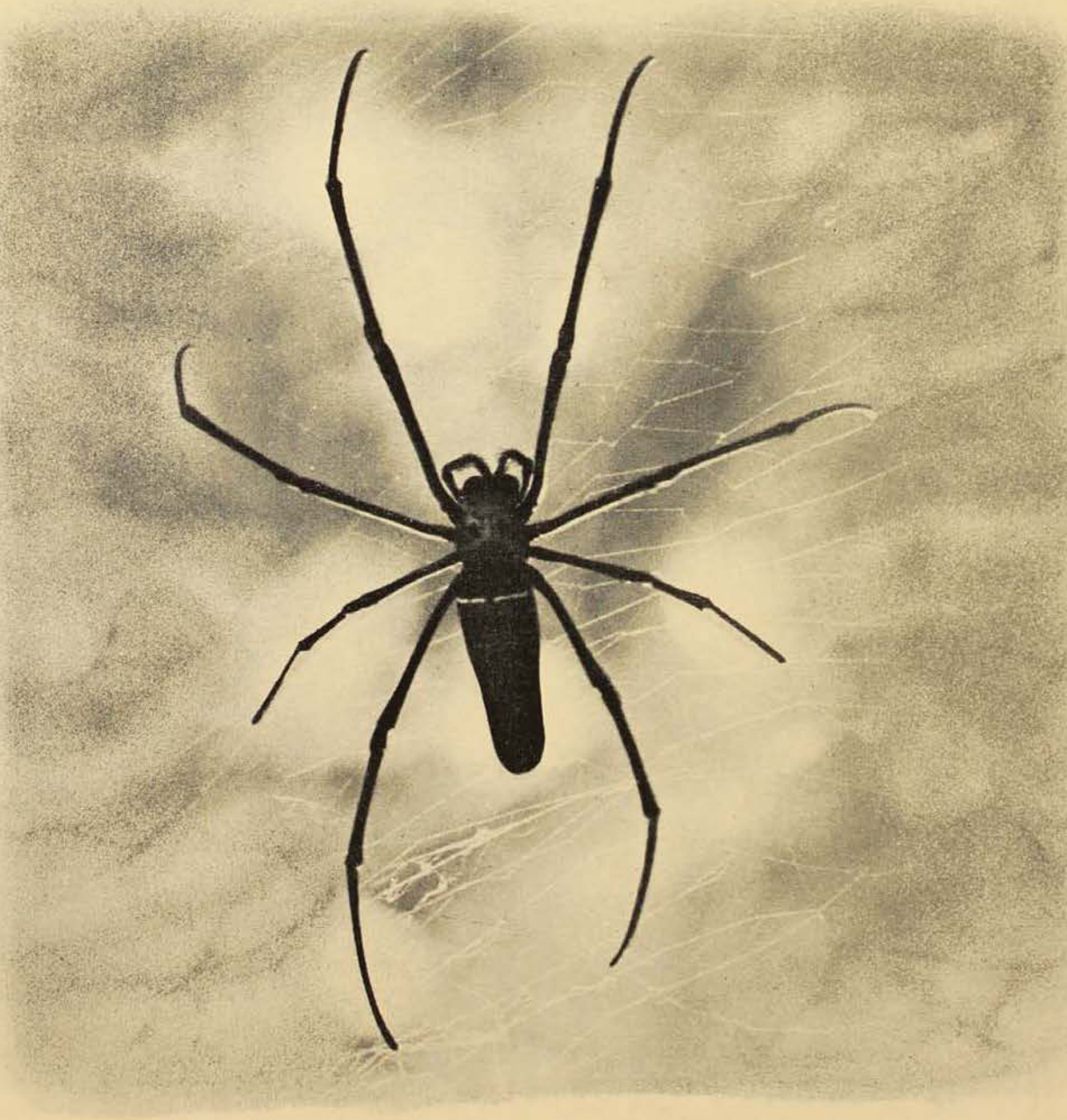
The AUSTRALIAN MUSEUM MAGAZINE

Vol. VIII, No. 4. APRIL–JUNE, 1943. Price—ONE SHILLING.



The Giant Orb-weaver.

Registered at the General Post Office, Sydney, for transmission by post as a periodical.

THE AUSTRALIAN MUSEUM

HYDE PARK, SYDNEY

BOARD OF TRUSTEES.

PRESIDENT:

F. S. MANCE, A.I.C.A.

CROWN TRUSTEE:

F. S. MANCE, A.I.C.A.

OFFICIAL TRUSTEES:

HIS HONOUR THE CHIEF JUSTICE.
THE HON. THE PRESIDENT OF THE LEGISLATIVE COUNCIL.
THE HON. THE COLONIAL SECRETARY.
THE HON. THE ATTORNEY-GENERAL.
THE HON. THE COLONIAL TREASURER.
THE HON. THE SECRETARY FOR PUBLIC WORKS.
THE HON. THE MINISTER OF PUBLIC INSTRUCTION.
THE AUDITOR-GENERAL.
THE PRESIDENT OF THE NEW SOUTH WALES MEDICAL BOARD.
THE SURVEYOR-GENERAL AND CHIEF SURVEYOR.
THE CROWN SOLICITOR.

ELECTIVE TRUSTEES:

E. C. ANDREWS, B.A.
C. GORDON MACLEOD, M.A., M.D., Ch.M.
G. A. WATERHOUSE, D.Sc., B.E., F.R.E.S.
PROF. A. N. St. G. BURKITT, M.B., B.Sc.
PROF. W. J. DAKIN, D.Sc., F.L.S., F.Z.S., F.R.Z.S.
H. B. MATHEWS, B.A.
FRANK B. SPENCER.
PROF. ERIC ASHBY, D.Sc. (London), A.R.C.S., D.I.C.
JOHN SPENCE, C.M.G.
THE HON. SIR SAMUEL WALDER, Kt., M.L.C.
C. A. SUSSMILCH, F.G.S.
O. G. VICKERY, B.E. (Mech. Elect.), A.M.I.E. Aust.

DIRECTOR:

A. B. WALKOM, D.Sc.

Assistant to the Director:

J. R. KINGHORN, C.M.Z.S.

SCIENTIFIC STAFF:

Vertebrate Zoology:

Birds, Reptiles and Amphibians.
J. R. KINGHORN, C.M.Z.S.

Mammals and Skeletons.
E. LE G. TROUGHTON, F.R.Z.S., C.M.Z.S.

Fishes.
G. P. WHITLEY, F.R.Z.S.

Geology:

Minerals and Rocks.
T. HODGE-SMITH.
R. O. CHALMERS, A.S.T.C.

Fossils.
H. O. FLETCHER.

Invertebrate Zoology:

Insects and Arachnids.
A. MUSGRAVE, F.R.Z.S., F.R.E.S.
K. C. McKEOWN, F.R.Z.S.
NANCY B. ADAMS.

Molluscs.
T. IREDALE, F.R.Z.S.
JOYCE ALLAN.

Crustacea and other groups.
F. A. McNEILL.
ELIZABETH C. POPE, M.Sc.

Anthropology:
F. D. McCARTHY, Dip.Anthr.

LIBRARIAN:

W. A. RAINBOW.

DEPARTMENT OF PREPARATION:

T. HODGE-SMITH.
G. C. CLUTTON, *Preparator.*
J. KINGSLEY *Preparator.*

HONORARY SCIENTIFIC STAFF:

Zoologists.

PROF. T. HARVEY JOHNSTON, M.A., D.Sc.
Asst. PROF. E. A. BRIGGS, D.Sc.
H. LEIGHTON KESTEVEN, D.Sc., M.D.
MELBOURNE WARD, F.R.Z.S., F.Z.S.

Entomologists.

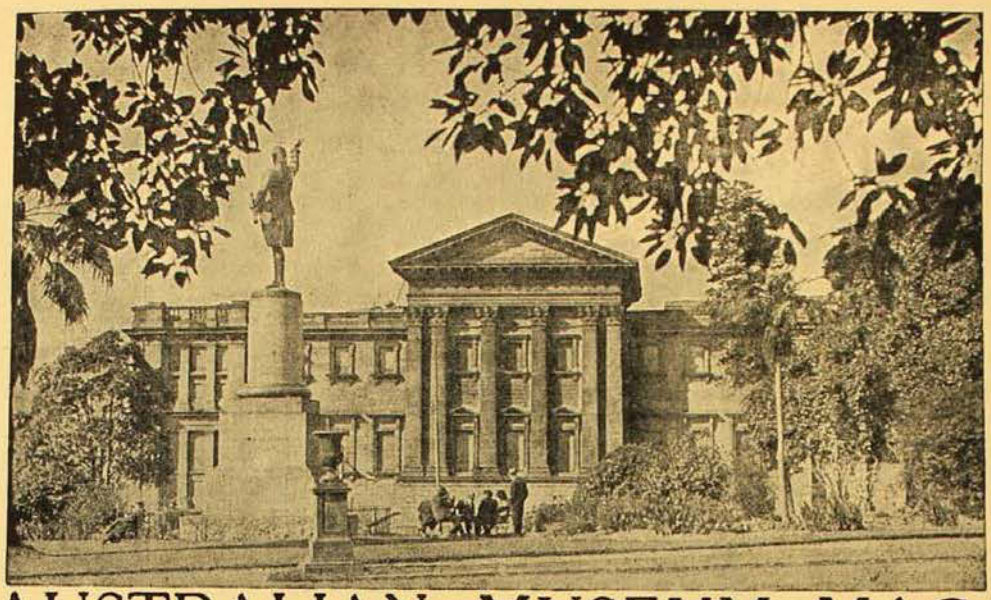
G. A. WATERHOUSE, D.Sc., B.E., F.R.Z.S.
T. H. GUTHRIE.

Ornithologists.

A. F. BASSET HULL, M.B.E., F.R.Z.S.
K. A. HINDWOOD, C.F.A.O.U., F.R.Z.S.
A. J. MARSHALL.

Archaeologists.

PROF. J. L. SHELLSHEAR, M.B., Ch.M.
GEORGE A. THOMAS.

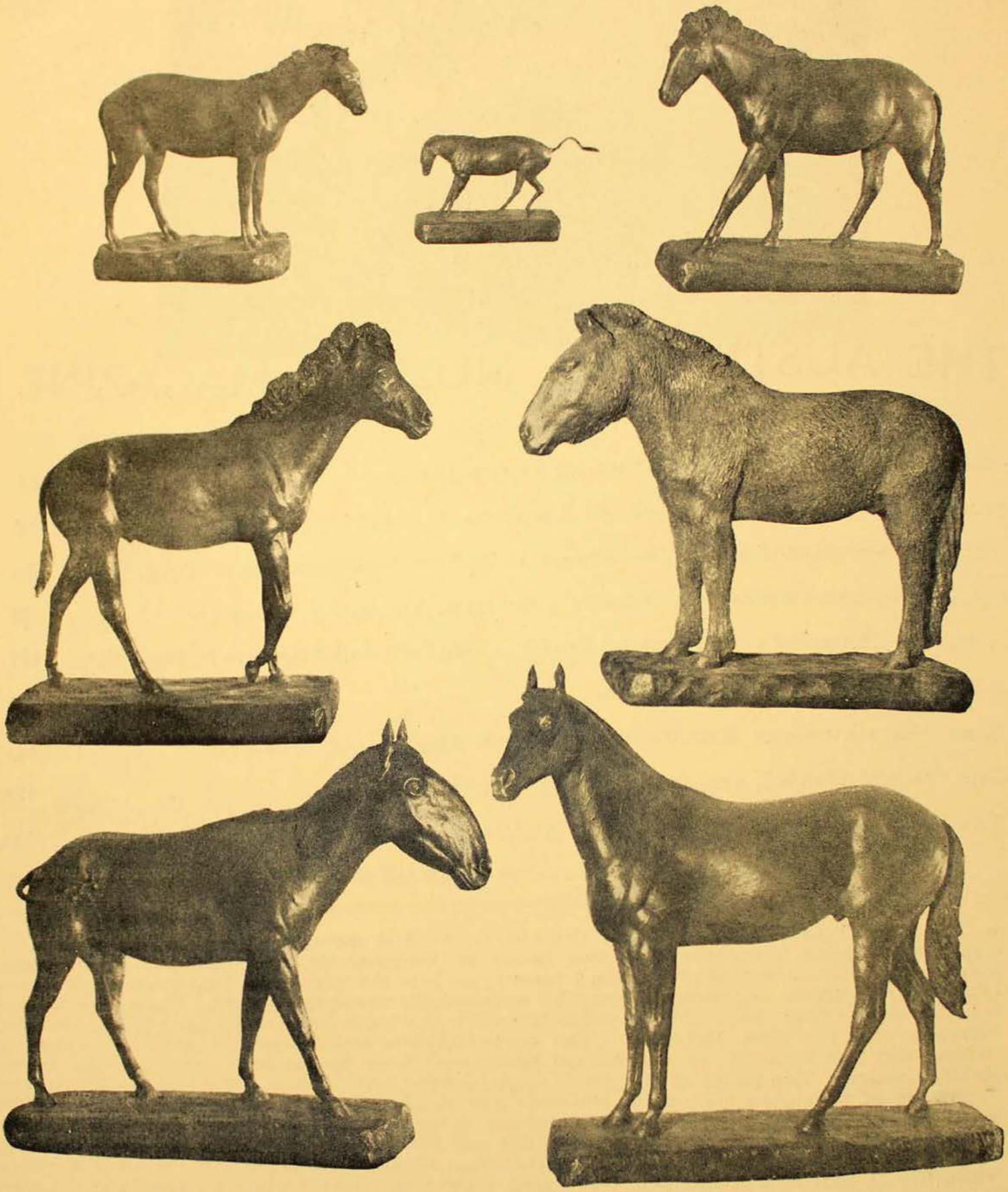


THE AUSTRALIAN MUSEUM MAGAZINE

(Photography, unless otherwise stated, is by G. C. Clutton.)

• OUR FRONT COVER. The Giant Orb-weaver, *Nephila maculata* Fabricius, is from a photograph by Anthony Musgrave and was taken at Yeppoon, on the coast near Rockhampton, Queensland. This spider, of which the female is perhaps the largest of all the orb-weaving spiders (Family Argiopidae), is common along the seaboard of tropical Queensland. The species was first described from China, but its wide range is known to include New Guinea and tropical Australia, Polynesia and the New Hebrides. The genus *Nephila* includes spiders which live chiefly in tropical and, more rarely, in subtropical countries, many forms being found in the Austro-Malayan region. The males of the genus *Nephila* are all very small, about a sixth of the size of the female, of which the body of *N. maculata* may measure about 1½ inches in length. The yellow web spun by the females is strong enough to entrap small birds as well as insects; it has been put to various uses by the natives of New Guinea and the Pacific Islands. The male spider lives on the outskirts of the web and, together with the small silvery-bodied spiders of the genus *Argyrodes* which live as boarders in the web, feeds upon those small insects which are caught by the sticky threads but which are too minute to be noticed by the builder of the web. The picture gives no idea of the true coloration of the spider, in which the cephalothorax is black and the abdomen olive-green or yellowish, the long black legs being characteristically tufted with hairs. It is not recorded as harmful to man, despite its somewhat forbidding appearance.

VOLUME VIII, NUMBER 4. APRIL–JUNE, 1943.



Mesohippus (Oligocene).
Hipparion (Pliocene).
Hippidion (Pleistocene).

Eohippus (Eocene).

Merychippus (Miocene).
Wild Horse (present day).
Modern Thoroughbred.

THE EVOLUTION OF THE HORSE. A NEW MUSEUM EXHIBIT. (See page 136.)

THE AUSTRALIAN MUSEUM MAGAZINE

Published by the Australian Museum - - - - - - - - - - *College Street, Sydney*
Editor: A. B. WALKOM, D.Sc. Annual Subscription, Post Free, 4/4

VOL. VIII, No. 4. APRIL–JUNE, 1943.

The Malcolm Stanley Collection of Fossil Insects

SIR EDGEWORTH DAVID wrote in his *Explanatory Notes to Accompany a New Geological Map of the Commonwealth of Australia* (1932) that "an important contribution to knowledge of the development of insect life throughout the world has resulted from the discovery by the late John Mitchell of a remarkable Upper Permian insect fauna". The principal locality where these fossils are found is between Belmont and Warner's Bay near Lake Macquarie, New South Wales.

The classical work of the late Dr. R. J. Tillyard was largely made possible by a trio of enthusiastic collectors consisting of Messrs. John Mitchell, T. H. Pincombe and Malcolm S. Stanley. Of these three, Mr. Stanley is the only active collector today. He is a well-known consulting engineer in Sydney, and has spent a considerable amount of his spare time and money searching for these elusive fossil insects. The fossils are preserved in a very light grey chert, largely formed of very finely divided particles of devitrified rhyolitic tuff. Apparently the insects were suffocated by the fine dust from some local volcanic eruption and then buried in the thick accumulation of dust.

As Upper Permian times date back somewhere between two hundred and three hundred million years, it is natural that only the impressions of the insects remain. Many of the impressions are perfect, the minutest details being preserved.

Already new forms have been described among the specimens of this collection, and it is certain that when all the material has been investigated, our knowledge of the Upper Permian insect fauna of Australia, differing as it does quite substantially from that of Europe, will be materially advanced.

The collection is to be known as the Malcolm Stanley Collection, and Mr. Stanley hopes to add to it in the future.

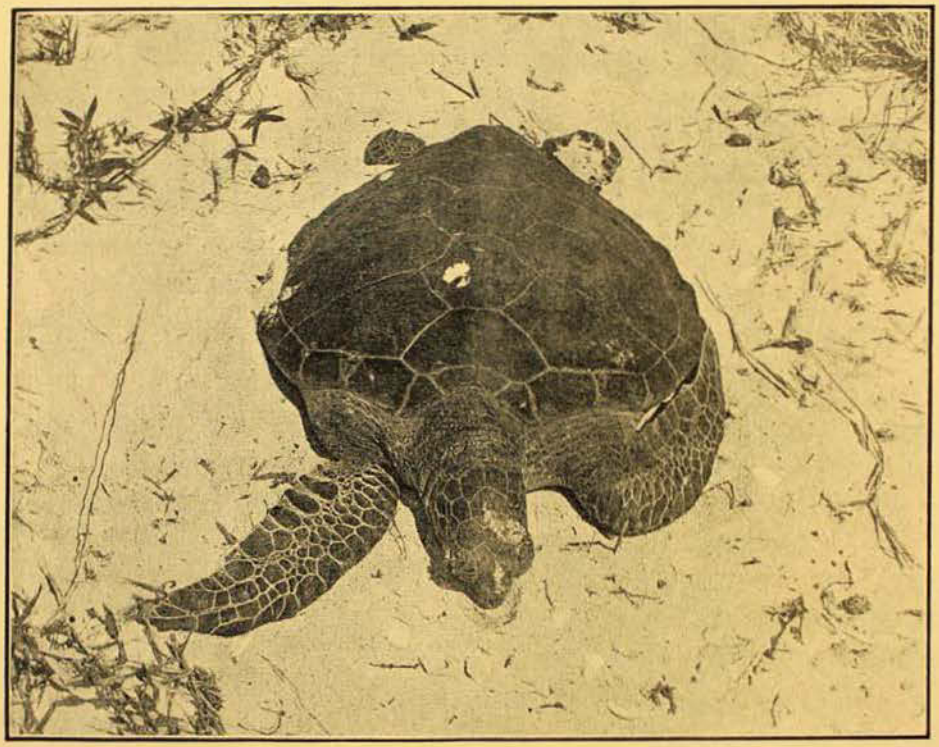
In presenting this valuable collection to the Trustees of the Australian Museum, Mr. Stanley has made a considerable contribution, not only to Australian science, but to science the world over. His expressed wish is that the work of Dr. Tillyard should be carried on. Steps have been taken to have portion of the collection investigated by specialists.

Some New Guinea Reptiles

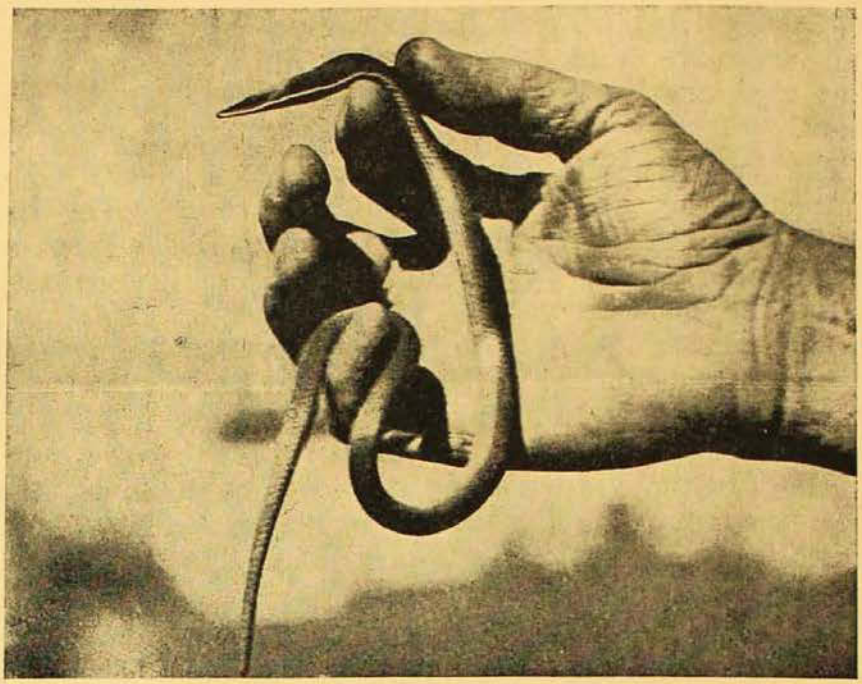
By J. R. KINGHORN, C.M.Z.S.

NEW GUINEA has been a happy hunting ground for zoologists for more than half a century, and though many collections of reptiles have been made and forwarded to museums throughout the world, these were secured mainly from coastal and other equally accessible places. During more recent years, white man has penetrated the jungles and opened up parts of the interior, and from these locations many rare and new species have been made available to specialists. Despite the numerous, though perhaps small, collections already made, we still are only scratching the surface of this rugged country, and it naturally follows that little is known of the habits of the reptilian fauna.

In the river estuaries and the sea surrounding New Guinea are several species of turtle, but these, being marine in habits, and therefore wanderers, are common to many of the tropical islands of the Pacific and Indian Oceans. Crocodiles are restricted to streams and swamps of the coastal areas, whilst snakes and lizards abound everywhere except in the colder parts of the high mountains. The reptilian fauna is classified as Austro-Malayan, and its great interest lies in its affinity with both Indian and Australian types. The turtles of the area include such well-known forms as the Green Turtle, from which the world-famed turtle steak and soup are obtained. There is the Hawksbill or Tortoise-shell Turtle, which, as the name suggests, provides the genuine tortoise-shell. Then there are several other species, not so well known, including that extraordinary and truly enormous Leathery Turtle or Luth. This giant of the family, with its leathery shell and outsized



A young Green Turtle. This is the species which for ages past has supplied the world's banquets with turtle soup.
Photo.—A. Musgrave.



Lialis burtonis, a common type of legless lizard.

flippers, may measure more than eight feet from tip of snout to tail and weigh as much as half a ton. It appears to be the sole living member of a group of turtles otherwise long extinct.

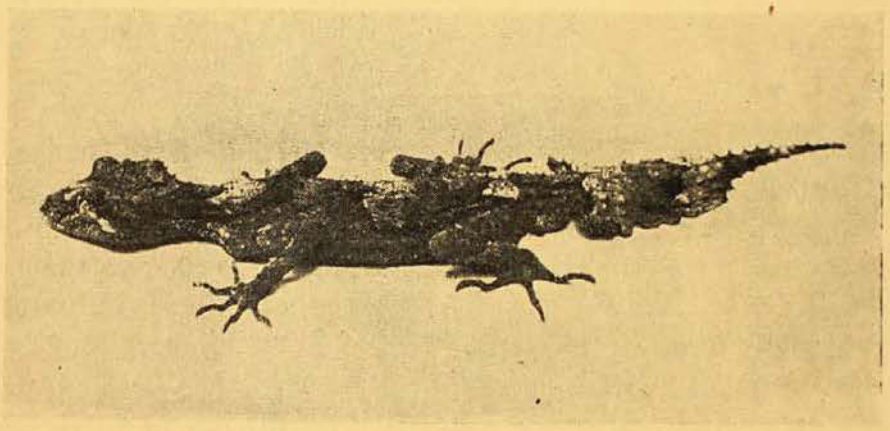
Of the better known kinds, the Green Turtle is the one most frequently seen lumbering across a beach above high-water mark, in search of a suitable spot to dig its "nest". This is a hole carefully dug in the sand, in which the eggs are laid. These are about the size of a ping-pong ball, are somewhat parchment-like at first, but become hardened some time after laying, and there may be anything between one hundred and two hundred in a clutch. The turtle, being quite satisfied that a good job has been done, fills in the hole with sand, carefully smooths the surface, and waddles back to the sea, leaving the eggs in their natural incubator, to hatch out in approximately sixty days time. The actual period of incubation varies somewhat, depending on climatic conditions, but all the eggs in one clutch hatch almost at the same time and the young scramble through the sand to the surface. Then commences what is virtually a race to the water. Once started on their journey there must be no loitering, for this is a very critical time in the life of a young turtle, little more than an inch in length, the reason being that hundreds of hungry sea birds pounce on them and gorge themselves on those unfortunate youngsters that have not been able to reach the water in time.

In addition to turtles there are several species of fresh-water tortoises on the island, most of which are so closely allied to our Macquarie Tortoise and Long-necked Tortoise that only a specialist could hope to distinguish one from the other. The marine turtles have flippers or paddles, whereas the fresh-water tortoises have walking legs and webbed feet, and therefore are good walkers as well as swimmers, and it can be said that they are as much at home on land as in water. These fresh-water tortoises also dig holes in which the eggs are laid. The holes are generally in the bank of or within easy distance of a stream, and the eggs, which seldom exceed twenty in number, are hard shelled and oblong in shape. Among the rarer forms of tortoises to be found in New Guinea is one known as the Fly River Turtle, which, to the present day, is found in the Fly and Strickland Rivers; very few specimens are known and practically nothing is

known of its habits. As with most reptiles, all turtles and tortoises are shy and secretive, and it naturally follows that comparatively little is known about them.

The well-known crocodile of New Guinea is the same as that found on the north and north-east coast of Australia. It is an Indian type known as the Estuarine or Salt-water Crocodile, and called "Gator", short for Alligator, by residents and hunters in North Australia. It is a fact that there are no alligators in Australia or New Guinea, these reptiles being known only by a large species common to Central America and a small species well known in China. It is generally agreed that alligators are somewhat shy, timid and inoffensive, whereas crocodiles are sly and dangerous to man. Crocodiles bask on the mud banks along or in the middle of a stream, or they float low in the water, with only tip of snout and eyes showing, and often have been mistaken for floating logs. Whilst these reptiles are comparatively slow moving on land, they are extremely fast and agile in water. They feed on fish, small mammals and birds, mainly water birds. They lie in wait for hours near the bank of a stream waiting for some unwary creature to come to drink, when it is either caught by the nose or flung into the water by a rapid twirl of the crocodile's tail, drowned, and, if not eaten then and there, stowed away in some mud hole under the water to be devoured at leisure. Crocodiles measuring between fourteen and sixteen feet in length have been known to drag a fully grown ox into the water, and many a human being, white, black, or yellow, has been attacked by much smaller crocodiles.

The lizard population of New Guinea is large and varied and is very similar in many respects to that of Australia. There are several species of goanna, the largest being a blackish, yellow-spotted creature, growing to more than seven feet in length, whilst the smallest is a pale greenish-grey one, criss-crossed with narrow black lines, often forming a network pattern. It never attains a greater length than twelve inches. Though excellent climbers, often being found searching for young birds and eggs in nests high up in the trees, goannas live mainly on the floor of the forest, where ground birds, small mammals, small lizards and even large insects form a varied diet.



One of the tree geckos common to New Guinea and Cape York. The natural camouflage of these tiny lizards is almost perfect.

Among the skink lizards, shiny, smooth denizens of the grass, are many different kinds, of many different hues, from pale brown to vivid green. The largest member of this family, measuring perhaps twenty inches from snout to tip of tail, is a close relative of our well-known friend the Blue-tongued Lizard, and, whilst it is evidently distributed throughout the island, it is nowhere more common than in the Port Moresby area.

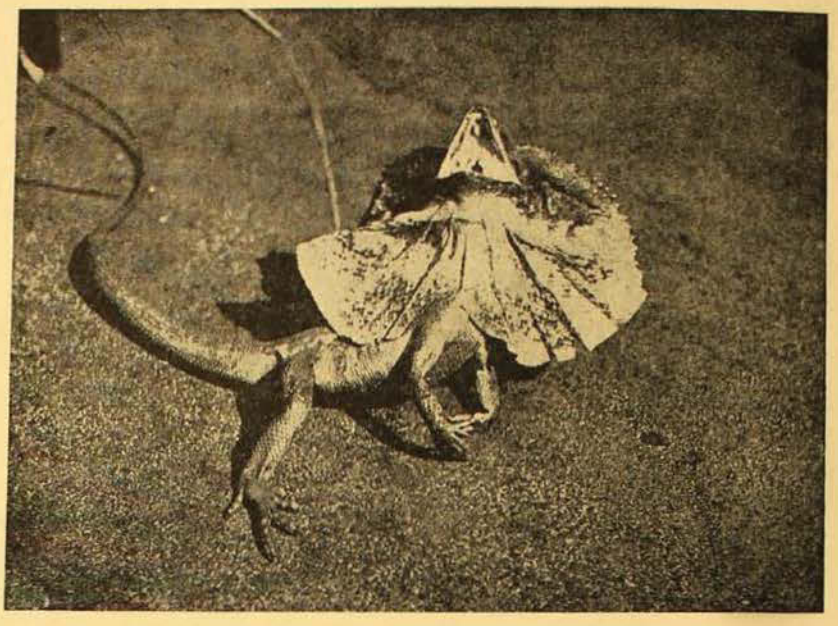
There are two species of Legless Lizard, one being our Australian *Lialis burtonis* and the other a very sharp-snouted kind,

Lialis jicari. Neither can be said to be very common, though the latter is not found anywhere except in New Guinea. These are very snake-like in general appearance, but, like most other lizards, they are harmless, and feed mainly on insects and very small lizards of various kinds.

The Gecko lizards, often wrongly referred to as Wood Adders and Rock Adders, are extremely abundant. Some are essentially rock dwellers, whilst others live on trees, decayed stumps or under loose bark, their outward appearance resembling the material on which they are found. Geckos are the best camouflaged of all lizards, not only in regard to coloration but also in regard to structure, and they blend beautifully with and merge completely into their surroundings. Despite the fact that they sometimes are referred to as Wood or Rock Adders, they are absolutely harmless, insect-eating reptiles, nocturnal in habits, and well known in most tropical homes, where they crawl over the ceilings and walls at night in search of any insect that may be offering.

The Jew Lizard family is well represented by both tree-living and terrestrial forms. The best known of the tree lizards is locally but quite erroneously called chameleon, though in the general shape of the head it is not unlike that reptile. Actually it is more closely related to our common Eastern Water Lizard, which is well known along many of the fresh-water streams of south-eastern New Guinea. This water lizard poses on logs and rocks near the water's edge, jumping in when alarmed and often remaining submerged for more than ten minutes until it is sure that the danger has passed. The Jew Lizard of Australia is sometimes called Frilled Lizard, but the two are quite different; the "Jewie" is typically Australian, the Frilled Lizard being common to North Australia and New Guinea. The frill of this reptile is like paper and is erected when the lizard is annoyed, but is folded back over the shoulders when it is at rest, or is running away, which it does on its hind legs and at an extremely rapid pace. The Frilled Lizard often hides away in hollow logs or in the deep burrows of mammals, and

The Eastern Water Dragon, Physignathus lesueurii, may often be seen on the rocks or logs near by the water's edge.
Photo.—A. Musgrave.



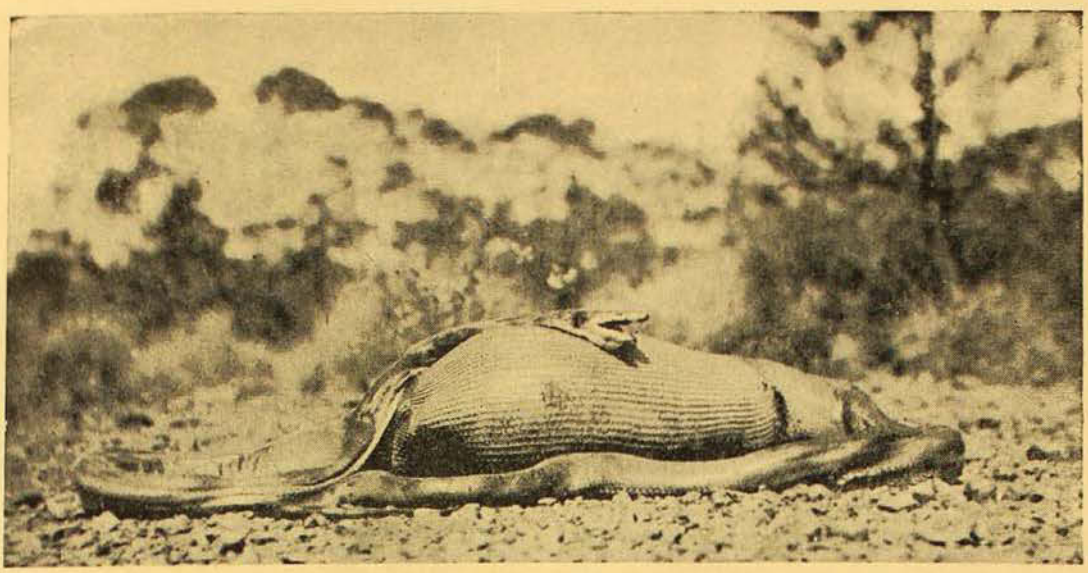
The Frilled Lizard, Chlamydosaurus kingii, common to north Australia and New Guinea.
Photo.—J. R. Kinghorn.

actually has been found in burrows also occupied by small pythons.

As in most tropical countries, snakes are plentiful, both in numbers and in the variety of species. Harmless varieties consist of Blind Snakes, those worm-like burrowers that live on ant eggs and termites, Green Tree Snakes, some small grass snakes and small pythons. Large pythons, such as the Amethyst Python, a relative of our Carpet Snake, can hardly be classed as harmless, even though they are non-venomous. These large pythons grow to about twenty feet in length, and even a fourteen-foot specimen could easily swallow a wallaby. The Amethyst Python is of Indian origin, but is known also from Cape York area, Queensland. All pythons are not patterned like a carpet, for in the trees of New Guinea are some, more strictly of the boa family, that are either bright green or lemon-yellow in colour. All prefer a diet of warm-blooded animals, such as birds, rats, mice and other small mammals.

The Green Tree Snake, a solid-toothed, non-venomous snake, is extremely common, whilst the Brown Tree Snake, a back-fanged, slightly venomous snake, crossed with black wavy lines, is also widely distributed throughout the island. Tree snakes differ from the terrestrial forms in having, on each side of the ventral plates, a well-defined keel, extending the entire length of body and tail, thereby providing a "grip" when climbing even the smoothest branches.

The venomous snakes of the mainland and neighbouring islands are mostly small kinds, not more than twenty inches in length and not thicker than an ordinary fountain pen. Such snakes, though capable of poisoning small mammals and birds, might be regarded as practically harmless to man. Among these are many that never attain a length greater than eighteen inches, and that are generally brightly coloured about the head and underparts. Such small species feed mainly upon insects and perhaps small lizards and toadlets. In addition to these terrestrial types there are many different kinds of sea snakes, all of which are venomous, but few of which are capable of inflicting a bite dangerous to man. There are Yellow-bellied Sea Snakes, grey and white banded, and plain brown kinds. The first named grows to about forty inches in length, and one of the banded sea snakes may exceed seven feet in length. Sea snakes are specially adapted to an aquatic life. The body is laterally compressed, being rounded above and keeled below, a cross section somewhat resembling that of a ship. The tail is flattened vertically, thereby forming a paddle; the nostrils, which are valvular, are situated on top of the snout, thereby



The Amethyst Python (Python amethystinus) after having swallowed a wallaby.
Photo.—W. E. Stirling.

making breathing easier when floating on the surface, or, by closing the valve, the snake is enabled to swallow under water without inconvenience. Although sea snakes live their entire life in the water, some species occasionally wriggle ashore or onto suitable rocks and rest or bask in the sun. All are excellent and graceful swimmers, and speedy enough to catch eels or fish upon which they live.

Whilst there is a New Guinea representative of the Australian Black Snake and Brown Snake, neither is regarded as deadly, though a bite from a large black variety might cause serious effects. The two deadly snakes of New Guinea are actually Australian species, and they are the Death Adder and the Taipan, known also as the Giant Brown Snake. The latter was first discovered only a few years ago in the Cape York area, but later was found to extend to the country surrounding the Gulf of Carpentaria and Arnhem Land. In New Guinea it apparently has a very restricted range, and has been found only about the mouth of the Fly River. The Taipan grows to more than eleven feet in length, and is second in size only to the world's largest venomous snake, the King Cobra. It is an aggressive species and, having fangs nearly half an inch in length and a goodly supply of venom, is an extremely dangerous snake.

The Death Adder, that broad-headed, fat-bodied, sluggish terror, so well known as Australia's deadliest snake, is found throughout New Guinea, and from Ceram in the west to New Britain in the east, in addition to many of the smaller islands off the mainland. Its distribution, however, is restricted to the coastal belt and surrounding uplands.

Speedy and economical removal of marine growth from ships is of greater importance than ever at present, and many devices obviating docking are being tried. For some time past museum zoologists and port engineers have been conducting investigations into marine growths and pests and their incidence. The principal application of the results of these investigations has been in the protection and preservation of wharving, but the range may now be extended.

Malaria, New Guinea and Us

By FRANK A. McNEILL and ELIZABETH C. POPE, M.Sc.

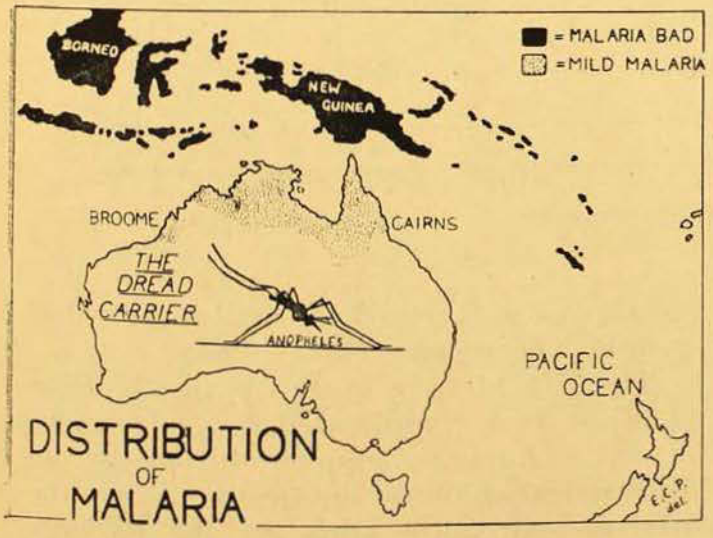
OUR armed forces in New Guinea are opposed by the most deadly machines of war, but bullets and bombs are truly less of a menace to fighting men than epidemic disease. In the cauldron of conflict human hordes become haphazardly mixed, and are subjected to strange forms of infection that cannot be avoided. The history of the past is little different from that of today. Ages ago scourges wiped out armies and the populations of cities. Strangely enough, during the course of a war, the importance of all this is overshadowed by the more spectacular news of advances and reverses of soldiers in the field.

Take as an example malarial fever. How many know that it is responsible for a higher death rate than any known malady, not forgetting death from bullets? Estimates suggest that some 800 million persons suffer from malaria, and the average annual deaths from the same cause exceed 3½ millions. How does Australia stand in respect to malarial fever? Fortunately, this country has been comparatively free from it. Our freedom has been due to natural isolation, and possibly to conditions unfavourable to the causal parasite. Occasional small outbreaks in the tropical northern parts of Australia have been controlled by sensible and strict preventive measures. That continual official watchfulness is necessary and justified may be seen from the following story. A bad outbreak of malarial fever occurred in Brazil in the early nineteen thirties. Until 1930 the area concerned had been free of malaria-carrying mosquitoes, but in this year several infected anophelines (harbourers of the scourge in their native country) were conveyed thither from Africa through the agency of fast transport. Their presence was immediately noted, but it was confidently hoped that the unfavourable natural conditions would wipe them out. Consequently no immediate and special preventive measures were taken. The mosquitoes, however, thrived and multiplied and spread abroad the malaria they carried. Soon tens of thousands of people were suffering from the fever. Grave economic loss was caused through inability to overcome the menace, and in 1940 alone the cost to the Brazilian Government and to the Rockefeller Foundation was about 1,000,000 dollars.

In much earlier times malaria was introduced into the islands of Reunion and Mauritius, which had been completely free of it prior to the year 1864. The disease has persisted, and, as a result, Mauritius (population 383,000) alone has now to meet an annual bill of approximately £A93,750. It was not until 1900 that the life history of the malaria parasite was finally worked out, so failure to control outbreaks before this life history was known is easily understood.

In New Guinea malarial fever is rife. The constant military traffic between this place and the mainland provides opportunities for the introduction of the disease. What will be the effect of present extensive operations in that area? Not only will our fighting men contract and suffer from the fever while on service, but numbers of them will bring the causal parasite back to the mainland in their blood. It therefore behoves us to take steps to ensure that history does not repeat itself and malarial fever become a burden in Australia as it has in other places.

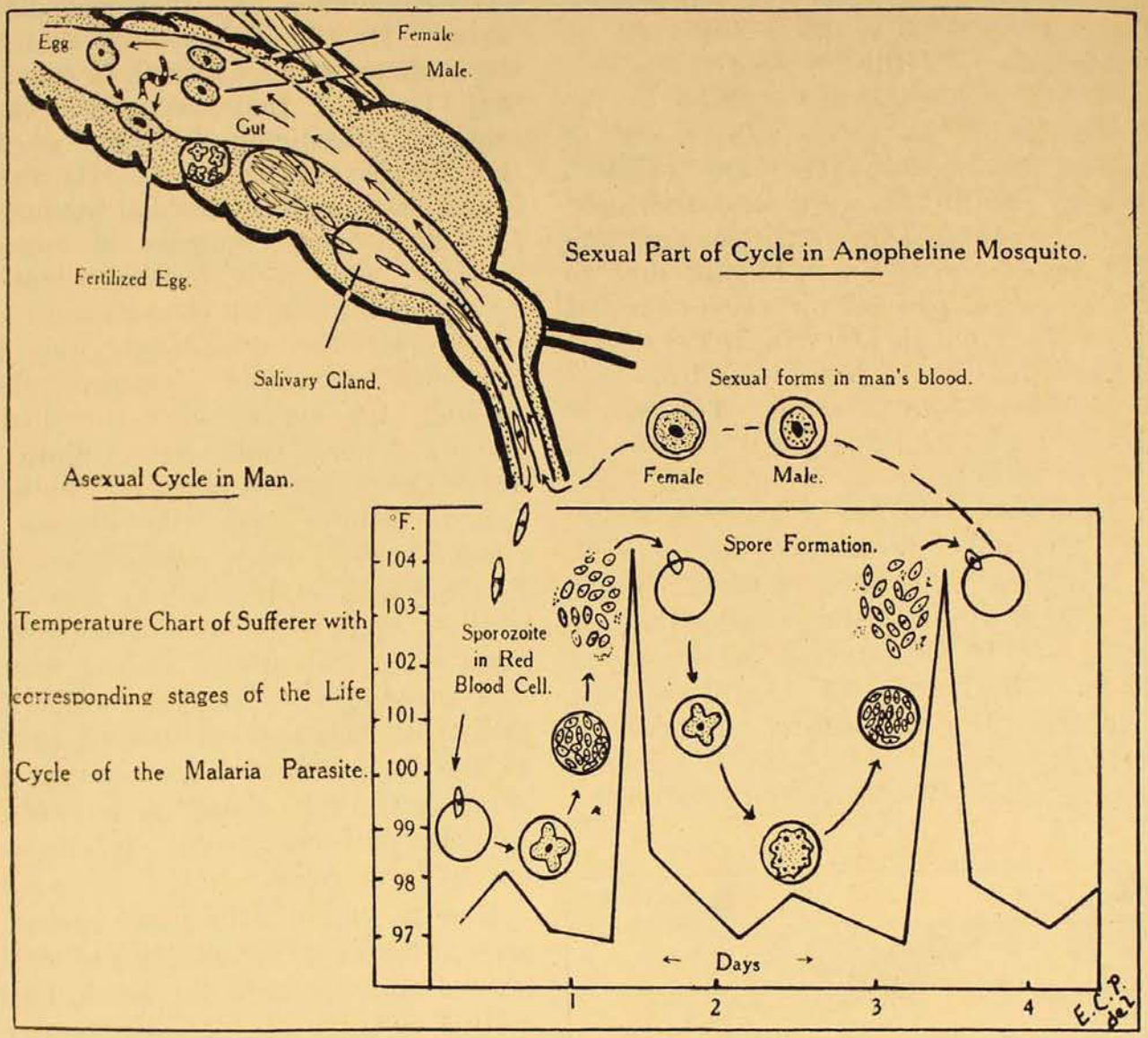
It is of interest to review here some of the outbreaks that have occurred on the mainland. In the very early records there is no evidence of malaria in the land, but there is subsequent proof of epidemics associated with gold "rushes", arising in completely new and scattered areas. In 1885 Charters Towers was visited by so severe an epidemic that to escape infection proved the exception and not the rule. Then in Darwin in 1909 more than one-third of the hospital admissions were sufferers from malaria. The source of this infection and also that of 1910 was traced to numbers of miners who had come from New Guinea to work on newly opened tin-fields in the Northern Territory, bringing malaria with them. There were a number of fatal cases, and, at the time of the publication of these and other facts in Dr. R. W. Cilento's work on malaria (*circa* 1924), numbers of infected persons in north Australia traced their original illness to that occasion.



The outbreak of "black sickness" at Burketown in 1864 has since been recognized as malignant malaria. Of the population of some seventy-six people originally in good health, about fifty succumbed. This severe epidemic was considered quite probably to have been introduced by Malays coming across in praos from Java. At that time on one of the creeks some miles away, a small sailing vessel was discovered with a number of dead people on board; they were from Java and they had died of "fever". Dr. Cilento has stated that, from the evidence at his disposal, in general it may be said that malarial fever is nowhere endemic in Australia south of the Tropic of Capricorn. He further found that north Queensland produces by far the greatest number of cases of malaria, and it is probable that the disease is introduced by two main routes. One route, he considered, was from Northern Territory (Roper River) through the agency of cattle drovers; the other was from New Guinea and outlying groups of islands. While Dr. Cilento believed that the disease was endemic over a large part of Cape York Peninsula, it is recalled by one of the writers that there were few cases of malaria in and around Cairns when he was there late in the year 1928. Rigid preventive measures were being enforced at the time and very good results were being achieved. Recently, however, an epidemic has broken out and there are hundreds of cases.

How is Australia to guard against the present increased introduction of malarial fever from islands to the north, particularly New Guinea? Our daily papers tell us that for every Australian casualty from a Japanese bullet in New Guinea, four other soldiers contract tropical disease, most frequently malaria. It only needs those men infected with malaria to come back in numbers to the mainland to provide ready reservoirs from which rapid increase of the disease may develop in the north. In Australia we have the carrier mosquito *Anopheles* in abundance, but as yet only sparsely infected. Normally there is not a large population north of the Tropic of Capricorn, but of late years this position has changed considerably, with consequent increased risk of outbreaks of malaria. The authorities are well aware of this risk and are doing everything they can to prevent epidemics.

In order to combat a scourge like malarial fever it is necessary to know the complete life cycle of the microscopic animal parasite which causes it. In the life cycle of the parasite there is an



Life Cycle of Malaria Parasite.

intermediate host—a female mosquito—which carries the disease from one human subject to another. Always the malaria-carrying mosquito has been found to belong to a particular kind, named *Anopheles*. In different parts of the world different species of anopheline mosquitoes act as carriers. Never in any scientific investigation, however, has any kind of mosquito other than an anopheline proved to be the culprit.

There are many people who erroneously believe that the carrier mosquito is the chief danger when epidemics of malaria occur, and they forget entirely the tiny organisms which are at the root of all the trouble—the single-celled parasitic animals called *Plasmodium*. In the absence of these *Plasmodium* parasites, mosquitoes may bite continuously, and no sign of malarial fever will be found in people who receive these bites.

The life history of the parasitic *Plasmodium* is a complicated one. It begins when a human being is bitten by an infected anopheline mosquito. A minute, active, sporozoite stage of the parasite passes from the mosquito into the blood-stream of the victim, being injected along with the mosquito's saliva into the puncture. Upon entering the blood-stream, the parasite penetrates one of the minute red blood cells. There it feeds and grows, and breaks up into numerous spore-like forms. These then burst forth from the red blood cell and, in doing so, release a quantity of waste products and poisons into the blood-stream. The minute spores, released in this way, soon enter other red blood cells and go through the same pro-

cesses as their parent, producing in their turn new batches of offspring. So the continually multiplying brood increases to millions of parasites, all going through the feeding and growing stages, and all bursting out of their red cell habitations at the same time. Not only are they responsible for the destruction of millions of the important red blood cells—in itself a very serious matter—but the quantity of poison also liberated by great numbers of the parasites causes serious harm to the infected person and brings about the periodical rises in temperature which are so characteristic of malarial fever. The exact correlation of the spore-forming or asexual part of the life cycle of *Plasmodium* and the behaviour of the temperature of the victim may be seen if a study is made of the diagram which shows the full life cycle of the parasite. In the diagram the bursting of a red blood cell and the release of the contained young spores and poisons are shown to occur just before the high peak in the line which shows the fluctuations of temperature. There are several kinds of *Plasmodium* parasites causing malaria, and in each kind the spore-forming part of the life cycle takes a different period of time. In one it occurs every 72 hours, and in another every 48 hours. In consequence the sharp bouts of fever recur at regular intervals. As time goes on these bouts become more and more severe, until the disease is overcome by the natural resistance of the patient or death supervenes.

When a female mosquito sucks in blood containing the spore stages of the parasite, these are destroyed by the insect's digestive processes. How, then, is a new human host infected by the female mosquito? This is how it happens. Certain of the parasites in the red blood cells do not form spores, but develop instead into sexual forms—male and female. These lie dormant until sucked in by a female anopheline mosquito. The stage whereon the remainder of the life history of *Plasmodium* is enacted now shifts from the human being to the body of the mosquito. Here the male and female phases of the microscopic parasite breed together and ultimately produce large numbers of offspring—individuals of the infective sporozoite stage with which our story of the life cycle began. All the developmental stages of the sexual part of the life cycle of the parasite, however, are not passed in the intestine of the mosquito. Let us trace its progress in the body of the new host. First the fertilized eggs burrow through the stomach wall and become encysted. Then they develop and divide up into numerous young sickle-shaped forms which find their way through the mosquito's body to the salivary glands. From that point they are pumped into another human host when the mosquito bites. Thus a new victim becomes infected and the life cycle goes on.

To stamp out a parasite like *Plasmodium,* it is evident that its life cycle must be interrupted at one point, and the easiest way to attack it is through the mosquito host. The advantages of this method are understood when we realize that the mosquito is more than just a mere carrier of the disease. The insect is also a necessary breeding ground wherein the sexual part of the life cycle is completed. So if we obliterate the mosquito we arrest the spread of malaria. How can this be accomplished? The civil and military authorities are already busily engaged on the problem. If they receive intelligent co-operation from a public which realizes the need for a set of rather irksome regulations, success of their campaign is assured.

"It has been said that a good malaria fighter must learn to think like a mosquito." So claimed George E. Vincent in his report to the Rockefeller Foundation in 1928. "He must ask: Which of many kinds of anopheline mosquitoes shall I try to imagine myself? How far is it possible to fly? When and where is food to be had? . . . . where is the best place to deposit eggs? Is the water of the right kind and temperature? Is it stagnant or flowing?" Only by thinking over the various problems and attacking them in this manner can an effective anti-

mosquito policy be framed. Then if the mosquito is wiped out there can be no possibility of outbreaks of malaria.

Measures of combating malarial fever include the screening of human habitations against the entry of mosquitoes, and the wearing of mosquito-proof clothing by the individual. Preventive community measures would call for the segregation of patients in order that the carrier mosquitoes cannot have access to them and so pick up the infection. Other measures include the clearing of vegetation, the drainage of swamps, fumigation of houses, and spraying and regular oiling of mosquito breeding places. The biological control of the disease may be attempted too by introducing the natural enemies of the mosquito—fish and the larvae of water beetles and other creatures which eat the mosquito larvae and pupae. Already the small introduced fish *Gambusia* has been very effective in this way in New Guinea.

Another very important measure is to ensure that the living conditions of neighbouring native races are such that they enjoy the same chances of immunity as the whites. As long as a native population remains infected, it acts as a reservoir from which the disease may be spread by the mosquitoes to the whites. Examinations made in certain areas of New Guinea proved that 80% of the children had enlarged spleens, a sure indication that they suffered from malarial fever. In places where chances of infection are high, regular daily doses

A small sufferer from chronic malaria. Note the wasted appearance and the one-sided swelling of the abdomen due to enlargement of the spleen.
Photo.—
F. H. Taylor.

of quinine or other similar prophylactic should be administered. This precaution, however, should be secondary to the eradication of the mosquitoes, for only in this way can the malaria parasite be wiped out.

Such preventive measures as have been suggested obviously cost a considerable amount of money. When, however, this initial expense is measured up with the cost which the government might be forced to meet in the future in maintaining a debilitated and malaria-ridden population, it is well worth while. A little foresight saves untold labour and expense.

Dr. G. A. Waterhouse, B.E., F.R.E.S., a Trustee and past president of the Australian Museum, has been elected a Special Life Fellow of the Royal Entomological Society of London in recognition of his services to entomology. Dr. Waterhouse is a world authority on Rhopalocera (Butterflies).

Mr. J. Kingsley, who has been on the staff of the Australian Museum since 1913, has been advanced to the position of preparator. Mr. Kingsley, under the auspices of the Carnegie Corporation of New York, visited the United States of America to study advanced methods in taxidermy and museum technique. Many of the models on exhibit are from his hands.

Dr. A. B. Walkom, Director of the Australian Museum, has been elected president of the Royal Society of New South Wales.

Mr. E. Le G. Troughton, F.R.Z.S., C.M.Z.S., Mammalogist, the Australian Museum, has been elected president of the Linnean Society of New South Wales.

Collecting and Preserving Insects and their Allies

By A. MUSGRAVE

INQUIRIES are frequently made of the Museum regarding the collecting of insects, spiders, scorpions, ticks, mites, centipedes and millipedes. Some time has elapsed since this subject was treated in THE AUSTRALIAN MUSEUM MAGAZINE,[1] so the following account of methods employed by collectors is intended to assist those wishing to preserve their material correctly.

INSECTS.

While the collecting and preserving of some insects may be carried out in the field with a minimum of trouble, others must await special treatment until camp or home is reached.

Collecting Gear.—Haversack or satchel, butterfly net,* beating net or umbrella,* small net or wire tea-strainer,* killing bottle (cyanide), long forceps, strong-bladed knife or tomahawk,* chloroform tubes (4 × 1 inch), spirit tubes (3 × 1 inch), tins, pocket-box, pill-boxes or cardboard boxes, labels (cartridge paper), butterfly envelopes, magnifying glass. (* To be carried according to requirements.)

The general collector of insects will require more impedimenta than one confining his attention to a single group of insects, and the suggestions here given are for the general collector.

Haversack.—To carry the gear in the field a light but strong haversack, preferably of two compartments, is a first essential.

Nets.—A butterfly net is necessary for the capture of flying insects such as moths, butterflies, dragon-flies, flies, wasps and active insects of all kinds. Various types, such as collapsible kinds which are, as a rule, oval rather than circular, are sold by dealers in natural history material. These have the advantage of taking up little room when not in use. One type is made of spring steel and can be opened and fastened with a wing-nut. This kind is the type used by the Museum. As these more elaborate types are not always procurable, a home-made net may be constructed. A ring of fencing wire (no. 8 gauge), about 15 inches in diameter, has the ends straightened and bound to a ferrule of light metal with fine wire and then soldered. If no ferrule is available, the ends of the ring may be bound with wire to a wooden handle, which may be a portion of a broomstick, previously grooved at the sides to accommodate the wire ends. A calico strip 3 or 4 inches in depth into which the wire frame has first been inserted, will serve to reinforce the bag which is attached to it. The bag should be of Bretonne net (which has a smaller mesh than mosquito net), and this should be about 18 inches in depth, tapering to the bottom. The bag of a butterfly net should be at least twice the diameter of the net—that is, it should fold over from one side of the ring to the other. The handle need not be more than about 18 inches in length; too long a handle makes the net unwieldy.

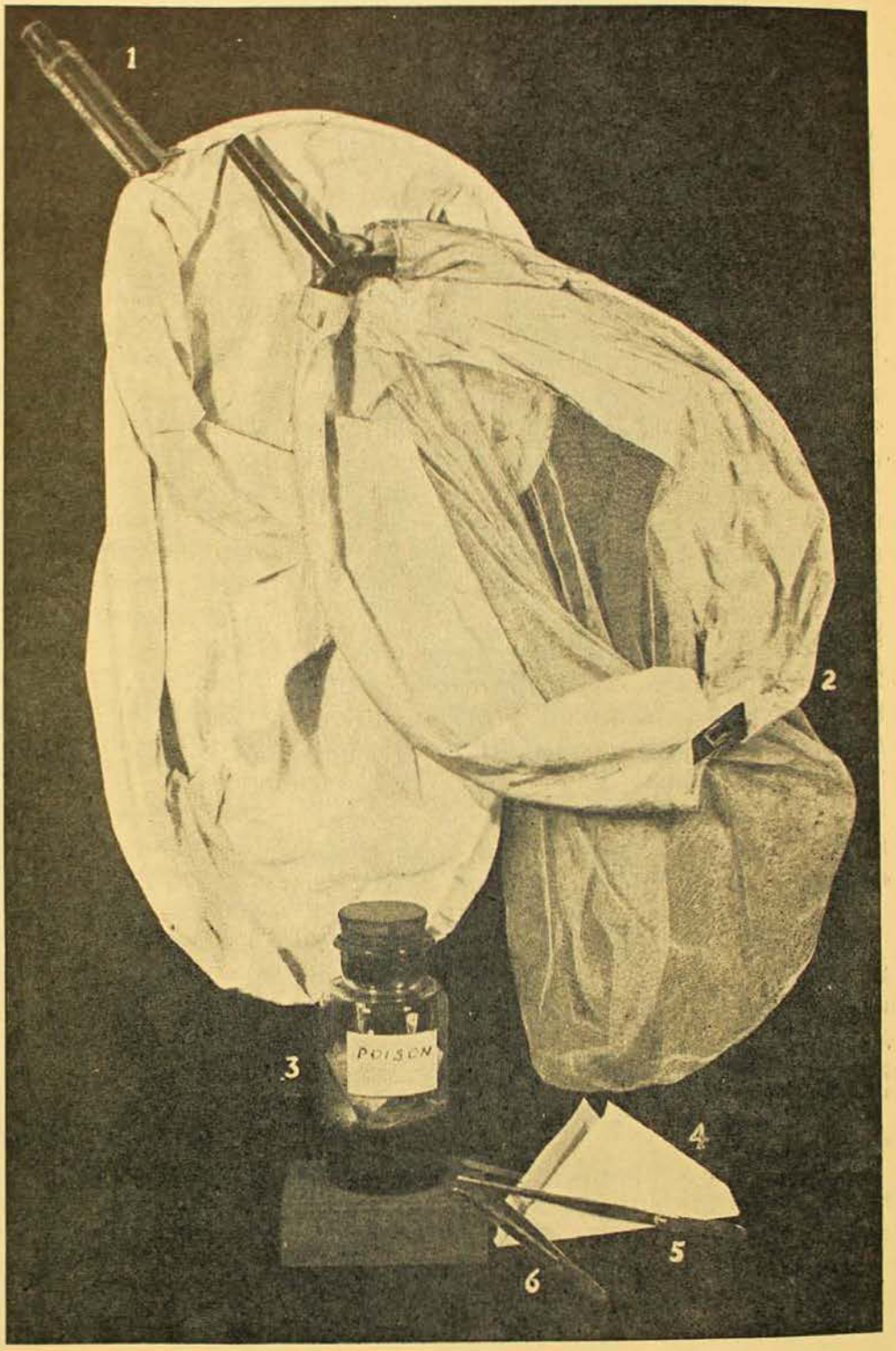
For collecting insects on bushes an open *umbrella* is held under a bush which is then vigorously shaken. All sorts of insects and spiders are thus dislodged and, falling on to the black cloth, are easily seen and captured.

Some collectors employ a *beating net* made after the manner of a butterfly net, but with a heavier wire frame (no. 4 gauge) and a strong calico bag with straight sides and rounded at the bottom in one piece. The ferrule serves as a handle and need not be longer than six inches.

[1] Nancy B. Adams: Hints on the Preservation of Insects and Spiders. AUSTR. MUS. MAG., iv, 5 Jan., 1931, pp. 173-175, illustr.

The *water net* for aquatic insects should be made of cheese cloth and need only be half the depth of a butterfly net. A small wire tea-strainer will be found a useful aid for this class of collecting.

Killing bottles.—While many hard-bodied insects may be killed and preserved in alcohol, there are others, such as moths, butterflies, flies and wasps, which are ruined or, at least, not improved by immersion in a liquid. Insects are usually killed in a killing bottle by means of the fumes of such substances as acetic ether, chloroform or cyanide of potassium (the last being a deadly poison and requiring care in handling). *Chloroform* is useful for killing specimens quickly, particularly those too large for the killing bottle, but it has the disadvantage of hardening the muscles, making the setting of the specimens a difficult task unless set soon after death. However, a small bottle of chloroform and some 4 × 1 inch corked tubes with a small pad of cotton wool or sponge rubber pressed well down on to the bottom of the tubes and covered with disks of paper make a useful addition to the collecting kit. The cotton wool is damped with chloroform as required. Care must be taken to see that the inside of each tube does not become wet with chloroform, which may ruin the wings of many insects.



Some Collecting Gear.
1. **Beating net.** 2. **Butterfly net.**
3. **Cyanide killing bottle.**
4. **Butterfly envelope showing method of folding.**
5. **Long forceps for field collecting.**
6. **Setting forceps.**

The *cyanide killing bottle* is the universal favourite of the insect collector, and insects killed in it remain in a relaxed state. A cyanide bottle is prepared by

placing some small pieces of potassium cyanide at the bottom of a wide-mouthed bottle provided with a tight-fitting cork. Plaster of Paris in a semi-fluid state is poured over the cyanide to cover it to a depth of a quarter of an inch. The bottle is left uncorked until the plaster is dry and hard. The inside of the bottle is cleaned of traces of plaster and blotting paper cut to the diameter of the bottle may be pressed on to the top of the plaster. This is to absorb surplus moisture as cyanide is hygroscopic, and the paper will require to be replaced from time to time. The cyanide too will eventually become a dirty-brown, but until its lethal properties become exhausted, no notice may be taken of this discoloration. *A label should be affixed to the killing bottle indicating its poisonous contents.* Some collectors paint the cork of the killing bottle red so that it is not easily misplaced.

Boxes.—Material collected in the field may be emptied from the killing bottle or chloroform tubes and placed in *cardboard boxes, tins, glass-bottomed pill-boxes,* or *match-boxes* with a little wadding or cotton wool (though this last-named can be a nuisance by getting entangled in the legs of the specimens). Here they remain until they are ready to be set or mounted for the collection. Some collectors use pocket-boxes (corked) in which they pin the dead specimens. Moths and butterflies may be placed in *butterfly envelopes* which have been prepared prior to setting out. Butterflies when caught in the net should have the wings folded back and a sharp pinch given to the thorax near the base of the legs. This affects the nervous system so that the insect may be placed in the killing bottle without fear of damage. The envelopes are prepared by taking pieces of paper of an oblong shape, say, $5\frac{1}{2}'' \times 3''$, folding them diagonally across and folding over the two ends so that they lie flat. Information such as *locality, date of capture, elevation,* and *collector's name* may be written on one of the flaps. The envelopes may be stored in tins, such as tobacco tins. A little flaked naphthaline or crushed moth ball should be placed with the envelopes. In the tropics the envelopes may be put in wooden boxes with naphthaline, as the humid weather soon rots the bodies.

COLLECTING.

Insects occur everywhere, but broadly speaking they are aquatic or terrestrial. Some forms, such as dragon-flies and may-flies, are aquatic in the larval stages and live an aerial existence in the adult. Many water-insects can leave ponds and streams and fly to more suitable localities. Most of these water-loving forms may be secured by means of a net from the bottom of the stream or from amongst the weeds along the margin. Water-striders (*Gerris*) skim over the surface-film, Whirligig beetles (Gyrinidae) gyrate on the surface, and there are representatives of about fourteen families of water-bugs. Almost every part of a pond or stream may be expected to yield some form of aquatic insect or its larva. The larvae and pupae of mosquitoes, according to the species, show preferences for dirty or clear water. Water on the ground attracts some forms, others prefer water in tanks and buckets, or even cavities in trees, and some haunt ponds and streams. Even salt-water pools are frequented by certain species of mosquito larvae, while marine bugs (*Halobates*) may be taken in quiet reaches of a harbour or river estuary, or even far out at sea.

Among the *terrestrial* forms a similar preference for a special type of environment is shown by groups of insects. By turning over stones and rolling logs, by breaking up decaying wood with a stout knife or tomahawk, ground beetles (Carabidae and Tenebrionidae), cockroaches and other insects are exposed to view. Tins, such as jam tins, sunk to ground level, act as traps for many ground-frequenting insects. In the nests of ants occur not only the ants themselves but inquilines, insects living as guests or parasites of the ants. These are best secured during the winter months.

Along the sandy shore-lines of beaches, lakes and streams, insects not met with

elsewhere are encountered. Here Tiger Beetles (Cicindelidae) may be captured by means of a net or by throwing handfuls of wet sand at them and seizing them before they have recovered from the shock. About Sydney, in the summer, the high-water marks of the beaches are frequently strewn with the bodies of insects overwhelmed by the waves after an offshore breeze has carried them seawards. Here, too, bodies of marine animals washed up attract insect scavengers.

Further up the beach, among the dunes, we find other species living among the beach plants. Proceeding inland, every alteration of rock or soil, with its corresponding changes in the plants, produces differences in the insect life. These zones with their inter-relationships of plants and animals (ecology) are a profitable study. Trees, shrubs, flowering plants, even mosses and fungi, provide sustenance for many kinds of insects. The roots are attacked by the larvae of moths and beetles, by scale-insects and crickets. The trunks are veritable sky-scrapers inhabited by forms tunnelling in the wood, in or under the bark; cicadas and plant-bugs suck up the sap, while other species, such as flies, rest there in the sunlight. On the branches we find all kinds of bugs, frog-hoppers, scale-insects and beetles. If the branches of the Native Figs are lopped, many insects attracted by the exuding sap will arrive.

On the leaves we find many leaf-eating forms of beetles, phasmids, and the larvae of moths, butterflies and sawflies.

The flowers of wild or cultivated plants are attractive to many kinds of insects. During the spring the white or creamy blossoms of the Tick Bush (*Kunzea ambigua*) and the Tea Trees (*Leptospermum*) yield insects not seen later in the year. In the early summer the Wild Apple (*Angophora cordifolia*) is recognized as being especially alluring to insects when its creamy-white corymbs are in full bloom. Similarly the flowers of the Acacias and the eucalypts are also happy hunting-grounds for the entomologist and, in many areas, constitute the chief flowering plants.

The fruits of wild and cultivated trees yield fruit-flies, moths, beetles and their parasites.

The galls made by various kinds of insects occur on the roots, stems, branches and leaves of plants, and should not be overlooked.

Beating vines over an umbrella or a beating net in the dense jungles or brushes of Australia and the Pacific islands usually results in many longicorn, Chrysomelid and other beetles, whose presence would otherwise be unsuspected, tumbling down. Sweeping with a net amongst grass and herbage is also a profitable mode of collecting.

To all those forms cited above may be added the predatory insects which live on other insects and those which attack man and the domestic animals.

The majority of moths are attracted to lights, and this instinct is utilized by the collector who hangs up a strong petrol lamp before a white sheet and stands by with his butterfly net. In a suitable locality the dazzling beams bring not only moths but other kinds of insects. Butterflies are often bred from the larvae or pupae, and in a text-book on Australian butterflies will be found an account of special collecting methods and the food plants of the species.

In southern Australia, where the insects are affected by cold conditions, August to April are the best months for collecting, while in northern Australia the best season appears to be after the monsoonal rains, from April to June.

(To be concluded.)

A Deadly Poisonous Jellyfish

By FRANK A. McNEILL and ELIZABETH C. POPE, M.Sc.

FOR many years mystery has surrounded the identity of an extremely venomous marine organism known to occur in the waters off the coast of Queensland and northern Australia. Its evil reputation is of long standing and is well deserved. A number of excruciatingly painful stingings, cases of temporary paralysis and even deaths are credited to what is now known to be a medusoid jellyfish, believed to be a carybdeid or Sea Wasp.*

Up to the present this animal has been confused with the "Portuguese Man-o'-war", especially in newspaper reports. However, the stings of the true Portuguese Man-o'-war are rarely, if ever, fatal and the effects seldom persist for more than a few hours. On the other hand, the tropical stinger caused excruciating pain, lasting weals, prolonged symptoms and quite a number of deaths, so we suspected that the cause of the attacks in northern waters was a different kind of animal. Bent on elucidating the mystery, one of the authors (F.A.McN.) made careful enquiries during a visit to the Bowen district in 1936, and the stories of local observers and of eye witnesses of accidents convinced him that the Queenslanders' so-called "Portuguese Man-o'-war" was not the animal that should rightly bear this name, for never once has a float been mentioned or observed in connection with the northern attacker. The culprit was believed to be a medusoid jellyfish, and not the float-bearing siphonophore *Physalia*, the familiar Portuguese Man-o'-war or Blue-bottle of the New South Wales beaches. There should be no reason for confusing two types of organisms superficially so unlike, as reference to the illustrations will readily show.

A Sea Wasp or carybdeid has no float, and is a tough, rather box-shaped jellyfish medusa. It has only four long stinging tentacles, which may or may not be branched. In the particular one illustrated the tentacles are unbranched. These are attached to the four lower corners of the body, the maximum width of which is about two and a half inches.

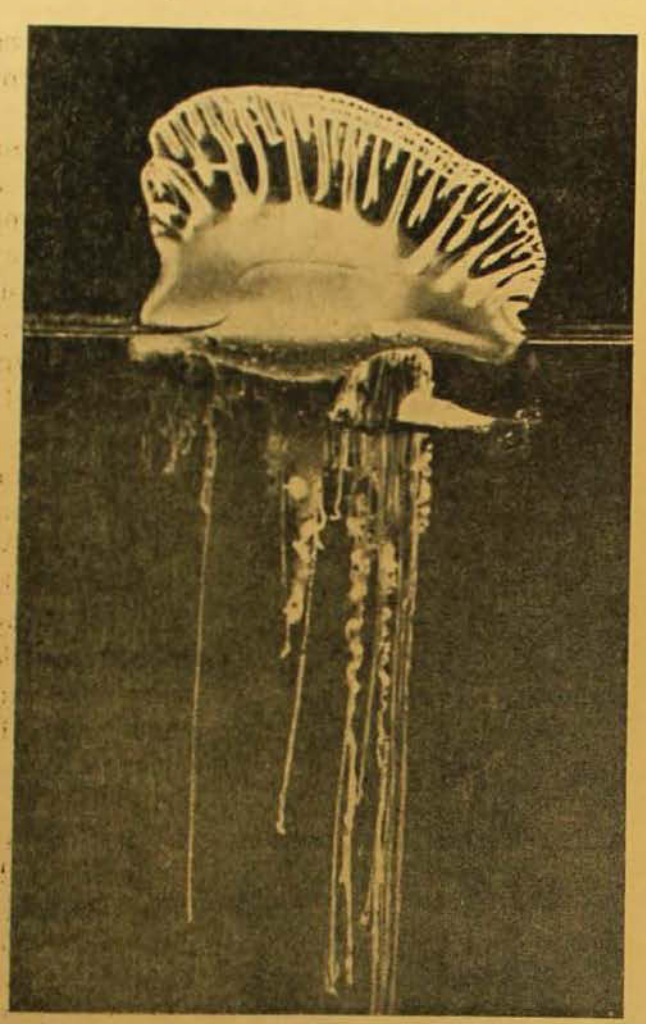
The Portuguese Man-o'-war or Blue-bottle has a prominent air-filled float produced at its top into a ridge-like "sail", and it rests on the surface of the sea. From the float a number of long, trailing tentacles hang down, but, unlike those of the Sea Wasp, they are not limited in number, and they may be joined to the air-float at any point below the water-line.

The stinging medusa does not float *on* the surface of the sea, but, as an adult, swims or drifts just *below* it. It inhabits the warmer seas, particularly in the tropics. Several small specimens have been collected in the waters near Sydney. There are, however, no records of tragedies or even stingings on the coast of New South Wales.* Usually Sea Wasps are found in the open ocean, but occasionally they occur also in bays and inlets near land. Young stages seem to prefer living at or near the bottom, only coming towards the surface as they mature. On the other hand, the Portuguese Man-o'-war floats *on* the surface of tropic and temperate seas, drifting before the wind and ocean currents. Occasionally it is seen on the beaches and in the inlets of the coast of New South Wale .

* Very severe stingings of a similar nature are reported from Onslow, Western Australia, where the cause is said to be another medusoid jellyfish—a trachymedusa. Apparently, in the West, the Portuguese man-o'-war has rightly not come under suspicion in these cases.

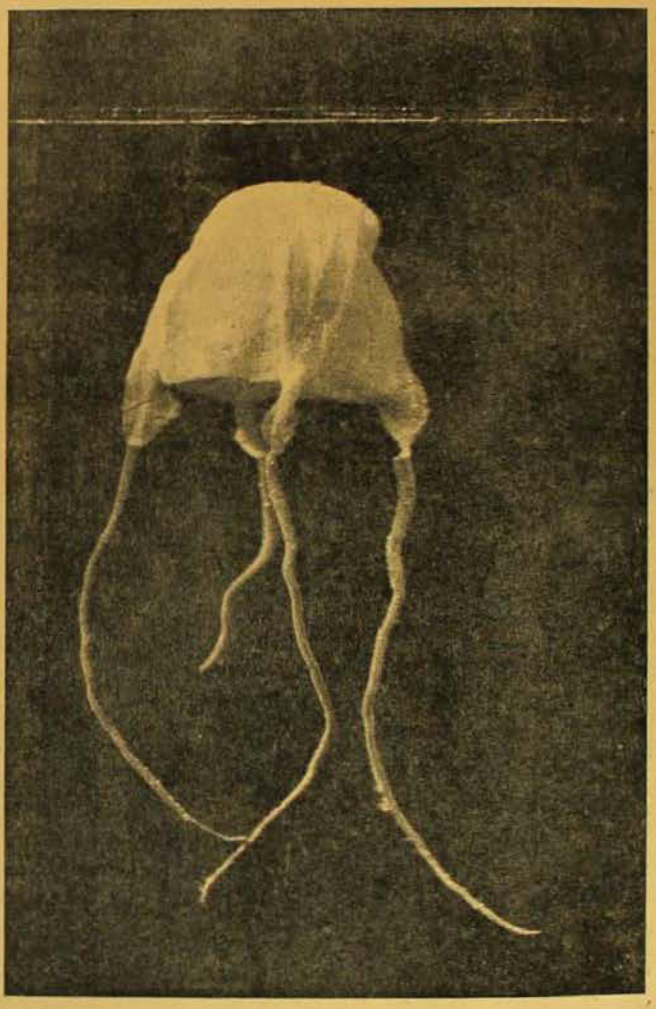
* Minor stingings by carybdeid jellyfish are recorded from St. Vincent Gulf, South Australia, where it is reported to occur in schools of up to fifty in number. This would appear to be the most southerly record of stingings.

The sting inflicted by a Portuguese Man-o'-war has been excellently described by Dr. George Bennett, a naturalist of Sydney in the early part of the last century. Here are some extracts from his description: "The sensation was



Portuguese man-o'-war supported by its float on the surface of the sea. The tentacles of both animals are highly contractile. Tentacles, several feet long, can contract to a few inches as shown in the illustrations.
(Courtesy N.Y. Zoological Society.)

similar at first to that produced by a nettle, but before a few minutes had elapsed, a violent aching pain succeeded." He claimed that the application of cold water, rather than relieving his pain, increased it enormously. Then "the irritation resulting from the poisonous fluid increasing in extent and severity (apparently acting along the course of the nerves), and in the space of a quarter of an hour the effect in the forearm . . . was very violent, and at the elbow joint still more so". The doctor tells how the pain became at last almost unbearable, and was increased when the arm was moved. Then the pain spread to the chest muscles, and the doctor's breathing became "oppressed". "The continuance of the pain was very severe for nearly half an hour, after which it gradually abated, but the after effects were felt during the remainder of the day in a slight degree of numbness and increased temperature of the arm." A further observation by the same writer was that,



A type of sea wasp or carybdeid medusa which swims below the surface and has four tentacles. Though not actually the killer, it illustrates the characteristics of the family.

on a tender skin, vesicles sometimes occur at the site of the sting.

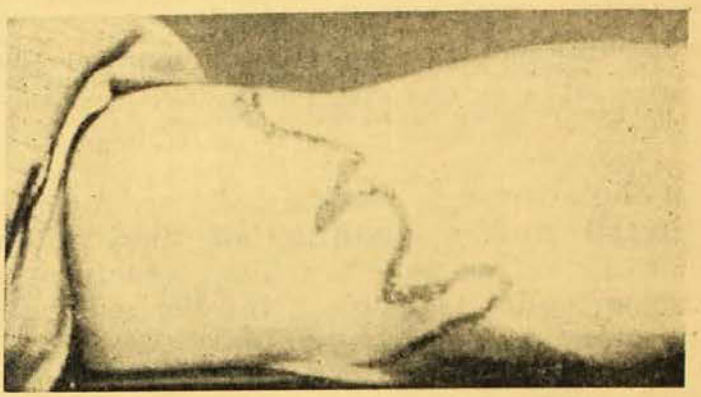
Each year, on the Sydney surf beaches, many bathers are stung, but fatalities are practically unknown. The few deaths that have occurred were in patients who already had some grave disability such as heart trouble or who were aged.

On the other hand the tropical medusa's sting is exceedingly severe, as may be judged by the following paraphrase of an account by an eye-witness who is a doctor in one of the fighting services. The victim in this case was a twenty-one-year-old male who was physically fit when he entered the water. Immediately after, the patient was stung on the left wrist and forearm. He told the doctor that the pain in his arm was excruciating, and while being helped to the beach he further complained of severe cramp-like pains in the back. On reaching the beach he collapsed, and the doctor considered that death took place within three minutes of the patient's being stung. A mild convulsion was noticed, associated with frothing at the mouth, and the patient had a blue cyanosed look due to the lack of oxygen in his blood. The pupils of his eyes were not round, but were slightly dilated and oval-shaped.

From his observations the doctor believed that the poison entered the blood stream and was carried to the brain. Here the toxin acted on the nerves, especially those parts of the brain that control breathing and the circulation of the blood, and put them out of action. If this is how the poison works, stings of the tropical jellyfish must be treated as drastically as the bite of the most venomous snake. The toxin must, if possible, be kept from entering the general blood circulation. A tourniquet should be immediately applied and the blood drained from the veins of the affected part. The doctor advocated also the immediate application of artificial respiration and the giving of heart stimulants.

Not everyone stung by the jellyfish dies, but the terrible pain and the breathing disturbances continue for hours after the attack. One victim in Queensland said that he felt as though he had been given repeated electric shocks, and "the same sensations were experienced for some days, but greatly diminished in intensity". Six days later this man still had the mark of the sting on his arm. "It measured about eighteen inches in length . . . and presented all the appearance of a surface burn", as may be seen in the accompanying illustration.

In both the medusa and Portuguese Man-o'-war the stinging mechanism works in the same way, the difference between their stings being only in the potency and possibly the nature of their poisons. This is only to be expected, for though superficially unlike, the two animals are distantly related and belong to the group Coelenterata. The softness of their body tissues and the apparent defencelessness



The sting presents all the appearance of a surface burn.
Photo.—P. C. Poulsen.

of this group of animals, which includes anemones and corals as well as jellyfish and Portuguese Men-o'-war, is misleading, for they all possess batteries of stinging capsules. These stinging cells are used, as a rule, to stun their prey and so enable them to capture quite large animals for food. Most of the stinging cells of this group of animals have no effect on humans; the tropical stinger and Portuguese Man-o'-war are the notable exceptions.

The stinging capsules occur in the outer tissues of the body, but are exceptionally numerous in the long trailing tentacles, where they are found in thousands. The general arrangement of the stinging cells in the tentacles is shown in the accompanying drawing. Each stinging cell protrudes beyond the general surface of the body and has a small, sensitive trigger-hair—the mechanism that acts like a fuse and "touches off the works". Microscopical examination shows a flask-shaped capsule lying

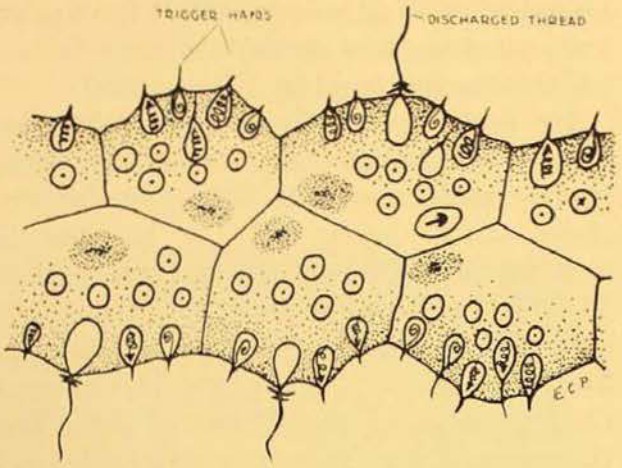
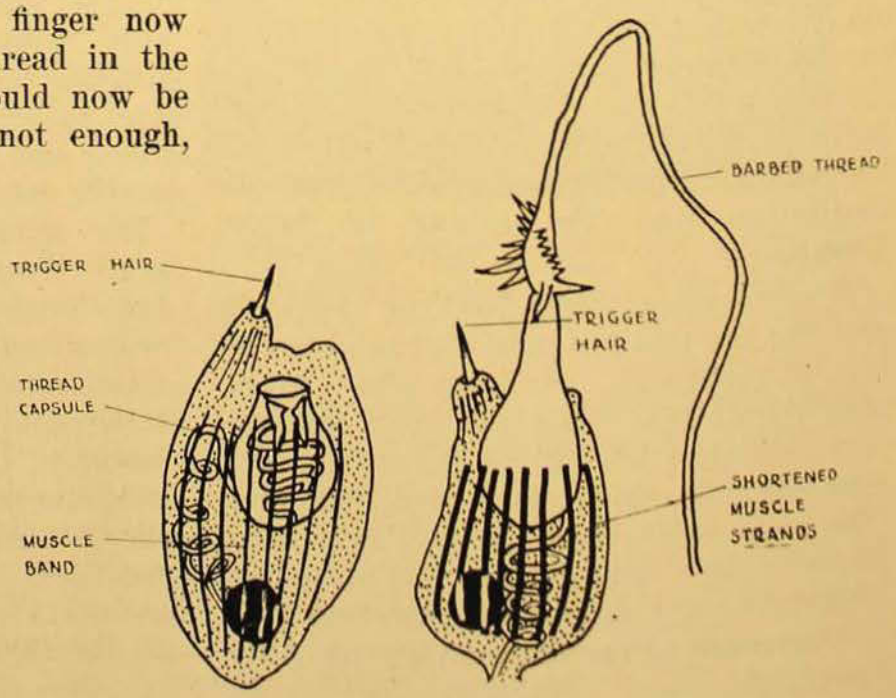


Diagram of microscopic structure of a section of a tentacle with batteries of stinging capsules. The trigger hairs stick out through the skin; "touching off" these causes the stinging threads to be released. Three capsules have been set off in this way and their cruelly barbed threads may be seen projecting.
E. C. Pope, del.

in the stinging cell, and in it are a coiled thread and a quantity of fluid which contains the poison. The structure of these cells is shown in the enlarged drawings.

Stimulation of the trigger-hair immediately brings the stinging mechanism into action. Certain strands of muscle which surround the capsule shorten and bring pressure to bear on the contained fluid and coiled thread, and, as a result, the thread is shot out with great force. The exact nature of the shooting of the thread may be demonstrated by using a rubber glove in the following way. Push in one of the fingers of the glove till it is inverted into the palm part. This finger now corresponds to the coiled thread in the capsule. A little water should now be introduced into the glove—not enough, however, to distend it, but just enough to fill it loosely. The wrist end of the glove should then be tied off tightly. If now, pressure is applied to the glove and increased, the inverted finger will shoot out, back to its normal position. Sharp and sudden pressure will shoot the glove finger out with great force and one is well able to imagine that the tiny stinging capsules can work with just as much, if not more, force than the rubber-glove apparatus. At their bases the stinging threads are armed with barbs which penetrate the skin and so introduce the poison. In addition, poison may seep through the free tip of the thread.

Scientists have found out by experiment that it is not the mechanical stimulation of the trigger-hair that sets the stinging mechanism in motion. It is a chemical one. When a victim brushes against the hair, some chemical is given off which affects the trigger. This is proved by the fact that a solution of the juices of the body of an animal is quite sufficient to set off the release of stinging hairs of a Portuguese Man-o'-war when the solution is merely introduced into the surrounding water. On the other hand, the trigger may be continually touched with a clean probe and no response is obtained from the stinging capsules. Touch alone is not a sufficient stimulus.



Enlarged diagrams of a stinging capsule. "Touching off" the trigger-hair brings the stinging mechanism into action. As the muscle strands shorten and contract the capsule the pressure of the contained fluid shoots the thread out. The barbs on the thread pierce the skin of the victim and introduce the poison into the blood stream.
E. C. Pope, del.

With regard to the nature of the poisons, we know little, except that two medical men who have observed the effects are convinced that they are neurotoxins or nerve poisons. The chemical nature remains, as yet, unknown. There does, however, seem to be a definite season, in the summer months, when deaths from stingings occur with greater frequency. It remains to be found whether this is because more people bathe in summer and so more are stung, or whether the animal stings only during this season. Perhaps some reader may be able to supply some information on this point. The authors would be interested to have any more evidence on the subject.

[Another account of this stinging carybdeid medusa has appeared in *The Australian Journal of Science*, vol. v, no. 6, June, 1943, p. 188.]

A Rare Mineral

ON 5 April, 1898, Dr. L. J. Spencer[1] read a paper on marshite, miersite and iodyrite from Broken Hill, New South Wales, before the Mineralogical Society, London. These minerals are respectively copper iodide, copper-silver iodide, and silver iodide. They are all very rare minerals, but miersite is particularly rare. It was only found in minute quantities in the upper levels of the Proprietary Mine, where it occurred as very small crystals. It has been found nowhere else in the world, though a closely related mineral, cuproiodargyrite, another copper-silver iodide, has been found at Iquique, Chile. The Chilean mineral is not so rich in silver as miersite and lies intermediate between it and marshite.

Ever since the publication of Dr. Spencer's paper the Trustees of the Australian Museum have been anxious to secure at least one specimen of this mineralogical rarity. Every collection of Broken Hill minerals acquired has been carefully examined in the hope of finding miersite. As the largest crystals on record are only about one-twelfth of an inch across and generally much smaller, every fragment had to be subjected to a very close scrutiny.

The latest acquisition of Broken Hill minerals is the G. H. Blakemore Collection.[2] It contained a considerable amount of material that at first sight appeared worthless, but this was put aside to be examined as opportunity arose. While examining some of this material Mr. R. O. Chalmers, Assistant Mineralogist, discovered a specimen of this long-sought-after mineral and so, forty-five years after Dr. Spencer announced the discovery of miersite, it has been added to the Museum Collection.

Both miersite and marshite were first discovered at Broken Hill, and the latter was the first new mineral species to be discovered there. Other new species discovered there, subsequently, are raspite (a tungstate of lead), willyamite (a sulph-antimonide of cobalt and nickel) and sturtite (a hydrous silicate of manganese and iron).

Marshite is generally described as an oil-brown mineral, but when massive it is a tawny colour. Iodyrite occurs as pale yellow or green incrustations, or as pale yellow crystals. The only description of miersite is that given by Dr. Spencer, who describes it as translucent, having a canary-yellow colour, high lustre and a dodecahedral cleavage like that of sphalerite. Both marshite and miersite crystallize in the Isometric system, while iodyrite belongs to the Hexagonal system and it is probably the only naturally occurring representative in the hemimorphic class of that system.

In our specimen, tetrahedral crystals of miersite occur sparingly with crystals of marshite on a limonitic gossan. At one end of the specimen is an incrustation of the tawny-coloured marshite.

T. HODGE-SMITH.

[1] *Mineralogical Magazine*, xiii, 1901.
[2] THE AUSTRALIAN MUSEUM MAGAZINE, viii, 1, 1942, p. 22.

Some Arachnids and Millipedes from New Guinea

By A. MUSGRAVE

MOST descriptions of travel in New Guinea dwell on the dense jungles, the switch-back nature of the country, the swamps of the deltas, the mosquitoes and scrub-itch mites. Concerning the latter, referred to by explorer and soldier alike, we are not dealing with an insect, but with a member of the class Arachnida, of the order Acarina (ticks and mites). These are 8-legged animals in the nymphal and adult stages, but in the larval stages they are 6-legged. The "scrub-itch" mites (like the "harvest mites" of England and Europe) seem to be known only in the 6-legged stage.

European association with these mites in New Guinea goes back to at least 1875, for in that year the Italian explorer D'Albertis, while with a party on the Fly River, wrote in his journal[1]:

> For some days past all on board have complained of a violent itching in different parts of the body, without finding the cause for it; but to-day an almost microscopical insect was discovered, which has either attacked us in the forests, or has been carried on board in the skin of the gowras and other birds, which mostly live on land. I found that certain red lumps on the skin of these birds are actually formed of hundreds of these almost invisible creatures. The root of each feather becomes a pleasant abode for them. They must also possess immense productiveness; in fact our bodies were entirely covered with them. It was useless to wash ourselves, either with hot water and soap, or acid, or eau-de-Cologne; but to-day we had recourse to a new expedient, that of washing ourselves with petroleum. At Yule Island I found this process efficacious in similar cases, and also that the ulcer produced by the disease called cascado dies away after repeated applications of the oil. I also tried it at Andai in 1872, and at Yule Island this year.

In a more recent account by Archbold and Rand,[2] we read:

> No account of a New Guinea forest camp would be complete without a mention of the pests. Here we encountered "scrub itch", a little red mite which burrowed into our skins and burned and itched.

Various species of these mites have been recorded from New Guinea, particularly by Dr. C. Gunther, who for some years prior to the war was Medical Officer at the Bulolo Goldfields. To him we owe much of our knowledge of these tiny mites and the endemic typhus which they convey to Europeans.

The larval mites are microscopic creatures, and their characters thus difficult to detect. As earlier investigators sometimes failed to recognize affinities, we find the same species of mite described under a number of different names. A major difficulty is the working out of the life history of a species and the ability to associate the larvae with the adults. Confusion must arise when scientific names are given to larval or immature forms when nothing is known of the adult stage.

In Australia in the past the study of the Acarina has fallen on the shoulders of a few taxonomic workers, but of recent years the study of Scrub Typhus or Mossman Fever in Australia and New Guinea by medical men has extended our knowledge of the mites and the part they play in the transmission of disease. The following notes are based on recorded observations.

THE "BUSH MOKKA", TROMBICULA MINOR.

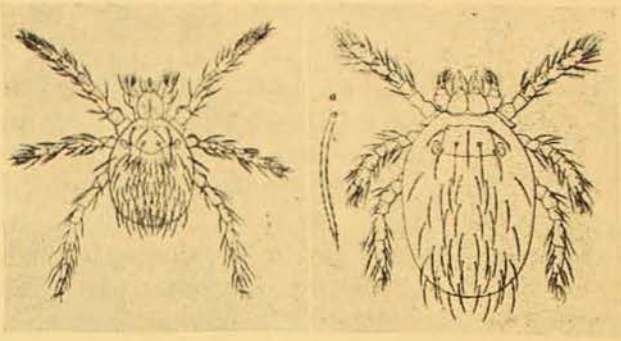
The "bush mokka", as the natives term it, *Trombicula minor*, is an extremely minute "harvest mite" of the family Trombidiidae, and was first recorded from Java by Berlese in 1905. In 1927 it was described by Sambon from Townsville, Queensland, under the name of *Trom-*

[1] D'Albertis.—*New Guinea: What I Did and What I Saw.* London, 1880. Vol. ii, p. 34.
[2] Archbold and Rand.—*New Guinea Expedition, Fly River Area,* 1936-1937. New York, 1940.

bicula hirsti, but this name is regarded as a synonym of *T. minor*. In the Queensland scrubs it has long been called the "scrub itch". The acarid is here known only from the larval form, and resembles in general appearance the well-known "harvest mite" of England, *T. autumnalis* Shaw, which is also capable of great irritation to man. More recently Drs. C. E. M. Gunther and W. G. Heaslip have considered *T. minor* to be identical with the Japanese River Fever Mite, *T. akamushi* Brumpt, which occurs in the ears of field mice or voles in the larval state and is the carrier of the rickettsial disease called Kedani. The voles are the reservoirs of the disease. In Japan the adults and nymphs live on reeds and daisies. The "bush mokka" of New Guinea is recorded by Dr. Gunther as occurring in great numbers in the Morobe district where, of 3,000 mites examined, about 2,700 proved to be this species. The remainder constituted thirteen species. *T. minor* has been found on nine different hosts, including man. Of these may be mentioned the bush pig, the bandicoot (believed to be the reservoir of the disease), bush turkey, bush fowl (said to be the chief host), ground pigeon, cassowary, and two species of rails. The mite is now known to range from Malaya, the Dutch East Indies, and Formosa to New Guinea and Australia. The mite is red, orange, or yellow and about half the size of a pin's head. They may be dug out of the skin with a needle.

In a paper published in *The Medical Journal of Australia* for August 6, 1938, Dr. Gunther makes the following observations about this mite:

> The *bush mokka* is distinctly regional in its habitat. In general, the *kunai* hills (switchback country covered with *kunai* grass and kangaroo grass) are practically free, although the scrub along the watercourses among the hills is fairly heavily infested. The bush is patchy; areas of dense, damp jungle in the river basins and smaller valleys are very heavily infested; sago palm (*sak sak*) and water bamboo (*pit pit*) swamps are reputed to be the most heavily infested spots of all; but the drier, less dense bush on the mountain slopes seems often to be quite free.
>
> The mites are picked up by man as he brushes against vegetation; it is also simply asking for trouble to sit on a log or stump in infested



(Left) Australian Harvest Mite, Leeuwenhoekia australiensis, also recorded from New Guinea. (After Hirst.)

(Right) The Japanese Harvest Mite, Trombicula akamushi, considered to be identical with the "bush mokka" or "scrub itch" mite of New Guinea and north Queensland. The carrier of pseudotyphus fever.

After Hirst.

areas. They prefer the parts of the body where clothing exerts pressure; around the waistline; beneath the stocking, especially on the dorsum of the foot and under the garter; and in the groins and armpits. The bites do not give rise to any symptoms for the first six to twelve hours; then papules, three to six millimetres across, appear; they are topped by a tiny blister and surrounded by a red areola; and they itch intolerably. It is rare to find the larva once the blister has formed; it either drops off or is rubbed off when the itching first develops. On account of being scratched, the blisters are usually torn open, and they become infected easily. They then rapidly break down to small indolent sloughing ulcers, very stubborn and inclined to spread. Many tropical ulcers (*ulcus tropicum*) in whites have their origin in "mokka bites".

The larva buries the whole length of its cheliceral fangs in the skin and then projects from between them a long delicate tubule, the hypopharynx; there an irritant secretion of saliva is injected, probably with the power to cause lysis of tissue and facilitate the penetration of the hypopharynx. The hypopharynx shortly becomes surrounded by a thickened adventitia produced by the host's tissues as a reaction against the saliva.

It is not hard to remove the larvae from the skin. A vigorous rub with a thick lather of soap serves to detach them. The use of a soft nailbrush or a coarse sponge over the selected areas is recommended. Zinc cream containing 1% of menthol, well rubbed into any itching spot, relieves the irritation and allows the papule to subside without causing further trouble. There seems to be no useful preparation which will render the skin distasteful to mites.

ENDEMIC TYPHUS OR PSEUDOTYPHUS.

In 1927 the late Dr. E. W. Ferguson suggested that the fever in north Queens-

land called "Mossman Fever" was allied to the Japanese River Fever and, like it, caused by a mite. In 1941, Dr. W. G. Heaslip, writing in *The Medical Journal of Australia,* states that "Mossman Fever" is the same as the Japanese River Fever, *tsutsugamushibyo,* and he regards the mite as identical with the Japanese Acarid. In a paper entitled "A Survey of Endemic Typhus in New Guinea", *The Medical Journal of Australia,* November 30, 1940, Dr. Gunther lists the New Guinea mites, and deals exhaustively with *T. minor*; he also points out that the bandicoot, *Echymipera cockerelli* Ramsay, is the effective reservoir of the rickettsial disease, endemic typhus. It is shown that in New Guinea white men working in the bush, especially in newly cleared areas, are particularly prone to contract the disease. They acquire the disease from the bite of a mite, infected by a bandicoot. The disease may appear ten days after being in an infected area. It is pointed out that "an infected bite probably does not itch, so the patient does not notice it for days, and there is never any history of previous ulceration at its site". An eschar then develops which "consists of a central tough adherent black slough measuring four to eight millimetres across, surrounded by a dull red areola from two to six millimetres wide. It presents neither pain, tenderness nor itching, and is often unnoticed by the patient". The disease then proceeds to take its course and as it has a mortality rate of 19%, it is of medical importance. The medical aspects of the disease will be found in this and other papers, and need not be dwelt upon here.

AVOIDING THE DISEASE.

Attention might be drawn, however, to the suggested measures advocated by Dr. Gunther which "aim at minimizing the risks of contracting the disease".

1. The systematic trapping and burning of rats and bandicoots around camp sites, and proper disposal of rubbish likely to attract them. Poison baits should not be laid, since the mites would only leave the carcasses and seek new hosts immediately; this might increase the risk of being bitten.

2. The restriction of activity, wherever possible, to pathways and clearings which have been burnt off. Paths should be cut at least four feet wide, and the grass and brush should be burnt where it lies.

3. The taking of a bath immediately on coming in from work in the bush, particular attention being paid to the sites favoured by the mites, with the use of a soft nailbrush and a thick lather of soap.

4. The watching of these sites for the earliest appearance of an eschar, so that it can be identified and excised before the onset of general symptoms, in the hope of aborting the threatened attack.

THE AUSTRALIAN HARVEST MITE.

Another "harvest mite" harmful to man, which has been recorded by Dr. Gunther from New Guinea and Celebes, is the local Sydney species, *Leeuwenhoekia australiensis,* described by the late Stanley Hirst in 1925 from specimens collected at Ashfield near Sydney. Specimens have been brought into the Museum from this suburb, where they occur in gardens and backyards, attacking those who work or move about amongst the plants. A letter which I received some years ago from a resident of Ashfield states: "When the children play in the backyard they come in simply covered with the mites, which raise lumps on them about the size of a sixpenny piece." This species has been recorded by Mr. H. Womersley from the ears of a cat at Glen Osmond, South Australia, while the New Guinea forms were taken by Dr. Gunther from the ears chiefly of a number of different kinds of birds.

SPIDERS.

Spiders (order Araneida) are well represented in the New Guinea fauna. The only species known to the writer as harmful to man is the Red-spot Spider, *Latrodectus hasseltii.* This species has a wide distribution from Australia and New Guinea to India. A white resident of Port Moresby who was bitten by one of these spiders heard his "boys" remark as he lay in a comatose state, "close up master he pinish". However, like most sufferers from this spider's bite, he recovered. A common spider in New Guinea with a wide distribution in India, Polynesia and north Australia is the

large orb-weaving spider, *Nephila maculata*. The males are very insignificant in size when compared with the huge females and live on the outskirts of the web. The strong yellow web has been used by the natives of the Pacific Islands for various purposes.

MILLIPEDES.

Millipedes are commonly found in New Guinea, as one would expect with conditions so favourable, namely, abundant moisture and vegetation. They are distinguished from their near allies, the centipedes, by the fact that these last-named have a pair of legs to each body ring, whereas the millipedes have two pairs of legs to most of the body joints. The body is rounded in millipedes and flattened in centipedes, while the antennae are short in the former and long in the latter. The centipedes are quick in their movements, aggressive, and feed on small living creatures which occur under the logs and stones where they live. Millipedes, on the other hand, are slow-moving, and feed on vegetable matter.

Though the majority of millipedes are harmless creatures, certain Pacific island forms are able to secrete for their protection a fluid which is said to cause blindness should it enter the eyes. While the late C. T. McNamara was stationed at Imanaturu, in the Mount Lamington Range, Papua, he wrote the following letter to the Australian Museum, which gives first-hand information about one of these New Guinea forms.

A very large species of millipede is extremely common about the bush here, the natives holding it in great dread. I have actually seen carriers weighted down by heavy loads leave the track by reason of them having observed a millipede on a branch under which they would have to pass, and make a wide detour through the bush to pass this spot. Their fear of these things rather interested me, for I used to handle and examine them with impunity, and the natives tell me that these Myriapoda squirt out a jet black, viscid, liquid which, if it finds the person's eye, renders the eye immediately useless and further volunteered the information that there are numerous men, women, and children in villages in the Northern Division who have lost the sight of an eye through this millipede. I have not met with a single instance of a native who has lost the sight of an eye through this thing, and I have often deliberately worried the millipedes, taking care to have my open hand well over it in case of accidents, and have had them shoot a jet of fluid on my open palm, the fluid resembling very much pure iodine. Now for it. I was working on a plantation and had cleared the land, on which many of these Myriapoda occurred, and my small fox terrier puppy nosed one. Having smelt it, it immediately fell back in extreme pain and a nearby native said, 'Now you will believe us, your dog will lose its eye'.

This alarmed me very much, for I am very attached to this little chap. This happened ten or more days ago, and though I have continually bathed and dressed the eye, the sight has completely gone. Only one eye was affected. The eye is now quite white and the dog cannot see from it. This myriapod is a common species running to six and more inches long with yellow and black markings, the yellow being the predominant colour. I will handle them less carelessly now.

Such, then, are some of the lesser-known animals of New Guinea capable of causing annoyance, disease, and even death to man. As our knowledge of the Papuan fauna extends, others may yet be found to provide problems for study and investigation.

RECENT accessions to the Department of Anthropology include several collections of Pacific Island and Australian material presented by Sir William Dixson, Mr. T. P. Steel, and the late Dr. J. M. Sterling-Levis; a collection of Middle East archaeological specimens from the late Dr. G. H. Abbott, a former Trustee; a series of stone artefacts from the Lower Macquarie River, New South Wales, from Mr. J. P. Brennan; and two exceptionally fine cylindro-conical stones from the Broken Hill district from Mr. A. R. Campbell.

A collection of more than two hundred specimens, the majority being stone axes and adzes from the Solomon Islands, was purchased from Mrs. J. H. L. Waterhouse.

Mr. F. D. McCarthy, anthropologist, the Australian Museum, recently made a record of three undescribed groups of rock engravings in French's Forest, east Killara, and on the northern shore of Brisbane Water. He also investigated a prehistoric site found at Singleton by Mr. T. A. Davidson.

The "Dawn Horse" and Its Progeny[1]

By H. O. FLETCHER

THE animal kingdom, through the geological ages, has been subject to gradual evolution from the earliest lowly forms of life. On the one hand there has been a ruthless weeding out of the unfit, and on the other the gradual fashioning and adaptation of those destined to be the ancestors of present-day living forms. The earth has been a fantastic battle-ground for the animal kingdom, which has had to contend with great earth movements, a variety of diseases, climatic changes and the ceaseless preying on one species by another in the guise of a harsh and relentless enemy.

It is difficult to imagine the length of time taken by the progressive changes culminating in the evolution of present-day animals, among which man is the most highly developed. The history of man can be traced for about seven thousand years. The palaeontologist, by studying and interpreting the fossil remains of the animal kingdom, can look back over a period of approximately seven hundred and fifty million years. In geological history man is a newcomer compared with many other animal groups. His geological history began a mere million or so years ago, a short space of time compared with the history of other highly perfected creatures alive today.

The geological history of the horse, with which this article is directly concerned, is far better known that that of man. The cave-men of Europe were still in the infancy of their development when the horse stock was nearing the end of its specialization through about fifty-five million years. The story of the horse and its ancestors[2] is one of successful adaptation to new environments. It is a story in which progressive changes can be traced, step by step, from a diminutive creature known as the "Dawn Horse" to the superb and flawless thoroughbred of today.

This story is built up from a wealth of fossil material collected from rocks of the Early Eocene and succeeding geological periods. An unbroken chain of evidence is provided by fossil remains of some three hundred species of horses which roamed the land surfaces throughout the Tertiary and Pleistocene days. Each species played its part in what has been termed a classic example of evolution before falling out of line and making way for a relative with more advanced structure to cope with the ever-changing conditions of life. The structural changes in successive species of horses were essential to their very existence. Climatic conditions forced them from an easy life in the forests to an arduous and dangerous existence in the open plain country. If these changes had not come about we could not have enjoyed the pleasure of watching the powerful and swift gallop of a thoroughbred or known the sport of kings.

The graceful and effortless movements of the horse have always been a source of admiration. They captured the imagination of the early Egyptians, who, for nearly forty centuries, depicted the animal prancing and charging. The Assyrians made it a subject of painting and carving long before the Egyptians, and it is possible that their acquaintance was derived from the Aryan Persians, always noted as a race of horsemen.

Glancing still further back to primitive man, we find, on the smoke-begrimed walls of his caves, sketches of galloping horses which, no doubt, he tamed or attempted to tame for utilitarian purposes. The drawings indicate a likeness to Przevalski's or the Tarpan horse, a wild animal discovered in Central Asia and considered to be the only living link

[1] See Frontispiece.

[2] "The Horse and its Ancestors", AUSTRALIAN MUSEUM MAGAZINE, Vol. ii, No. 8, 1925, pp. 260-265.

with the prehistoric horse. It is something like an overgrown pony, having a much larger head and smaller feet than the horse as we know it.

Man has given evolution a helping hand by the artificial breeding of horses. The horse-breeder breeds only from pure blood stock on each side, and then only from selected animals with pedigrees extending through many generations.

In order to appreciate the slower evolutionary changes which have produced the modern horse, it is necessary to know the important features of the ancestral horse, *Eohippus,* or, as it is commonly referred to in literature, the "Dawn Horse". Although usually referred to as the five-toed horse, *Eohippus* had only four toes, and was the most primitive of the horse stock found in America. The front foot had four functional toes and an indication of a splint, while the hind foot had three toes and perhaps two splints. The evolution of the horse group shows that splints were usually functional as toes in the ancestor, so that *Eohippus* must have had an ancestral form somewhere.

Living in Lower Eocene time in Europe, while *Eohippus* roamed the forests of North America, was a small animal known as *Hyracotherium*. This is thought by many to be the real ancestor of the horse stock, the evolutionary stage before *Eohippus,* a relationship not even guessed by Owen, who described it in 1856. It was very different from the horse of today, being about the size of a fox-terrier and possessing five toes and primitive teeth suitable for browsing and masticating soft leaves. Whether it was the true ancestor or not remains to be seen, but it is thought that America was the developmental centre of the early horses.

In early Eocene days the climate was a temperate one with a plentiful rainfall. The land surfaces were covered with large forests, vast areas of shallow lakes and a soft marshy terrain. Living under these conditions were a host of animals quite unlike those of today. With them was *Eohippus* enjoying life to the full, as food

Eohippus (Eocene).

was plentiful and danger from enemies was slight in the obscurity of the dense forests. Its teeth were primitive and fitted only for browsing. They were short, low-crowned and provided with rounded cusps, but never with the grinding ridges characteristic of existing horses. Possession of four toes materially assisted *Eohippus* in travelling over the soft ground, but it was unable to attain great speed.

Towards the middle of the Eocene period the climate became progressively drier and the forests began to diminish. The land surface also began to dry up and open prairie country developed where new species of wiry and thin grasses flourished under the new arid conditions. A few of the forest dwellers now ventured out from the overcrowded forest areas, and began a new life under arduous and trying conditions. *Eohippus* was one which bade farewell to the easy life of the forest and began afresh in an environment where life was hard and adventurous. The diet was new, and there was no concealment from natural enemies, such as the ancestors of the wolf, which now began to exact a heavy toll from the ranks of little *Eohippus.*

It was necessary to change its mode of life, and from this time we can trace, step by step, the progressive changes which led to the tall, single-toed horse capable of attaining great speed, with specialized grinding teeth suitable for chewing fine and tough grasses. The necessity for speed and the change of food were the two factors behind all the evolutionary changes in the horse stock.

Speed was essential to save the species from harm as they were inoffensive creatures with no means of defending themselves, and later, as the arid conditions persisted, to carry them long distances in search of food and water. In brief, the whole structure of the horse throughout the history of its evolution has been adapted for swift running.

There was a constant increase in size from the small horse of the Eocene, and, being a grazing animal, it was necessary for it to have a neck sufficiently long to enable the mouth to reach the ground. So we find the elongation of the head kept pace with the lengthening and specialization of the teeth, while the neck kept pace with the lengthening of the legs and feet. The primitive teeth of *Eohippus* gradually changed to a highly complex pattern of ridges and crests, and the premolars assumed the size and shape of the molars. They became high-crowned, prismatic and cement-filled. The teeth developed remarkably in length, and in the modern horse we find that during the first eight years of life they keep growing from below as they wear away. After this roots are formed and the teeth are pushed up to compensate for any wear. The space below becomes filled with spongy bone. When finally worn away the horse dies from starvation, but, as the balance between wear and growth is so well regulated, the teeth never disappear before at least thirty years.

The relatively long and slender legs of *Eohippus* became much longer in later species. It is a rule that as the number of toes decreases, so the speed of an animal increases. We find this holds in tracing the history of the horse. In the true horse the feet became elongated and each foot developed a single functional toe, on the tip of which it walks; this is the third or middle toe of the primitive five-toed ancestor. The other toes gradually disappeared and became functionless, though in some cases they are retained as splints. The wrist of *Eohippus* is now what horsemen call the fetlock, and the heel the hock.

The semi-arid conditions, which prevailed about Middle Eocene times, increased in severity and persisted through the Tertiary periods until the Pleistocene, when the climate changed drastically and glacial conditions predominated. The Oligocene, Miocene and the early part of the Pliocene period were characterized by arid conditions, and the land surfaces became vast open plains covered with new species of grasses. With the disappearance of forest areas conservative animals, which had remained as forest dwellers, suffered a period of want with ultimate survival of only a few species. On the other hand, the early horses, which had forsaken the forests, were adapting themselves to life on the plains.

In the Middle Eocene *Eohippus* and its thirteen known species were followed by the Mountain Horse, *Orohippus*. Ten species have been described, but very little change is noticeable in their structure. The premolars became molars in the later species and the rudimentary hind toe of *Eohippus* was completely lost. In both these genera the lower arm and leg contain two separate bones.

The little Uinta Horse, *Epihippus*, with only two described species from the Upper Eocene, showed a slight advance in that two of the three premolar teeth developed almost into true grinders. It was still a four-toed horse, but the fourth toe was small, with the central toes becoming elongated.

Eocene times, of approximately fourteen million years' duration, were succeeded by the Oligocene period in which arid conditions became more intense. In this period *Mesohippus* was an important genus, with many species ranging through the rocks of the Lower, Middle and Upper Oligocene. *Mesohippus* was the first of the three-toed horses, having three functional toes on the forefoot, the median one enlarged and supporting most of the weight, while a long splint represented the fifth toe. The hind foot was three-toed without a splint. The skull of *Mesohippus* resembled that of a small modern horse except for the

Mesohippus (Oligocene).

shallowness of the jaws. Depth was not necessary at this stage, as the teeth were still low-crowned, although all the premolars, with the exception of the first, had already acquired the molar pattern and were suitable for the mastication of desert grasses.

Associated with *Mesohippus* on the Oligocene plains were other genera such as *Miohippus,* with its seventeen known species. Little advance had been made in this group except a slight increase in size, the horses still, however, being about the size of a sheep.

Forest areas almost completely disappeared in the succeeding Miocene period and few of the forest dwellers remained alive. The adaptation of the horses up to this stage had been chiefly in specialization of the teeth, although their speed had also increased to some extent. An important genus appeared amongst the Miocene horses in *Merychippus,* a progressive form which dominated the middle and later portions of the period. It followed an early Miocene horse known as *Parahippus,* considered to be a connecting link between the Oligocene and Miocene horses, and represented by about eighteen species. In some of the later species of *Parahippus* the outer digits were so much reduced as to be useless, while the teeth showed a decided advance, as a cement filling appeared for the first time.

At about this stage of evolution the browsing species were becoming rare and the grazing species were taking their place. *Merychippus* was an intermediate form, but was well on the road to being a grazing type. It was an abundant genus with many species. The side toes did not reach the ground, while in the fore-leg the dwindling second bone, the ulna, although represented by a separate splint in the colts, was fused with the main bone, the radius, as it is from birth onwards in the modern horse. In the early species of *Merychippus* the teeth were all grinders, but only as high as wide, whereas in the later species the depth had increased, their height being two and a half times the width. As a result, the depth of the head increased and the shape was rapidly approaching that of the modern horse. The teeth were cemented in *Merychippus,* although the cement was not deposited until just before the teeth emerged from the bone socket. In the modern horse the cement is deposited some time before the emergence of the teeth. The horse was now about the size of a Shetland pony, it was a grazing form, and its neck had lengthened sufficiently to allow it to graze in comfort.

In the Upper Miocene the same conditions prevailed, and no new types evolved showing any marked difference in structure. In the later days of the succeeding Pliocene period a species of the modern genus *Equus* appeared for the first time. In the twelve million years of Pliocene time an assemblage of

Merychippus (Miocene).

progressive genera were evolved, exhibiting many important changes which ultimately produced *Equus*. The climate in this period became progressively colder, leading to the glacial stage of the Pleistocene. There were great earth movements, with a rearrangement of continental coast-lines. Land bridges were formed and over them strayed many of the North American species.

Hipparion is a well-known genus which evolved from the *Merychippus* stock in the late Miocene and ran on to the close of the Pliocene, when it became extinct. It included about thirty-five species in which the two outer toes were retained, although they did not touch the ground. In the Pliocene, other genera had reduced the side toes to splints and their single hoof was similar to that of the modern horse. The teeth of *Hipparion* were very complex and specialized for eating tough desert grasses which needed a good deal of grinding before they could be beneficial as food. Their teeth were even more specialized for grinding than those of the modern horse, and perhaps this fact accounts for their becoming extinct when conditions changed in the late Pliocene.

The *Hipparion* group introduced *Pliohippus,* which appeared at the end of the Miocene and continue through to the Middle Pliocene. The Pliocene horses were small animals, lightly built for speed, and deer-like in proportions. They still possessed three toes, but the median one was the largest and carried all the weight. The side toes or splints also carried a small hoof similar to the main one, but much more slender.

Pliohippus is considered to be the ancestral form of the large South American Pleistocene horse *Hippidion,* which displayed a curious modification of the nasal bones. Their legs were extremely short and they probably lived only in mountainous regions. Their heads were large and essentially the same structurally as the modern horse. The South American horses possibly lingered on into recent times. They were just as abundant in the Pleistocene as were those in North America and Europe, but had disappeared before the discovery of America. The early Spaniards make no mention of wild horses in South America, and their bones have never been found in association with relics of the early South American civilizations.

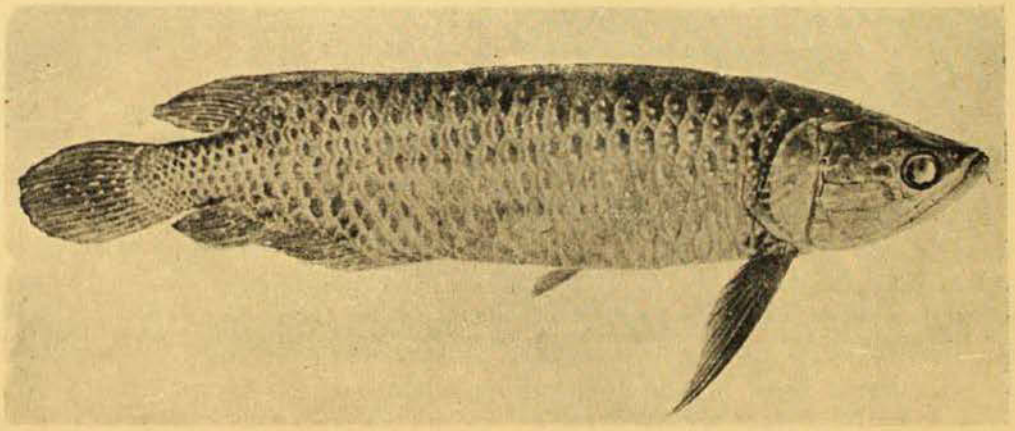
Actually it was not until the discovery of Przevalski's horse in Central Asia in 1879 that indisputable evidence could be produced to prove that truly wild horses live at the present time. Looking back into the history of our early civilizations we find the horse domesticated in Europe. Caesar found the Germans and even the ancient Britons using war chariots drawn by horses. The immediate predecessors of these were a much smaller type, about the size of a pony, and, as mentioned before, artificial breeding has produced the horse as we know it. But it was the behaviour of its ancestors in seeking safety in flight that kept the line intact and allowed their progeny to flourish for fifty-five million years and ultimately to produce what is without doubt one of the most beautiful and intelligent of all creatures.

Recently the technical staff of the Australian Museum, after a good deal of preliminary research, prepared quarter-size model reconstructions of five outstanding prehistoric horses. The horses selected are genera which show the progressive structural changes, and a representative from each geological period is portrayed. These are: *Eohippus* (Eocene); *Mesohippus* (Oligocene); *Merychippus* (Miocene); *Hipparion* (Pliocene), and *Hippidion* (Pleistocene). A model of a present-day thoroughbred and one of Przevalski's horse are also included to complete the group which is exhibited at the Australian Museum.

The Fishes of New Guinea

By G. P. WHITLEY

WHEN the Allied troops return victorious from Papua, what fish stories will they bring back from that strange clouded continent? Possibly they may say that fish were only too rarely seen, or they may tell tall stories of the ones that got away. Yet if they say that in New Guinea there are fish that skip about on land, others that carry their young in their mouths or their eggs on a hook on the forehead, and some that shoot their prey, they will only be repeating truthful commonplaces.



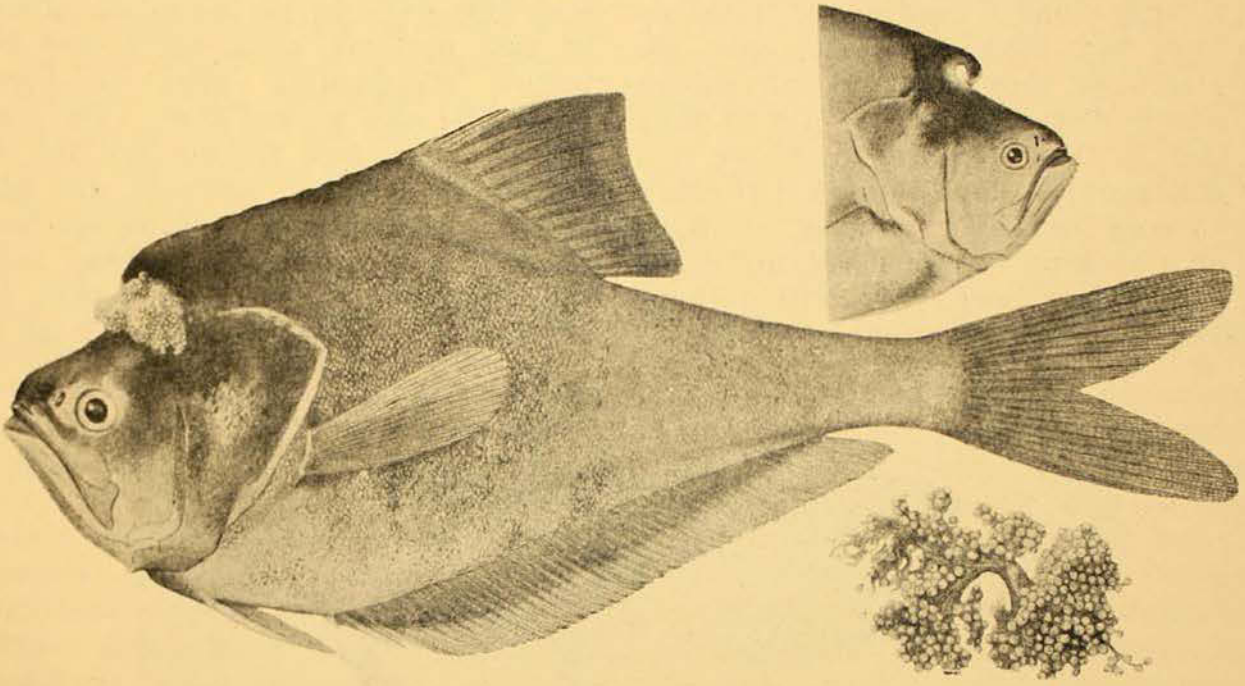
The Gulf of Carpentaria Burramundi (Scleropages leichhardti jardinii) has crescentic marks, sometimes broken up into several spots, on the scales.
After Saville-Kent.

There is, regrettably, no book on the fishes of New Guinea as a whole. Fowler's *Fishes of Oceania* (1928-34) included all the recorded species, but many have since been added to the list as the result of numerous expeditions and patrols in recent years. Both the Australian Museum and the Macleay Museum, Sydney, have interesting New Guinea collections, parts of which have yet to be classified.

The freshwater fishes north of a line running from about Geelvink Bay to Samarai are different from the southern ones. Some freshwater sunfishes in this northern region have evolved into specialized genera, and the last described species of freshwater eel (*Anguilla interioris*) was discovered in the mountain streams of this northern area, which has been named Gaimardian after a French naturalist who worked there. The southern rivers in New Guinea and the Aru Islands have fishes, molluscs, and other animals belonging to the same species as those in Australian rivers from north-east of Broome across to the western half of Cape York; thus the fishes of the Fly River and the rivers flowing into the Gulf of Carpentaria are of uniform facies, or general appearance. A noteworthy negative feature of this vast Leichhardtian region is the absence of freshwater eels.

The Burramundi (*Scleropages leichhardti jardinii*), found in the Digul River, southern New Guinea, is of interest not only because of its unusual appearance, but because it is one of the few ancient types of fishes which either antedate or have crossed Wallace's Line, that zoogeographical boundary between Bali and Lombok, Borneo and the Celebes, which has prevented the freshwater fishes

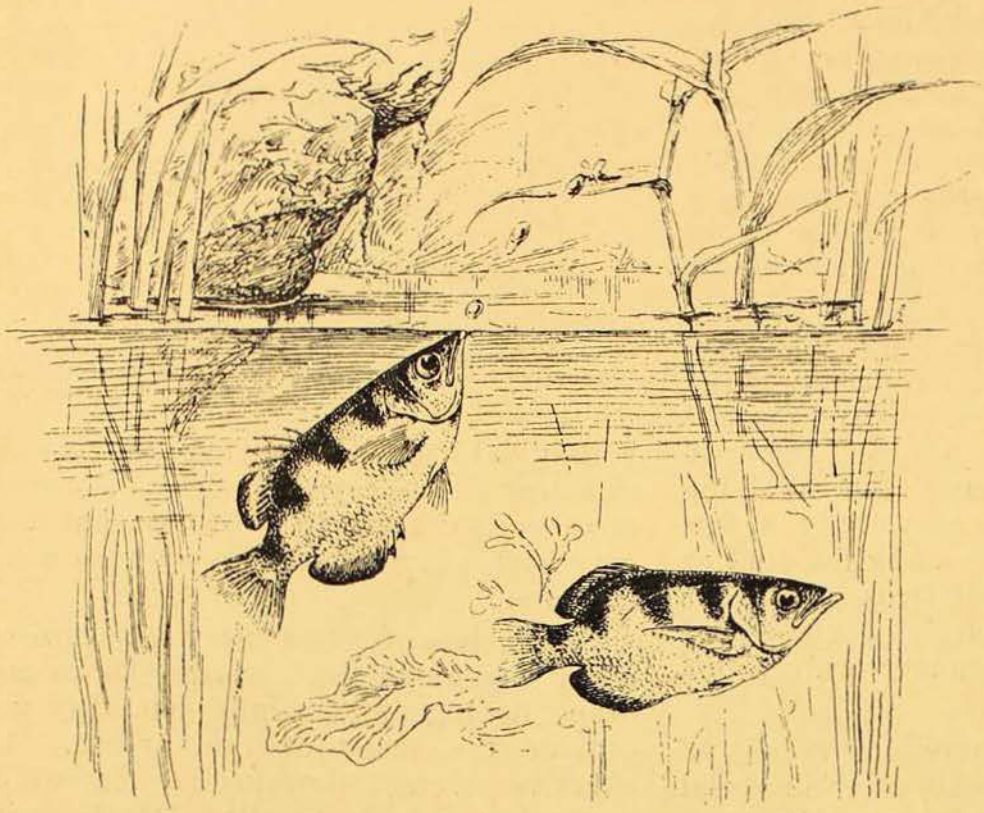
of Asia from entering New Guinea and Australia. A few of the catfishes have similarly trespassed into the rivers of New Guinea, where certain kinds incubate their eggs in their mouths. Due to some local condition which it is difficult for one who has not been there to understand, these peculiar rearing habits have been developed. Another method of caring for the eggs and young is practised by the Nursery Fish (*Kurtus gulliveri*). This is a humpbacked, transparent, river fish which is said to grow to seventeen inches in length. On top of his head the adult male develops a hook which holds the eggs, laid by the female, inside its crook, where they are united by numerous interlacing filaments. So they are carried around by the father fish, like bunches of grapes, until the young hatch. The Nursery Fish is found in the rivers of the Leichhardtian area.



The Nursery Fish (Kurtus gulliveri), male. Inset: Head, showing the hook which the male develops to carry the grape-like eggs, which are also illustrated.
After Weber.

The Archer or Rifle Fish (*Toxotes*) is a surface-swimming fish, usually less than one foot long, yellow with several large dark blotches on the sides. It can shoot jets of water at insects on the foliage overhanging the banks, thus bringing them down to where it can eat them. The mouth, when closed, has a central orifice, like that of a garden hose, and there is a groove along the top of the fish's mouth which forms a nozzle so that, when it compresses its gill-covers and lifts the floor of the mouth, a jet of water can be expelled up to a height of four or five feet. Uncanny accuracy is shown in hitting the mark, as the fish sees well through water and air with its large and mobile eyes. It has even been known to shoot at, and extinguish, the lighted end of a man's cigarette, and the shooting habit is practised even by young fish only an inch long. Truly, *Toxotes* is the sniper of the Indo-Australian rivers.

The Blue Eyes (*Pseudomugil*) and the freshwater Sunfishes (family Melanotaeniidae) are dainty little fishes found only in the rivers of Australia and New Guinea. There are many species, all of them useful as destroyers of mosquito larvae and thus of value in combating malaria and other mosquito-borne diseases. They enter the shallowest water, and some kinds have little teeth outside (as well as in) the jaws for nibbling their food. The Dutch zoologist Max Weber wrote of them: "when stand-



The Archer or Rifle Fish (Toxotes) shooting at an insect.
After Zolotnitsky.

ing bare-legged in the clear water, I could feel and see how the fishes scraped at the skin of my legs."

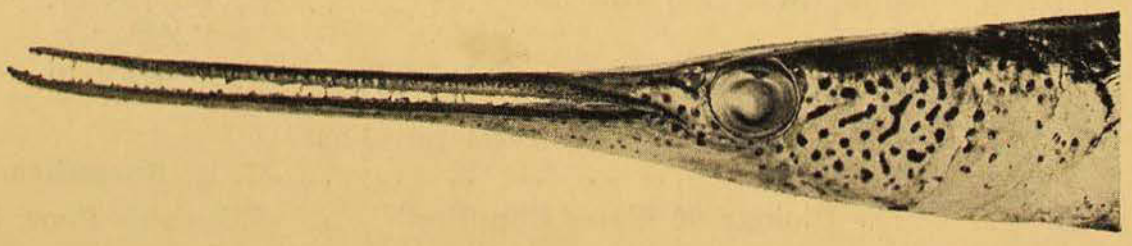
Other modest little scavengers of the rivers and estuaries are the Gobies and Gudgeons, of which there are many kinds, generally too small for human food, but of value because they keep down mosquito larvae and dispose of impurities in the water.

A species of Long Tom (*Stenocaulus perornatus*) with ornate spots and long, toothed jaws, preys on smaller fish in the rivers of New Guinea, and tiny garfishes (*Zenarchopterus*) also invade the rivers.

There is no fish comparable with the Murray Cod in New Guinea, but there are some perches (*Datnioides*) and grunters (*Terapon*) which are good to eat.

The marine fishes of New Guinea are similar to those found over a wide area, from the Red Sea to Madagascar and across the Indo-Australian archipelagoes to the southern Pacific Ocean, although there is a local difference between those of the north and south coasts, the line of separation being near Samarai. Sharks and rays occur, but are incompletely known because their large size prevents their collection for scientific study. The same conditions apply to swordfishes and big game fish.

The fishes of the coral reefs are brightly coloured, and there are many different kinds. Amongst mangrove swamps, off

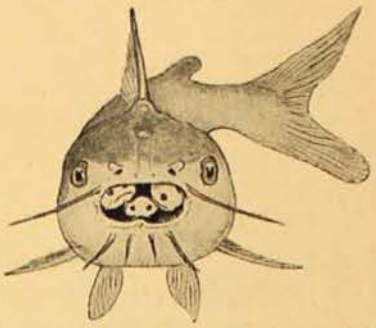


Head of a Long Tom (Stenocaulus perornatus), from a specimen nearly twenty inches in length.

sandy beaches and in estuaries, different, more modestly tinted fishes are found, and these are more palatable than the gaudy reef species. A few of the coral-reef fishes are poisonous to eat, notably the pear-shaped toadfishes and porcupine fishes, and, possibly, some of the larger kinds, especially if they are not freshly cleaned.

Stonefishes, catfishes and stingrays have venomous spines, which can inflict very bad wounds, whilst eels and gropers are sometimes vicious. Amongst the mangrove swamps is found the Walking Fish, a quaint little goby, only a few inches long, which hops along the mud or even climbs the roots of trees, rolling its prominent eyes in search of crabs and other food. If kept under water, this fish will drown!

Whilst there is a marvellous variety of fish-life, enormous schools of commercial fishes are not likely to occur. Nevertheless, along the New Guinea coastline, fish to vary the diet of troops may be caught, some of them, like the trevallies,



Young Catfish (Nedystoma dayi) being carried in mouth of parent. Strickland River, Papua.
G. P. Whitley, del.

mullet, whiting and garfish, making an excellent dish. Very few soles or flounders are recorded from New Guinea, but they may well occur on sand in a few fathoms of water.

The natives of New Guinea have devised many ingenious nets, snares, hooks and other fishing implements, but they are outside the scope of this article. An effective, though destructive, method of procuring fish is recalled by the grim jester who, during an air raid on a Papuan port, remarked that at least the boys would have some fresh fish to eat.

Australian Museum Lectures

THE Australian Museum Popular Science Lectures will enter upon the final section of the 1943 syllabus on August 19, when Mr. Maze, M.Sc., will speak on "Science and Soil Conservation".

The remaining lectures are:

SEPTEMBER	2	"Cruising in the South Pacific"	E. Le G. Troughton, C.M.Z.S., F.R.Z.S.
„	16	"Mosquitoes and Disease"	F. H. Taylor, F.R.E.S., F.Z.S.
„	30	"Marine Borer Pests"	F. A. McNeill.
OCTOBER	14	"The Climate of Australia in Past Ages"	C. A. Sussmilch, F.G.S.
„	28	"The Biology of Water Supplies"	Elizabeth Pope, M.Sc.

These lectures are held in the Australian Museum, College Street, Hyde Park, at 8 p.m. Generally they are illustrated by films or lantern slides. Admission is free.