, who experimented for several years with light-traps at Rothamsted in England, concluded that a light-trap catches species in proportion to their abundance, so that only common species are caught in large numbers. After four years of continuous light-trapping, he could find no evidence that this had had the slightest effect on the local abundance of any insect.

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