The AUSTRALIAN MUSEUM MAGAZINE

VOL. XIII, NO. 8

Price—TWO SHILLINGS

A Wandering Albatross off Thirroul, New South Wales. Wandering Albatrosses banded near Thirroul have been recaptured as far away as the southern Indian Ocean and the southern tip of South America. (See article, "The Birds of Sydney", on page 241.)

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This issue is devoted to the natural history of the Sydney area.

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● The photo of a Wandering Albatross (*Diomedea exulans*) on our front cover was taken by Mr. J. D. Gibson, who is studying and banding these birds off Thirroul, New South Wales. Wandering Albatrosses are the largest of all sea-birds, having an average wing-span of 10 ft.

VOL. XIII, No. 8. DECEMBER 15, 1960.

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THE AUSTRALIAN MUSEUM MAGAZINE

Published Quarterly by the Australian Museum - - - College Street, Sydney

Editor: J. W. Evans, Sc.D. Annual Subscription, Posted, 10/-

VOLUME XIII, NUMBER 8. DECEMBER 15, 1960.

The Birds of Sydney

By K. A. HINDWOOD

Past-president of the Royal Australasian Ornithologists' Union

FROM the point of view of bird-students, the Sydney district is usually regarded as the County of Cumberland, an area of 1,650 square miles largely enclosed by the Hawkesbury-Nepean River system with the Pacific Ocean on its eastern boundary.

Two main geological formations occur within the county; they are the Hawkesbury sandstone series and the Wianamatta shales. A third formation, of lesser extent though important ornithologically, is the Narrabeen series, consisting largely of chocolate shales. Each of the three types of country supports characteristic vegetation, which in turn attracts certain birds not found in the other divisions. However, there are many birds, especially forest-frequenting species, that range throughout the county.

In the rugged sandstone to the north and south of Sydney may be found the Lyrebird, Satin Bower-bird, Rock Warbler, Heath-wren, Variegated Wren and Spotted Quail-thrush. The undulating shale country to the west of Sydney harbours such species as the Speckled Warbler, Red-capped Robin, Hooded Robin, Chough and Brown Tree-creeper. Rain-forest or jungle vegetation is largely associated with the Narrabeen or chocolate shale and the rich soils of damp sheltered gullies. The Lyrebird also frequents the rain-forests, and characteristic species there include the Catbird, Yellow-throated Scrub-wren, Large-billed Scrub-wren, Brown Warbler, Rufous Fantail and Black-faced Flycatcher. Some of these birds, being either migratory or nomadic, may be observed in other habitats in the non-breeding season.

400 Species In Sydney Area

Almost 400 species of birds have been recorded from near Sydney. Quite a number, of course, are merely stragglers from other parts of the continent and are seldom recorded; others are rare migrants from places beyond Australia. Some, such as the Emu, the Ground Parrot and the Bristle-bird, no longer occur close to the metropolis. Yet it is still possible for an experienced observer to record 100 kinds in a single day and, perhaps, 200 within a year.

Altogether, some 200 native species are known to have bred in the Sydney district. In addition, some 15 introduced birds, including the Starling, House Sparrow, Goldfinch, Spice Finch, Bul-bul, Myna, Turtle-dove and Skylark, also breed and, for the most part, flourish in the county. Such a wealth of bird-life is based partly on the geographical position of Sydney, but more so on the diversity of habitats within the county.

The nocturnal Tawny Frogmouth (*Podargus strigoides*). Though common in the Sydney district, this bird is not often seen because the colour of its plumage resembles that of the bark of the trees in which it rests during the daytime.

Photo.—Author.

The ocean and sea-shore, estuarine flats, swamps, open country and grasslands, heathlands and forests, and the air above—all these have their birds. True, there is often a gradual merging of one habitat with another, so that the distinctions are seldom, if ever, absolute, yet each type of area has its characteristic forms and an experienced naturalist will anticipate with a considerable degree of accuracy the presence of certain kinds of birds wherever he happens to wander.

The habits and movements of so many interesting birds in the Sydney district provide a constant source of pleasure to local bird-watchers and are also a delight to visiting naturalists.

Recently Rosario Mazzeo, a member of the Boston Symphony Orchestra, U.S.A., experienced what he described as "one of the great triumphs" of his ornithological life, and that was at Malabar, only a few miles south of the City of Sydney.

"It must be the only place in the world", he said, "where you can look into the viewfinder of your camera and see 400 Wandering Albatrosses all at once".

The Wandering Albatross is the largest of all sea-birds, with a wing-span of some 10 ft. and an average weight of 18 lb. With other pelagic species it gathers about the sewer outlets at Malabar to feed on offal from the Homebush Abattoirs and food-wastes from other sources discharged into the sea at that point.

In the summer the Albatrosses move south to their breeding grounds on sub-Antarctic islands. During the past few years many of them have been caught and banded near Sydney and also on their nesting islands. A Wandering Albatross ringed near Thirroul, south of Sydney, was found some four months later on Bird Island, South Georgia, at the southern tip of South America. Another Thirroul bird was found nesting in a colony on Marion Island, in the South Indian Ocean. Such extensive journeys, involving many thousands of miles, show that the Wandering Albatross is well named. This great bird is somewhat gross when feeding on sewer rubbish or on the remains of cuttlefish left by dolphins, but how magnificent it is when in effortless flight—and this is a sight that can be enjoyed any time in the autumn, winter or early spring from the cliffs of Malabar.

Old Records Of Sydney Birds

The records of Sydney's birds go back long before European exploration and settlement. Hundreds, perhaps thousands, of years ago the Aborigines laboriously carved on the sandstone rocks outlines of Emus, Penguins and, in one instance at least, a Lyrebird. Although only a few species are thus depicted, the natives were doubtless well acquainted with the bird and other animal life within their hunting grounds.

When the "Endeavour", under the command of James Cook, sailed into Botany Bay in May, 1770, the naturalists on board

were eager to explore the surrounding "woods" and collect botanical and zoological specimens.

Joseph Banks remarks in his journal: "I made a short excursion to shoot anything I could meet with, and found a large quantity of quails (Stubble Quail) much resembling our English ones, of which I might have killed as many almost as I pleased, had I given my time up to it; but my business was to kill variety, and not too many individuals of any one species".

One day Tupia, a native who boarded the "Endeavour" at Tahiti and completed the voyage to England as Banks' guest, wandered away in pursuit of parrots, of which he shot several—and, incidentally, he met with nine "Indians", who ran from him in alarm. It is, therefore, no idle fancy to imagine that the earliest published illustration of a bird from Sydney, that of a Rainbow Lorikeet, in Peter Brown's "New Illustrations of Zoology" (1776), was one of the parrots shot by Tupia, the Tahitian native, on the shores of Botany Bay in 1770.

The return of Banks and Solander with extensive botanical and zoological collections aroused much scientific interest in the natural history of the Australian continent. Thus, when settlement began in 1788, eighteen years after the visit of Cook, specimens were sent to England by every returning ship. Most of the early books on the colony figure and discuss birds, and many original drawings of birds and other subjects date from that period; these drawings are a valuable source of information on the avifauna of Sydney more than 170 years ago.

Changed Environment

In January, 1788, when Surgeon Bowes of the transport "Lady Penrhyn" first gazed upon the beautiful surroundings of Sydney Harbour, he exclaimed that the singing of the birds amongst the trees made all around seem like enchantment. How surprised he would be to-day! The small town that was Sydney at the close of the 18th century has grown to a metropolis of more than two million people, and has spread widely; inevitably, the disturbance of natural surroundings caused by settlement has had its effect on the bird-life of the area. It is to be noted, however, that while some species have vanished from the local scene and others are now extremely rare, many have been able to adjust their habits to changed conditions and even increase in numbers.

Aside from the influence of settlement, and apart from known migratory and nomadic movements, there may appear to be little change over the seasons in the bird-life of a particular area. Actually, that is not the case. The state of the weather, variations in food supply (perhaps in the form of nectar from flowering trees) and many other factors influence the activities of birds. Thus it is that the unexpected and unusual frequently happen, and it is this element of surprise that provides one of the main pleasures of bird-watching.

The Black-faced Flycatcher (*Monarcha melanopsis*) migrates to the Sydney district from north-eastern Australia in the summer to breed. The outside of its nest is covered with green moss.

Photo.—Author.

A female Yellow-throated Scrub-wren (*Sericornis lathami*) at her bulky, hanging nest in Royal National Park

Photo.—Author.

In a recent publication, "The Birds of Sydney," by K. A. Hindwood and A. R. McGill, published by the Royal Zoological Society of New South Wales, are notes on all the birds recorded from near the Sydney district between 1770 and 1958, the number being 377 native and 15 introduced species. It might seem that few additions would be made to such a total, yet, since late in 1958, four newcomers have been recorded. These birds are the Westland Petrel, Marsh Sandpiper, Cattle Egret and Pink Cockatoo. Some brief remarks about these four species may be of interest.

The Westland Petrel

The Westland Petrel is a dark-brown seabird, related to the mutton birds of commerce. It is a comparatively "new" species, having been named and described as recently as 1946. Its known breeding grounds are in the hills near Barrytown, Westland, New Zealand. In December, 1958, an ornithologist walking along Cronulla Beach, Sydney, in search of derelict sea-birds found a Westland Petrel above the tide-line, this being the second record for Australia. The first known specimen was found on Corrimal Beach, New South Wales, in 1956.

Most of the migratory wading birds that breed in eastern Siberia and visit Australia during the northern winter have been noted near Sydney. Until recently, one species, the Marsh Sandpiper or Little Greenshank, had eluded observers; then, from November, 1958, to January, 1959, up to 15 of these birds were present on Pitt Town Lagoon. They aroused much interest among Sydney naturalists.

Cattle Egrets have been noted in large numbers, during recent years, in the Northern Territory, where they associate with buffaloes. Such birds may have descended from 18 that were liberated in the Kimberleys, north-western Australia, in 1933, or they may have originated from individuals that found their own way to Australia from countries to the north. A small breeding colony of the species, first reported in 1954, is to be found near Ulmarra, north-eastern New South Wales, and stragglers have been observed in Victoria and Western Australia. The first record for a Cattle Egret near Sydney relates to a lone bird seen with some cows near Windsor in June, 1960. It is the habit of the species to closely follow grazing animals, the movements of which disturb insects and other forms of life on which the birds feed.

The Pink Cockatoo, largely a bird of the dry inland in New South Wales, has been noted near Sydney during the past two years, and nesting has been recorded. Many of these beautiful birds are sold in pet shops, so the fortunate ones observed in a free state were possibly escapees from cages.

Birds that have not previously been recorded from a district certainly arouse much enthusiasm among observers, yet many other aspects of bird study create just as much interest, as was recently the case with a small bird banded near Sydney.

Until recent years it was thought that the Silvereyes found near Sydney had distinct seasonal plumage phases, yellow throats and pale buff sides in summer and grey throats and deep-chestnut sides in winter. However, the researches of Dr. Allen Keast ("Races, Colonisation and Migration in the Silvereye," Gould League Notes, Vol. 24, 1958, pp. 10-13, photos and maps) indicate that the so-called "winter-plumaged" birds were in all probability migrants from Tasmania. Actual proof that this tiny bird, weighing slightly less than half an ounce, sometimes crosses Bass Strait was forthcoming in a most surprising way. Many hundreds of Silvereyes have been banded by ornithologists. One such bird, ringed at Lane Cove, a Sydney suburb, on June 20, 1959, was caught by a cat at Rosevears, 12 miles north of Launceston, Tasmania, on January 19, 1960. This, no doubt, is one of the few occasions when a domestic cat has been looked upon with favour by bird-lovers.

On the whole, it is still possible to enjoy the pleasures of bird-watching to a considerable extent close to Sydney. Centennial Park, where more than 100 species of birds have been recorded over the years, and the Royal Botanic Gardens offer much of interest to ornithologists. Farther afield such extensive reserves as Davidson Park, Ku-ring-gai Chase and the Royal National Park are the haunts of many native birds. Water catchments, State forests and military reserves are also, in effect, sanctuaries for birds.

The wonderfully interesting bird-life that is part of Sydney's heritage depends to a large degree on reserves and refuges. Existing sanctuaries should be left in as natural a state as possible, and additional ones, covering various habitats, should be proclaimed whenever opportunity offers.

Native trees and shrubs planted in home gardens will attract many nectar-feeding and berry-eating birds. There is also the suggestion that it is often well worth while to provide "artificial" food for birds. A resident of Killara, northern Sydney, who places dishes of sweetened bread-mash in his garden, is host to many Rainbow and Scaly-breasted Lorikeets. They make a beautiful sight—and this within a few yards, almost, of one of Sydney's busiest highways.

The first two floors of the Australian Museum's new six-storey building, which were officially opened in August. They contain curators' offices, laboratories and collections.

Photo.—Howard Hughes.

The eastern native cat (*Dasyurus quoll*) is rare in New South Wales, but still occurs in the Vaucluse area.

Photo.—Howard Hughes.

THE MAMMALS OF THE SYDNEY DISTRICT

By B. J. MARLOW

THE Sydney district, as far as the study of mammals is concerned, may be defined as that region which is bounded on the north by the Hawkesbury River, in the south by Wollongong and in the west by the Blue Mountains.

This is an area of fairly uniform habitat and topography consisting of a narrow coastal plain in the east which is flanked by mountainous country rising to an altitude of about 1,500 ft. in the west. The terrain becomes progressively steeper until, in the Blue Mountains, altitudes of 3,500 ft. occur, which form the eastern boundary of the Great Dividing Range.

The coastal plain has an impoverished flora consisting mainly of low shrub scrub, in which the dominant plants are bottlebrushes, *Callistemon* or *Grevillea* sp. Extensive dry sclerophyll forest covers the remainder of the area on the higher mountainous country of the typical Hawkesbury sandstone formation, and consists of various species of dominant eucalypts, with an under-storey of shrubs which include cycads, bottlebrushes, ti-trees, grass-trees and a ground flora of bracken and grasses. In areas where the rainfall is heavier or more surface water is available, as in creek beds, further elements, such as palms and tree

ferns, are included in the flora, which is then known as wet sclerophyll forest. The distribution of these natural habitats has been radically altered by human development in both urban and suburban districts, and this is reflected in the distribution of many of the species of mammals. All the species of terrestrial mammals which are recorded from the Sydney area occur primarily in the sclerophyll forest, while some of them also extend into the coastal plain and into areas close to human development.

MONOTREMES

These primitive egg-laying mammals are confined to Australasia, and show an interesting combination of primitive reptilian and specialized features. By far the most common species of this group in the Sydney area is the short-beaked spiny ant-eater (*Tachyglossus aculeatus*), which is widely distributed through a variety of habitats over most of the continent. This species is found both close to human habitation and in the dry sclerophyll forest, where it feeds on termites. In contrast, the platypus is uncommon in the Sydney district although it is reported to occur in small numbers in Royal National Park, near Sydney. This animal seems to be more abundant in the deep, still pools of the river systems in the west, particularly in the Warragamba and Nepean Rivers.

MARSUPIALS

All five of the major families of marsupials or pouched mammals which are such a characteristic element of the Australian mammal fauna are represented in the area and form its major component. These families are the carnivorous marsupials, bandicoots, possums, wombats and kangaroos.

Carnivorous Marsupials

In former times the native cat (*Dasyurus quoll*) and the tiger cat (*Dasyurops maculatus*) were abundant here, but both have suffered a decline, due mainly to the impact of white settlement. The tiger cat, which is the largest flesh-eating marsupial on the mainland, still occurs in the Blue Mountains, while the smaller native cat, although appreciably rarer, still persists in the Vaucluse district, on the coast east of Sydney Harbour. Included in this family are also small insectivorous marsupials known as marsupial mice, belonging to two separate groups. The narrow-footed genus *Sminthopsis* is represented by *S. murina*, which is found in the dry sclerophyll forests, where it shelters under logs and sheets of bark. It is appreciably less common than the broad-footed *Antechinus flavipes*, which is the most abundant member of this family around Sydney. Although rarely seen unless brought into the house by domestic cats, *Antechinus flavipes* is widespread in the dry sclerophyll forest of the typical Hawkesbury sandstone formations, where it lives in rock piles or in wind-worn caves which occur in profusion in the sandstone outcrops.

Bandicoots

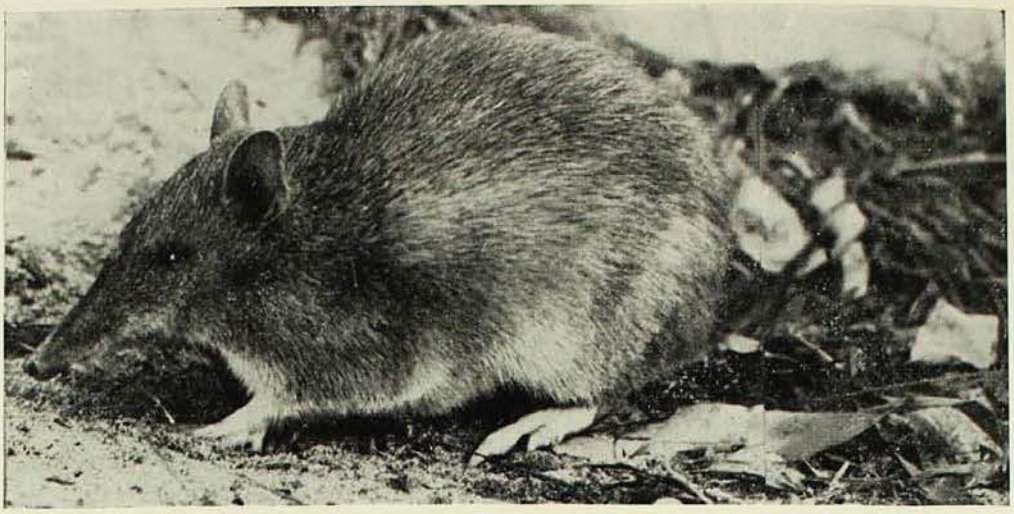
The common long-nosed bandicoot (*Perameles nasuta*) is an extremely abundant and well-known marsupial which occurs in all habitats in the district and which often arouses dislike among suburban gardeners for its habit of digging up their lawns and flower beds in its search for the grubs and other insects on which it feeds. Bandicoots also act as hosts for ticks which may cause paralysis both in humans and domestic animals, and their destruction has been advocated accordingly. Such a course would, however, have little effect, since the ticks can adapt themselves readily to any alternative mammalian host. Short-nosed bandicoots (*Isoodon spp.*) occur much less frequently around Sydney, although they may be found in the open cultivated areas near Gosford.

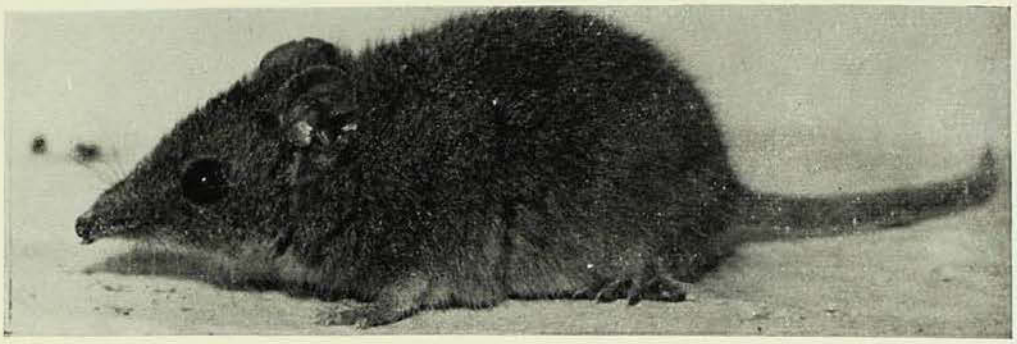
Wombats

These large, powerful, burrowing marsupials are not found in the immediate vicinity of Sydney, but the common wombat (*Phascolomis mitchelli*) occurs in reasonable numbers in the high, dry sclerophyll forests of the Blue Mountains.

Possums

These marsupials, which are well adapted for an arboreal life, are well represented around Sydney. The common brush-tailed possum (*Trichosurus vulpecula*) is probably the most abundant and familiar marsupial in the district, as it has become commensal with man. It not only feeds readily on kitchen refuse, but also may cause annoyance by living in the roofs of older houses.





Top: The long-nosed bandicoot (*Perameles nasuta*) is common in Sydney suburban gardens, where it may damage lawns and flower beds in its search for insect larvae. Bottom: The marsupial mouse (*Antechinus flavipes*), the commonest species of carnivorous marsupial in the Sydney district.

Photos.—Howard Hughes.

Many residents are keenly interested in these animals, and encourage them with food to such an extent that they become extremely tame. A related species, the short-eared possum (*Trichosurus caninus*), is found in the wet sclerophyll forests to the west of Sydney. The ring-tail possum (*Pseudocheirus laniginosus*) is slightly less common than the brush-tail and is widespread throughout the district. This animal, which feeds more exclusively on eucalyptus leaves, does not normally frequent human dwellings. The pygmy possum (*Cercartetus nanus*), which feeds largely on blossoms and insects, occurs throughout the area, particularly where shrubs such as bottlebrushes afford its food and shelter.

In addition to the more familiar possums, this family also includes the gliders, marsupials with a loose membrane along the flanks and attached to the limbs which enables them to glide from one tree to another. The most familiar of the four species here is probably the small grey sugar glider (*Petaurus breviceps*), which is quite common when compared with the larger squirrel glider (*Petaurus norfolcensis*). The largest species of glider, *Schoinobates volans*, is very common in the mountainous eucalyptus forests, where it nests in hollow spouts of tall gum trees. This striking black and white animal is not closely related to the other gliders, but rather to the ring-tail possum and koala. The pygmy glider (*Acrobates pygmeus*) is the smallest glider, and is fairly common although rarely seen. This animal's tail bears a remarkable lateral fringe of stiff hairs, giving the whole structure the appearance of a feather, from which the popular name "feather-tail" is derived.

The last member of the possum family which occurs in the Sydney district is the well-known koala, which is in fact a highly specialized tail-less possum that feeds exclusively on eucalyptus leaves. Formerly the koala was quite common here, but its population suffered a severe decline and it is now found mainly in the Newport and Palm Beach districts and in the Blue Mountains.

Kangaroos

Several species of these ground-living marsupials occur around Sydney. The smaller forms, which are known as rat-kangaroos, are now extremely rare. The crest-tailed rat-kangaroos (*Bettongia spp.*) seem to have vanished completely, but a potoroo (*Potorous tridactylus*) was recorded recently from Gosford. Rock wallabies (*Petrogale penicillata*) were formerly more

plentiful than at present, but they still persist in the Blue Mountains, especially at Jenolan Caves, where they form a tourist attraction. The most abundant member of this family around Sydney is the swamp wallaby (*Wallabia bicolor*), which is found mainly in the wet sclerophyll gullies west of the coastal plain. The red-necked wallaby (*Wallabia rufogrisea*) is more plentiful in the dry sclerophyll forest at higher altitudes, especially in the Blue Mountains. The small parma wallaby (*W. parma*) occurred formerly around Lake Illawarra, south of Wollongong, but it has disappeared from the district and has not been recorded there since 1889. Of the two species of kangaroo, the wallaroo (*Macropus robustus*) and the grey kangaroo (*Macropus major*) are both confined to the dry sclerophyll forests, particularly on the slopes of the Dividing Range.

PLACENTAL MAMMALS

In addition to the monotremes and marsupials, two groups of advanced placental mammals also exist. These are the rodents and bats. The native water rat (*Hydromys chrysogaster*) occurs throughout the Sydney district, where it lives in rivers and creeks, feeding on fish and other aquatic animals. It may be distinguished from all other local rodents by its white-tipped tail and thick fur, which is of economic value. The common house mouse (*Mus musculus*), the black rat (*Rattus rattus*) and the brown rat (*Rattus norvegicus*) have been introduced here as in other parts of the world, and are of significance as economic pests and disease carriers. Two species of rats are, however, indigenous to this area; these are the allied rat (*Rattus assimilis*) and the swamp rat (*Rattus lutreolus*). The former is common in the dry sclerophyll forests, while the latter occurs in swamps and lagoons at varying altitudes.

Bats fall naturally into two main groups, the large fruit-eating flying foxes and the smaller insectivorous bats. Of the former, only the grey-headed fruit bat (*Pteropus poliocephalus*) occurs in the Sydney district during its migrations from Queensland to Victoria.

The distribution of the smaller insect-eating bats is determined to a large extent by topographical and geological factors, since only those species which roost individually in old buildings or hollow trees normally occur here, while the highly gregarious forms, which collect in limestone caves, are usually absent. Thus, included among the local bat fauna are horse-shoe bats, long-eared bats (*Nyctophilus* spp.); mastiff bats (*Tadarida* spp.); sheath-tailed bats (*Taphozous* spp.) and lobe-chinned bats (*Chalinolobus* spp.). One species normally found in caves, however, is the bent-winged bat (*Miniopterus schreibersi*), which occupies disused railway tunnels in the Sydney district.

MARINE MAMMALS

Three groups of marine placental mammals occur in the coastal waters of Sydney. On occasion specimens of the Australian fur seal (*Arctocephalus doriferus*) and the sea-leopard (*Hydrurga leptonyx*) visit Sydney beaches. The second group, the dugongs (*Dugong dugon*), occur only as stragglers from northern Queensland. A specimen was examined in February, 1959, which had been washed up alive at Port Hacking and had died subsequently. There are several species of the third group, the whales, which occur off the Sydney coast. The most common species is probably the humpback whale (*Megaptera novaeangliae*), while specimens of the piked whale (*Balaenoptera acutorostrata*) have also been recorded. At the time of writing, a female southern right whale (*Eubalaena australis*) had calved off Newport Beach, north of Sydney, and had remained in the vicinity for more than 10 days.

The familiar dolphins, often referred to erroneously as porpoises, belong to this same group. The two most common species are the bottle-nosed dolphin (*Tursiops tursio*) and the common dolphin (*Delphinus delphis*).

The mammal fauna of Sydney is thus extremely varied, and several of its elements are very successful in spite of extensive urbanisation. The relationships of the mammal fauna as a whole are obviously with those of eastern New South Wales, and as far as the terrestrial forms are concerned no species occurs in the Sydney fauna which is not represented elsewhere in Eastern Australia.

SNAKES, LIZARDS AND CHELONIANS

By HAROLD G. COGGER

THE reptile fauna of the Sydney district is rich and varied; if the marine reptiles which visit our shores are included, Sydney can claim a total of about 25 snakes, 25 lizards and five chelonians (tortoises and turtles) within the small area bounded by the Hawkesbury River to the north, Wollongong to the south and the Great Dividing Range to the west.

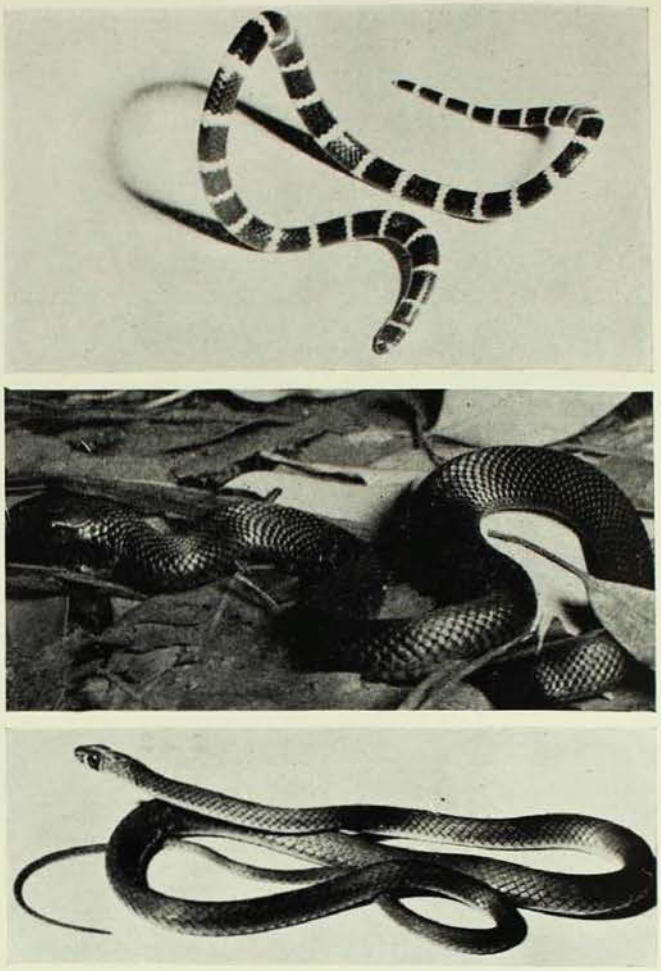
Although the generalisation can be made that most of the terrestrial species which occur in this area may be found throughout it, there are nevertheless certain forms which are restricted to, or at least occur in much denser populations within, pockets of country that may be characterized by specific vegetation, soils, etc.

Skink Lizards

The most common lizards to be seen are the skink lizards (family Scincidae), of which more than 15 species occur in the Sydney district. Skinks are typically shiny, smooth-scaled, sun-loving lizards with moderately developed limbs. Some species bear their young alive (ovoviviparous), while others are egg-layers (oviparous), the number of eggs or young varying considerably from species to species. Nearly all of them feed on small insects and spiders.

The Garden Skink (*Leiolepisma guichenoti*) is without doubt the most common of all reptiles in the area, and has been able to co-exist with man even in densely-populated areas.

In outlying suburbs, the Copper-tailed Skink (*Sphenomorphus taeniolata*) is a common species, while the Water Skink (*Sphenomorphus quoyi*) is a wary inhabitant of rocky creek-beds. The latter is the larger of the two, growing to about 10 in. in length. Both are brightly-marked species with alternate dark and light stripes on the upper surface of the body.



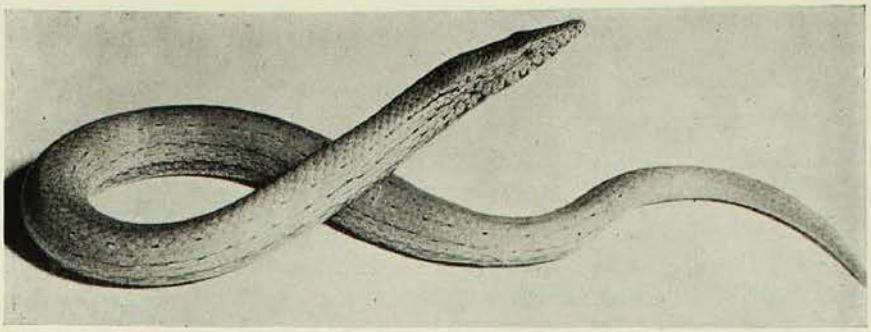
Top: Bandy-bandy Snake (*Vermicella annulata*). Centre: Red-bellied Black Snake (*Pseudechis porphyriacus*). Bottom: Yellow-faced Whip Snake (*Demansia psammophis*).
Photos.—Author.

Another skink which, though common, is infrequently found, is the Three-toed Skink (*Siaphos aequalis*), a burrowing form with minute fore and hind limbs. It grows to about 8 in. in length, and is a dark chocolate-brown above and bright orange below.

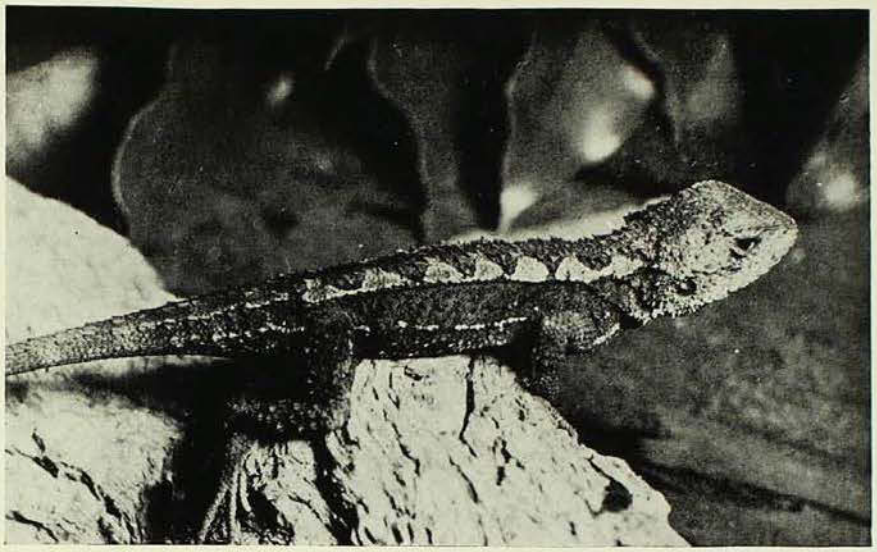
One of the world's largest skinks is the Blue-tongued Lizard (*Tiliqua scincoides*), common in bushland suburbs. Although widely believed to be dangerous, it is, in fact, quite harmless, and is frequently made a pet by small boys.

Four Gecko Species In Sydney Area

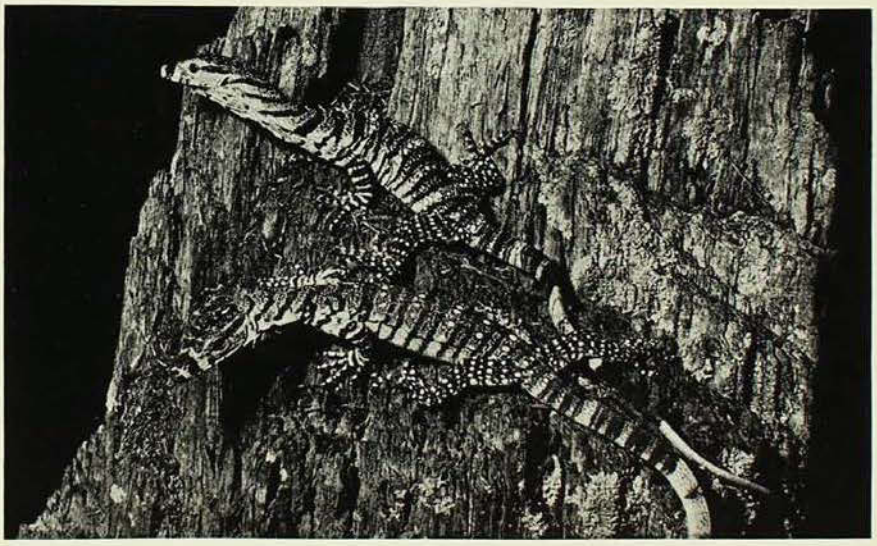
Another group of lizards well represented in Australia are the geckos (family Gekkonidae), of which four species occur in the Sydney district. Geckos rarely reach a length of more than 6 in.; all Australian species lay only two eggs, and feed on small insects. Though frequently called "adders", they are quite harmless.



The Sharp-snouted Legless Lizard (*Lialis burtonis*).



The Tree Dragon (*Amphibolurus muricatus*).



Young Lace Goannas (*Varanus varius*).

Photos.—Author.

The Southern Leaf-tailed Gecko (*Phyllurus platurus*) is most often found in sandstone crevices and caves, where its dull grey colouration helps to conceal it from enemies. However, it may often be seen in the evenings, stalking its prey on the walls of houses.

Another gecko most common in sandstone areas is the little Velvet Gecko (*Oedura lesueurii*), which is light grey with darker zig-zag markings. Unlike the Leaf-tailed Gecko, which has bird-like claws, the Velvet Gecko has small pads on its feet which allow it to climb over smooth surfaces. Two other geckos, the Thick-tailed Gecko (*Phyllurus millii*) and the Wood Gecko (*Diplodactylus vittatus*), are usually found in timber or under logs.

Legless lizards (family Pygopodidae), though very different in appearance from geckos, are nevertheless closely related to them. Although frequently mistaken for snakes, legless lizards may be readily distinguished by two small flaps of skin near the vent (which represent rudimentary hind

limbs), an external ear-opening a short distance behind the eye, and a flat, broad, fleshy tongue. The most distinctive of the two legless lizards found in the Sydney district is the sharp-snouted *Lialis burtonis* which grows to about 2 ft. in length. The other species is the Scaly-foot (*Pygopus lepidopodus*), a rough-scaled form growing to about the same size. Both species lay eggs, and feed on insects and small lizards.

Goannas And Dragon Lizards

Only two goannas (family Varanidae) occur in the Sydney district. One is the common Ground Goanna of the inland, which grows to about 4 ft. in length; it is uncommon on the coast. The Lace Goanna (*Varanus varius*), however, is quite common in bushland areas. All goannas lay eggs; the Lace Goanna often lays its eggs in a hole scratched in a termite mound. The termites repair the damage made to their nest after the goanna's eggs are laid, and the eggs incubate in safety. Goannas feed on insects, lizards, snakes, birds and other small animals.

The last group of lizards is the family Agamidae, or Dragon Lizards. These are rough-scaled, egg-laying, diurnal lizards, of which about four species are found in the Sydney district.

The best-known is the Bearded Dragon (*Amphibolurus barbatus*), often confused with the northern Queensland Frilled Lizard (*Chlamydosaurus kingii*). The Bearded Dragon grows to about 18 in. in length, and is characterized by a spiny "beard" which is erected when the animal is alarmed. This "beard" is a fold of skin supported by the bones and cartilages of the hyoid apparatus.

Of similar size, but very different in appearance, is the Water Dragon (*Physignathus lesueurii*), which has a relatively slender body and a long, thin tail. It is most frequently found perched on the branches of trees which overhang rivers and streams; on being disturbed it drops from these branches into the water and sits on the bottom until the danger has passed.

A smaller (about 12 in.) dragon which is common throughout the district is the Tree Dragon (*Amphibolurus muricatus*).

Sydney's Snakes

The majority of Australian land snakes are venomous front-fanged forms which belong to the family Elapidae. However, only a handful of these 60-odd species are dangerous to man, for most of them are relatively small, with correspondingly short fangs and small venom dosages. This situation is reflected in the snakes of the Sydney district, for of about 17 species of land snakes which occur in this area, 12 belong to the family Elapidae. Of these, only three—the Death Adder (*Acanthophis antarcticus*), the Tiger Snake (*Notechis scutatus*) and the Brown Snake (*Demansia textilis*)—are generally conceded to be capable of inflicting a fatal bite, although the Red-bellied Black Snake (*Pseudechis porphyriacus*) and the Broad-headed snake (*Hoplocephalus bungaroides*) should be treated with caution.

The Death Adder grows to about 3 ft. in length, and is usually either a slaty-grey or reddish colour, with darker cross-bands. It is generally rather thick-set and sluggish, and has a light-coloured spine on the tip of its short, thin tail.

The Tiger Snake is particularly variable in colour: it may range from light grey, through olive to greenish-yellow, and even occasionally a bright, rusty red. Darker cross-bands may or may not be present.

The Brown Snake is equally variable; however, although the young are frequently found with alternate bands of brown and black, the adults almost invariably lack any pattern on the body. Brown Snakes of all ages have small orange spots on the belly shields.

The most common of the larger, conspicuous snakes is the Red-bellied Black Snake. It is usually found along river and creek banks, or in low-lying swampy areas, where it feeds largely on frogs. Its colouring is quite distinctive—jet black above, usually with a purplish sheen, and pink or red below, usually most brilliant where this colour meets the black of the upper surface.

Found under somewhat similar conditions is the Black-bellied Marsh Snake (*Denisonia signata*). Although capable of inflicting a painful bite, this smaller species (which grows to about 3 ft. in length) is essentially harmless, for its venom is fatal only to the

small frogs and lizards on which it feeds. This snake is usually a rich olive-brown above, while the belly is dark grey; there is a thin yellow stripe behind the eye and another along the upper lip, the latter stripe being edged above with black.

Another of the smaller, venomous snakes is the Yellow-faced Whip Snake (*Demansia psammophis*), which is slender and usually light grey with a comma-shaped yellow mark surrounding the eye. The tail of this comma is directed obliquely downwards and backwards. The belly is usually olive-green to yellow.

Two other elapine snakes merit attention because, although secretive in their habits, they are frequently sent to the Museum for identification. One is the Red-bellied or Golden-crowned Snake (*Aspidomorphus squamulosus*); it is generally blue-black above and a rich pink below, with a yellowish band around the snout and extending back to the neck on either side, often nearly meeting on the nape. It only occasionally grows to more than 2 ft. in length, and is not dangerous to humans; as it is a nocturnal species, it is most often found hiding under rocks and logs during the day, or out foraging at night for the insects and lizards on which it preys. The Golden-crowned Snake is often found close to the city in the northern harbour suburbs.

Related to this snake is the Red-naped Snake (*Aspidomorphus diadema*), a form with similar habits. It is a rich brown on the body and cream on the belly, and has a shiny black head and neck with a brilliant red, variably-shaped spot on the nape. This species, too, is harmless.

Related to the elapine snakes are the sea-snakes (family Hydrophiidae), seven species of which have occasionally been found alive, but exhausted, washed up on our beaches, usually during periods of very heavy seas. As sea-snakes are rarely encountered by most people, however, it will suffice to mention only one species, which is found much more frequently than any other. This is the Yellow-bellied Sea-snake (*Pelamis platurus*), a form which grows to nearly 4 ft. in length. It is black on the upper half of the body and yellow on the lower half, without any mixing of the two colours. The tail is paddle-shaped (a characteristic of all sea-snakes), with alternate broken bands of black and yellow. Although no bites from this species have been recorded in Australia, it should be treated as potentially dangerous.

Rudimentary Eyes

Blind snakes (family Typhlopidae) are worm-like, burrowing snakes with rudimentary eyes represented by two small black spots on the top of the head. They are usually a darker brown above and pinkish below, and their scales are very smooth and shiny. There is a blunt spine on the tip of the tail, which is quite harmless. Several species are found in the Sydney district but, because of their habits, they are rarely observed. Most of their lives are spent under ground, where they prey on small insects and their larvae; they may occasionally be seen above ground at night, particularly after rain. All species belong to the genus *Typhlops*.

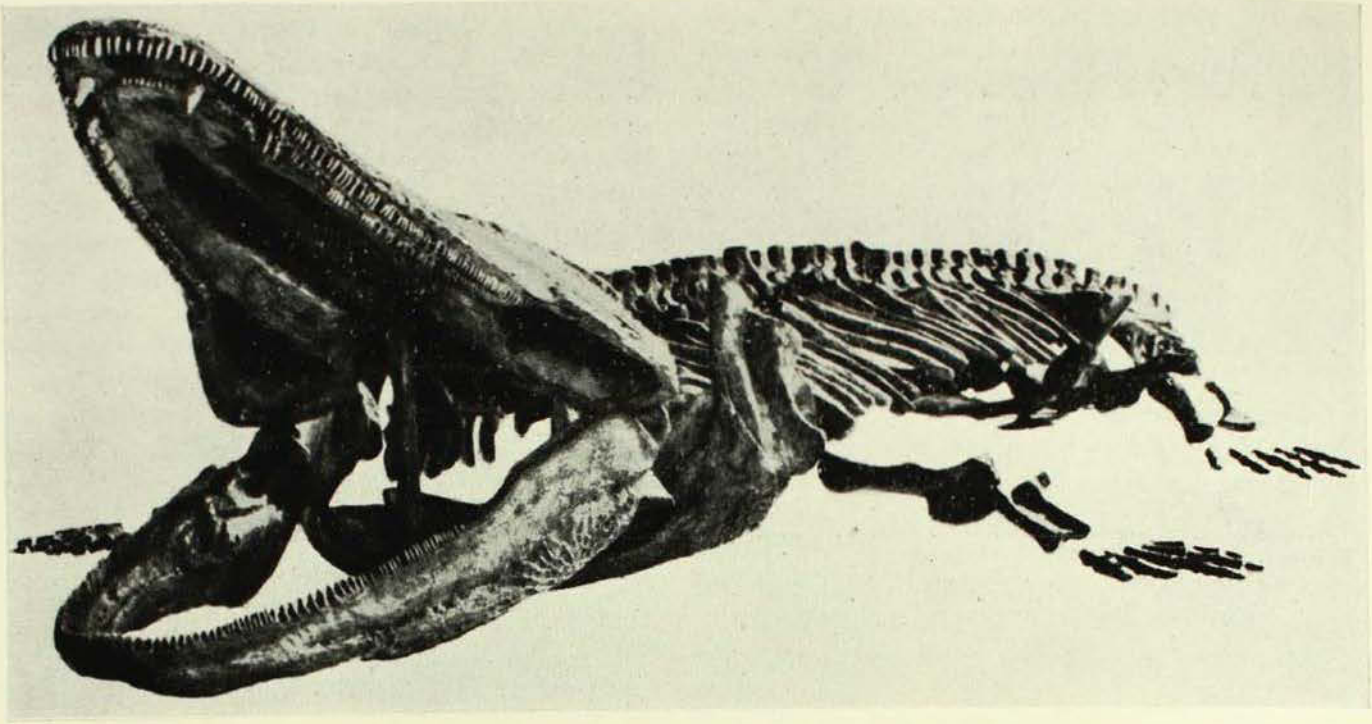
Three other groups of snakes are represented in the Sydney district, each by a single species. The Brown Tree Snake (*Boiga fusca*) is the only rear-fanged snake which occurs in the area, while the Green Tree Snake (*Dendrophis punctulatus*) is the only solid-toothed form. Both of these species belong to the family Colubridae.

The pythons (family Boidae) are represented by a single species, the Diamond Snake (*Morelia spilotes spilotes*).

Tortoises And Turtles

There is only one species of fresh-water tortoise which occurs naturally in the Sydney district; this is the Long-necked Tortoise (*Chelodina longicollis*), which is commonly found in creeks, rivers and swamps, where it feeds on aquatic insects, crustaceans and molluscs.

Many of the tropical marine turtles visit our shores from time to time; these, of course, are readily distinguished from the fresh-water tortoises (which rarely grow to a foot in length and which have well-developed legs) by their swimming flippers and large size. The Green Turtle (*Chelonia mydas*), the Loggerhead (*Caretta caretta*), the Hawksbill (*Eretmochelys imbricata*) and the Giant Luth or Leathery Turtle (*Dermochelys coriacea*) are regularly sighted in the waters of Broken Bay, Sydney Harbour and Botany Bay.



The restored and mounted skeleton of *Paracyclotosaurus davidi*, showing its teeth and very wide gape.

Fossils of the Sydney District

By H. O. FLETCHER

ALTHOUGH fossils of world-wide importance have been collected from the Sydney district, the exposed rocks forming the general surface are to a great extent unfossiliferous.

Rocks found in the neighbourhood of Sydney are of Triassic geological age and were deposited about 180 million years ago in a slowly-subsiding basin structure now known as the Sydney Basin. The rocks are divided into three groups which, in ascending order, are known as the Narrabeen group, the Hawkesbury sandstone and the Wianamatta group. All of them are almost exclusively of freshwater origin, the only exception being a limited horizon in the Minchinbury sandstone of the Wianamatta group, which contains an important assemblage of microfossil marine life including algae, foraminifera and ostracods. There is some doubt regarding the exact locality in which these fossils were originally collected, but it is thought to be along the Grose Vale-Kurrajong road.

Bores At Cremorne

Almost 70 years ago two diamond drill bores were put down on Robertson's Point at Cremorne, Sydney, with the object of proving the depth at which coal occurs under Sydney. In the first bore coal was reached at a depth of 2,802 ft., but it was found to have been charred or partly converted into coke owing to the intrusion of two local dolerite dykes.

A second bore was commenced in July, 1892, about half a mile from the original site, and on this occasion an excellent seam of coal, free from any alteration, was reached at a depth of 2,917 ft. The seam measured 10 ft. 3 in. in thickness. At a depth

of 3,000 ft. and immediately below the coal seam, a number of characteristic plant fossils of Permian geological age were recovered from the bore core. These included *Vertebraria*, which has a jointed root-like structure and in cross-section is seen to be built up with wedge-like segments. Originally regarded as a distinct type of plant, it is now considered to be the root-stem of *Glossopteris*, one of the most abundant of all Permian plants.

Valuable information regarding the thickness of Triassic rocks in the Sydney district was obtained from the two bores put down on Robertson's Point. Rocks of the Wianamatta group (Upper Triassic) were not present, as they had been denuded to such an extent that only occasional cappings are found overlying the Hawkesbury sandstone at various localities in the Sydney area.

Boring operations began in the Hawkesbury sandstone at a height of 143 ft. above sea-level, and a thickness of 1,020 ft. was determined for this formation; the underlying rocks of the Narrabeen group proved to be 1,900 ft. in thickness. Fossils were not found in the Hawkesbury sandstone, but in the first 1,000 ft. of the Narrabeen rocks many fossil plants were brought to the surface in the bore core. These consited of typical Triassic species, including a common and widely distributed fern known as *Thinnfeldia*.

Rocks of the Narrabeen group may also be found outcropping on the coastal headlands between Long Reef and Palm Beach, and most of them contain numerous but very fragmentary plant remains. Well-preserved and complete specimens of *Thinnfeldia* can be collected at Turrimetta Head and the southern and northern headlands of Avalon Beach, where three species are represented and can be recognised according to the relative length of the frond leaflets.

Rich Fossil Fauna

Interbedded with the Triassic rocks, mainly in the unfossiliferous Hawkesbury sandstone, is a number of lenticular deposits of shale, many of which contain a rich and interesting fossil fauna. The shale deposits vary in size and represent the sites of lakes, or lagoons, which in Triassic times were no doubt surrounded by sandhills, but into which fine mud and silt were carried and deposited by rain-water and creeks. This sediment, as it accumulated during the years, became the burial ground of the Triassic animals and plants which lived in the lagoon and on its banks about 180 million years ago.

For almost a century these shale deposits in the Sydney district have been quarried extensively for the manufacture of bricks and tiles. At the present time most of the shale has been removed, leaving open quarries or "brick pits". As the shale deposits were being quarried there was revealed such an amazing variety of fossil fish and other Triassic life that the localities have become world famous.

The Beacon Hill quarry, at Brookvale, near Sydney, originally consisted of a lenticular mass of shale, 25 ft. in thickness, lying between current bedded layers of

The impression in many blocks of ironstone of the upper surface of the skeleton of *Paracyclotosaurus davidi*, as it was collected in 1910 at St. Peters, Sydney.

sandstone and stratigraphically situated about midway in the Hawkesbury sandstone. The fossil fishes collected from the Beacon Hill quarry must number several thousands, while many other important and interesting forms of Triassic life have also been recorded. This fossil fauna is of particular interest, as it is intermediate in age between two other well-known Triassic faunas, one at Gosford in the top beds of the Narrabeen group (Lower Triassic) and one at St. Peters, Sydney, in the basal beds of the Wianamatta group (Upper Triassic). Stratigraphically the former is 650 ft. below the Beacon Hill quarry and the latter 600 ft. above it.

New Fish Species

The fishes from Brookvale are represented by 28 species, of which 23 were found to be new when being described by Sir Arthur Smith Woodward in 1890 and 1908 and by Dr. R. T. Wade in 1935. The specimens mainly occur as laterally-compressed external moulds, with the bodies and fins beautifully preserved and even the most delicate structures delineated. Most of the species belong to the Palaeoniscidae, a family of fishes which appeared in Devonian times about 75 million years before its Triassic descendants were flourishing and enjoying life in all parts of the world, but it has no representatives among the living fishes of today.

Two of the more common fishes recorded from the Beacon Hill quarry are *Cleithrolepis granulata*, a laterally-flattened type with granulated scales, and a small slender form known as *Brookvalia gracilis*. Other interesting fish species include *Ceratodus formosus*, a relative of the living *Neoceratodus* of Queensland, and a rare flying-fish described as a species of *Thoracopterus*.

The Gosford fish-horizon consisted of laminated mudstones and shales and had a thickness of about 6 ft. Although outside the limits of the Sydney district, it is interesting to know that 19 species of fishes were recorded from the quarry before all the material was quarried and removed. The fishes include a single species of shark, 17 species of ganoid fishes and the lungfish is represented by a new genus, *Gosfordia*.

A cross-section of the fossilized plant stem, *Vertebraria*.

At St. Peters, near Sydney, fish remains have been collected from five clay-pits now completely denuded of the fossiliferous shale. Thirteen species, representing 11 genera, have been recorded, and they include four genera which are closely related to earlier Palaeozoic forms found in the northern hemisphere. One of them is a well-known fossil shark, *Pleuracanthus*, found in the British coal-measures. Two palaeoniscid genera are also known from older rocks while the remainder have, as one would expect, Triassic affinities.

Labyrinthodonts

In Triassic times there lived a group of primitive amphibians known as the labyrinthodonts, which were destined to become extinct at the close of that period. They came into existence in late Devonian times, and were the first creatures to emerge from the water and lead a semi-terrestrial mode of life. They had evolved from the rhipidistian air-breathing fishes and, during the succeeding Carboniferous and Permian times, became well established in the humid swamp-forest areas in all parts of the world. They reached the peak of their development

in Triassic times. One of the most complete and important specimens ever found was collected in 1910 at St. Peters and is now in the British Museum (Natural History). This remarkable specimen, known as *Paracyclotosaurus davidi*, is 7½ ft. in length and is so perfectly preserved that it was possible to record many of the nerve structures on the inside of the skull. A portion of the skin was also preserved and is puckered in such a manner as to indicate that, even though it is covered with bony scale, it was to some extent flexible.

In describing this specimen in 1958, Dr. D. M. S. Watson, of the British Museum, suggested that certain displaced and cracked skull bones could have resulted from a large limb or trunk of a tree falling on the animal and killing it. The body could then have fallen or been washed into a lagoon where, sinking to the bed of the lagoon, it would soon have been buried by the accumulating silt and thus preserved as a complete skeleton.

Other labyrinthodont remains recorded from the Sydney district include: a complete skull of a smaller creature known as *Subcyclotosaurus brookvalensis* from the Beacon Hill quarry; fragmentary remains collected during excavations for the dock at Biloela, Cockatoo Island; a nearly-complete skeleton, *Platyceps wilkinsoni*, from the Gosford fish-bed, and jaws with teeth, vertebrae and ribs collected at Bowral from shales of the same age as those at St. Peters.

Dr. Watson, in describing the large labyrinthodont, *Paracyclotosaurus*, from St. Peters, estimated that its weight would have been much greater than that of a large man. In walking on land it would have left a track a little less than a yard wide with a stride of about 8 ins. The track would consist of two strips of forefoot prints with similar hindfoot prints just within them and with a wide streak of body impression.

Fossil footprints have been recorded from several localities in the Sydney district, but so far it has been difficult to identify them with any particular amphibian or reptile. In the Hawkesbury sandstone at Berowra Waters an excellent trail of footprints was found which could well have been made by such a type of labyrinthodont as *Paracyclotosaurus*. Other footprints have been recorded from various localities, including Annangrove, near Richmond.

A large series of insect wings have been collected from the Beacon Hill quarry and from the St. Peters quarry. They include a number of beautifully preserved wings of *Clatrotitan andersoni*, an insect of uncertain relationships. It had a wing-spread of about 11 ins., and on the wings was developed a stridulating or sound-producing area caused by a thickening and expansion of cross-veins. Hundreds of other types of insect wings have been collected from the Beacon Hill quarry and described and named, while others have yet to be identified and named.

Another important and interesting fossil from Brookvale is a small shrimp that is a close relative of the mountain-shrimp, *Anaspides*, which is today confined to pools on Mount Wellington and other high-altitude areas in Tasmania.

Numerous freshwater lamellibranchs have been collected from the basal beds of the Wianamatta group during excavations in Surry Hills and Waterloo. These small fossil shells consist of a number of species of *Unio* and *Unionella*, and recently new genera were described. Similar species of shells are found in rocks of the same geological age which are exposed at the northern end of the Gibraltar Tunnel at Mittagong.

[*Photos in this article are from the Bulletin of the British Museum (Natural History) Geology, Vol. 3, No. 7.*]

COLOURFUL PLANT LIFE ON SANDSTONE AND SHALE

By R. CAROLIN
Lecturer in Botany at the University of Sydney

Coastal sandstone heath country, showing the Black-boy (*Xanthorrhoea media*) in the foreground, Dwarf Apple (*Angophora cordifolia*), and *Banksia* species (background). Photo.—Author.

VEGETATION in the Sydney region is determined to a large extent by the two principal geological formations—the Hawkesbury sandstone, generally forming poor, thin soils, and the Wianamatta shale, forming somewhat better, clayey soils. The second main determining factor is the rainfall, which drops rapidly from 44.8 in. in Sydney to 29.74 in. in Penrith. Close to Sydney the vegetation has to contend not only with the poor nature of the soils but also, often, with the salt-containing sea-winds which can cause severe "scorching" to plants on the coastal headlands unless they are adapted to withstand its effects. The result of all these interacting factors on the vegetable life of the region is a large number of different plant communities, the members of which are nicely adapted to the conditions prevailing in these environments.

Despite the harsh conditions of the coastal sandstone heaths, it is here that many interesting plants are to be found. The vegetation is generally low and stunted and the layer of soil very thin. The coastal mallees, the commonest being *Eucalyptus obtusiflora*, are often found here in considerable numbers, for example, between Bundeena and Marlee Beach and above Garie Beach. More common bushes of these heaths, however, are the Dwarf Apple (*Angophora cordifolia*), producing masses of large cream flowers in the spring, various species of honeysuckle, such as *Banksia ericifolia*, with reddish spikes, and *B. asplenifolia*, with dove-grey ones, and stunted *Eucalyptus* species. One of the most impressive sights on the more sheltered sides of the slopes are the large numbers of spikes of one of the black-boys, *Xanthorrhoea media*, a species which only rarely forms a trunk. The lower layers of the plant society are occupied by small shrubs, such as *Darwinia fascicularis*, *Leucopogon microphyllus*, with tiny, white, bearded petals, and *Epacris microphylla*, a heath producing spikes of

white flowers. In some areas where the drainage may be impeded, or on creek banks, the unusual insectivorous plants may be found—*Drosera* species with sticky hairs covering their leaves which trap and digest insects, and *Utricularia* species with small bladder-traps below the ground serving the same function as *Drosera* leaves and producing beautiful, often large, blue flowers in the spring.

Dry Sclerophyll Forest

Many of these species also occur further from the coast, but the general structure of the vegetation changes as, further inland, more sheltered conditions are found. Here the dry sclerophyll forest occurs, with fairly tall trees, notably the scribbly gum (*Eucalyptus haemostoma*) and bloodwood (*E. gummifera*), a eucalypt with scaly bark. Where the soil is deeper in the shallower gullies, mahoganies (*E. umbra*), the peppermint (*E. piperita*) and the gnarled, red-boled, smooth-barked apple (*Angophora costata*) often form very tall trees.

The characteristic of the dry sclerophyll forest, however, is its undergrowth, which consists of large numbers of small shrubs, usually having hard, often small and spiney, leaves. The various kinds of needle-bush—for example, *Hakea sericea* and *H. pugioniformis*—are typical. It is here, also, that many *Grevillea* species grow, the hairy-flowered *G. buxifolia* and the red-flowered *G. punicea* and *G. oleoides* probably being the commonest. The yellow-peas, species of *Dillwynia* and *Pultenaea*, are a prominent and colourful component of dry sclerophyll forest shrub-layers in the spring, and in the gullies the Christmas bush (*Ceratopetalum gummiferum*) may cover considerable areas.

Occasionally the streams cut right down through the sandstone to the underlying Narrabeen shales, which form good soils, as at Bola Creek in Royal National Park. The combination of good soils, reliable water supply and shelter provide conditions for various sub-tropical rain-forest trees to grow. These trees, such as the lilly pilly (*Acmena smithii*), bearing pale purple berries; various figs (*Ficus*), and the good timber trees, coachwood (*Ceratopetalum apetalum*) and sassafras (*Doryphora sassafras*), are more at home in the forests of the north coast of New South Wales. There are, however, scattered patches down the coast as far as Tilba Tilba, where conditions are particularly mild. Before settlement was at all extensive in the Kiama-Robertson district, sub-tropical rain-forest probably dominated the picture on the basalt soil there.

Wet Sclerophyll Forest

In these deep gullies (where water supply is not quite so efficient or the soils are not quite so rich) and even on the tops of the ridges (where cappings of Wianamatta shale remain) another forest type, wet sclerophyll forest, is developed. This differs from dry sclerophyll forest in that there is no extensive layer of hard-leaved shrubs, and from rain-forest in the dominance of *Eucalyptus* species. The blue-gums (*E. deanei* and *E. saligna*) and the blackbutt (*E. pilularis*) are probably the commonest trees, but the peppermint (*E. piperita*), grey ironbark (*E. paniculata*) and turpentine (*Syncarpia glomulifera*) are also prominent.

The ground of this forest-type is covered with grass species; under natural conditions kangaroo-grass (*Themeda australis*) is probably the commonest nowadays, but unfortunately bladey-grass (*Imperatum cylindrica*) is often dominant. The latter is very vigorous after fire and, moreover, is itself a considerable fire hazard.

The dry sclerophyll forest may have a lot to offer in its profusion of beautiful flowering shrubs, but one of the most memorable experiences to be had around Sydney is to see the straight, shining, blue boles of the Sydney blue-gum springing from the grass-covered forest floor.

Out on the Wianamatta Stillstand, west of Parramatta, the rock sub-stratum is the same as that which often supports wet sclerophyll forest closer to the coast. Here, however, the rainfall is quite insufficient. The trees are more widely spaced, although the ground is still grass-covered, and there is not the profusion of hard-leaved shrubs found in dry sclerophyll forest. This vegetation is often referred to as savannah-woodland. The species of both *Eucalyptus* and grasses are different from those found nearer

the coast. The trees are mainly greybox (*Eucalyptus hemiphloia*) and forest redgum (*E. tereticornis*), while ironbarks (*E. sideroxylon* and *E. siderophloia*) are often common. It is in this plant community that the apiarist finds such good pastures for his bees. The honey formed from the various types of box is recognized to be one of the world's best, and the greybox is one of the commonest trees in this area.

Beach Flowers

It would hardly be cricket if a description of the Sydneyside vegetation, however brief, did not include some mention of the flowers to be found on or near the beaches. The martime sand-hills present very special problems with which their plant inhabitants must cope. The dryness, lack of soil-stability, presence of salt in both soil and air, and the strong scorching winds from the ocean, all combine to prevent most of the plants found on the Hawkesbury sandstones from growing on the maritime sand-hills.

The plants which do grow on these sand-hills often show special peculiarities whereby they protect themselves from the environment. Some, for example, produce very long trailers which eventually form interlacing mats, thus preventing the wind from blowing the sand about and stabilizing the soil. *Spinifex hirsutus*, a bluish-green grass, is the commonest of these plants and is present on almost every beach in the area. A pink-flowered morning-glory, *Ipomoea brasiliensis*, with the same habit, occurs on only a very few north-facing beaches in the region, it being essentially a tropical species. On many dunes, where protection from sea-breezes is afforded, *Acacia sophorae* can

Typical dry sclerophyll forest—*Eucalyptus gummifera, E. haemostoma, Banksia* species, *Xanthorrhoea media, Acacia suaveolens.*

Wet sclerophyll forest, including *Eucalyptus pilularis* with seedlings of *Casuarina littoralis*; *Themeda australis* (kangaroo-grass); *Imperatum cylindrica* (bladey-grass); *Lomandra* (sword-grasses), and ferns.

Photos.—Author.

form low, dark-green thickets, its semi-prostrate branches producing roots abundantly along their length, much like the *Spinifex* runners, and performing the same function of holding the sand down. Other plants rely on growing upwards and keeping pace with the sand which accumulates around their bases and which would otherwise submerge them. These plants tend to form hummocks because of this sand accumulation. A yellow daisy, *Seneco spathulatus*, and another grass, *Festuca littoralis*, are the commonest members of this group. The native *Pelargonium australe* is not quite so common, but on many dunes the pink-flowered South African *Pelargonium capitatum*, probably introduced in shipping ballast during the last century, is a common member of these pioneering plant communities which stabilize the moving sand. Further from the sea, where the effects of the salt-laden winds are a little less strong and the sand is more or less stabilized, small trees are able to grow. One of the ti-trees, *Leptospermum laevigatum*, can form quite dense thickets, while *Banksia serrata* often dominates pleasant open woodlands.

I have tried to make this article a little more than a mere list of plant names. The fact that a conscious effort is necessary to prevent this illustrates the extreme richness of the Sydneyside plant-life. Fewer than 50 species have been mentioned in this short description. How inadequate this is will be clearer when it is realized that there are, in all, over 1,000 species in the area.

"LIFE THROUGH THE AGES"

"Life Through the Ages", a coloured chart showing the progress of life through geological time, has just been published by the Australian Museum.

The chart (34 in. x 24 in.) relies on illustrations more than on wording, and is designed for hanging in schools so that it may be seen by all children, whether they are studying the biological sciences or not. It can also be used as an aid in the teaching of science, and will be of value to lay people interested in biological subjects.

The chart illustrates the kinds of life that have existed from the primitive invertebrates of more than 800 million years ago to the present. It shows the geological periods and their durations.

It is on sale at the Museum, price 6s.

Natural-history Films For Children

Natural history films will be screened for children at the Australian Museum during the school holidays in January.

Screenings will be at 2.30 p.m. every week-day from January 9 to January 27. Each programme will last half an hour, and admission will be free.

Subjects of the films include seashells, Funnel-web and Red-back spiders, scallop-fishing in Tasmania, Australia's venomous snakes, life among the Aborigines, animals of the Canadian Rocky Mountains, American birds, life in the ocean, wombats, African animals, the seals of Macquarie Island, fish and insects.

A feature of the screenings will be Walt Disney's film of animal and plant life, *Nature's Half Acre*.

The films are recommended for primary school children and secondary biology and social studies classes. Although the screenings are arranged specially for children, parents and teachers are also invited to attend.

Barranjoey, a tied island at the entrance of Broken Bay. When the world sea level dropped between 3,000 and 4,000 years ago a low sandridge was left exposed, linking the island with the mainland.

The Geology of the Sydney District

By W. R. BROWNE

Former Reader in Geology at the University of Sydney

THOUGH often considered geologically dull and monotonous, the Sydney district bears witness to quite a varied and interesting sequence of geological events.

The prevailing rocks are sedimentary and were deposited about 120 million years ago, during the Triassic Period, in a great basin extending north beyond Murrurundi, west to Cox's River, south beyond Kiama and east for some distance across what is now the Tasman Sea. It appears to have been a slowly-sinking depression close to sea-level —a great freshwater lake or series of lakes —fed by rivers that brought down vast quantities of sand, mud and gravel and deposited them on the floor or in deltas around the margin. For a time it was in direct communication with the ocean.

The rocks are conveniently grouped into three series: Narrabeen (maximum thickness 2,300 ft.), Hawkesbury (880 ft.) and Wianamatta (800 ft.). The oldest or Narrabeen is distinguished near the top by a very conspicuous bed of dark red or chocolate shale, well seen at Collaroy on the north and Garie Beach on the south; this is overlain by shales and shaly sandstones. The upper part of the sequence is displayed in cliffs and road-cuttings between Collaroy and Palm Beach and the lower, chiefly sandstones and shales, at Stanwell Park.

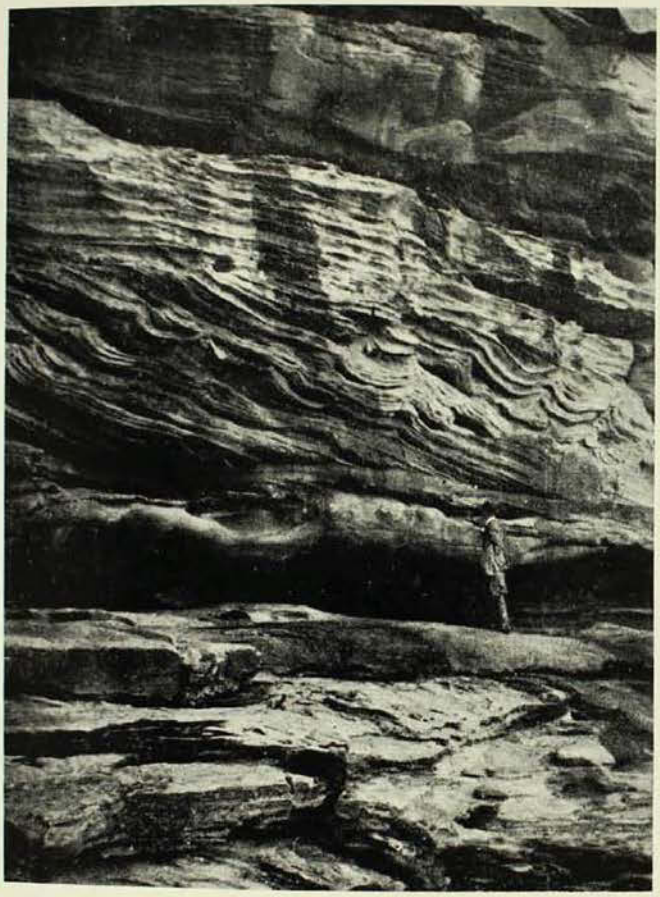
Coastal Cliffs

The most important of the three divisions is the Hawkesbury Series, which forms the precipitous coastal cliffs and most of the high country; it is composed of massive and well-bedded sandstone, with occasional beds of shale and rare bands of quartz-pebbles, and weathers to a barren sandy soil.

Only the lower part of the Wianamatta Series is to be seen. It is found in the low-lying western and Illawarra suburbs, from Ryde to beyond Hornsby and Pennant Hills, and in a narrow strip along the North Shore

railway-line north of St. Leonards. It consists of soft, well-bedded shales weathering to clay soils, with a few beds of calcareous sandstone, as at Minchinbury, and hard sandstone, as at Potts Hill. It also includes a few thin, impure coal-seams.

Throughout the whole sequence, but particularly in the Hawkesbury sandstone, current-bedding is common, where the Triassic rivers laid down their burden of sand to



Hawkesbury sandstone at Bondi, showing normal bedding and current-bedding which has been deformed by slumping caused by the weight of overlying layers.

form the foreset beds of deltas. Other interesting structures are the fossil ripple-marks on the rock-platforms at Collaroy, Newport Beach and elsewhere, formed originally in the Triassic lake-muds by waves whipped up by strong winds, and fossil sun-cracks produced by drying out and shrinkage when the muds were temporarily uncovered.

The beds enclose fossil remains of the life of the time. Shales have yielded plants allied to the horsetails, ferns, cycads and gingko, and the remains of fossil insects, fishes and a few amphibia, one of which, preserved in the shales of a St. Peters brick-pit, was 12 ft. long. Freshwater bivalves and tiny crustacea are also found, and of special interest are the foraminifera, microscopic marine protozoans, from Wianamatta calcareous sandstones, which testify to a temporary ingression of the sea.

After consolidation the beds were very gently folded and in places faulted, the result of probably more than one of the series of earth-movements referred to below. The dominant structure thus produced in the Sydney area is a great, broad, shallow, east-west basin or syncline, with its axis running through Ashfield and Fairfield and tilted very gently to the west. Within this structure the base of the Wianamatta shales —which is about 600 ft. above sea-level at Hornsby—drops to less than 50 ft. at Meadowbank, is more than 100 ft. below sea-level at Potts Hill and at sea-level a couple of miles further south, and at Loftus rises to 400 ft.

Botany Bay Basin

Botany Bay occupies part of the site of another, but smaller, shallow elliptical basin with a meridional axis. Occasional very local and minor foldings and faultings in Wianamatta shales are revealed by railway and road cuttings.

There is a big gap in our knowledge of events after Triassic time, but the lakes were drained and the rocks probably uplifted to form a land-surface which suffered some erosion. Early in Tertiary time, perhaps 60 million years ago, igneous activity broke out, of which we find evidence in the intrusive dolerite sill at Prospect and other smaller sills, the volcanic necks filled with lava-fragments from explosive eruptions, as at Hornsby and Dundas, and the scores of basalt dykes in the coastal belt. In some of these dykes the basalt is quite fresh, as at Long Reef; in others it has weathered to clay, which again may have been completely eroded away, leaving empty fissures in the sandstone. If lava ever flowed over the surface from any of the vents it has long since disappeared.

In contact with the larger intrusions the sandstone was hardened and prismatized or regularly cracked to form columns with

Prismatic sandstone in an old quarry at Bondi golf-links.

long axes generally normal to the cooling surface; excellent examples occur at Ben Buckler, near Bondi.

Later the land-surface was uplifted and subjected to prolonged erosion by rivers, which reduced it to a gently undulating lowland (peneplain) close to sea-level and with a gentle eastward slope. A great thickness of rock-material was removed, and, as a result, among other things the Prospect sill, which must have solidified under several hundred feet of cover and which resisted erosion, was laid bare and became a prominent landmark.

About the middle of Tertiary time, during a long period of continent-wide tropical or monsoonal conditions, a deposit of laterite was formed on the peneplain by chemical alteration of the surface rocks. Typically, this appears as a crust of little rusty or reddish-brown pellets cemented together, passing down into a mottled or reticulate zone and this into soft white or greyish clay. Good sections are revealed in railway cuttings at Chatswood and elsewhere, and partial sections in quarries on the plateau along the Pittwater Road and near Belrose. The white clay zone is well exposed near the French's Forest brickworks.

Kosciusko Epoch

Following the period of laterite formation came a further series of slow differential uplifts, the last and biggest of which culminated perhaps one million years ago during what is known as the Kosciusko epoch, though minor movement, including some subsidence of the country east of the Blue Mountains, probably continued until later. By these movements the old land-surface was unevenly raised to its present levels, producing considerable differences in elevation. The old rivers were revived and began to dissect vigorously the uplifted land, gashing it with great gorges, some of them hundreds of feet in depth.

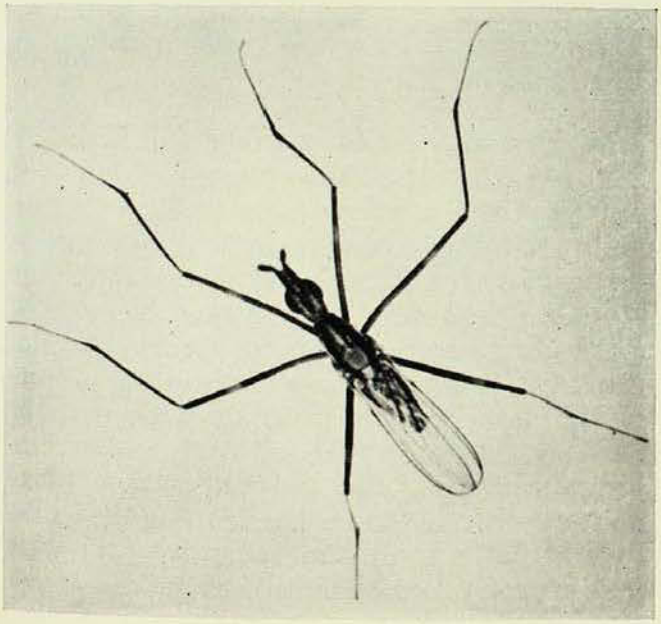
During Pleistocene time (from one million to 9,000 years ago) occurred the so-called Great Ice Age, when ice-sheets formed on the land in various parts of the world. The ice waxed and waned several times, causing world-wide fluctuations of sea-level, during some of which the sea may have dropped to as much as 450 ft. below its pre-glacial level. No glaciers formed in the Sydney area, but during glacial maxima the local rivers deepened their valleys towards the lowered sea-level. When at the close of the Ice Age most of the ice finally melted away the sea rose slowly to approximately its present level and flooded the lower parts of the coastal rivers, converting them into the estuaries and inlets of Broken Bay, Port Jackson and Botany Bay.

Between 3,000 and 4,000 years ago, just after the middle of Recent time, a relatively slight drop in temperature caused some increase in land-ice and a lowering of world sea-level by some 10 or 15 ft. This and other small eustatic movements, as they are called, are recorded along our coast by the peat-swamps and flat coastal lands only a few feet above sea-level and by the sand-bars

which, supplemented by wind-blown sands, have cut off lagoons like those of Narrabeen and Dee Why and tied rocky coastal islands to the mainland. Thus, Quarantine Island was converted into North Head peninsula, a large island stretching from South Head to Ben Buckler was tied by the sandy lowland running from Bondi Beach to Rose Bay, and Barranjoey was united to the mainland by a low sandridge at Palm Beach. The coastal rock-platforms now a few feet above sea-level have been laid bare by small eustatic movements.

The patches of wind-blown sand resting, well above sea-level, on the Triassic sandstones at Dover Heights, Edgecliff and other places around Sydney probably date back to one of the glacial maxima, when a retreat of the sea had laid bare much greater expanses of beach than exist at present and more sand was available for wind-transport.

The most striking and extensive accumulations of the coastal sands are those surrounding Botany Bay, which spread north to Redfern, Paddington and Waverley. They were deposited in the first instance in and around a larger Botany Bay, and were later supplemented by sand which, under the influence chiefly of strong southerly winds, was carried north and heaped up to considerable thicknesses. The sands occur up to altitudes of over 200 ft., and boring has shown them to extend down to at least 100 ft. below sea-level.



This Stilt-legged or Neriid Fly (*Telostylinus bivittatus* Cresson) belongs to the family Neriidae, most species of which are confined to tropical regions. Although the species illustrated had previously been found as far south as Sydney, there were no specimens of it from New South Wales in the Australian Museum collection until Mr. C. F. Nathan, of Vaucluse, and Mr. P. Matthews, of Dee Why, submitted some this year. These flies are of peculiar appearance, having slender bodies and wings, very elongate heads and long legs. They feed on sap oozing from trees. The larvae live under decaying bark or in decaying banana stalks, and apparently eat decomposing vegetable matter.

Photo.—Howard Hughes.

REVIEW

ATLAS OF AUSTRALIAN RESOURCES—MINERAL INDUSTRY MAP AND GEOLOGICAL MAP, prepared by the Department of National Development, Canberra, 1960.

These are two of the final set of five maps published recently to complete the total of 30 maps covering virtually the whole field of Australian resources, development and potentialities.

The Mineral Industry Map gives a remarkable amount of information about the most significant mineral products in Australia to the end of 1956. By using symbols, the map shows every locality in Australia concerned with significant production or treatment of minerals and metals extracted from minerals, whether by mining, concentration, smelting or refining, or a combination of these. It also gives the percentage of mineral production at each centre as compared with the total national production. Flow lines show the amounts of coal, other mineral products, concentrates and metals derived from ores that are transported within Australia, around the coast and overseas.

The Geological Map, compiled in 1958, is well printed in bright colours. It is on a scale of 94.7 miles to the inch, and is therefore only a little more than half the scale of David's Geological Map of the Commonwealth, so that the main geological periods, such as the Carboniferous, Permian and Triassic, in New South Wales, are not subdivided into the smaller units. Additions to our knowledge of Australian geology are shown. Many areas in the remote northern parts of the continent which were left blank on David's map have shrunk to a gratifying extent.

Each map is accompanied by a separate printed commentary, in the form of a booklet, which should be read carefully before interpreting the maps.

R.O.C.

SYDNEY: TOPOGRAPHY AND SETTLEMENT

By GRIFFITH TAYLOR

Former Professor of Geography at Sydney, Chicago and Toronto Universities

IN the following brief article I hope to show how greatly the distribution of settlement has been determined by the natural environment, i.e., by the geology, soils and topography of the district surrounding the city of Sydney.

As in all geographical papers the map is the key to the problem. I have borrowed three maps from my recent book, "Sydney-side Scenery" (1958), where the subject is treated in fairly full detail. The main map is a block diagram—looking to the west—of the region bounded by Broken Bay, the Great Divide near Mount Bindo, and the Moss Vale Plateau (south of Mittagong) on the south. It has much the appearance of the landscape as we should see it from an aeroplane flying at a low level along our seaboard. The salient feature is the area of low-land—shaped like a clenched fist—centred near Prospect, with the "wrist" reaching to the coast at Botany Bay. This I have labelled the "Wianamatta Stillstand", because it has not been so much influenced by crustal movements as have all the surrounding districts.

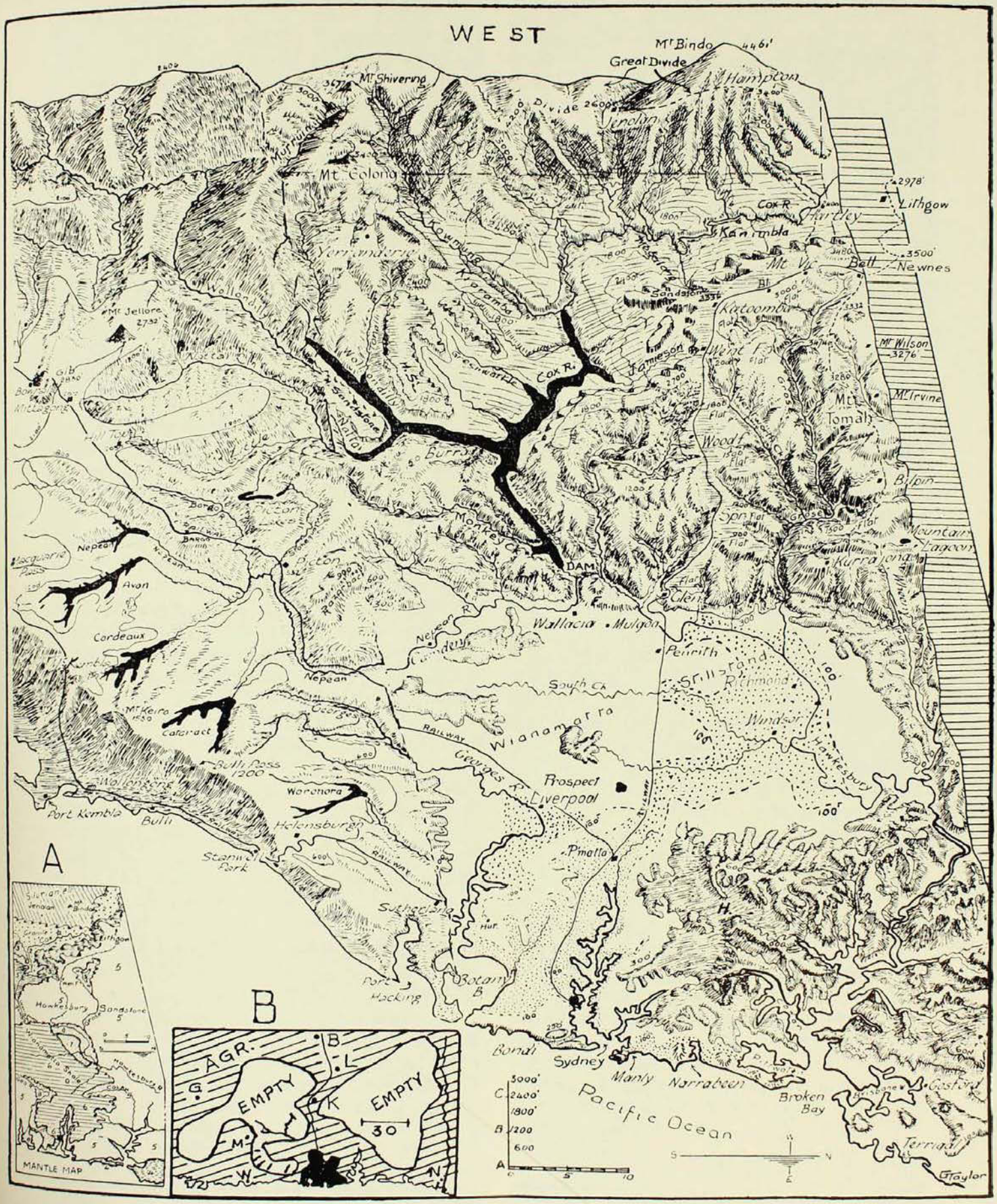
On the west we see the rugged slopes rising from the Nepean River near sea level to the highest point in our region, Mount Bindo, 4,461 feet above the Pacific. On the north-east is a less rugged plateau, of which the portion near Broken Bay appears in our map. In the south is a very regular rising slope—the Nepean ramp—which reaches a height of 2,100 feet near Mittagong. A last feature which appears clearly in our diagram is the remarkable scarp which bounds this "Ramp" on the ocean side. First viewed from the coast it was called the Illawarra Range; but it is no range, but the steep edge of the plateau which has been cut away by the action of the ocean, probably assisted by meridional cracks (faults) in the crust.

We must now summarise past geological history in our region. About 200 million years ago a downfold in the crust was occupied with shallow seas, swamps and lakes which ultimately collected the sands, shales and coal seams of Permo-Carboniferous times (3 in Inset A). For the next 100 million years thick beds of sands and shales were laid down in a somewhat similar downfold of rather less extent than that occupied by the underlying coal measures. These Triassic beds are the dominant formations in our region. They are numbered 4, 5 and 6 in Inset A.

In Tertiary times—which followed—our part of Australia was probably fairly flat and not much above sea level. It seems likely that the rivers flowed to the north or north-west, for such is the direction of those present rivers (e.g., the upper Nepean, the upper Shoalhaven, South Creek, Wollondilly, etc.) which have been least affected by the later crustal folding. Then in late Tertiary times, say about two or three million years ago, the marked warps of the crust produced the slopes leading up to Bindo and Mittagong and Hornsby (H) which have already been mentioned.

OPPOSITE

Block diagram of the Sydney region between Broken Bay, Wollongong and the Great Divide, looking to the west. The reservoirs are shown in black, the area below 100 ft. is dotted and other contours are given as faint lines. *Inset A:* A mantle map of the geology of the region, the younger formations being shown as mantles over the older. 1 is Paleozoic, 5 the dominant Triassic sandstone and 8 the rich silts of the Nepean River. *Inset B:* A simplified map of the settlement around Sydney. The built-up area is black, the fairly settled area is ruled. B, G and N indicate Bathurst, Goulburn and Newcastle.


WEST
Mt Bindo 4461'
Great Divide
Mt Shivering
Divide
Jenolan
Hampton
Mt Colong
Cox R
Kanimbla
Lithgow
Newnes
Mt Jellore 2732
Kowmung
Yerranderie
Wollondilly
Cox R.
Sandstone
Jamieson
Katoomba
Mt Wilson 3276'
Mt Irvine
Mt Tomah
Burra
Monkey Ck
DAM
Bilpin
Mountain Lagoon
Nepean
Avon
Cordeaux
Picton
Wallacia
Mulgoa
Penrith
Richmond
Windsor
Hawkesbury
South Ck
Wianamatta
Railway
Georges R
Prospect
Liverpool
Mt Keira 1650
Cataract
Bulli Pass 1200
Wollongong
Woronora
Port Kembla
Bulli
Helensburgh
Stanwell Park
Pittwater
Port Hacking
Botany B
Bondi
Sydney
Manly
Narrabeen
Broken Bay
Pacific Ocean
Terrigal
Gosford
Graylor
A
B
AGR.
EMPTY
EMPTY
30
MANTLE MAP
3000'
2400'
1800'
1200
600

The two areas least affected, as far as the rivers are concerned, were the Wianamatta Stillstand and the Moss Vale Plateau. Here South Creek and the upper Wingecarribee River still flow over fairly level surfaces, much as in earlier days. In the warped areas, and especially in the greatly elevated portions of the Nepean Ramp or the Blue Mountains or around Broken Bay, the scenery has been profoundly modified. Here we find the rugged topography with deep valleys and gorges, high cliffs, waterfalls and other features, which the topographer calls a *juvenile* landscape.

Evidence Of The Rivers

Let us observe the changes in the valley cross-section along two of the rivers in our district, for it is in such fashion that we may learn what has happened to our landscape in the last few million years. George's River rises just north of the Cataract Reservoir, only a mile or so from the 1,000-foot scarp near Bulli Pass. But the tiny streams flowing east down the great scarp have not yet had time to cut back to capture the headwaters of George's River, though this will certainly occur in a few thousand years. George's River flows nearly due north in a narrow juvenile valley until it approaches Liverpool. Here its waters meander over flat silts almost at sea level, and the river is said to be *senile*. Then it swings to the east, apparently heading for the long ridge near Hurstville (shown on map as Hur.). Now the valley section changes to something approaching a gorge, and the river reaches Botany Bay in a typical juvenile valley. This lower portion has, however, been drowned by the sea, as is generally the case with all our estuaries near Sydney.

The explanation lies in the fact that the river crosses land which has been elevated near its source, remained stationary (or perhaps even depressed a little) near Liverpool, and then has entered the narrow eastern "rim" of the Stillstand. It has cut its way down about as quickly as the crust has risen across its path; hence the juvenile gorge. The Nepean River shows similar changes, on a scale which is in some ways almost unique in my experience of river development. It rises near Mittagong and flows down the Nepean Ramp in a not very marked juvenile valley until it reaches Picton (see map). Here it swings east round the little Razorback plateau (perhaps a small horst or elevated block) until it approaches Camden. Then its path takes on a deep meandering course to the west. Such meanders are usually relics of a senile stage; but indicate late uplift, so slow that the river keeps to its meandering path, while entrenching itself in the harder formation underlying the silts. But the unique feature of the Nepean is the way in which the meridional crustal wrap has risen *across the middle* of two large meanders. Hence the western part of the meander has cut down 500 feet or so into the rising sandstone crust at Fairlight (F.), and to a lesser extent in the similar meander at Bents Basin. North of Penrith the Nepean flows across the silts of the Richmond-Windsor depression, where it has deposited the best agricultural soils anywhere in the Sydney region.

Only a brief reference is possible to the famous *bottle-neck valleys* of the Blue Mountains. Grose Valley is the most striking. Here the upper formation is the common sterile Hawkesbury Sandstone. Some 600 feet below the surface is a parallel layer of softer coal measures. The sandstone is usually cracked by fissures (joints), so that weathering readily reaches the softer shales below. Hence they are eroded (sapped) by weathering, and the blocks of sandstone fall down into the valleys. But where the warped crust is very steep—as north-west of Penrith—the river is always cutting down into the hard sandstone, and so makes a narrow gorge, and no sapping of the underlying shales occurs. Hence arises the bottle-neck where the Grose reaches the Nepean. North of Windsor the Nepean reaches the Northern (Hornsby) plateau, through which the Nepean was slowly cutting its gorge, about as quickly as the crust was rising. Hence the scenery of Broken Bay.

A word or two must be given to our picturesque coastlands. Few shores are quainter than those between Bondi and Palm Beach. We find a string of rocky "islands", as indicated in our main block diagram. South Head is isolated by the sandy gap south of Rose Bay. North Head is isolated by the Corso; Collaroy plateau is cut off by the Deewhy "strait"; a similar sand-filled "strait" links Mona Vale to Newport; Palm Beach shuts off Barranjoey

from the Avalon "island". My explanation is only tentative. I think we see here that the "entrenched meanders" (such as that of Fairlight) of a bygone north-flowing river have been cut across by the coastal erosion. The eastern parts of the meanders of this hypothetical river have vanished below the sea. The sand below the "straits" is probably over 100 feet deep, for the rocks of the former deep valleys were cut by *rivers* when the ocean was so much lower, part being locked in the ice-caps, in the major ice ages of the past. But this is a story of which I can only give a hint in this brief article.

The Control Of Settlement By Topography

The key to this aspect of the problem is given in a simplified form in Inset B in the illustration. The black patch shows the area around Sydney more or less covered by built-in streets. First of all the sterile narrow rim of sandstone was settled near Circular Quay (white in Inset A). Brick pits were dug near Ultimo at the nearest spot where the overlying shales (6) occurred. Near Rosehill (now Harris Park) the shales were found to offer much better soils than at Circular Quay, so Parramatta replaced Sydney temporarily as the centre of settlement. However, the deeper waters at the Quay made Sydney the chief port, while the Nepean Silts at Windsor (8 in Inset A) soon surpassed Rosehill as the granary of the colony.

As Tench observed in 1791, settlement inevitably spread over the Wianamatta Shales (Inset A); and settlement on the northern Hornsby plateau only occurred in the narrow capping of shales along the narrow divides between the deep sterile gorges. Gordon was such an early centre. For 60 years the city grew only on the flat lowlands of the Wianamatta Shales towards Parramatta. Then the picturesque rocky crags of the North Shore began to attract wealthy citizens. With the industrial expansion of the last 50 years, houses and factories sprang up to the south-west in the lowlands of the Stillstand.

Sydney is unlike any other large city known to the writer, in that it is almost completely hemmed in by a belt of sterile and almost empty terrain. The Inset B shows this huge area as a blank, only crossed by a narrow belt of settlement at Katoomba (K.). Only the northern geology is shown in Inset A, but if a complete geological map be consulted this empty area will be found to be built up of the very sterile sandstones (5) or the granites (2) of very much older date. Even more of a disability is the deeply dissected topography, due to the erosion by the rivers on the elevated crust, as shown in the main diagram.

The elevation of 3,000 feet (giving cool summers) and the lovely scenery in the valleys below the Katoomba Plateau, have led to a quite extensive settlement of a tourist nature. This environment has also made possible the development of the huge Warragamba Reservoir (black), which drowned very little good farming land. The near-empty area on the Nepean Ramp, with its four reservoirs, is also rather poor for agriculture, since on this slope the Wianamatta Shales have been stripped, though they are still present on the fairly level plateau south of Mittagong.

Beyond the Great Divide (which should not be called a "range") we find large areas of better soils based on Paleozoic rocks and granites. These have not been eroded into deep gorges as have the eastern flanks of the Great Divide. Here, then, we find widespread and prosperous farms and grazing lands near Bathurst (B.) and Goulburn, as our Inset B indicates.

35-mm. Colour-slides of Museum Exhibits

A series of 35-mm. colour slides, illustrating various Australian Museum exhibits, are on sale at the Museum.

Their subjects include Aboriginal exhibits, insects, named specimens of seashells, and a Funnel-web Spider exhibit.

These slides will be of particular interest to teachers, school pupils and amateur naturalists. They are available only at the Museum.

Rich and Varied Insect Fauna

By DAVID K. McALPINE

THE insect fauna of the Sydney district is, for a temperate climate, quite rich and varied and, judging from the fossil record, it has been so for many millions of years. The present nature of the insect fauna has been determined by its accessibility to faunas of other regions, the climate, the flora, the influence of other animals and, to some extent, by evolution within the area.

Many of the insects belong to groups which appear to have evolved within Australia and have few, if any, close relations overseas. Such insects form a much more conspicous part of the fauna near Sydney than they do in North Queensland but do not dominate the fauna to the same extent as in Tasmania and Victoria. Even in the nearby Blue Mountains the proportion of these insects is higher. Some representatives of these old endemic groups which are to be found around Sydney are the Common Brown Butterfly (*Heteronympha merope*) and the Toadstool Fly (*Tapeigaster marginifrons*), both of which occur in suburban gardens.

There are also insects which have reached Sydney more recently from the north and which seem to have originally entered Australia from adjacent tropical regions. Among these are the swallowtail butterflies (*Papilio*) and many more of the common butterflies, beetles, flies and other insects. A considerable number of them have evolved local species since arriving in Australia and have become adapted to a temperate climate. Thus the tropical butterflies of the genus *Delias* are represented by the Imperial White (*Delias harpalyce*) in New South Wales and Victoria. Most of the introduced insects have been accidentally transported, the Honey Bee (*Apis mellifera*) being one of the exceptions. There is a relatively high proportion of economically important species among the introduced insects, including both pest species and species introduced for the purpose of combating pests.

The Scorpion-fly *Harpobittacus tillyardi*, found in open heath scrub, uses its long legs to grasp the insects on which it feeds.

Drawn by N. B. Adams.

There are numerous kinds of environments close to Sydney which support notable insect populations. The natural vegetation consists of wet and dry sclerophyll forests (eucalypt forests), heath scrub and small areas of rain-forest. Sand dunes, marshes and mangrove swamps also occur. Some insects live in the fresh-water streams and swamps and a few inhabit the sea-shore. In developing the country for his own requirements man has made new environments for insects, ranging from pastures and cultivated areas to human dwellings.

Some Noteworthy Species

The dragonflies (Order Odonata) are common insects. Their carnivorous larvae may be found in any freshwater stream near Sydney, while the swift-flying adults sometimes appear in enormous numbers in gardens when a warm westerly wind is blowing. The larvae of mayflies (Order Ephemeroptera) and caddis-flies (Order Trichoptera) are abundant in small rocky streams in the Hawkesbury sandstone, and the adults may be seen flying over the streams or resting on nearby vegetation.

Cockroaches belonging to the Order Blattodea are represented by both introduced and native species. The American Cockroach (*Periplaneta americana*) is a common scavenger of settled areas which enters houses and may damage foods. The native Burrowing Cockroach (*Panesthia laevicollis*) lives in colonies in the bush and in some gardens, but fully-winged individuals are rarely seen because they chew off each other's wings. This species does not enter houses and is not a pest.

Several large species of cicadas (Order Hemiptera) are common near Sydney. The most plentiful species in settled areas is the Yellow Monday or Green Monday (*Cyclochila australasia*). Besides the familiar green and yellow forms of this species, there are the variety *spreta*, with a black abdomen and black markings on the thorax, the very dark-coloured "Black Prince" and a bluish or turquoise form. The shrill sound produced by several of this species in unison is ear-splitting at close quarters.

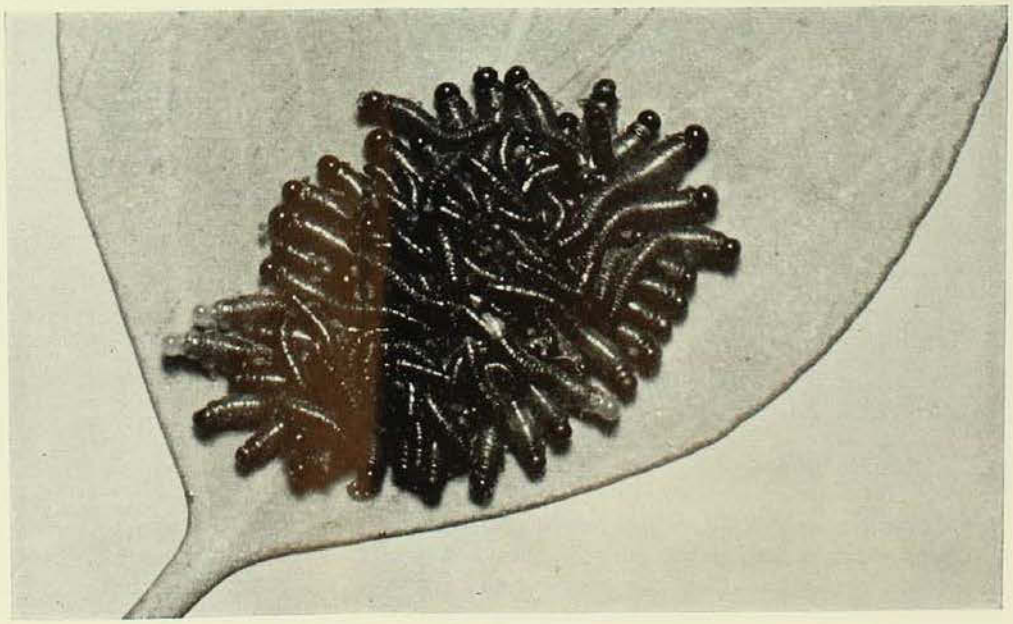
Only a few of the enormous number of beetle species (Order Coleoptera) may be noted here. The jewel beetles (family Buprestidae) are elongate beetles, often brightly coloured or conspicuously patterned. The adults are often found on the flowers of such native plants as Dwarf Apple (*Angophora cordifolia*) and Tea-tree (*Leptospermum*). The larvae excavate burrows in the trunks of trees.

The Christmas or King Beetles (*Anoplognathus*) are mostly large, pale-brown beetles with a metallic greenish or pinkish gold sheen on the head and thorax. They appear in large numbers for a short period in December and may severely damage the foliage of ornamental eucalypt trees.

The Steel-blue Sawfly (*Perga dorsalis*) is most frequently seen in the larval stage. The larvae, which live in clusters on the foliage and stems of eucalypts, resemble blackish caterpillars. They feed on the leaves and, when fully grown, pupate communally in the ground. The adult is about one inch long, metallic black with yellow areas on the thorax and yellow-brown wings. It is much more stoutly built than the wasps to which it is related.

The largest ants to be found near Sydney are the Bulldog Ants (*Myrmecia*), which may reach an inch in length. Their long mandibles and painful sting cause them to be avoided by picnickers. The Bulldog Ants, which are almost confined to Australia, are thought to be the most primitive of living ants.

There is only one common Scorpion-fly in the Sydney district. This is *Harpobittacus tillyardi*, which may be found in open heath scrub at Heathcote, French's Forest and other localities. This insect is reddish-brown with clear wings, and measures nearly two inches in wing span. The very long legs



A cluster of Sawfly larvae.

Photo.—D. H. Wilson.

are used for grasping other insects on which it feeds. Although this insect is quite common, the natural habitat of the larva has never been found. Larvae have, however, been raised from the peculiar cubic eggs.

The Robber-flies (family Asilidae) are characteristic of the Australian bush. These carnivorous insects are often seen with some smaller insect impaled on the proboscis or held between the legs. There are small, slender kinds (e.g., *Leptogaster*) and very large ones, such as *Blepharotes coriareus*, which measures up to three inches in wing span and flies very swiftly.

The Bush Fly (*Musca sorbens*) closely resembles the familiar House-fly (*Musca domestica*) in appearance. It causes considerable annoyance out of doors during the summer, both inland and on the beaches.

Saunder's Case-Moth

The larval case of the Saunder's Case-moth (*Oeceticus elongatus*) is a familiar object in Sydney gardens. It is a long spindle-shaped structure of tough silk to which pieces of stick are attached. The anterior part of the larva protrudes from one end when feeding or moving about, but it rapidly withdraws into the case on being disturbed. It eats the leaves of a variety of plants until ready to pupate inside the case. The female moth is wingless and does not leave the case. The winged black and reddish coloured male visits the case of the female and the eggs are laid inside it.

The Skipper Butterfly family (*Hesperiidae*) includes a subfamily, the Trapezitinae, which is almost exclusively Australian, only a few species occuring in New Guinea. At least 27 species of the subfamily occur in the Sydney district and the Blue Mountains. The Eliena Skipper (*Trapezites eliena*), one of the commonest species, is brown with bright yellow spots on the wings. The larvae of this and allied species eat the harsh, tufted, grass-like leaves of *Lomandra longifolia*, a common plant on the poor sandstone soils. The duller-coloured species of the genus *Toxidia* are frequently seen in gardens. Their larvae feed on grasses.

The Blue Fanny Butterfly (*Papilio sarpedon choredon*) is the Australian race of a species which extends through the Malay Archipelago to India. It reaches some distance south of Sydney, where it is one of the best-known swallowtail butterflies. The adult is a handsome black and sky-blue insect with triangular wings. The bright green larva formerly ate the leaves of various native plants, but now feeds principally on the introduced Camphor Laurel in Sydney.

Increase in Price of Magazine

As from the issue of March 15, 1961, the price of "The Australian Museum Magazine" will be increased to 3/- a copy (3/6 posted). The subscription rates (posted) will therefore be 14/- a year and £2/2/- for three years (the full volume).

This has been made essential by rises in the costs of printing, paper and process-engraving in recent years. It is the first increase in the price of the magazine since 1949, except for an extra charge of 1d. per posted copy in December, 1959, when higher postal rates raised the postage on the magazine from 3d. to 5d. It was then decided to bring the posted price to the round figure of 2/6, instead of 2/5, and thus offset, to a very slight extent, the heavy increases in production costs since 1949.

The fact that the price of the magazine has remained practically unchanged for 11 years indicates the Museum Trustees' desire that this educational and authoritative publication, the only one of its kind in Australia, shall be sold at as low a price as possible.

Improvements have been made to the magazine in the past two years, and this policy will be continued wherever practicable.