The AUSTRALIAN MUSEUM MAGAZINE

Vol. XIII, No. 11 Price—THREE SHILLINGS

The Great Barred Frog (*Mixophyes fasciolatus*) **is one of the largest of Australian frogs, growing to more than four inches in length. Common in many parts of the coast and highlands of eastern Australia, it feeds largely on insects but sometimes eats other frogs. This specimen was collected by the Australian Museum's Cape York Peninsula expedition, an article on which appears on page 362.**

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THE AUSTRALIAN MUSEUM

HYDE PARK, SYDNEY

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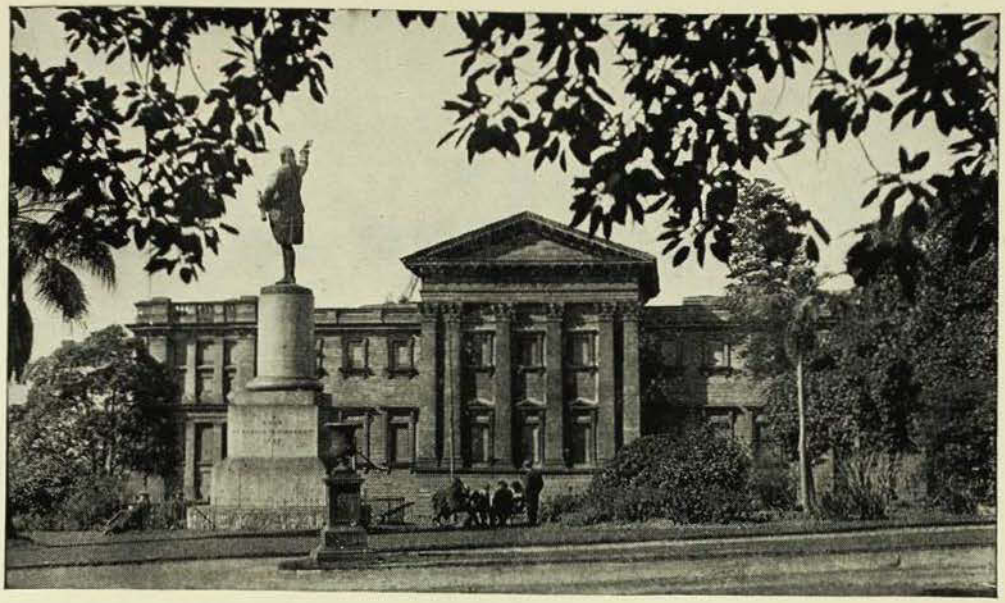

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● The photo on our front cover was taken by Mr. Harold G. Cogger, a member of the Australian Museum's expedition to Cape York Peninsula and author of the article on the expedition in this issue. The frog was collected in the rain forest behind Innisfail.

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The Boomerang

By FREDERICK D. McCARTHY

THERE are not many places in Australia now where boomerangs are still made and used by Aborigines who follow their old way of life. These places are in the most remote parts of the continent where white contact has not disrupted the Aborigines' culture. Boomerangs may still be obtained in the Northern Territory, the desert areas of Western Australia, parts of the Kimberleys and adjoining areas, and in the southern portion of Cape York. Most of these are non-returning boomerangs, the returning type having almost completely disappeared except in places like Palm Island, La Perouse and elsewhere where it is made for the souvenir trade.

The Turuwal tribe on the George's River, near Sydney, gave the name *bou-mar-ang* to the returning boomerang. It is a curious fact that each of the many hundreds of tribes which used a boomerang did not have their own name for the weapon. Instead, we find that a number of tribes in a district or region used the same name or a variant of it, indicating a common family of dialects and in some instances the diffusion of the boomerang and its name from tribe to tribe. Thus, it is called *birgan* at Moreton Bay, Queensland, and *barragadan* from the Brisbane River, Queensland, to the Hunter River, New South Wales, and many other instances could be cited. None of the names appear to reflect the swishing or whistling sound of the boomerang in flight.

The origin of the boomerang is still a mystery. The fact that the non-returning boomerang was used in the New Hebrides, southern India, the south-western United States and elsewhere, and in ancient times in Egypt and neighbouring countries, suggests that it had a wide distribution as a hunting and fighting weapon in times gone by. We do not know, however, whether the boomerang was part of the armoury of the first Australians who followed the non-boomerang-using Tasmanians into Australia thousands of years ago, or whether it was an invention of the Australian Aborigines on this continent. Many kinds of curved sticks were used in south-eastern Australia, and a fluted type in Western Australia, for throwing at goannas, birds, small mammals and fish, and it is possible that the boomerang evolved gradually from this kind of weapon.

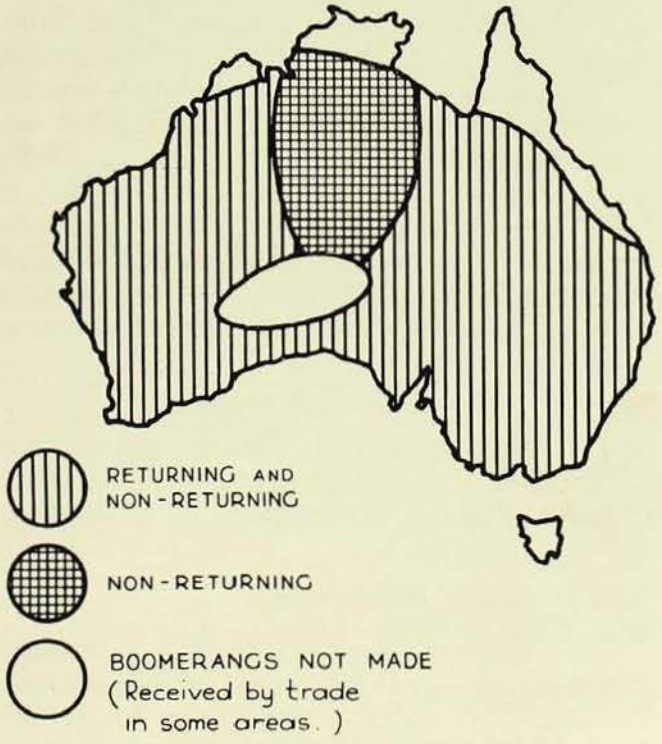
A fallacy commonly held is that all boomerangs return to the thrower, whereas in fact the hunting and fighting ones do not come back; the returning type is the least important of the boomerangs as a weapon.

Non-returning Boomerangs

This type of boomerang has a shallow curve in relation to its length, which is from 2 ft. to 3 ft., and it weighs up to 1½ lb. Some boomerangs are the same width from end to end, others taper to the two ends from a broad middle. This kind of

boomerang is a dangerous and effective weapon in the hands of a skilful thrower. As an Aboriginal boy grows up he practises throwing and evading weapons almost daily since his success in hunting, and his life in duels and warfare, are dependent upon his skill in these activities. This thin-edged weapon, travelling at high speed, causes death and serious injuries to men in warfare, and to animals of all kinds in hunting. It has to be thrown with split-second timing on the instant an animal pops out of hiding or a bird flies within range. It is thrown either directly at the victim, or in such a way that one end hits the ground and the boomerang bounds in a giant stride towards its bewildered quarry, confused by the whistling and whirring of this strange flying danger to its existence.

The non-returning boomerang was made all over Australia except in Cape York, Arnhem Land, the northern Kimberleys, and parts of the border region of South and Western Australia, localities where boomerangs were not made at all. The most famous non-returning boomerang is a fluted one made in central Australia, Northern Territory and western Queensland. It is flat on one side, convex on the other, painted red and sometimes decorated with a panel of red dots on a white field at one end. It has a greater distribution than any other kind of boomerang in Australia. Another fine type is a dark brown boomerang that was used in the region extending from northern New South Wales to western and central Queensland. The incised line designs on the convex side of this smoothly polished boomerang are highly varied and among the most skilfully executed decorative work of the Aborigines.



The distribution of boomerangs in Australia.

Map by David Rae.

NEW NAME FOR MAGAZINE

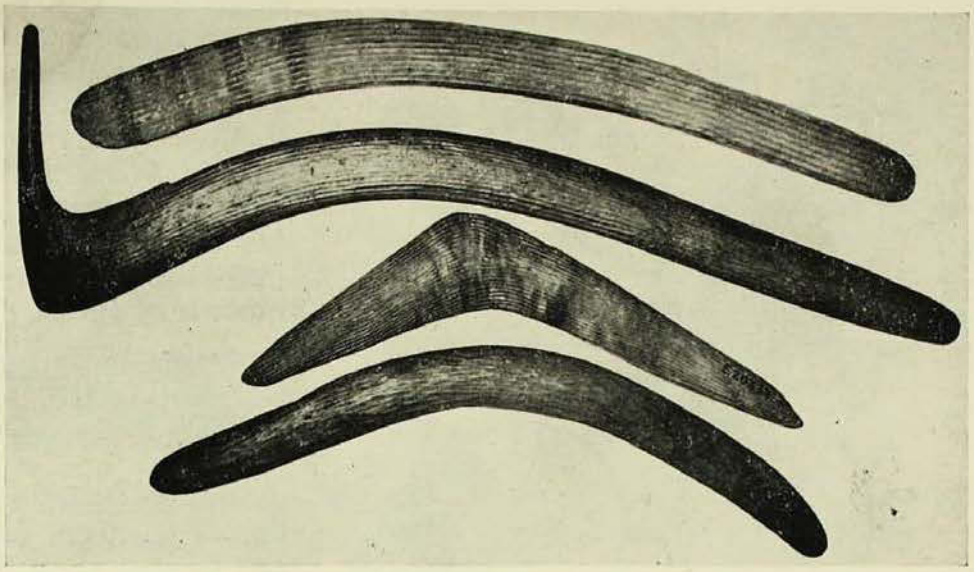
The Trustees of the Museum have decided to change the name of *The Australian Museum Magazine* to *Australian Natural History* as from the issue of March 15, 1962.

The new title has been adopted because it more accurately describes the magazine's scope.

The nature and content of the magazine will remain unchanged.

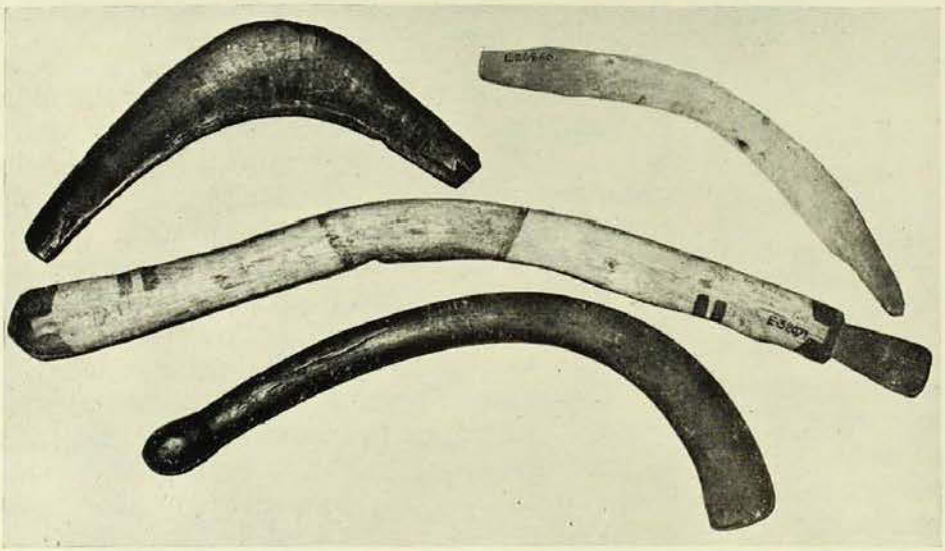
Dual Types

Lacking as we do precise field studies of the performance of boomerangs in many parts of eastern and Western Australia, we find it difficult, if not impossible, to say whether some of the boomerangs in museum collections are returning or non-returning kinds. In size, this dual form ranges from intermediate to near maximum for throwing boomerangs, so that it is an ideal non-returning weapon for hunting and fighting, and, with the contra twist added, can be transformed into a returning boomerang. In this group is a beautifully tooled, narrow and long boomerang, perhaps the most gracefully shaped of all the boomerangs, from central and western New South Wales, and a thick boomerang, convex on both sides, from eastern New South Wales.



Australian boomerangs: At top are two non-returning types, one of them hooked, used in Central Australia and the Northern Territory. Below them are two returning kinds from Western Australia.

Photo.—Howard Hughes.



A boomerang-shaped toy from New Hebrides (top left), an Ancient Egyptian boomerang (top right), a rabbit-killing missile from Arizona, U.S.A. (centre), and a southern Indian boomerang. These are all non-returning boomerangs.

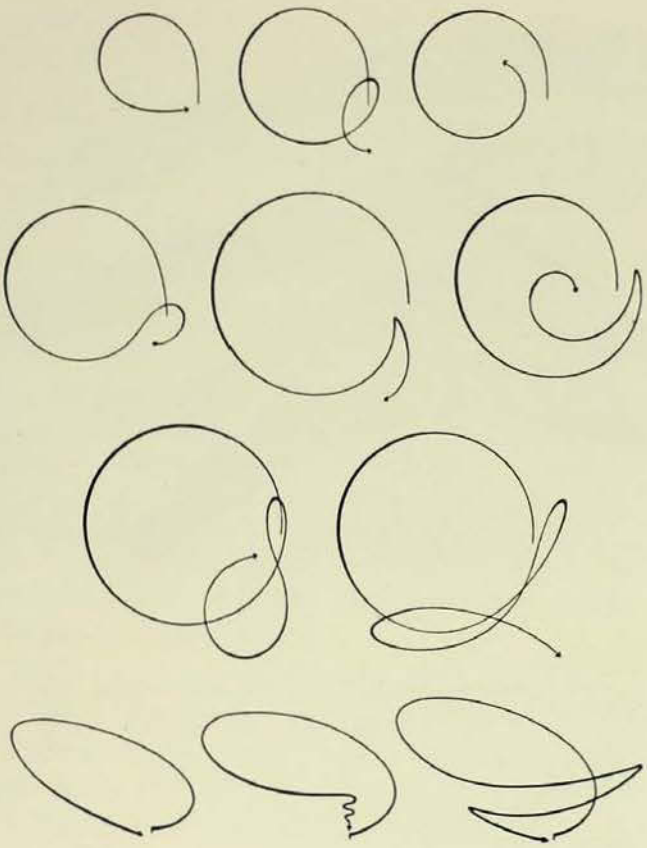
Photo.—Howard Hughes.

Returning Boomerangs

This type is a light, thin, well-balanced boomerang from 12 to 30 in. in length, 2 in. or 3 in. in width, and 3/16 to 3/8 of an inch in thickness. It is up to 12 oz. in weight. It varies considerably in shape, and in general has a deeper curve in relation to its length than the non-returning type. Thus, there are returning boomerangs with medium to deep curve, one convex and one concave arm, and angled with straight ends of which one may be longer than the other. One side is usually flat and one rounded, but both sides may be convex. The edges are sharp or slightly rounded to enable the weapon to cut through the air.

The most important technical feature of the boomerang is the twisting of the two ends in opposite directions, one forward and one backward. This twisting was either shaped into the boomerang as it was made, or the weapon was heated in hot ashy sand, and then twisted. It was sometimes soaked in water before heating.

The throwing of a returning boomerang requires the grace and timing of a golf or cricket stroke. The action is vigorous, and the thrower runs a few steps forward to gain greater impetus. The boomerang is held at one end, over the shoulder and behind the thrower's head, with the concave edge to the front. It is swung rapidly forward, with the flatter side toward the ground, and just before release is given added momentum by a powerful wrist movement similar to that used by a golfer. The thrower tests his poise and balance several times by shaking the boomerang and making a few practice



Flight tracks of a returning boomerang as recorded by Max Buchner with boomerangs specially made for testing.

swings, timing his throw according to the force and direction of the wind. The boomerang may be thrown downwards, horizontally or at an angle to the ground, but it soon sweeps upward to a height of 50 ft. or more. When thrown so that one end strikes the ground it ricochets into the air at terrific speed. It completes a circle 50 yards or more in diameter, and then two or three, occasionally more, ovals as it drops to the ground near the thrower. In some flights a figure-of-eight course is followed.

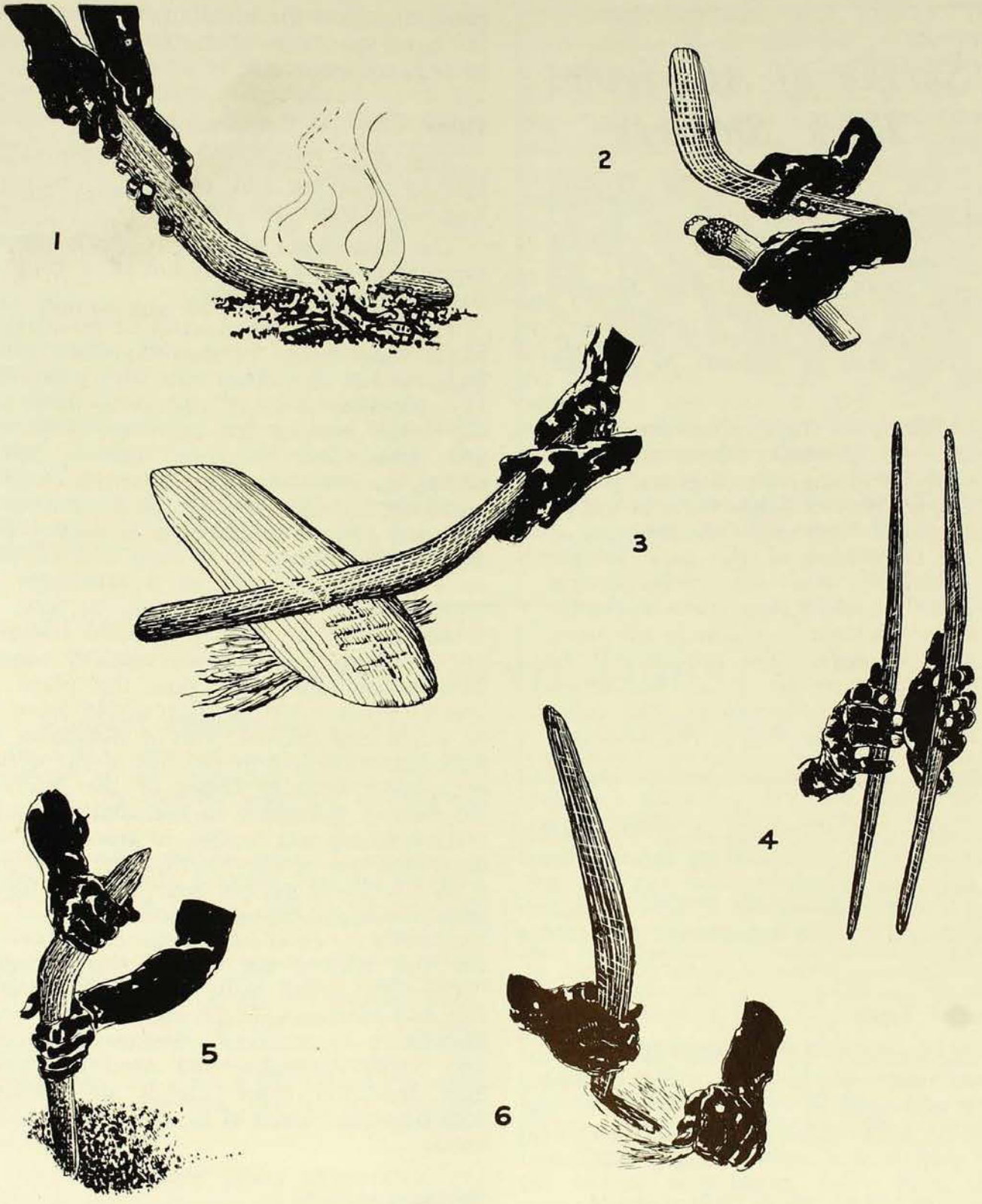
Two fallacies exist about the returning boomerang. One is that it was an offensive weapon, whereas it was chiefly a toy; the other is that it returns after striking an object, but when this happens it will fall to the ground.

Some tribes used the returning boomerang in hunting. They strung nets across a stream, or between trees in the open forest, and as a flock of ducks, parrakeets or other birds approached this trap the boomerang was thrown above them to imitate a hawk whose call the hunters made. The birds dived downwards to evade their swift-flying enemy, and many of them became entangled in the net. As part of their training as warriors the men dodged the boomerang as it dived swiftly to the ground on its return, and in Western Australia some tribesmen held tournaments to see who could bring his boomerang back nearest to a peg, or make his boomerang accomplish the greatest number of circles.

Returning boomerangs were used in eastern Australia (except Cape York) and Western Australia (except northern Kimberleys), but not in the Northern Territory, central Australia and most of South Australia. They were usually a lighter, narrower and smaller form of the local non-returning types. The *kaili* boomerangs of Western Australia are among the best known of the returning types.

The uncanny flight of the returning boomerang puzzled scientists for 50 years before its secret was unfolded. Early observers were of the opinion that its return was due to the combination of flat and curved surfaces. As the air pressed on the flat surface, the lower one in flight, the rounded upward side allowed the air currents to slip by and the missile to rise. In 1846 Sir Thomas Mitchell discovered that the contra, or opposite twist of the ends of the boomerang, was the real explanation. The effect of air pressure on the two opposed surfaces produced by this twisting, combined with the spinning of the boomerang, causes the latter to fly in circles of decreasing size as it loses momentum and falls to the ground. S. T. Walker, from his experiments in England, demonstrated that alterations in the ratios of size, weight, twist and rounding of the surfaces will cause changes in flight which he demonstrated in mathematical equations. As no proof that a returning boomerang exists or has existed in any other country, it is generally believed that it originated in Australia as a gradual development from the non-returning type, the flight of which is often of a curving nature.

Mulga and similar woods are favoured for making boomerangs in the vast region from central-western New South Wales and Queensland right across the interior to Western Australia, where the *kaili* is a good



Boomerangs are used for a variety of purposes, such as (1) scraping hot ashes over the carcase of an animal being cooked in a pit; (2) trimming the edge of a hafted chisel; (3) as a fire-saw (an occasional use when a suitable saw is not available); (4) striking together as clapsticks to mark the rhythm of a song or dance; (5) digging a cooking-pit with a sharpened end; (6) using a sharpened end to cut open the abdomen of a kangaroo. The fluted non-returning boomerang of Central Australia is used more commonly than other types for these purposes.

Drawings by David Rae.

Survey of Aboriginal Rock Shelters

The chairman of the Nuffield Foundation Australian Advisory Committee, Mr. Colin Syme, recently announced that a grant of £915 had been made to the Australian Museum for an archaeological survey of Aboriginal rock shelters in the Cobar-Louth area of western New South Wales.

During the survey Aboriginal paintings in 26 rock shelters will be recorded in scale drawings and photographs. Several habitation sites will be excavated to ascertain the antiquity of the occupation of the area by the Aborigines and the archaeological period to which their stone-implement culture belongs. A film of the work will be made. The survey will be undertaken by Mr. F. D. McCarthy, Curator of Anthropology, and other members of the staff of the Museum.

example of this plum-red to brown timber, mottled with yellow. Along the east coast of Australia, mangrove wood was favoured, and elsewhere a variety of timber, including myrtle. Some boomerangs were made of bark.

Special Types

The hooked or swan-necked variety of the fluted boomerang in the Northern Territory is a well-balanced boomerang. It is said that the hook catches on the edge of a shield or spearthrower (used for parrying) and the shaft whips round and strikes the defender. This action could not be very dangerous, and I believe that the hook forms a pick for fighting at close quarters, like the stone-bladed pick in this region. In Arnhem Land a short broad boomerang called the *galiwali* is used in ritual operations on girls. In the Lake Eyre district a hook is a typical feature of a curved ritual boomerang, and a fin-like hook is to be seen projecting from the middle of the outside of the curve on a few of the *kaili* boomerangs in Western Australia.

Other Uses Of Boomerangs

Apart from the above uses as hunting and fighting weapons and playthings, boomerangs serve other purposes.

The flatter faces of two are gently rapped together to mark the rhythm of a song or dance all over Australia.

The fluted central Australian boomerang has a wider range of uses than any other type. It has one sharp end with which the men cut-open animals and chop them up, dig wells, fire-pits for cooking kangaroos and emus, and holes to uncover totem stones, unearth honey ants, lizards and other burrowing animals, and scrape the hot ashes over and away from cooking carcases. The edge of the boomerang is used as a fire-saw on a softwood shield, as a fabricator to retouch stone adzes, and, as a bow, is rubbed across the edge of another boomerang to produce a curious musical sound. This boomerang thus takes the place of several other artifacts that would have to be made and carried, and it illustrates an important principle in the life of the desert or spinifex country tribes of the interior. To them a reduction in the chattels to be carried means less weight to transport and more freedom of movement, vital needs for a semi-nomadic people who have to travel great distances between waterholes and in the search for food in a harsh environment. For this reason, the use of this versatile boomerang spread from the central Australian and Northern Territory tribes to those in western Queensland, Western Australia and South Australia, and until the white man destroyed tribal life it was rapidly replacing other kinds of boomerangs in these areas.

Boomerang-clubs

Many kinds of curved clubs stemmed from the boomerang. In New South Wales and Victoria a beautifully incised bladed weapon, the *lil lil*, and boomerangs with one end widened into a triangular shape, known as the *yachi*, were used as hand weapons and as missiles in fighting and hunting. Curved and flat-bladed sword-clubs were

used in many parts of Australia; notable among them are one kind up to 6 ft. long, used in duels by the tribesmen of Lake Eyre and western Queensland, and the enormously heavy ones of north-eastern Queensland. They demonstrate the capacity of the Aborigines to modify and adapt their limited range of artifacts in response to cultural needs and to the ideas of keen-minded men in different localities.

The Boomerang In Art And Legend

Although the spear is the principal weapon of the Aborigines, it is interesting to note that among the rock engravings and paintings in eastern and western New South Wales, north-western Australia and elsewhere, a variety of animals, including kangaroos and emus, are shown being struck with boomerangs. In fact, men are shown fighting with them in the rock art more commonly than with spears. The great creator-heroes depicted in the rock engravings of the Sydney-Hawkesbury district, and on the initiation grounds of New South Wales and Victoria, are armed with boomerangs. In north-western Australia another hero threw a boomerang in a deadly manner with his left hand, and there are many legends in which the boomerang is featured as a weapon of great magical power. Designs representing totemic clans and the travels of spirit-heroes were incised on boomerangs in the northern New South Wales and central Queensland area, and in the Kimberleys. Simple designs were painted on one end of them in central Australia and the Northern Territory. Elsewhere they were either fluted or plain, apart from the neat tooling pattern skilfully worked out in western New South Wales and on some of the *kaili* in Western Australia.

NOTES AND NEWS

MUSEUM EXHIBIT ON WHALES

An exhibit on whales and whaling has been completed at the Australian Museum. It tells of whales' life histories, migration, breeding and feeding, and contains models of 15 different species of whales and of whaling ships with whales being flensed on deck. The exhibit includes an explosive harpoon, used for capturing whales; a flensing knife; a dart of the kind fired into whales from shotguns as markers to enable the mammals' movements to be ascertained; krill (shrimp-like animals) on which whalebone whales feed; a baleen fringe with which these whales filter out the krill from mouthfuls of sea water; a wax ear-plug from markings on which a whale's age may be determined; and photos of whaling operations at sea and at shore stations.

Maps show the areas in the Antarctic in which whaling is carried out, the location of shore stations and the areas in which whales are protected.

FISHES FROM PORT STEPHENS

The Museum's Curator of Fishes, Mr. G. P. Whitley, visited the Port Stephens, New South Wales, area to obtain trawled and game fishes for the new fish gallery and for the reference collections.

VAMPIRE BATS

The Australian Museum recently received its first vampire bats, which were sent in exchange by Dr. Felten, of Frankfurt, Germany. These bats were collected in El Salvador, Central America.

GIFT TO MUSEUM

Mr. Bob Dyer, well-known television and radio personality, recently presented to the Australian Museum a Black and a Striped Marlin, to be cast for display. When the latter was being prepared, a rare species of Sucking Fish was found inside its gill-chamber.

VISITOR FROM MANILA

Miss P. V. Conlu, a Colombo Plan ichthyologist from Manila, the Philippine Islands, visited the Australian Museum recently to examine the fish collections and identify gobies and blennies from Queensland.

ABORIGINAL EXHIBITS ON TV

A direct telecast was made by ABN (Channel 2) from the Museum's Australian Aboriginal Gallery on June 27. The economic life, crafts and art of the Aborigines were illustrated with exhibits and specimens.

INDIAN VISITOR TO MUSEUM

Mr. Anand Bisht, Conservator at the National Museum of India, spent four weeks in the preparation section of the Australian Museum early this year, receiving instruction in preparing specimens for display. Mr. Bisht had already spent a few months at the National Art Gallery, Sydney, learning advanced techniques in the restoration of paintings. His visit to Australia was under a scholarship from the Commonwealth Office of Education.

INSECT MIGRATION

By C. N. SMITHERS

A full-scale butterfly migration is one of the most spectacular of insect activities.

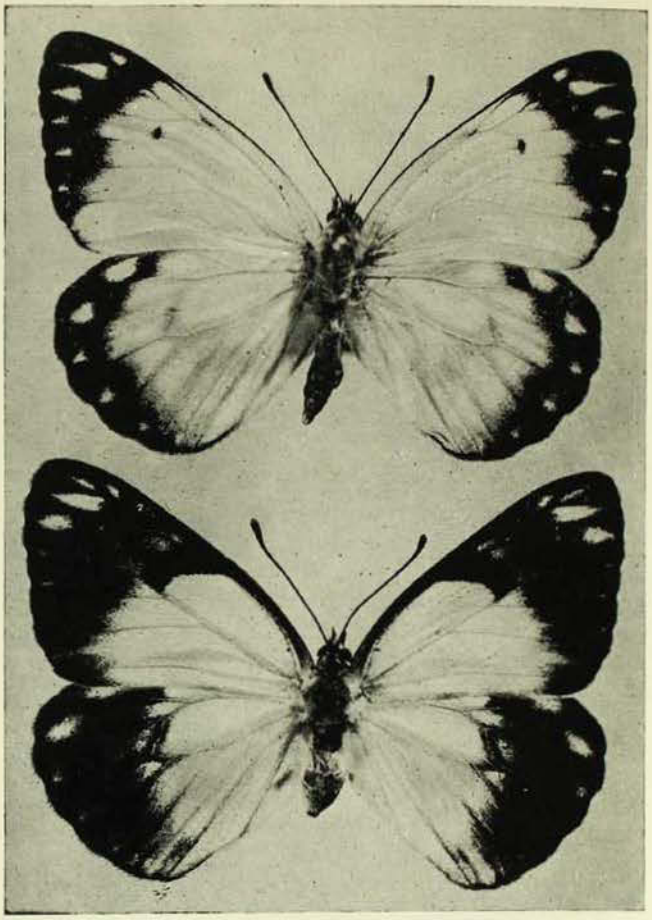
In temperate regions the number of individuals taking part is often small and the migrations may go unnoticed, although they occur fairly commonly. In tropical areas the number of individuals may be so great and the migrations so prolonged and regular in occurrence that they have become the subject of folklore and superstition in several parts of the world. In Ceylon, for example, the annual movements of butterflies are believed to be orientated towards Adam's Peak, the highest mountain on the island, where there is a rock formation which bears some resemblance to a large human footprint. This is regarded as a footprint of Buddha, and the butterflies are believed to be going on a pilgrimage to the mountain to pay homage.

In Australia, the migrations of the Bogong Moth (*Agrotis infusa*) culminate in their assembling in masses on rock outcrops in the Australian Capital Territory, the Snowy Mountains and the Victorian Highlands; these assemblages were known to the Aborigines of the area, who collected the aestivating moths for food.

A conspicuous migrant butterfly is the Caper White (*Glycestha java teutonia*), the caterpillars of which feed mainly on various species of *Capparis*. This species migrates during the months October to February; occasionally the migrations involve tremendous numbers of insects, and some spectacular flights have been seen in the Sydney district. Movements of this species have been reported from as far north as Cairns and from Tasmania in the south.

Long Migrations

Although it is amongst butterflies and moths that migrations are most frequently observed and reported, these are not the only insects which migrate. Some of the dragonflies, hover flies, parasitic wasps and other Hymenoptera, locusts and some sucking bugs are regular migrants, sometimes undertaking journeys of several hundreds of miles, distances which are surprisingly long when you consider the small size of the insects. Mixed migrations, of species belonging to several different orders of insects, all travelling in the same direction, are quite frequent and there are some records of coincident migration in which different species were travelling in different directions.



Male (above) and female of the Caper White Butterfly, a conspicuous migrant along the eastern coastline of Australia.

Photo.—Howard Hughes.

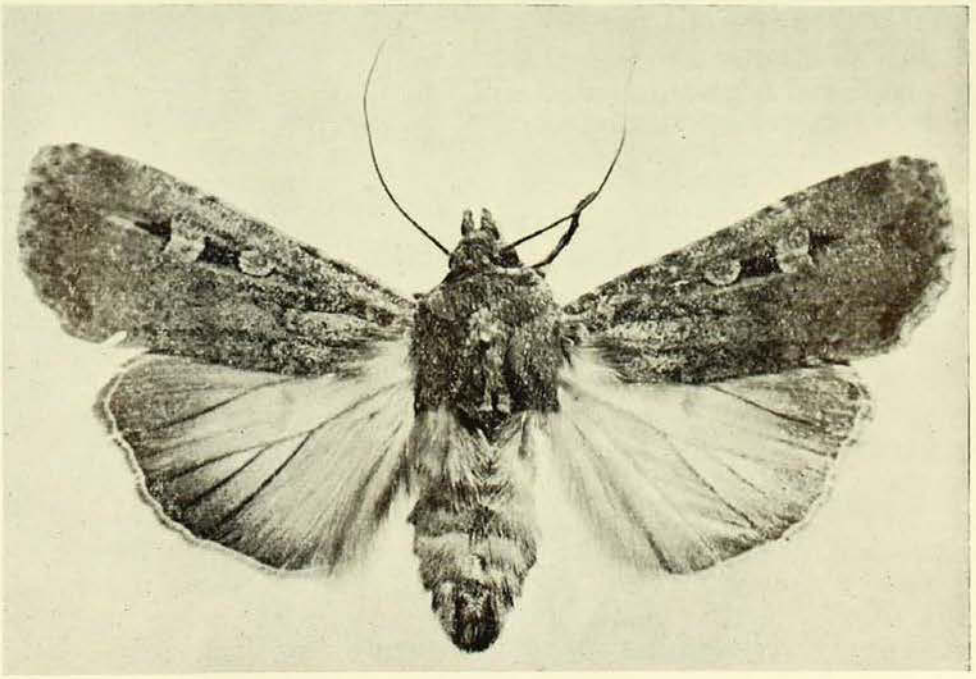
Some of the early observers of migration thought that the direction of flight was largely determined by wind direction, as it hardly seemed possible that such apparently weak animals as insects could undertake directional flights for any distance without some help. One of the reasons given for migration was overcrowding; it was thought that, when the population level was high and food became scarce, the insects took off in search of a more congenial environment—one with an adequate food supply.

As more precise information has been gathered over the years and more records have been kept by people on the lookout for migrating insects, it has become clear that the direction of the wind is not necessarily that of the insects. Many insects migrate when there is no wind, and many prolonged migrations have been noted in which the insects were flying at an angle to, or even directly opposed to, the wind. Also, the direction of flight is often the same over a broad front; in the case of some species it may extend several hundreds of miles. The flight does not radiate out from one central area, as it would do if the insects were leaving an area of over-population and food shortage. In any case, the phenomenon has been discovered in many species which are never overcrowded, either as larvae or adults.

It is not easy, on the other hand, to say, in general, why insects migrate; in fact, it will probably transpire that not all migrant species do so for the same reason. Not many migrants have been studied with the sole object of investigating this habit. Dr. I. Common, who has studied the Bogong Moth, has pointed out that in this species the migrations ensure that the adults are not in the breeding areas at the time of the year when suitable food plants for the larvae are not readily available. The adults return to suitable country at a time when the dicotyledonous food plants, on which the larvae feed, have germinated—that is, in late summer and autumn. It is clearly necessary to make a study of the overall ecology and biology of a migrant species before conclusions can be reached on the importance of the migratory habit. How the migratory habit evolves is also a problem to which it is difficult to suggest a solution.

Undeviating Flights

One of the most characteristic features of insects on a migration flight, as opposed to those indulging in normal flight activity, is the persistence in flight and in flight direction. When butterflies migrate they keep fairly strictly to one direction, and will not deviate from the set course even by a small angle unless under some strong influence. For example, a migrating butterfly will approach an obstacle, say a tree, and, instead of deviating a few feet to one side in order to skirt the tree, it will fly up one side of the tree, over the top, and down the other side, keeping all the time to the same direction of flight. If a migrating butterfly meets a thick patch of vegetation it will fly up the side of the outside trees and over the tree tops keeping above them at about the same height as that at which it was previously flying above the ground. The direction of flight is usually more or less



The Bogong Moth, a regular migrant in Australia. The Aborigines collected the aestivating moths for food.

Photo.—Howard Hughes.

constant over most of the flight route, but sometimes a clearly defined change in direction may be made. When this happens, all the insects change direction when they get to the same place in the route. The reasons for this are not always clear, and in many cases no change is made when it would seem to us that a change of course was obviously needed. The Caper White Butterfly flies out over the coast of New South Wales, in vast numbers at times, to perish in the sea. In Canada, a stream of Monarch Butterflies has been seen to change course over a set point above an open stretch of water.

Why a particular species sets out in a particular direction is not known, nor have we very much information on how the individual copes with the problem of navigation, although a great variety of guiding devices have been suggested. These include such things as the wind, scent, the sun's rays, temperature-gradients, air-pressure, humidity and the earth's magnetic field. There are objections to all of these, and we can only admit that we are still ignorant of the means by which a butterfly finds its way over hundreds of miles of territory which it has never seen before.

Species which migrate during the day rest at night, setting off again the following day; they may also stop to feed en route. The sudden appearance of large numbers of an insect species in light-traps, at lighthouses and around shop windows, its prevalence over a short period, and then its equally sudden disappearance may indicate that it is a nocturnal migrant intercepted during the hours of darkness by being attracted to the light.

Return Flights

When we think of migration we usually imply that, some time later, a return flight will be made. This holds true for many insects which do, indeed, have a return flight, but this usually involves much smaller numbers of insects and, due, no doubt, to the relatively short life of most insect species, the returning migrants are usually members of a later generation. Migrations of small populations are not easy to detect and have to be looked for very carefully; this has resulted in the return flight for only a small proportion of known migrants being detected and recorded. Gradually, however, as more people are taking an interest in looking for and recording migrations more and more species are being added to the list of those known to have a return flight.

The study of migration is a difficult matter for the individual. The answers to the questions raised will be found eventually on the basis of information collected by many people. It is the kind of study to which naturalists all over Australia could make contributions. First of all, records must be kept of migrations as they are observed, with data on direction of flight, place, time, date, wind force and direction, and numbers of insects involved. The best way of calculating the numbers of insects migrating is to count all those crossing a line of known length in a given period of time. An estimate can then be calculated of the numbers crossing a front of one mile in one hour. This can be used as a standard for comparison. Most important of all, specimens of the migrating insects should be kept for identification and future reference. As mixed migrations of superficially similar insects can take place, the more specimens which are captured the better; this might also give some indication of the proportion of individuals of each species participating in the flight. It is also useful to make a note of the weather conditions at the time.

Special Issue of Magazine

The next issue of The Australian Museum Magazine, to be published on December 15, 1961, will be a special issue devoted entirely to the minerals of Australia.

A wide range of mineralogical subjects will be covered in the articles, which will be by specialists in their particular fields.

Marking of insects, with their subsequent release, is also a possible line of work. The chances, however, of a marked insect being recaptured in a country as large as Australia and with such a small number of people likely to be interested in capturing an insect, render it a not-very-hopeful source of information. On the other hand, that is the main method by which we have come to learn so much of the migration of birds and other animals, and it should not be discarded out of hand as a useless method of study where insects are concerned.

There is a fascination in following, in the mind's eye, the journey of such a small organism as an insect, a journey which may be over land and water, over forest or open country, a journey of which we know so little of the how or why.

RETIREMENT OF MUSEUM CURATOR

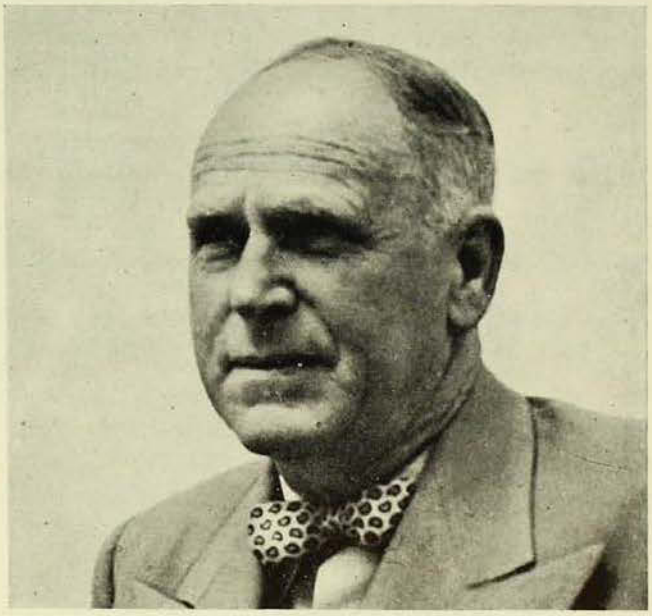
Mr. F. A. McNeill retired from the curatorship of the Department of Crustacea and Coelenterates at the Australian Museum on June 2, after 47 years as a zoologist on the staff.

He joined the staff as a scientific cadet in May, 1914, and received his early zoological training from Museum scientists and at the Sydney Technical College. His early work was with fishes and reptiles. In February, 1922, he was appointed Zoologist in Charge of Lower Invertebrates, the title being changed to Curator in 1948.

Mr. McNeill is a specialist on Australian crustacea, and his research papers have appeared in various scientific journals. His final project, prior to retirement, was the preparation of a detailed report for the British Museum (Natural History) on the Crustacea Decapoda collected by the British Great Barrier Reef Expedition during 1928-1929. In his many popular writings, which have appeared regularly in the "Australian Museum Magazine" and other publications, he has revealed an immense knowledge of the invertebrate groups of animals with which he was mainly concerned. He is joint-author, with Mr. Keith Gillett, of a beautifully produced and well received book, "The Great Barrier Reef and Adjacent Isles", recently published by A. K. Murray Pty. Ltd., Sydney. Other contributions include articles in the "Australian Encyclopaedia" and "This Land of Ours".

His research in the field of economic zoology dealt with investigation into the destruction of under-water timber structures by marine boring organisms. This work, carried out in collaboration with Mr. R. A. Johnson, Engineer Research Officer of the Maritime Services Board, was finally incorporated in one complete volume of more than 250 pages. In the 1953-1954 report of the Maritime Services Board, it is stated that, since the commencement of this research in 1927, the savings to the State in piling alone amounted to £250,000.

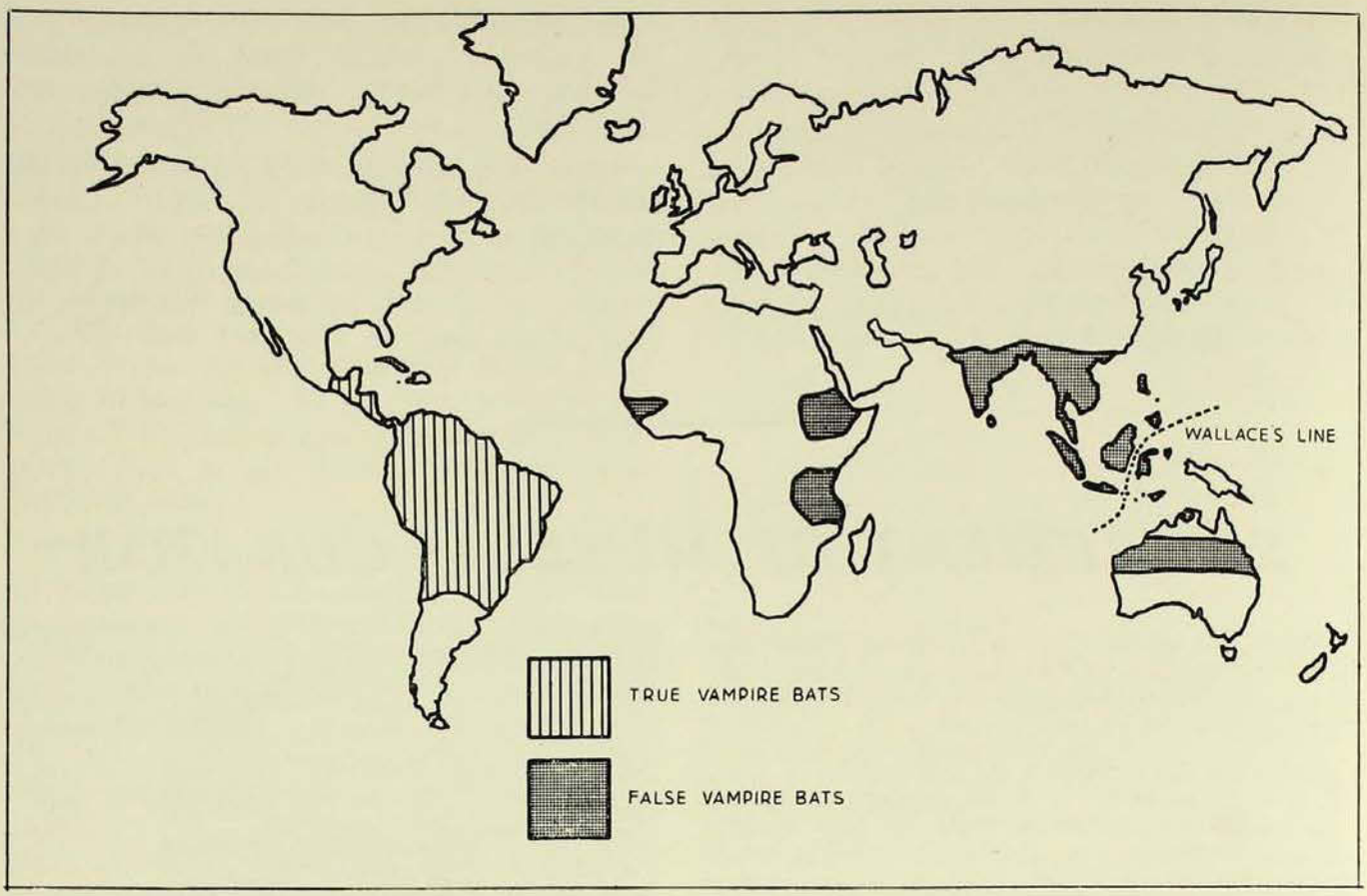
The field investigations carried out by Mr. McNeill included many visits to the Great Barrier Reef, principally as a member of expeditions, and the material he collected on these occasions has considerably enriched the national collections. He is a recognised authority on the Great Barrier Reef and its fauna, and it was largely due to his efforts that turtles were protected by the Queensland Government from exploitation in that area.



Mr. F. A. McNeill.

Mr. McNeill is an enthusiastic broadcaster on natural-history subjects, and in the past was a member of a committee controlling the Nature Study programme in the A.B.C. School Broadcasts Section. For three and a half years he broadcast as "Sandy the Naturalist" in the National Children's Session over 2FC.

As a member of the Royal Zoological Society of New South Wales he took an active part in the early years of the Section of Marine Zoology, and has held the office of honorary secretary and vice-chairman. In 1960, the council of the society conferred on him the title of Fellow.



This map shows the distribution of the true vampire bats in the Western hemisphere and the false vampire bats in the Eastern hemisphere. Although the latter group is widely distributed in south-eastern Asia and Australia, it does not occur in New Guinea.

Map by David Rae.

Vampire Bats—True and False

By B. J. MARLOW

BELIEF in the existence of supernatural beings which feed on the blood of living humans has exercised a macabre fascination among men since prehistoric times in many parts of the world.

The term "vampire" originated in eastern Europe, particularly among Slavonic people, who believed that these beings were the spirits of the dead which could leave the corpse and adopt the form of various animals. The vampires would leave the body at night in the shape of werewolves, horses, cats, dogs and other animals and search for the human victims on which they fed. The form of a bat was excluded from these shapes in the early stages of this superstition, but when the Spaniards returned from the newly-discovered Americas with tales of blood-sucking bats, these animals were soon added to the list of the possible forms that a vampire could adopt. Due mainly to such works as Bram Stoker's "Dracula", the bat has become fixed in imagination as the main physical manifestation of a vampire.

The term vampire bat has since come to be applied indiscriminately to many species, especially if they happen to be large and of grotesque appearance, even though they do not merit this name.

True Vampire Bats

True vampire bats are all included in the family Desmodontidae which is contained within the large group of spear-nosed bats, Phyllostomatoidea, which is exclusively American. There are three genera each containing a single species; *Diaemus youngi* and *Diphylla ecaudata* are uncommon, while *Desmodus rotundus* is the most abundant and most extensively studied species.

Vampire bats (*Desmodus rotundus*) are distributed from southern Mexico south through Central America to Uruguay in South America. During the day they rest in limestone caves, where they hide in the deep cracks and fissures in the walls. At dusk they emerge in search of the warm-blooded vertebrates on which they feed.

Feeding Behaviour

Vampire bats are medium-sized animals with a wing span of about 12 in. Unlike most other small bats, vampires are able to walk or run with dexterity on the ground. During this process, the wings are kept tightly folded and the body is supported on the large thumbs of the wings and the hind feet. Once a victim has been located, the bat lands close by, creeps carefully on to its body and inflicts a bite, often in the region of the shoulder.

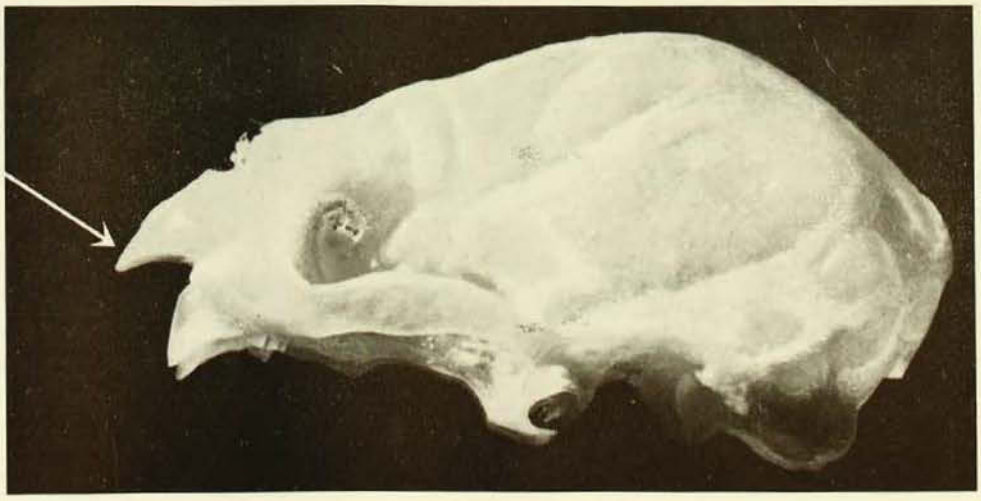
The upper incisor teeth (see photo on this page) are very well developed and enable the bat to scoop out a shallow, crater-shaped wound from which the blood flows freely. It is stated that this bite is painless and does not awaken the sleeping victim. The saliva of the bat contains an anti-coagulant which prevents the blood from clotting, and the wound continues to bleed for some time after the bat has ceased to feed. The wound is not sucked, but rather the tongue moves backwards and forwards with great rapidity so that it functions as a piston. In this way the blood is drawn in through two channels which lie below the tongue on either side of the mouth. This pumping action of the tongue is facilitated by the extreme reduction of the lower incisors, which do not pierce the gums, and also by a V-shaped groove situated on the lower lip.

The simple stomach of these bats is capacious, and the animal becomes visibly distended as it feeds; it is from this feature that the specific name *rotundus* is derived.

Economic Significance Of Vampire Bats

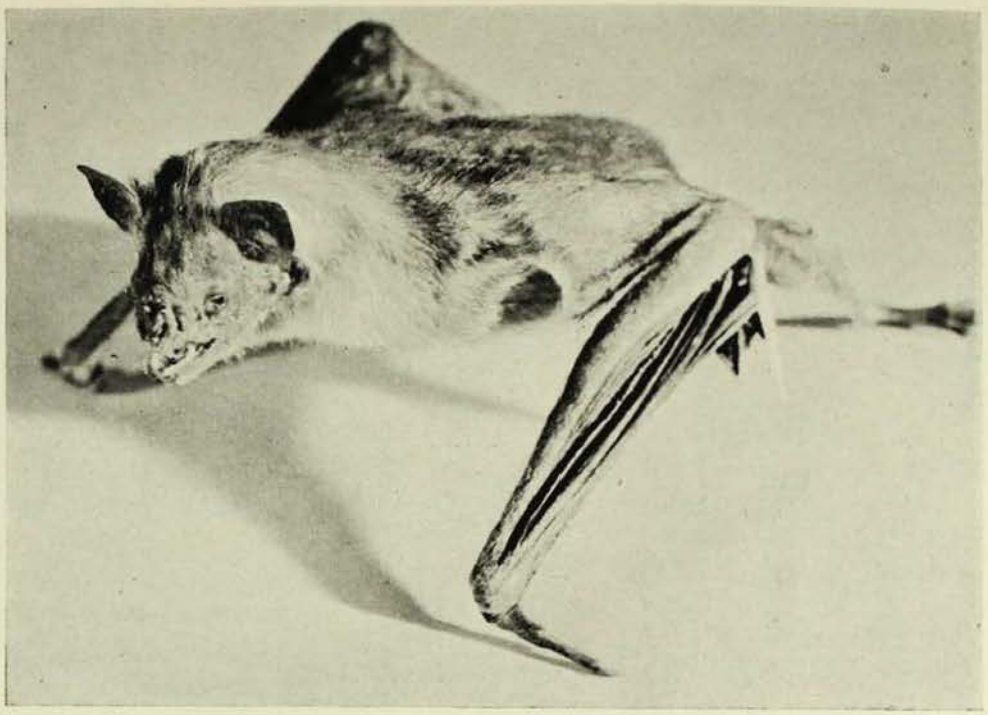
Not only do these bats feed on domestic animals such as horses, cattle and poultry, but they will also attack humans, in which case bites are normally delivered on some extremity of the body, such as the fingers, toes or nose. Continued attacks on man and his domestic animals may cause severe debility because of frequent and prolonged haemorrhage. In some districts of Central America it is impossible to rear domestic stock because of the attacks of vampire bats. Of far greater significance than the mechanical damage which is inflicted by these animals, however, are the diseases that they are able to transmit.

A disease called "murrina" in Central America is caused by a protozoan blood



The skull of a true vampire bat (*Desmodus rotundus*). The arrow indicates the modified upper incisor teeth with which the typical shallow, crater-like bite is inflicted.

Photo.—Howard Hughes.



A true vampire bat (*Desmodus rotundus*) from El Salvador, Central America.

Photo.—Howard Hughes.

parasite, *Trypanosoma hippicum*, which is transmitted to horses by the bite of infected vampire bats. Similarly, these bats are able to convey rabies to humans and domestic stock, and a severe outbreak of this disease occurred in Trinidad in 1932. Since vampire bats are difficult to control directly, the diseases they convey are prevented both by prophylactic inocculations and by housing humans and stock in bat-proof buildings at night.

Feeding Behaviour In Other Spear-Nosed Bats

Spear-nosed bats have a wide range of feeding habits and, in addition to insectivorous and blood-feeding species, there are carnivorous forms such as *Phyllostomus*, which feeds on small vertebrates as well as insects and fruit.

The true fruit bats or flying foxes are absent from America, where the niche of fruit-eating bats is filled by the spear-nosed bats. Similarly, the nectar-feeding Macroglossinae of the eastern hemisphere are represented by *Glossophaga* among the American spear-nosed species. *Glossophaga*, together with *Artibeus* and *Vampyrum*, has acquired the name of vampire without any justification, since none of these forms are blood-feeders.

False Vampire Bats Of The Eastern Hemisphere

Among the insect-eating bats, Microchiroptera, is a large super-family, the Rhinolophoidea, which, besides containing the horse-shoe bats, also includes the family of false vampire bats, the Megadermatidae. This family comprises three genera, which are widely distributed in the Eastern hemisphere (see map). *Lavia frons*, the yellow-winged bat, is the African representative of this family, while in the Oriental region there are two species in the genus *Megaderma*, *M. spasma* and *M. lyra*.

The third genus is *Macroderma gigas*, the false vampire bat of northern Australia. Like many other groups of bats, the false vampires have been able to cross Wallace's line, which lies between Bali and Lombok, and separates the typically Asiatic fauna in the west from the Australasian fauna in the east. In spite of this, the group is absent from New Guinea, although it forms an important element in the fauna of Australia.

The Australian False Vampire

This bat, *Macroderma gigas*, is the largest species of the group of insect-eating bats, the Microchiroptera, and is distributed across northern Australia, from the north of Western Australia through Alice Springs to Rockhampton in Queensland. During

the day these animals live in limestone caves, where they hang from the walls fairly close to the entrance. Their mummified remains may often be found on the cave floors. The wing-span is over 2 ft., and the colour may vary from brown to very pale fawn. This pale colour has been responsible for the vernacular name of "ghost bat" which is often applied to this species.

These bats show many structural peculiarities, particularly about the head (see illustration on this page). There is a conspicuous nose leaf, the ears are joined in the mid-line and, in contrast with the horse-shoe bats, there is a well-developed forked tragus within the ear. Although these animals are called false vampires, they are in no way related to the true vampire bats of America, nor do they share their peculiar blood-feeding habits. Since the upper incisor teeth are absent in the false vampires, it would be impossible for them to deliver a bite comparable with that of the American species.

The head of an Australian false vampire bat (*Macroderma gigas*). This species does not feed on blood as do the true vampire bats of southern Mexico, Central America and South America. It may be recognized by its large size (its wing-span is over 2 ft.) and the forked tragus within the ear.

Drawing by David Rae.

Feeding Habits Of False Vampire Bats

False vampire bats are mainly carnivorous, although they will also eat large insects. All classes of vertebrates are consumed, as fish, frogs, lizards, small birds and rodents have all been recorded as food items in their diet. Well authenticated records exist which show that the Asiatic species *Megaderma lyra* feeds on smaller bats as well as the other vertebrates listed above, and it has been suggested that the Australian species *Macroderma gigas* does the same. Wood-Jones records that he has found quantities of the hair of small bats in the stomachs of mummified specimens of *Macroderma* collected from the floors of caves. Further investigation of the feeding behaviour of this very interesting species is needed so that an accurate assessment of its diet can be established.

The diet of the smaller bats (Microchiroptera) is thus extremely varied and, although the majority feed only on insects, others may be fruit or nectar eaters, while others are actively carnivorous. The name vampire bat should be restricted to those highly-specialised American bats which feed exclusively on the blood of warm-blooded vertebrates.

CONFERENCE ON ABORIGINAL STUDIES

At the invitation of the Commonwealth Government, Mr. F. D. McCarthy, Curator of Anthropology at the Australian Museum, attended a conference on Aboriginal studies last May, and contributed one of the data papers, his subject being "Aboriginal Economic Life and Material Culture". The conference was held to assess knowledge of all aspects of Aboriginal life and culture, the gaps in it to be filled, and the broad programme of research necessary to record all data possible before modern civilization extinguishes Aboriginal culture in the remaining areas where it may still be studied.

HOW TO RECOGNIZE METEORITES

By R. O. CHALMERS

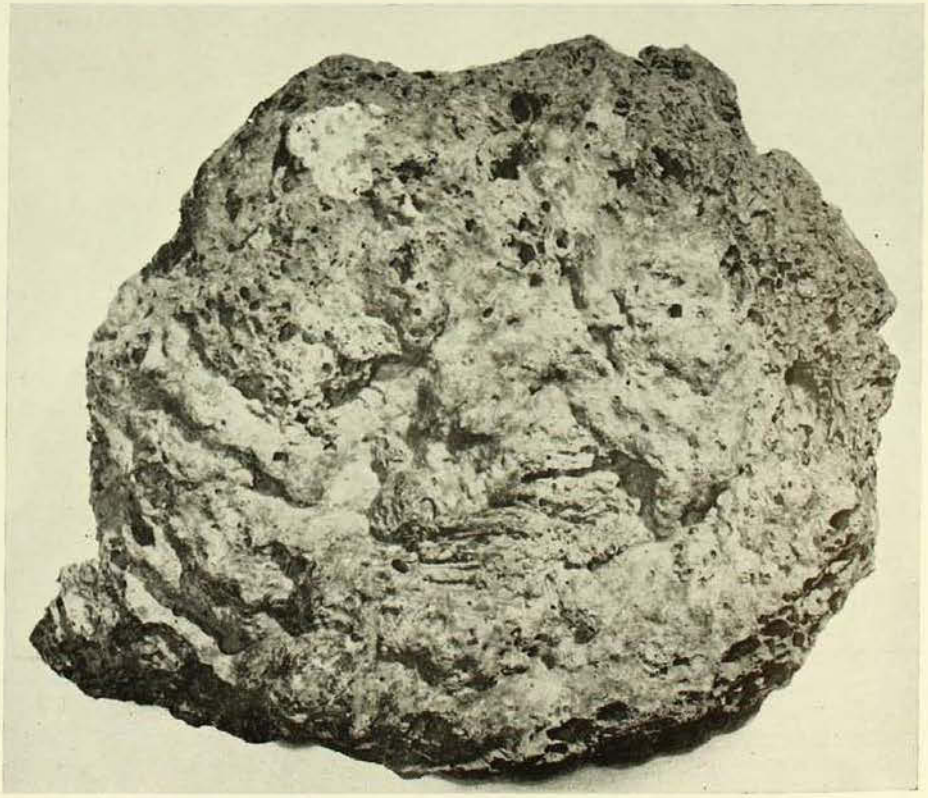
THE fall of meteorites either singly or in a shower has been noted throughout the centuries since Plutarch published the first authentic record in 492 B.C.

The noise of a meteorite rushing immediately overhead at low altitude and high speed, leaving behind a brilliant luminous "tail", has struck awe and terror in the hearts of observers, very often through fear of the supernatural.

This is evidenced by the veneration attached to stones which are in all probability meteorites, such as the famous one in the Kaaba, one of the buildings of the Great Mosque in Mecca. In 1640 a religious tract called "The Voyce of the Lord in the Temple" recorded the hurtling of "a Fiery Ball into the Church of St. Anthony, neere Plimmouth, Cornwall, to the scorching and astonishment of fourteen severall persons . . . ".

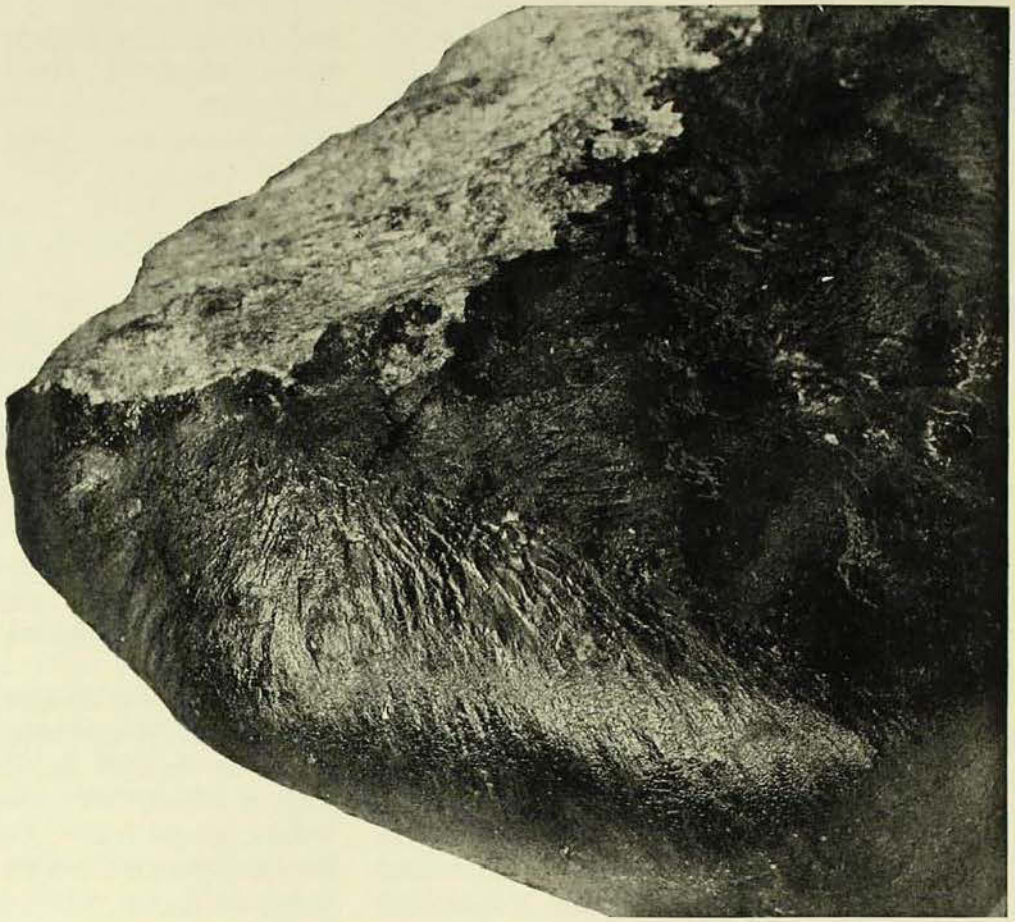
Even in our enlightened times, in 1949, a meteor was seen at very close quarters at night in Caernarvonshire, Wales, and eventually plunged through the roof of a hotel. One observer said that although he was not "as a rule frightened or timid of nightfall he stood perplexed wondering if this could be the second advent of Our Saviour . . . ".

Accounts such as these through the centuries understandably enough failed to gain credence from scientists, including the famous Lavoisier. Even after 1803, when French physicist Biot verified the fall of thousands of stony meteorites not far from Paris, scepticism still prevailed in non-scientific circles. United States President Jefferson made his famous howler when he said, on being told that two American scientists, Silliman and Kingsley, had recorded the fall of meteorites in Connecti-



A specimen of fused rock, about 9 in. long, which an untrained observer could mistake for a meteorite. It is believed to be from an Aboriginal fireplace four miles north of Narrandera, New South Wales. It was presented to the Museum by Mr. Len Jones, the owner of the property on which it was found.

Photo.—Howard Hughes.



Portion of the Binda aerolite (stony meteorite), which was seen to fall near Crookwell, New South Wales, in 1912. Its fused crust and markings caused by its flight through the air are clearly seen. The entire specimen weighed 12 lb.

cut in 1807, "It is easier to believe that two Yankee professors would lie than to believe that stones could fall from the sky".

Whether the public interest in meteorites is a sub-conscious hangover from the dawn of history or due rather to an increasing general awareness that meteorites originate from the break-up of small planetary bodies, and as such provide the only tangible evidence of the type of solid matter that exists outside the earth's atmosphere, the fact remains that a large and varied assortment of objects thought to be meteorites continually comes to the Museum for identification.

Three Main Types Of Meteorites

The salient features of meteorites are now described in the hope that the interest of readers may be aroused. There are three main types:—

• Metallic meteorites (siderites) consisting in the main of a natural alloy of nickel and iron, the nickel being present mostly in amounts of from 6 per cent. to 10 per cent.

• Stony meteorites (aerolites) consisting of a mixture of rock-forming minerals, mostly members of the feldspar, pyroxene and olivine groups, of the same type as found in the great group of terrestrial basic igneous rocks, and in nearly every instance a proportion of nickel iron. In the relatively few instances where no nickel iron whatever is present a very detailed microscopic examination may be required to distinguish the meteorite from certain types of terrestrial rock.

• Tektites, which are natural glasses found in relatively few countries of the world, including Australia, and about the origin of which opinion is by no means yet unanimous. It would be correct to say, however, that majority opinion favours a cosmic origin.

The popular belief is that meteorites are completely melted and almost red-hot when they reach the ground. Such is not the case, because during the meteorite's high-velocity flight through the air the heat caused by friction fuses the outer surface but since this

continually streams off in the form of the luminous "tail" the heat is also rapidly dissipated. When the meteorite finally comes to rest on the ground the fused layer hardens to form a thin crust.

Some stony meteorites that are particularly fusible have a glossy shining black crust, sometimes showing ripple-like flow-lines that indicate the movements of the surface layer when fused. In most cases, however, this crust shows up on both stones and irons as a dull black or brownish-black patina. Very often the surface of meteorites, particularly siderites, shows characteristic depressions aptly named "thumb marks", thought to be due to unequal melting of the surface. These vary in size from small pits up to cavities large enough for a small child to nestle in. The shapes of siderites vary markedly, and they vary in size from a few ounces up to 80 tons. Aerolites may occur as tiny fragments or in masses up to one ton. Being less tough than siderites, they tend to break up either in flight or on hitting the ground. That is why so many more showers of aerolites occur than showers of siderites. Aerolites are more regular in shape than siderites, having well-defined surfaces joining in reasonably sharp edges. The largest tektite weighs only a few ounces. Australites, the tektite variety from Australia, display a variety of regular symmetrical shapes. Other tektites are more irregular.

Objects Mistaken For Meteorites

Because of this popular belief that meteorites melt completely during flight, objects that have a fused appearance, such as furnace slag, are very often believed to be meteorites. Masses of limonite, the yellowish-brown hydrated oxide of iron, or "ironstone", which is shale heavily impregnated with limonite, often have a glossy, polished appearance and regular, somewhat "ropy", surface markings reminiscent of the melted surface of a slag from a furnace. Any untrained person finding it could be pardoned for thinking it had suffered the effects of intense heat. However, such limonite masses are formed mainly by deposition or precipitation of viscous gelatinous masses of hydrated iron oxide from solutions, and not by the action of heat.

A thin coating of black or brown iron and manganese oxides forms on a great variety of rocks, due to a complex interplay of factors, mainly climatic, in arid and semi-arid countries. This thin coating, which sometimes has a glossy lustre, and is called "desert varnish", is very like the surface crust of meteorites, and could be a source of confusion.

In its quest for meteorites, the Museum receives from time to time masses of vesicular scoriaceous material resembling the "clinker" formed by the sintering and partial fusion of coal ash in boiler and locomotive furnaces. These are found quite frequently, and in the vicinity of railway lines they may be from the locomotive fire-box, but in many instances they are masses of soil partially fused by the heat of bush-fires, especially near a large hollow burning log through which the forced draught causes quite high temperatures. In one case it seems as though the heat that had produced such a mass, near Narrandera, New South Wales, might have come from a fire burning for long periods on an Aboriginal camp site. Some of these "clinkers" may be soil fused by ball lightning striking in exposed places, as opposed to the tubular, highly-siliceous fulgurites formed by the fusion of sand in dunes by fork lightning.

Natural Glass

When the source of heat is very intense, complete fusion of soil may take place and a natural glass results. Glass may also form from the burning of plant material with an appreciable content of silica at high temperatures. Lumps of greenish glass are found after the accidental burning of hay-ricks, and in incinerators in sawmills used for burning sawdust. Material of this type can be mistaken for tektites. Irregular fragments of greyish glass known as Darwin glass or Queenstownite are found on Mount Darwin in the remote West Coast Range near Queenstown, Tasmania. First described many years ago as a variety of tektite, this material is now thought to have been formed by fusion of siliceous soils due to the slow, prolonged burning of peat bogs. A rare type of natural glass which might be confused with tektites is that formed around meteorite craters, as at Henbury, central

Australia. This forms because of the complete melting of the country rock by the great heat generated by the impact of a giant meteorite. Other materials mistaken for tektites are masses of glass dumped after cleaning out glass furnaces, glassy slags from blast furnaces and, of course, glassy minerals and rocks such as quartz, obsidian, pitchstone and perlite.

Since siderites are probably the most striking types of meteorites, it follows that quite a number of metallic objects are submitted to the Museum. Among these are metals produced in blast furnaces, such as pig iron, lumps of which are found in the most unlikely places. These are probably mainly from foundries, and are very often portions of castings that have gone wrong and have been carted away and dumped.

Only recently an enquirer from Homebush submitted a flattened metallic object with a dark brownish-black surface covered with small pits generally resembling a siderite. The enquirer had dug this up in his back yard, associated with some shells, and thought it might have been an Aboriginal stone implement, apparently not realizing that it consisted of metal. It had to be cut and a polished section examined before it was identified with certainty as pig iron. It must obviously have been transported by human agency to where it was found.

Steel Ball Through Roof

A visitor from Balmain once called with a perfectly spherical metallic ball about one inch in diameter which had fallen through his roof. It might well have been thrown by someone and found a weak spot in his roof, but it was a steel ball from a ball mill, and not a meteorite.

Ferro-alloys which are metallic, hard and heavy are often picked up, even right out in the bush, and thought to be metallic meteorites. These are manufactured alloys of iron mixed with a high proportion of silicon, manganese, molybdenum, vanadium, tungsten or whatever metal it is desired to add to steel to impart special properties. It is believed that these artificial products are taken away as souvenirs by visitors to steelworks and then dropped or thrown away in many unlikely places. It may seem almost unbelievable that so many artificial substances, such as metals, glass and ferro-alloys, are found in remote places which people would be unlikely to visit; indeed, enquirers are often hard to convince on this point. None the less, the fact remains that these are artificial materials and, no matter how unlikely it may appear, they have been taken by human agency to where they are eventually found.

The Museum is always glad to receive any object considered to be a meteorite. Although most received consist of the various substances just described, the interest of the general public is much appreciated and occasionally a genuine one turns up. Additions to knowledge of Australian meteorites depend on people finding meteorites and submitting them to the Museum for identification. In a sparsely-populated country such as ours, meteorites are seldom seen to fall. In 1954, after a special appeal was made in a popular illustrated magazine, out of the dozens of specimens submitted, two were genuine. One was a small aerolite, weighing 13 5/6 oz., that had been ploughed up in an orchard near Coolamon, N.S.W., between 1920 and 1922 by Mr. George Eisenhauer. The other was quite a large australite, weighing $4\frac{3}{4}$ oz., from Lake Grace, Western Australia, found by Mrs. A. Ellis a few years before 1954. Mr. Eisenhauer and Mrs. Ellis generously presented these specimens to this Museum.

FURTHER READING

Meteorites

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Chalmers, R. O.: "New Meteorites from N.S.W.", Aust. Mus. Mag., Vol. 9, No. 8.

Lovering, J. F.: "Meteorites and the Earth", Aust. Mus. Mag., Vol. 12, No. 3.

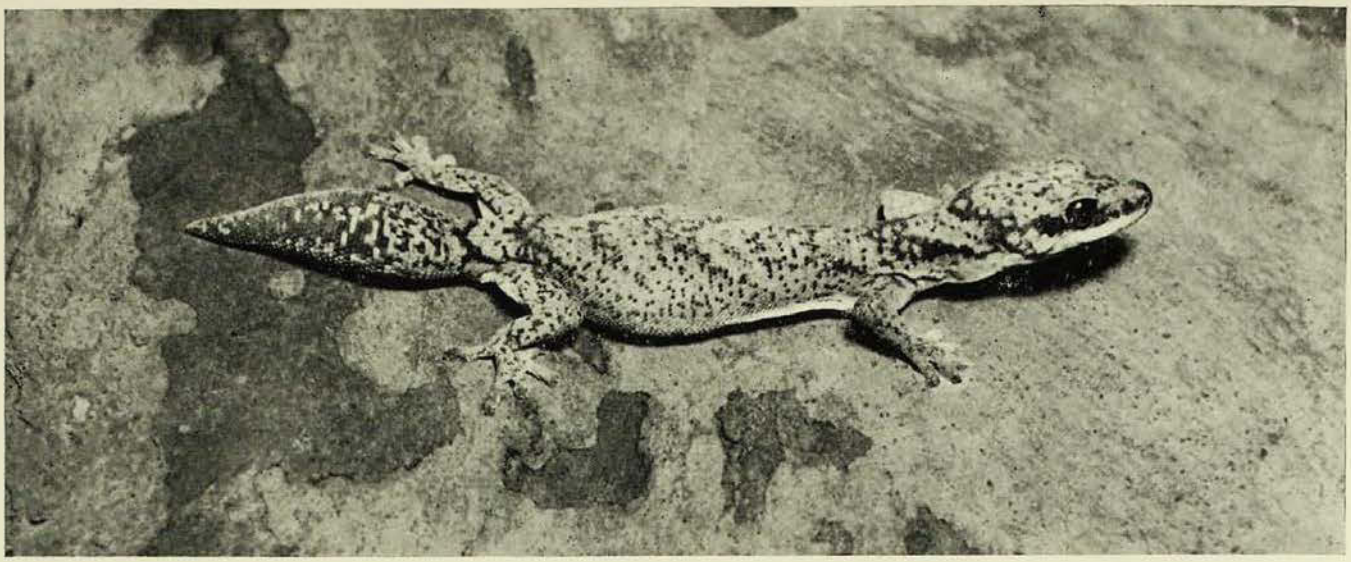
Tektites

Hodge-Smith, T.: "Tektites", Aust. Mus. Mag., Vol. 5, No. 7.

Cassidy, W. A.: "Australia's Fiery Rain", Aust. Mus. Mag., Vol. 12, No. 6.

Various Natural Glasses

Chalmers, R. O.: "Lightning, Meteorites and the Atomic Bomb", Aust. Mus. Mag., Vol. 9, No. 2.



The Velvet Gecko (*Oedura marmorata*) is commonly found under bark on trees throughout Cape York Peninsula.

Photo.—Author.

An Expedition To Cape York Peninsula

By HAROLD G. COGGER

DURING June and July, 1960, three members of the staff of the Australian Museum undertook extensive field work in various parts of Cape York Peninsula, Queensland. Mr. B. J. Marlow, mammalogist, Mr. C. N. Smithers, entomologist, and the author, as herpetologist, comprised the party, and in the hope of studying many of the animals which abound during, and immediately after, the northern Australian "wet" season, it was planned to enter the Peninsula as soon after the end of this season as road conditions would allow.

The accompanying map shows the route taken by the expedition, the major collecting localities, and the nature of the country in some of these localities.

Monsoonal Rains

Cape York Peninsula is often mistakenly believed to be a more or less homogeneous tropical region, consisting of large expanses of tropical jungle. The peninsula, like most other parts of northern Australia, is subject to monsoonal rains. This means that the greater part of the annual rainfall occurs between January and April, with the result that the remainder of the year is very dry. The former period is referred to as the "wet" season, the latter as the "dry". Such conditions are unsuitable for the development of rain forest, and the greater part of the peninsula is covered by a dry sclerophyll forest consisting largely of various species of eucalypts.

It is the seasonal rainfall, together with the topography of Cape York Peninsula, which explains the distribution of most of the plants and animals in this region. The Great Dividing Range lies close to the eastern coast, except where it deviates inland around the area between Princess Charlotte Bay and Cooktown. Both the eastern and western river systems owe their origin to the Great Divide, but whereas the eastern rivers are typically short, relatively swift-flowing streams which reach the coast in a few miles, the western rivers are usually broad, and often amble for more than 100 miles to the Gulf of Carpentaria.

In the dry season, these western rivers (with the exception of their tidal reaches near the coast) are usually approached by steep, water-worn banks which fall steeply into the sandy, sometimes rocky, bed of the river. Early in the dry season, there may be large expanses of shallow water, with occasional deep pools in which many fishes and the Fresh-water Crocodile (*Crocodylus johnsonii*) abound. As the dry season nears its end, only a few of the larger waterholes remain. Only the more northern (and therefore shorter) of the western rivers are perennial, and prove a serious problem to travelling during the dry season.

During the wet season, however, these western rivers become broad, deep, impassable, swift-flowing waterways, often much broader than their dry-season boundaries would indicate. Debris lodged in trees high above one's head offers evidence of the destructive force of these rivers in full flood and the vast quantities of water which must pass to the sea.

All signs of this wet-season activity may be lost almost within weeks of the end of the season. The lush, temporary vegetation which flourishes during and immediately after the "wet" is soon reduced to a relatively sparse grassland and open forest, and, to promote the growth of new feed, large tracts of the peninsula are deliberately burnt-off each year soon after the end of the "wet". It is difficult to determine what effects this burning-off may have on the fauna of the area, though it has undoubtedly brought about some considerable changes. It rarely affects more than the grassy cover.

Dry Sclerophyll Forest

From this brief description it may be seen that, for the greater part of the year, the area west of the Great Dividing Range is largely covered by dry, open sclerophyll forest, and is more or less continuous, as a habitat, with many other parts of northern and central Queensland. It is, therefore, not surprising that we should find that much of the fauna of this western section of the peninsula is the same as, or closely allied to, much of the fauna of the drier inland regions of Queensland and New South Wales. It is also interesting to note that this open eucalyptus forest covers large areas of the lowlands of New Guinea, opposite the tip of Cape York Peninsula, with the result that the faunas of these two areas have much in common. Typical examples are the Common Ground Goanna (*Varanus gouldii*) and the Frilled Lizard (*Chlamydosaurus kingii*), identical forms of which are found throughout most of Queensland and in southern Papua.

It is the area east of the Great Divide, however, which provides the greatest interest to most zoologists. Where the mountains are very close to the coast they receive the benefit of the winter trade winds, so that localised falls of rain may occur throughout the year. Generally, the higher the mountains are the greater and more frequent is the rainfall. As the Great Dividing Range progressively loses altitude from south to north, rainfall is greatest at its southern end, in the area roughly between Innisfail and Cairns. It is largely this year-round rainfall which allows the development of large tracts of rain forest, or related vegetational types. The rain forest of the higher-rainfall areas of the southern part of the peninsula is usually somewhat different in constitution from that in the north, often having a much thicker scrub layer, and therefore being more difficult to penetrate. There are two main areas of rain forest in Cape York; the largest stretches from a little south of Cooktown to the region of Townsville, while the other extends roughly from the Pascoe River in the north to Port Stewart in the south.

Rain-forest Fauna Distinctive

The fauna of these areas of rain forest is very distinctive and there is a high degree of endemicity (that is, a large number of the animals found in rain forest are not to be found in any other habitat). This is of considerable value to the zoologist, for, as rain forest is such a distinctive habitat and is clearly broken up into a number of disconnected patches along the eastern coast of Australia, he is able to see, much more clearly, the effects of this discontinuous distribution on the animals which inhabit rain forest regions. This is of considerable value in working out the mechanisms whereby new species are formed—one of the basic questions in evolution.

Rain forest is also interesting for another reason. A substantial part of New Guinea consists of various types of rain forest, and in reptiles and frogs, for example, most New Guinean (and Indo-Malayan) species are adapted to survive in this habitat. Hence, it is in the reptiles of the north Queensland rain forests that one would expect to find forms which are most closely allied to those in New Guinea. There are, of course, important habitats besides those discussed above, but they are generally of minor extent and are significant in the distribution of only a small minority of animal groups.

Travelling in a one-ton Willys jeep, the party left Sydney at the end of May, 1960, and, except for a brief stop at Brisbane, travelled through to Innisfail. There, collecting was carried out in a small patch of rain forest which was in the process of being cleared for sugar cane, and also in the surrounding canefields. In the former locality the clearing operations enabled us to enter parts of the forest that would normally be inaccessible, with the result that a number of interesting reptiles were obtained, including the Queensland Rock-python (*Liasis amethystinus*), two 8 ft.-10 ft. specimens of which were caught in less than an hour. An interesting lizard obtained in this locality (and in many subsequent localities) was the Forest Skink (*Tropidophorus queenslandiae*); little is known of the habits of this small (6 in.) lizard, for even in the middle of the day it is found deep in the forest under fallen, rotting logs. Related species are common throughout the Indo-Malayan Archipelago, but this is the only species to be found in Australia, and is entirely restricted to the north Queensland rain forests.

Giant Cane Toad

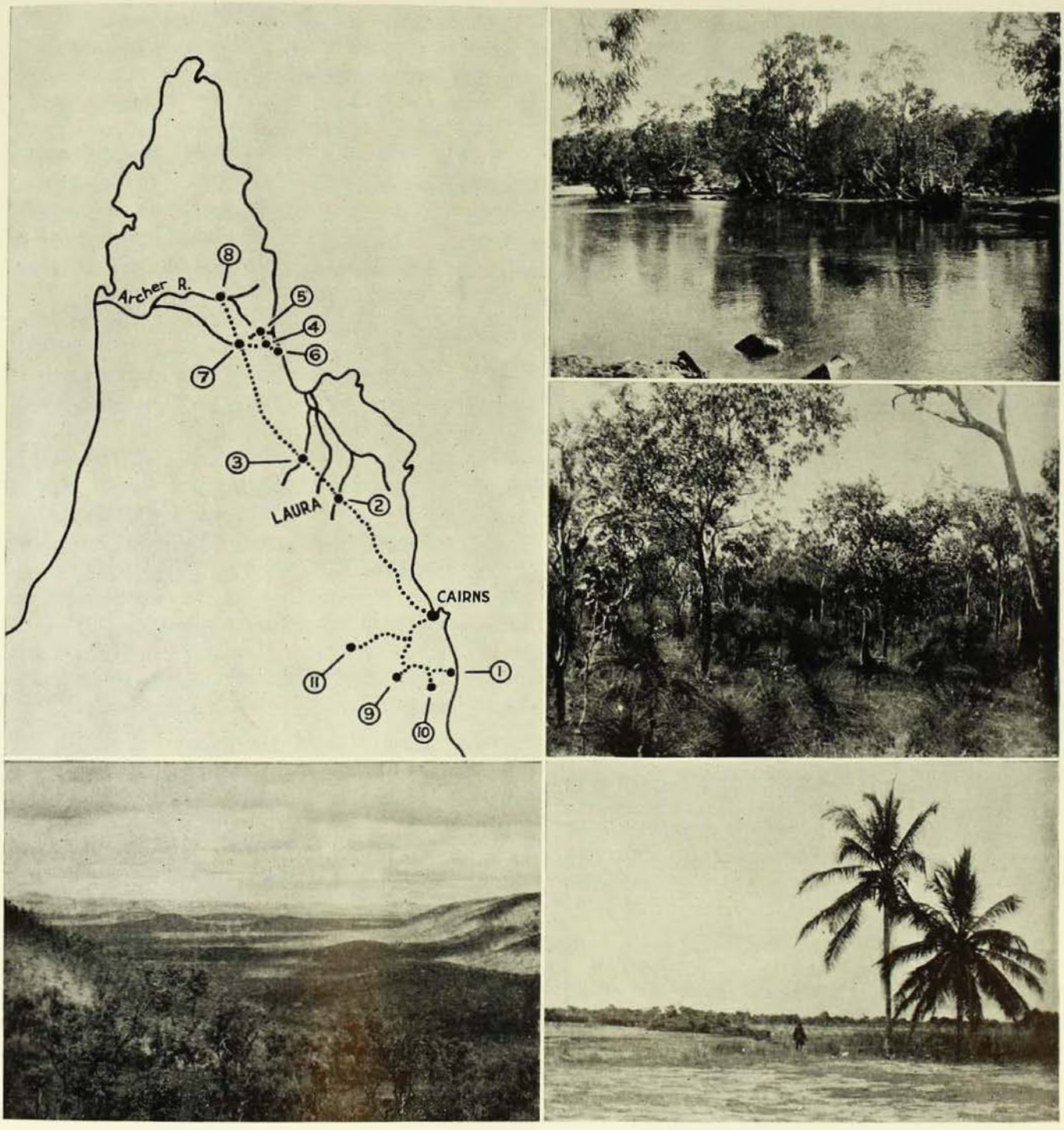
In the canefields of the Innisfail district, large numbers of frogs were found, including, of course, the ubiquitous Giant Cane Toad (*Bufo marinus*), a Central American toad that was introduced into the Australian canefields in the 1930's in the hope that it would eradicate or control the destructive cane beetle and its larvae. Whether it has done anything toward achieving this aim is questionable, but that it readily feeds on small native mammals, reptiles and frogs is beyond question. It is to be hoped that a survey will soon be made to study the effects of the introduction of *Bufo* on our native fauna and on the pests for the control of which it was introduced. Fortunately, this frog was not found north of the Laura River, in Cape York Peninsula.

After leaving the fertile country of Innisfail and Cairns, the expedition travelled to the Laura River, where brief collecting was carried out, and then on through Musgrave Telegraph Station to Coen. During most of the journey from Laura to Coen, the "road" follows the overland telegraph line. There are innumerable sand ridges and steep creek crossings to be traversed, and most of the country consists of open eucalypt forest, dry grassy flats, and countless thousands of giant termite mounds, or "anthills". These consist of two basic types. The well-known "magnetic anthills" may be up to 12 ft. high, 2 ft.-3 ft. thick at the base, and 7 ft.-8 ft. broad. The long axes of these termitaria all point in the same direction, roughly north-south. The other type of "anthill" is large, more or less circular, and up to 10 ft. in height, and has a series of "battlements" extending out from the larger central "fortress".

Valuable Animals

Soon after passing Musgrave Telegraph Station, the road passes through and over the Great Dividing Range, which at this point consists of little more than a series of hills. The township of Coen nestles in a broad valley surrounded by rolling mountains covered by open forest. The airfield is situated about 15 miles north of the town, and receives three commercial flights each week. As it would be too expensive to freight other than perishable and fragile goods by air, Coen receives its supplies by boat, which delivers goods to a point on the coast, east of Coen, known as Port Stewart. The latter consists solely of a large shed, in which stores are protected from the weather, and some stockyards, for cattle are shipped south from Port Stewart.

The expedition left Coen and travelled along the Port Stewart road (which is open only during the dry season) over the McIlraith Range and on to Silver Plains homestead, a few miles north of the Port Stewart road and about 10 miles from the



The map shows the expedition's route. Major collecting sites were: (1) Innisfail; (2) Laura River; (3) Moorehead River; (4) Silver Plains; (5) Rocky River; (6) Port Stewart; (7) Coen; (8) Archer River; (9) Ravenshoe; (10) Tully Falls district; (11) Petford-Lappa Junction. The photos show: upper right, the Archer River; middle right, open forest at Silver Plains; lower right, Port Stewart; lower left, Byerstown Range, south of Laura.

Map by B. P. Bertram; photos by author.

coast. At Silver Plains, members of the party were treated to the wonderful hospitality of Mr. and Mrs. J. L. Wassel and their two sons. Mr. Wassell has an outstanding knowledge of Cape York and its fauna, and subsequently accompanied the party to the Rocky River and its associated rain forest.

The Rocky River is about 15 miles north of Silver Plains; it rises in the ranges, which at this point are only a few miles from the coast. Its bed is a mass of tumbled rocks and sandy pools, with a series of waterfalls and rapids, and it often passes between steep banks which are lined with a dense growth of jungle extending into the mountains behind. Toward the coast it passes through open forest country, though its banks are usually lined with gallery rain forest.

Numerous interesting and valuable mammals, insects, reptiles and frogs were collected in the country near the Rocky River, and our work was greatly assisted by Mr. Wassell. During this period, Mr. Wassell and Mr. Marlow remained at the Rocky River while Mr. Smithers and the author travelled back to the Port Stewart road, collecting in various habitats between Coen and Port Stewart with considerable success.

After returning from the Rocky River, the party spent several days in the vicinity of Silver Plains homestead. This area consists of open forest, and rich collections were obtained. For example, 13 species of frogs were found in an area within 200 to 300 yards of the homestead.

Water Goanna

Leaving Silver Plains, the party returned to Coen, where the mammalogist remained while the entomologist, the author and Mr. David Wassell travelled about 50 miles further north to the Archer River—a delightful river (at that time of year), with large, clear stretches of water flowing over alternate rocky and sandy beds. Of considerable interest there was the Water Goanna (*Varanus mertensi*), a species not previously recorded from Cape York Peninsula. A number of specimens were seen, but only one was collected.

After leaving the Archer River, the expedition returned to Coen, and then immediately to Cairns. Our route then lay over the Atherton Tableland to a point west of Ravenshoe, and thence to a camp site deep in rain forest in the Tully Falls district.

The mammalogist and entomologist spent a week in this area while the author travelled into the dry country to the west, through Irvinebank, Petford and Lappa Junction, in a successful search for certain Dragon Lizards (Family Agamidae) which were required for current research.

The party then went back to Innisfail, returning soon after to Sydney (with only a brief stop at Rockhampton) in mid-July.

Expedition's Aims

Why, of the numerous remote areas which still exist in Australia, was Cape York Peninsula chosen as a site for this expedition? The answer to this question is threefold:—

• Firstly, there are many localities in Cape York Peninsula which are known as "type localities", that is, localities from which certain animals were described to science for the first time. Many problems associated with the classification of animals can only be solved by obtaining fresh specimens from these "type localities".

• Secondly, very little is known about the general animal life in Cape York Peninsula. It is frequently not realised by the public that, apart from the exhibits on display, each scientific department of the Museum maintains an enormous research collection of many thousands of specimens. These specimens are used not only by the scientific staff of the Museum, but by zoologists throughout the world working on a wide range of scientific problems. One of the prime objects of the expedition was to obtain representatives of the little-known animals from Cape York Peninsula to add to these reference collections.

• The third, and, to the author, the most important, object of the expedition, was to try to gain some idea of the role played by Cape York Peninsula in the origin and present-day distribution of much of the Australian fauna.

Australia is an island with an extensive fauna, and there are many problems concerned with explaining the origin of this fauna. This has resulted in several theories

concerning postulated land-connections in the past between Australia and other continents, and such theories continue to be a source of disagreement among biologists and geologists.

However, there is no doubt that within recent geological time (as recent as the Pleistocene), Australia and New Guinea were united by a broad land-connection. Although this fact is not particularly significant in the distribution of many animal groups, within those groups studied by the author (reptiles and amphibians) the distribution of many contemporary forms is closely correlated with these known land-connections.

The situation is, of course, not a simple one, and there are innumerable unknown factors. Nevertheless, the expedition enabled the author and his colleagues to study, to some degree, the general ecological conditions which play a vital part in governing the constitution and distribution of much of Australia's unique fauna.

Mammals of Cape York Peninsula

By B. J. Marlow

The mammals of Cape York Peninsula are of particular interest and show striking relationships with certain species which occur in New Guinea. During the expedition some good series of mammals were collected which are poorly represented in the collections of the Australian Museum. Among these were specimens of a large, handsome marsupial mouse, *Antechinus godmani*.

Extensions to the range of other marsupial mice were also discovered during this expedition, since *Antechinus maculatus* and *Planigale ingrami* were obtained from the Coen district; neither of these species has been recorded before from Cape York Peninsula.

Small mammals were far more abundant in the rain forest than in the more open woodland, and many interesting specimens were obtained in the Ravenshoe district, near Cairns.

About 80 mammals were collected in all, and included among these were marsupial mice, native cats, bandicoots, possums, gliders, rodents and bats.

Some poorly-known Australian sub-species of New Guinea leaf-nosed bats, *Hipposideros diadema reginae* and *Hipposideros muscinus semoni*, were also obtained from Coen.

Insect Collections

By C. N. Smithers

The purpose of this expedition, from the entomologist's point of view, was twofold.

Firstly, general collections of insects, from as many habitats as possible, were made. The material was intended to fill some of the gaps in the Museum's collections, in which north Queensland material is not particularly well represented. This material will, after sorting and preparation, be stored in the research collections and should provide valuable additional data on the distribution and relationships of the species concerned.

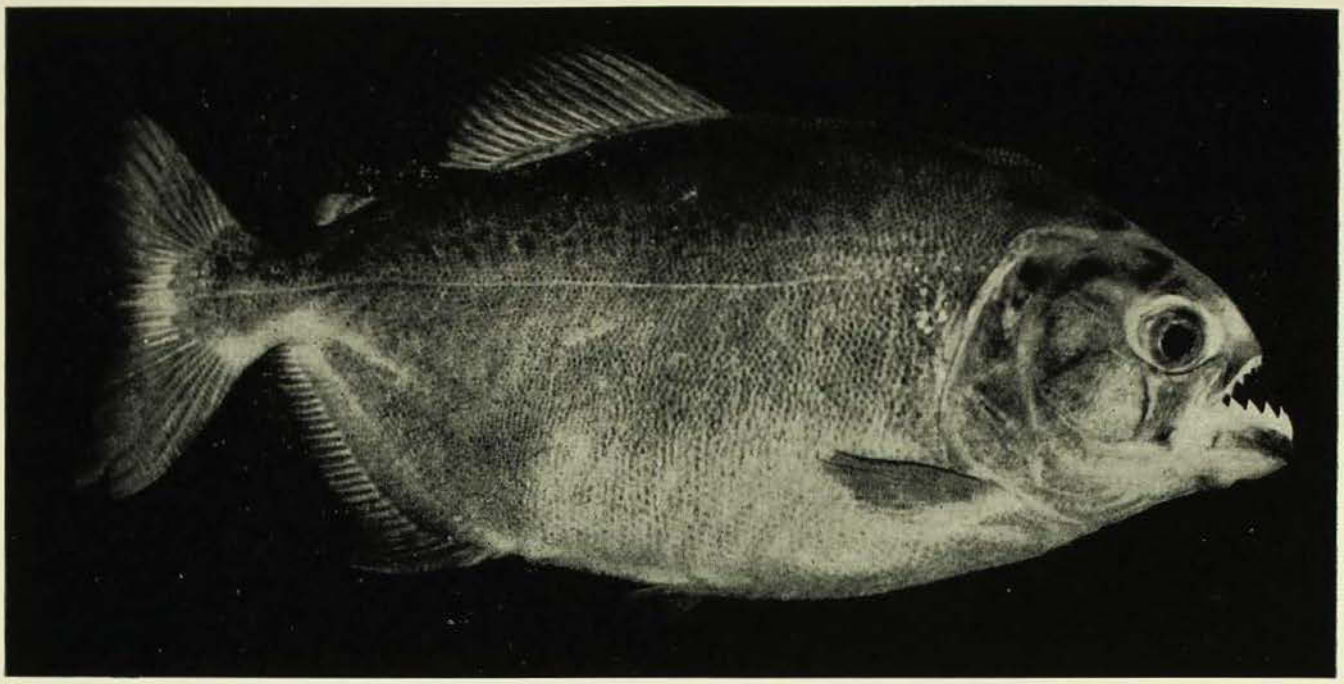
Secondly, special attention was paid to the collection of Psocoptera (Bark Lice or Psocids), an order of insects much neglected in Australia. The number of species of these collected by the expedition in Cape York Peninsula alone was almost equal to the number previously known from the whole of Australia, and the material contains many new species. The sorting of the collections and their preparation, cataloguing and proper storage will take several months.

CORRECTION

The names of some of the proclaimed rare birds and marsupials in the New South Wales Fauna Protection Panel's list, published in our last issue, were misspelled because of typing errors. They should have read as follows:—

Turquoise Parrot (*Neophema pulchella*); Topknot Pigeon (*Lopholaimus antarcticus*); Painted Snipe (*Rostratula benghalensis*); Brolga (*Grus rubicunda*); Bustard or Plain Turkey (*Eupodotis australis*); Swamp Parrot (*Pezoporus wallicus*).

Long-nosed Rat-kangaroo (*Potorous tridactylus*); Bridled Nail-tail Wallaby (*Onychogalea fraenata*); Pigmy Marsupial Mouse (*Antechinus maculatus*); Pigmy Possum (*Cercartetus nanus*); Whiptail or Pretty-face Wallaby (*Protemnodon parryi*).



A piranha recently presented to the Australian Museum by the Museu Paraense Emilio Goeldi, at Belem, Brazil, and now on display in the new fish gallery. The lips have been pulled back slightly to show the teeth.

Photo.—Howard Hughes.

THE VORACIOUS PIRANHA OF SOUTH AMERICA

By GILBERT P. WHITLEY

THE name piranha is from the general South American Indian language called Tupi-Guarani, which is widespread in Brazil.

The patois spoken along the Amazon River is a hybrid language formed mostly of Tupi, with some Portuguese and other elements added. It is called the Lingua Geral (General Tongue or Language) : pira means fish and ranha is the word for tooth, so piranha means "fish-tooth" or "toothed fish".

Piranha is pronounced pee-rahn-yah, with the accent on the rahn and the r very faintly rolled. The whole word is formed in the front of the mouth with the tongue kept to the teeth. The alternate name for piranhas among the locals is Perai or Carib Fish.

Piranhas belong to the family Characidae or Characinidae, genus *Serrasalmus*, the most vicious species being *Serrasalmus nattereri*.

The earliest account of the piranha in Brazil is that of Gabriel de Sousa in his "Descriptive Treatise on Brazil in 1587" (printed in 1825). The first published drawing of a piranha appeared in Marcgrave's work on Brazilian natural history, printed in 1648.

S. nattereri Kner is the most widespread species of the true piranha, and is undoubtedly the one that has figured in most of the human fatalities reported. It is found throughout the basin of the Orinoco River in Venezuela, the rivers of Guiana, the Amazon basin, and the Parana and Paraguay basins clear to Argentina. It is not found in the Sao Francisco or in any of the coastal rivers in south-eastern Brazil. (The latter are, fortunately, free of all species of

piranhas). Piranhas do not occur in the swift waters of rapids. They prefer quieter places and deep pools, and they seem to keep near the bottom. They never go into brackish or salt water, but are strictly fresh-water fishes.

Razor-sharp Teeth

Generally, the colours of fresh-caught piranhas are grey on the back and sides gradating to silvery below. In the breeding season, the males especially are very bright; the sides show much metallic blue and the undersides of the head and belly are smeared with brilliant red. Because of this the fish is often called piranha vermelha.

The largest measured piranha on record is an *S. nattereri* in the British Museum, which is 10½ inches long.

The piranha is a short, stocky, muscular fish of quick movement, with a nervous and unpredictable temperament. It keeps up a constant "flicking" of its pectoral fins. The jaws are short, heavy and so powerful that there is scarcely any living substance, save the hardest ironwood, that will not be clipped off. The mouth is small and filled with razor-sharp teeth so set that they form a zig-zag cutting edge in each jaw; the size of the average piece bitten off would be that of a large olive or nutmeg, and the pieces are swallowed whole and rapidly, the fish snapping many times.

Piranhas travel in schools of 100 to 1,000 and, once scenting blood in the water, they attack in droves with the speed of lightning. The swimmer caught 25 feet from shore by a school of them is not likely ever to get there. In 10 minutes he will be skeletonized. Any splashing or commotion in the water will instantly attract them.

When food appears, the whole school flashes savagely at the prey, chopping off pieces and swallowing in a swirl of darting fishes. It is probably at this time that the fishes, in a cloud of blood and juices from the victim, most frequently bite each other accidentally, and once one of their number is injured they will devour it in seconds.

They have no fear of man or beast whatsoever, and will attack a fish 10 times their own weight, devouring all but the head. The tail is attacked first and the fish, thus being left without the principal organ of motion, is eaten with ease. Large alligators which have been wounded in the tail also become their prey.

Attacks On Humans

The piranha is chiefly a fish-eater, but quite often terrestrial animals become its victims. Several observations are on record of reptile-eating birds flying low over the water and their prey, trailing from their talons, being snatched from them by piranhas. Almost any animal which falls into the water accidentally is likely to be eaten. It is a common sight to see domestic ducks strutting along on stumps, having lost their webbed feet to piranhas. Piranhas eat vegetable matter at times, and can be caught on hooks baited with dough-balls. They are also known to eat fruit.

Theodore Roosevelt, in his book "Through the Brazilian Wilderness" (1914), was the first to introduce this fish to the English-speaking public. The gruesome stories he repeated, especially the one concerning a man who fell off his horse while fording a Brazilian river and was completely skeletonized by piranhas, made the whole world aware of the terrible nature of this fearsome fish.

Roosevelt wrote: "I never witnessed an exhibition of such impotent savage fury as was shown by the piranhas as they flapped on deck. When fresh from the water and thrown on the boards they uttered an extraordinary squealing sound. As they flapped about they hit with vicious eagerness at whatever presented itself. One of them flapped into a cloth and seized it with a bulldog grip. Another grasped one of its fellows; another snapped at a piece of wood, and left the teeth-marks deep therein."

Fishermen trailing their hands in the water have lost fingers; women pounding their washing near the shore have lost toes.

A 16-year-old boy swimming in British Guiana was heard to scream first in fear, then in agony. Before he could be reached he disappeared below the surface and all that was recovered, a few hours later, was his skeleton.

A party of explorers dynamited a stream, and when some of the fish settled to the bottom a diver went after them. Taking a

stunned fish in each hand, he held the head of a third with his teeth. Just before he reached the shore the fish recovered and snapped off a section of his tongue, producing a strong haemorrhage, which nearly suffocated him.

During the South American wars around 1810, one way of disposing of prisoners was to cut the throats of half a dozen and toss them into the water as bait for piranhas, which came by the thousands. Then, as the river seethed, the remaining prisoners were thrown in alive, to be reduced to skeletons in a matter of minutes.

On one occasion a member of a party went off by himself on a mule. The mule returned to camp alone. Following the man's track, his companions came to a ford, where in the water they found his skeleton, his clothes undamaged, but every particle of flesh stripped from his bones. Whether he had drowned, and the fishes had then eaten his body, or whether they had killed him, it was impossible to say. They had got in under his clothes, which made it seem likely that there had been no struggle.

The piranha is migratory, but its seasonal movements have never been carefully studied.

The fish breed in the rainy season when the rivers rise. They clean out a shallow nest on the sandy bottom of a currentless inlet and spawn in it. The female guards the nest and viciously attacks any living thing that comes near.

[*Acknowledgement is made to G. S. Myers' "A Monograph of the Piranha" (Aquarium Journal, U.S.A., 1949) for some of the information in this article.*]

NOTES AND NEWS

CAVE-MAN EXHIBIT

A striking new exhibit at the Australian Museum shows a scene from the everyday life of Neanderthal man during the last Ice Age from 30,000 to 60,000 years ago. Life-size models of a Neanderthal woman and child are seen at the mouth of their cave watching two men spearing a Great Cave Bear, one of the animals which the Neanderthalers hunted for food and clothing. In the background is a range of snow-capped mountains. The exhibit was devised and made by Mr. B. P. Bertram, of the Museum's Art and Design Section.

SCIENTISTS TO COLLECT FOSSILS

Three scientists, Professor R. A. Stirton, Dr. Alden H. Miller and Dr. R. Tedford, from the Museum of Palaeontology, University of California, U.S.A., recently visited the Australian Museum on their way to collect vertebrate fossil material from various localities in the country east of Lake Eyre, South Australia. This was the fifth time Professor Stirton had visited Australia in search of fossil vertebrates. On his previous visits he discovered extensive horizons containing fossils of late Tertiary and Pleistocene age in the Menindee district, New South Wales, and in the Lake Eyre district of South Australia. Research carried out on the fossil material collected on these occasions proved it to be of considerable interest and importance. Professor Stirton and his party feel sure that the fossils collected on this visit will materially add to our knowledge of the Tertiary and Pleistocene vertebrate fauna. During their visit to Sydney the three scientists addressed the Australian Mammal Society at a meeting held at the Australian Museum. Professor Stirton spoke on the "Macropodid Genus *Protemnodon* with a Review of the Species"; Dr. Miller spoke on "The Reproductive Cycles in Equatorial Birds", and Dr. Tedford on the "Cenozoic Stratigraphy and Vertebrate Palaeontology of the Tirari Desert, South Australia".

PACIFIC SCIENCE CONGRESS

Two members of the staff of the Australian Museum attended the 10th Pacific Science Congress at Honolulu, Hawaii, recently. Mr. F. D. McCarthy, Curator of Anthropology, presented a paper on the archaeology of Australia and Melanesia. Dr. D. F. McMichael, Curator of Molluscs, participated in a symposium on the Zoogeography of Pacific Islands Land Snails. After the congress Dr. McMichael went to the U.S.A. for a short period of study at a number of museums. From there he will go to London to spend four months in the Department of Mollusca at the British Museum (Natural History).

SURVEY OF LIBRARY RESOURCES

Professor Maurice Tauber, of the School of Library Service, Columbia University, New York, inspected the Australian Museum Library in April as part of a systematic survey of Australian library resources he is making on behalf of the Australian Advisory Council on Bibliographical Services. Professor Tauber is in Australia on a Fulbright grant.

EDUCATION OFFICER IN U.S.A.

The Museum's Education Officer, Miss P. McDonald, spent May and June studying museum education methods in the U.S.A. She was the guest of the American Association of Museums during May.

POLLINATION OF THE PROTEACEAE

By R. CAROLIN

Lecturer in Botany at the University of Sydney.

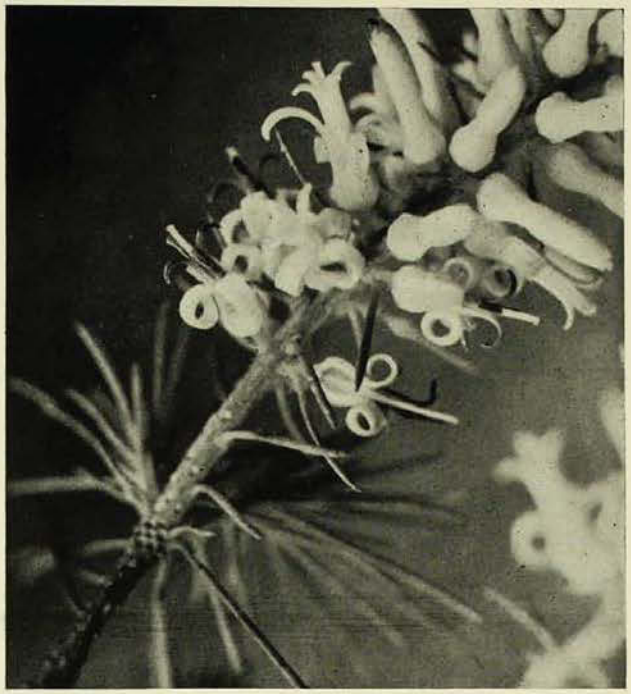
THE average person, when looking at a flower, tends to think in terms of its aesthetic value alone, the effect of the form on his mind. What generally escapes him is the importance of the flower in the life of the plant. Indeed, if the flower is not aesthetically satisfying the layman may not even grace it with the name of flower.

The flower is, in point of fact, an integral part of the life-cycle of the plant. Its shape, colour and size are all orientated towards the one end — the production of the next generation, the continuation of the race. That many wild flowers are also objects of beauty is purely coincidental.

Just as in most animals, in most plants the production of young (seeds) is dependent upon the union of two units. In animals these units are called sperms and eggs; in plants there are also sperms and eggs, but the sperms are contained in the pollen grains and the eggs within the ovary (pistil). It is necessary that pollen be deposited on part (stigma) of the prolongation of the ovary (style) before seed can be "set". The manner in which this transference of pollen from where it is produced (anther) to the stigma is called the pollination mechanism, and this, in turn, is dependent upon the form of the flower.

Fascinating Study

Pollinating mechanisms are a fascinating study for the amateur naturalist; a good eye and a lot of patience are all that is needed. Let us consider the family of plants known as the Proteaceae. In most of these plants (Banksias, Mountain Devils, Spider-flowers, Drumsticks) the pollen is placed on the stigma by animals of some kind or another, e.g., flies, bees or birds. The simplest case is probably that



Persoonia acerosa, a collection of flowers. The lower ones are almost in the stigmatic stage, and their stamens are dark-coloured and curved right away from the knob-like stigma. Higher, the stamens are recurved only slightly and are still pale in colour. Higher still, the perianth is closed and the flowers are still in the bud stage.

of *Persoonia*, the Geebung. For example, in *P. acerosa* (illustrated on this page), the flowers are visited by bees, mainly for the nectar which is secreted by small glands at the base of the flower. When the flower buds open the four petal-like units on the outside (perianth) curl downwards to reveal the stamens bearing long anthers which surround the central style bearing a terminal stigma. The anthers have slits on the inside. Now, a visiting bee must push its proboscis down between the encircling anthers and style to obtain the nectar at the base of the flower. Its position at this stage is such that it rubs against the anther slits and pollen is deposited over its proboscis and body. As the flower grows older the anthers curl backwards and the stigma becomes sticky; it is now ready to receive pollen from a visiting insect which the latter has previously collected as outlined above.

This mechanism illustrates several points. Firstly, the floral form forces the insect, if it wishes to derive any benefit itself from its visit, into such a position that it receives pollen. Secondly, the anthers assume a position close to the stigma;

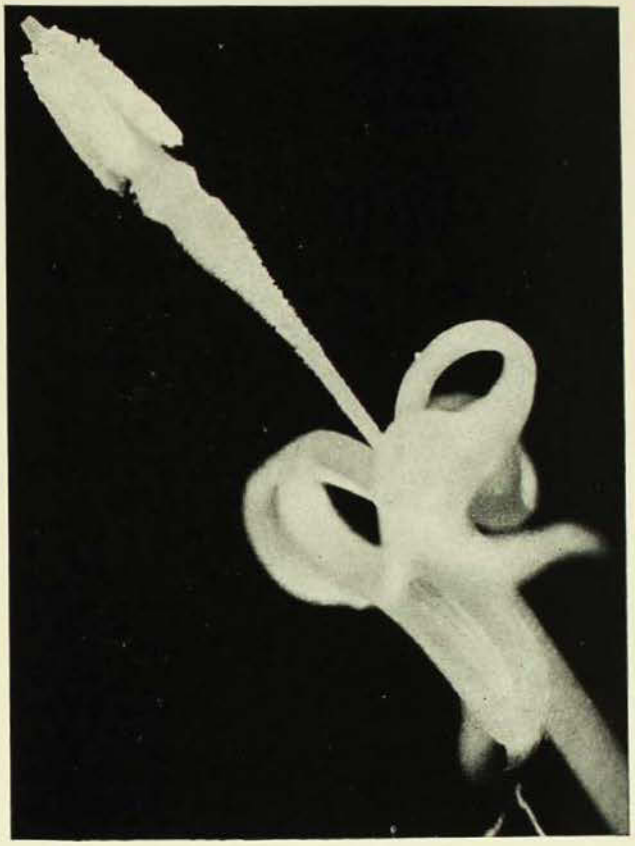
pollen is deposited on the insect in the same place that the stigma of an older flower is going to brush against. Both these provide for the most efficient use of the pollen. Thirdly, the anthers mature before the stigma of the same flower; "self-pollination", at least as far as the individual flowers are concerned, is minimized. These are common, although by no means universal, features of flowers.

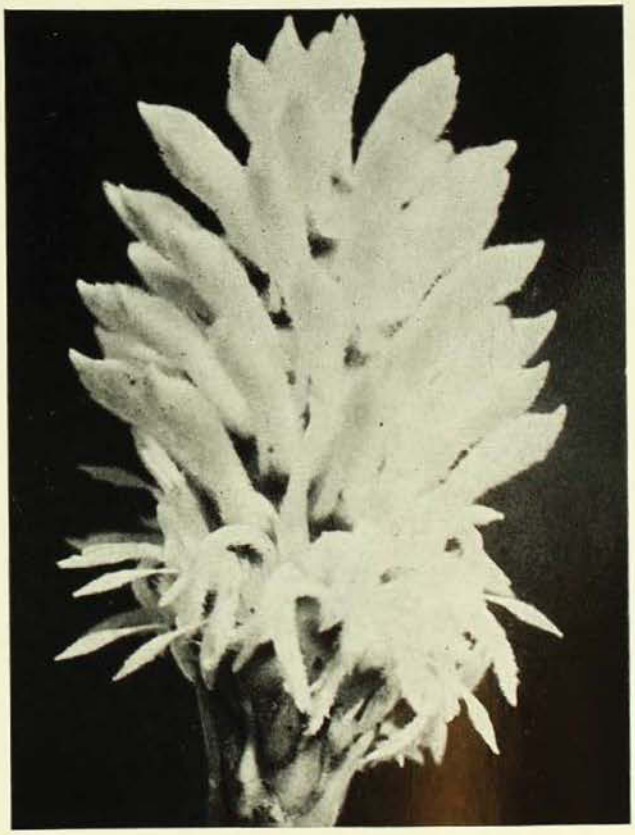
Many of the other genera in the family show various degrees of "improvement" upon this system. I write "improvement" advisedly because, although at first sight it would seem that an increase in efficiency of pollen use has taken place, in actual fact *Persoonia* often shows better fruit production than these other genera. Factors other than seed *quantity*, with which we cannot deal here, enter into consideration.

Drumsticks

In *Isopogon anethifolius* (Drumsticks) the anthers burst in the bud, where they are tightly pressed against the style. The upper part of the style is sticky and a swelling just below the level of the anthers blocks the lower end of the anther canal, preventing pollen from falling into the lower parts of the flower. Thus, when the perianth curls backwards, carrying the anthers with it, the style is left bearing the pollen, which often retains the outline of the anther cavity (upper photo on this page). The stigma, however, is terminal and tucked away amongst the tips of the perianth segments. Not only is no pollen deposited on it in the bud, but pollen would probably be unable to germinate on it even if some were; as in *Persoonia*, there is a pollen stage and a stigma stage in each flower. The pollen, then, is presented to the insect in an even closer position to that of the stigma than in the case of *Persoonia* although fusion of male and female units from the same flower is again prevented. *Petrophila fucifolia* (Cone-sticks), seen in the lower photo on this page, shows a similar construction, but in this case the pollen is held on the style with the aid of short hairs.

This form of pollination mechanism is repeated, with variations, in many other members of the family. In *Lambertia*





Above: *Isopogon anethifolius*, a single flower. Note the recurved perianth-segment bearing the stamen, the pollen retaining the outline of the anther but stuck on the style, the bulge in the style below the pollen, and the stigma above it. Below: A flowering head of *Petrophila fucifolia*.

(Mountain Devil), for example, the pollen is deposited on the sticky upper part of the style in the bud and then on the visiting insect when the perianth has opened. In this case the perianth segments remain joined together from about half-way downwards, and once again the animal is forced to brush against the style and pollen in probing for the nectar at the base of the perianth-tube. The stigma is a cleft running down the style for a short distance from the apex. In the bud this cleft is closed and no pollen can be deposited within it at this stage. The stigmatic cleft opens only after the flower has been open for some time and most of the pollen on the style has either been brushed off or died. Examination of the newly-opened flowers of *Lambertia* shows, very clearly, the yellow clump of pollen at the top of the style (upper photo, this page), while later in the day the stigmatic cleft can be seen exposed. It seems that honey-eaters are the main pollinating agent in this case, carrying the pollen grains about on their bills. It can be seen that the approximation of the pollen and the stigma is even closer in this case, although they still mature at different times. *Banksia* (Honeysuckle) shows a similar mechanism, and it is appropriate to draw attention to the fact that, of the hundreds of flowers in a *Banksia* "spike", very few indeed set seed.

Difference In Mechanism

Grevillea (Spider-flower), *Hakea* (Needle Bush), *Telopea* (Waratah), *Lomatia* and others show a rather different mechanism, although quite clearly of the same general pattern. The style is flattened at the top and it is upon this disc that the stamens burst in the bud. The stigma is a small mound in the centre of the disc, as yet immature, around and upon which the pollen is heaped (lower photo, this page). Furthermore, this disc is retained within the upper parts of the perianth even after the lower parts have separated, giving the typical "hairpin" appearance. In some species, this disc is not released until forcibly separated by an animal fossicking around for nectar at the base of the flower. This separation can be quite sudden and the animal, often a honey-eater, is brushed with pollen on the disc as it becomes free.

Above: A flowering head of *Lambertia formosa*. Note the recurved perianth and the styles bearing terminal clumps of pollen. Below: *Lomatia siliaefolia*—the stylar disc bearing the mound of pollen.

Thus the pollen is not exposed to the vicissitudes of the outer world until its deposition upon an animal is imminent. Later, the stigmatic mound grows larger and is ready to receive pollen from the bill

of the foraging honey-eater. The same sequence of maturation is shown as in the previous cases.

A totally different type of mechanism is found in another group of genera. In the previous genera described, the flower is relatively passive in presenting pollen to its pollinator. In *Symphyonema* and *Conospermum* the flower is active; in fact it is explosive.

Symphyonema is not a particularly common species around Sydney, but one can find it in damp or swampy places. The flowers are small and yellow and the anthers are joined around the style. When these are mature the perianth curls backwards. Any insect (and the pollinator may be a moth) seeking nectar at the base of the flower bangs against the anther-stalks. The anthers separate suddenly although the upper parts of their stalks remain joined. The result is that pollen is sprayed about in all directions, and some of it usually lands on the insect. When the latter visits another flower some of this pollen may be brushed on to the stigma. Clearly, this is a less "efficient" mechanism than those which we have met previously.

Explosive Anthers

The rather more common *Conospermum* is a conspicuous member of dry sclerophyll and heath communities, with its large groups of white or blue flowers. In Western Australia some species are known as "Smoke-bush". In this genus not all the anthers produce pollen, although they are all joined around the style, and some of them terminate in a long bristle or "awn". The style is bent into a swan's-neck shape with the stigma pointing away from those anthers containing pollen (photo, this page). The whole flower is in a state of tension when it first opens, and the slightest touch on the style or the awns will cause the anthers to separate with explosive violence. Firstly, the stigma moves from one side of the flower towards the empty anthers. As it does so, it will strike the object which has caused the explosion. This object, of course, is generally a pollinator—often a fly in fact—and, should any pollen be already on it, the stigma will brush some off. This moving style is only just ahead of a small cloud of pollen ejected from the separating anthers. Some of the pollen will land on the fly, which may carry it to another flower. This, again, does not seem as "efficient" as the *Lambertia* mechanism, although there is some improvement on that of *Symphyonema*. Firstly, the stigma moves towards the sterile anthers, away from the pollen cloud, and, secondly, it clearly strikes the visitor before the pollen does. It seems that self-pollination within the flower is reduced. In fact, however, if one disturbs the tensed flower with a blade of grass some of the pollen almost invariably sticks to the stigma.

This short account of pollination of some members of a single family, incomplete as it is, should have convinced the reader that the flower is, indeed, a complicated piece of machinery. That this mechanism is nicely tuned to the best interests of the propagation of the race is not so evident and requires more facts than are supplied here. Mechanisms such as these were studied by Charles Darwin in the middle of the last century—studies that helped to convince him of the validity of the theory of evolution by natural selection.

An unexploded flower of *Conospermum ellipticum*. Note the "swan-neck" of the style in the centre, the black fertile stamens behind and the white sterile stamen parts in the front.

[*The photos in this article are by the author.*]