

# Part 1

## PHYSICAL ENVIRONMENT

### *Birds of Victoria\**

#### **Geology, Physiography, and Climate**

The vegetation of any area depends upon these three factors which, therefore, indirectly control its bird life. Although Victorian birds are not confronted with any physiographic barriers of magnitude, the principle relating to barriers (i.e., their hampering effect upon species distribution) still holds to some degree and the Dividing Range provides an example. Generally hotter and drier in the north and north-west, Victoria is in fact transitional between the sub-tropical situation of New South Wales and the temperate situation of Tasmania, between the high rainfall character of the south-eastern Australian coastlands and the arid interior. Such a climatic interpretation, which could be extended to include strong south-westerly "blows" in winter and spring from cold southern waters (and which carry sub-antarctic seabirds to the south-west coast), is basically not in conflict with the earlier and more static Eyrean/Bassian concept of Australian regions.

The distinctions between the Eyrean and Bassian, so marked in habitat and environment even within Victoria, are reflected also in the birds of the State and contribute to its transitional character.

#### **Vegetation**

For most bird species, vegetation of some kind is an essential part of the bird's habitat. Much of Victoria's vegetation (habitat) is being or has been removed, modified, or replaced by something different. Unfortunately many bird species are habitat selective and remain evicted by habitat alteration. The idea of native birds being "pushed back" by ecological change is valid only where virgin habitat remains for them to be "pushed back into"; in most cases they are pushed "out" to become locally extinct. Part of knowledgeable acquaintance with Victorian birds, therefore, is a familiarity with the habitats used by them. Vegetation types forming habitats can be described in various ways, one of which is based on structure. Thus, Grassland is a community dominated by grasses or crop; Savannah, a grass/cropland community with widely scattered trees; Woodland, a community dominated by trees in which the depth of the crown (foliage) is equal to or greater than the length of the bole (bare trunk); Forest, a closed community dominated by trees in which the length of the bole is greater than the depth of the crown; Mallee, a community dominated by multi-stemmed trees, i.e., Mallees, the several stems of which emerge separately from ground level; and Scrub, a community dominated by single-stemmed shrubs branching near ground level.

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\* A glossary of technical terms and diagrams will be found on pages 26 to 28.

Other vegetation types will be found and some of those enumerated above may be combined (e.g., Savannah-Woodland), or more nicely distinguished (e.g., Dry Sclerophyll Forest). The vegetation of Victoria is marked by its variety and a transition between extremes does occur; between, for example, the hot dry Mallee and the herbfield of the High Plains or the treefern gullies of the Sherbrooke Rain Forest.

On the map opposite are shown seven arbitrary divisions of the State for use as regions in Victorian ornithology. The map legend names some bird species typical of various habitats and of the proposed State regions.

Most bird communities share common features; for example, hawk predators and the preyed upon; parasites (cuckoos) and the parasitized; birds of the tree tops, of the shrub layer, and ground feeders; nectar gatherers, insect hunters, and seed eaters; the scavengers and, appropriately enough among sea-going forms, the pirates (skuas). Birds filling any of these ecological niches may be studied within the State. However, for those who prefer to seek variety in terms of species character, there are many contrasts—from the solitude surrounding Major Mitchells on Pine Plains to the sedate appearance of the English Songthrush working suburban lawns; from the monotony of midsummer-calling Kingfishers in Murray River flats to the elusiveness of the ringing “cracks” of Whipbirds in rain-soaked Gippsland gullies.

### Birds

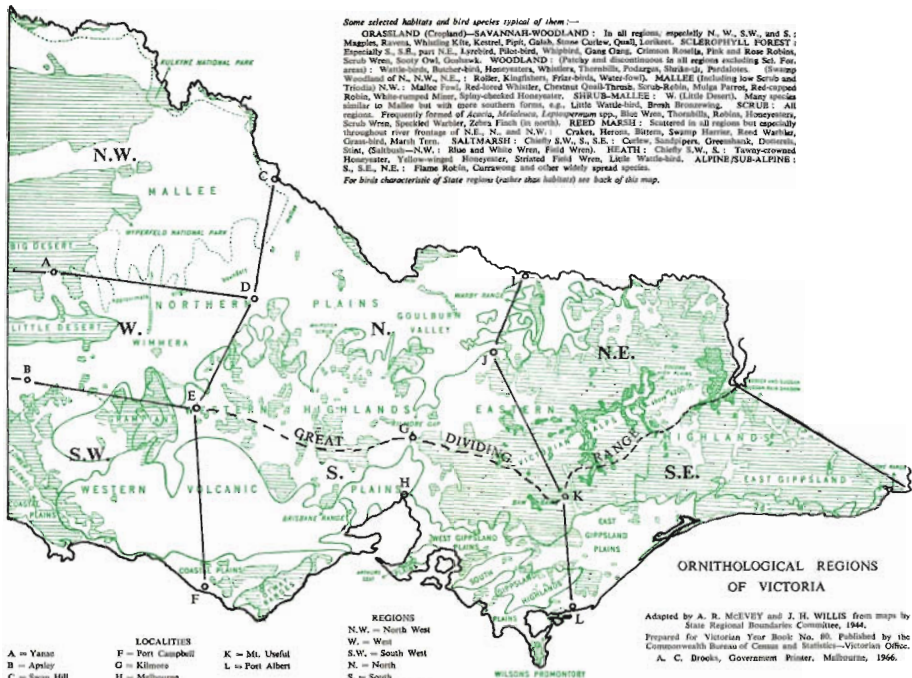
Birds belong to class Aves of the Sub-phylum Vertebrata. Sharing their ancestors with reptiles, and carrying evidence of this in possessing a single occipital condyle of the skull, a movable quadrate bone, and scales, they are yet distinctive animals and, with mammals, comprise the higher vertebrates. Birds may be defined as warm-blooded, oviparous, feathered bipeds, and the majority of them are capable of flight. Their skeletons are light; their respiratory system involves elaborate internal air sacs additional to lungs; and their usually rapid metabolic rate is generally associated with very active lives. Birds always, and alone, possess feathers.

#### *Fossil Birds*

The earliest known bird is *Archaeopteryx* which has survived only as a fossil from the Jurassic Period which ended some 120 mill. years ago. Limited but important collecting of fossil birds has been carried out in Australia, including the Victorian discovery of an almost complete right humerus of a Penguin (*Anthropodytes gilli*) of Miocene age representing a genus as yet known only from Australia. Fossil footprints of a large and probably Emu-like bird have been found in Warrnambool Sandstone (Pleistocene?) and a variety of seabird fossil remains in coastal areas. Mixed seabird and water-fowl bones from aboriginal middens have also been gathered.

#### *Living Birds*

About 8,600 species of recent birds are known. Great Britain and Ireland have over 400 species, North America about 800, and South America about 1,500. In Australia, some 650 species are known (the 707 of the checklist awaits amendment) and of these some 430 have



*State regions and some bird species characteristic of them though not necessarily common :-*

- N. W. Emu, Mallee Fowl, Peaceful Dove, Diamond Dove, Crested Pigeon, Marsh Tern, Gull-billed Tern, Red-kneed Dotterel, Black Kite, Grey Falcon, Major Mitchell, Little Corella, Regent Parrot, Yellow Rosella, Mulga Parrot, Budgeryga, Red-backed Kingfisher, Spotted Nightjar, White-backed Swallow, Red-capped Robin, Red-lored and Black-lored (Gilbert) Whistlers, Crested Bellbird, Ground Cuckoo-Shrike, Chestnut Quail-Thrush, Chestnut-crowned Babbler, Crimson Chat, Orange Chat, Red-tailed Thornbill, Red-throat, Striated Grass-Wren, Mallee Emu-Wren, Black-backed, Purple-backed, and Blue and White Wrens, Black-capped Sittella, White-browed Tree-Creeper, Yellow-tailed Pardalote, Striped, White-fronted, Purple-gaped, Yellow-plumed, Spiny-cheeked, and Blue-faced Honeyeaters, White-rumped and Dusky Miners, Apostle-bird, Spotted Bowerbird, Black-winged Currawong, Little Crow, Pied Butcher-bird.
- W. Emu, Mallee Fowl, Stubble Quail, Little Quail, Peaceful Dove, Common Bronzewing, Banded Plover, Ringneck Parrot, Red-capped Robin, Southern Scrub-Robin, Red-tailed Thornbill, Dark Thornbill, Purple-backed and Black-backed Wrens, Black-lored Whistler, Yellow-tailed Pardalote, Tawny-crowned, White-fronted, Yellow-plumed, Yellow-winged, and Spiny-cheeked Honeyeaters, Zebra Finch, Black-winged Currawong.
- S. W. Emu, Brush Bronzewing, Seabirds (Shearwaters, Albatrosses, Fairy Tern), Black-faced Cormorant, Waders, Shelduck, Powerful Owl, Yellow-tailed Black Cockatoo, Corella, Crimson Rosella, Blue-winged Parrot, Ground Parrot, Rufous Bristle-bird, Golden-headed Fantail Warbler, Southern Emu-Wren, Tawny-crowned, Crescent and Yellow-winged Honeyeaters, Little Wattle-bird, Beautiful Firetail, Skylark.
- N. Painted Quail, Peaceful Dove, Crested Bronzewing, Gull-billed Tern, Marsh Tern, Waders, Swamp birds and Ducks, Winking Owl, Red-backed Parrot, Eastern Broad-billed Roller, Rainbow-bird, Hooded Robin, Crested Bell-bird, White-winged Triller, Spotted Quail-Thrush, Western Warbler, Chestnut-tailed Thornbill, Chestnut-tailed and Shy Ground-Wrens, Speckled Warbler, Golden-headed Fantail Warbler, Purple-backed Wren, Black-chinned, Fuscous, Yellow-tufted, Painted, and Regent Honeyeaters.
- S. Stubble Quail, Plain-Wanderer, Seabirds (Fairy and Little Terns), Waders (Including Oystercatchers, Grey and Golden Plovers, Sand-Dotterels, Stilts, Avocet, Curlew, Whimbrels, Godwits, Sandpipers, Greenshank, and others), Shelduck, White Goshawk, Sooty Owl, Rainbow Lorikeet, Gang Gang, Crimson Rosella, Swift Parrot, Superb Lyrebird, Pink and Rose Robins, Olive Whistler, Eastern Whipbird, Aust. Ground Thrush, Large-billed Scrub Wren, Pilot-bird, Orange-winged Sittella, Helmeted Honeyeater, Bell Miner, Little Wattle-bird, Beautiful Firetail, Diamond Firetail, Red-browed Finch, Greenfinch, Satin Bowerbird, Red-whiskered Bulbul, Skylark.
- N. E. Peaceful Dove, Crested Pigeon, Wonga Pigeon, Marsh Tern, Swamp birds and Ducks, Winking Owl, Gang Gang, Cockatiel, King Parrot, Yellow Rosella, Red-backed Parrot, Eastern Broad-billed Roller, Red-backed Kingfisher, Rainbow-bird, Superb Lyrebird, White-backed Swallow, Crested Bell-bird, Cicada-bird, White-winged Triller, White-throated Warbler, Eastern Whiteface, Regent, Fuscous, Yellow-tufted, and White-plumed Honeyeaters, Friar-birds, Zebra Finch, Pied Currawong.
- S. E. Emu, Wonga Pigeon, Seabirds (Little Tern), Waders, White-breasted Sea Eagle, Powerful Owl, Masked Owl, Glossy Black Cockatoo, Yellow-tailed Black Cockatoo, Crimson Rosella, Ground Parrot, Superb Lyrebird, Black-faced Flycatcher, Rose Robin, Eastern Whipbird, Brown Warbler, Large-billed Scrub Wren, Chestnut-tailed Ground-Wren, Pilot-bird, Eastern Bristle-bird, Southern Emu-Wren, Orange-winged Sittella, Red-browed Tree-Creeper, Scarlet, Tawny-crowned, Lewin, Yellow-winged, and Yellow-tufted Honeyeaters, Bell Miner, Beautiful Firetail, Red-browed Finch, Satin Bowerbird, Grey Currawong.

been recorded in Victoria. The Australian avifauna possesses representatives of some widely distributed bird groups (e.g., pigeons, kingfishers); lacks examples of others (e.g., pheasants, woodpeckers, and true finches); shows slight transitional affinity with the Indian Region (e.g., woodswallows); and possesses some groups that are more or less exclusively Australian (e.g., emus, lyrebirds, butcher-birds, and others).

### Victorian Bird Families

In the following list only brief information can be given. Generic names are not repeated unless necessary to give sense to the sentence. The terms S., N.E., "south-west", "west", etc., generally refer to regions shown on map. Occasionally a broad meaning will be evident. For significance of bracketed numbers see note under Keartland, G. A. (1900), in bibliography on page 25.

*Spheniscidae*: Penguins. Five penguin species including the truly antarctic Adelle (*Pygoscelis adeliae*) have been recorded on the Victorian coast. South-westerly winds doubtless encourage their occurrence. The common Little or Fairy Penguin (*Eudyptula minor*) (184 and 185), weighing about 1½ lb., is one of the smallest of the family; it breeds regularly at Phillip Island between August and March, spending the remaining period at sea, presumably southward. Penguins generally lay from one to three eggs and are flightless, using only their wings for swimming and their feet partly for steering. They are confined almost entirely to the Southern hemisphere, most species occurring on islands of the southern ocean and/or the Antarctic continent.

*Dromaiidae*: Emus. The Emu (*Dromaius novae-hollandiae*) formerly more widely spread, may still be seen in isolated areas, especially in the west, north-west, and the highlands. The second largest living bird, it feeds on native fruits, seeds, and plant material and can cause damage to crops. It is flightless, runs at high speed, nests on the ground and swims readily. The eggs are dark blue-green, weigh about 20 ounces each, and usually number eight to ten. Incubation occupies about 60 days and only the male broods. Adult birds weigh 70 to 80 pounds. The idea of evolutionary affinity with other *Ratites* (Rhea, Ostrich, etc.) is controversial but is supported by some recent research.

*Podicipedidae*: Grebes. The three Australian species of this world-wide family of fully aquatic birds breed in Victoria. Their plumage is dense and smooth, the tarsus (legbone) laterally flattened, the tibia possesses a strong crest, the toes are lobed, the wings small, and the tail non-existent. Head plumes developed in the breeding season are characteristic of the group.

The Great Crested Grebe (*Podiceps cristatus*) is a quaint bird developing a striking nuptial frill of head feathers and indulging in an appealing courtship display. *P. ruficollis* (183), the Little, and (*P. poliocephalus*), the Hoary-headed Grebe, are smaller than ducks. They are all expert divers and swimmers on lakes and marshes and occasionally in coastal waters.

The next four families belong to the Order *Procellariiformes* or Tube-nosed swimmers (*Tubinares*) characterized by nostrils often united in a tube on top of the bill, the separation of the horny bill sheath into distinct pieces, three webbed toes, hooked bills, and a prolonged crest on the tibia. They are pelagic, being the true seabirds, unlike the "coastal" gulls and cormorants, and come ashore only to breed. Most nest in burrows or under rocks; all lay only one, generally white, egg; incubate for several weeks; and have downy young which remain long in the nest and are abandoned after being fed to repletion. The young vacate the nest after the growth of flight feathers. In general, members of the group feed on fish, squid, and small marine life, have a musty smell, regurgitate oily food for their young, and discharge oil from bill and nostrils when alarmed. They are an ancient and cosmopolitan group varying much in size but little in colouration through grey, black, white, brown, and blueish.

*Diomedidae*: Albatrosses. Among the largest of all living flying birds, the Albatrosses are typical of the Southern Ocean, but range from the Antarctic to the tropics. All seven Australian species have been recorded off the Victorian coast or as beach washed specimens but only one, the White-capped or Shy Albatross (*Diomedea cauta*) breeds locally (i.e., on Bass Strait Islands). Authoritative evidence indicates that approximately 11 ft. 6 in. is the maximum known authentic wingspan for the largest species, the Wandering Albatross (*D. exulans*). Smaller species are the Grey-headed, Black-browed, and Yellow-nosed, all of the genus *Diomedea*, while two grey-brown species of the genus *Phoebastria* are known chiefly from beach finds.

*Procellariidae*: Shearwaters, Petrels, Fulmars, Prions. Over twenty species are known either as living or beach-washed specimens on our coast, and they may be divided roughly into the following groups:—*Puffinus*, the dark grey or sooty and white Shearwaters; *Procellaria*, large black, or grey, rare petrels; *Pterodroma*, sooty or grey and white, rather rare species; *Macronectes*, the single very large, black, occasionally white, Giant Petrel; *Daption*, a mottled black and white pigeon-like petrel; *Halobaena*, a beautiful cerulean blue petrel; and *Pachyptila*, a collection of several small "soft-blue" and white Prions of which the Fairy P. (*P. turtur*) breeds on Bass Strait Islands. *Puffinus tenuirostris* is the Mutton-bird or Short-tailed Shearwater known at least by name to most Victorians. It arrives to breed on Phillip Island, Bass Strait Islands, and the western coast of Victoria in late September; prepares its burrow; lays its single, oval, white egg (of which the over 50-day incubation is shared by both parents) in November; hatches its chick in mid-January; feeds it for about three months; and abandons it in April. After about a fortnight, the youngster follows its parents on migration north to the seas off Japan and across to North America until the southward return journey in Spring.

*Hydrobatidae*: Storm Petrels. The smallest of the seabirds, Storm Petrels vary from sooty black to grey and white; have either long and spindly, or short legs; nest in burrows or natural hollows; lay white eggs that in some cases are lightly spotted; have an erratic flight over the water; and occasionally patter on its surface with their

feet while flying. The most common Victorian species is the White-faced Storm Petrel (*Pelagodroma marina*) which breeds on Mud Island. The dainty sooty-black Wilson's Storm Petrel (*Oceanites oceanicus*) is occasionally recorded.

*Pelecanoididae* : Diving Petrels. These plump little soot-coloured, short-winged birds might be termed "quail of the sea" from their habit of starting up out of the water and going away with a rapid blurr of wingbeats low over the waves like a quail over crop. They are confined to the southern hemisphere and comprise four species of which *Pelecanoides urinatrix*, the Common Diving Petrel, occurs in Victorian waters and breeds on Bass Strait Islands.

The next six families comprise the Order *Pelecaniformes*, fish-eating water birds of both marine and fresh water habitats, in which the hallux is turned forward and all four toes are fully webbed. In some the wishbone is firmly joined to the sternum.

*Phaethontidae* : Tropic-Birds. This small family is represented in Victorian avifauna only by rare records of stragglers of the Red-tailed Tropic-Bird, *Phaethon rubricaudus* which breeds on Lord Howe Island, laying its variably speckled egg typically on rock ledges.

*Pelecanidae* : Pelicans. Our single Australian Pelican (*Pelecanus conspicillatus*) (178) which extends into New Guinea and other islands is one of about eight species in the family spread over the major continents. Its appearance and its prodigious and distensible gular pouch, which can hold 2 to 3 gallons of water and often does hold fish temporarily, are well known. It breeds in colonies situated on islands (e.g., Bass Strait) and has nested in Southern Victoria laying its two or three white eggs in a ground nest.

*Sulidae* : Gannets and Boobies. Only one species, the Australian Gannet (*Sula serrator*) (182), of the four Australian forms occurs regularly over Victorian waters. Characteristic features are its total lack of nostrils, its breathing being made possible by a gap at the angle of the bill, and its ability to dive vertically into the sea after fish from a considerable height above water. Victorian birds breed on Lawrence Rock off Portland and in colonies on Bass Strait Islands. The Brown Gannet (*S. leucogaster*) has occurred locally.

*Phalacrocoracidae* : Cormorants. These expert swimmers and surface divers occur along sea-coasts and on inland waters in most parts of the world. Five species occur in Australia (including Victoria) all of which belong to the genus *Phalacrocorax*; *P. carbo* (179) the Black, *P. sulcirostris* (181) the Little, *P. fuscescens* the Black-faced (White-breasted), *P. varius* the Pied (Yellow-faced), and *P. melanoleucus* (180) the Little Pied. All of these except the Black-faced may be seen on both coastal and inland waters though the Pied is not common inland. The Black-faced is not only purely coastal, but is a more immaculate and more typical marine Cormorant. An interesting osteological character of the group is the presence of a bone pointing back from the posterior of the skull—an occipital style or nuchal bone which articulates with the supra-occipital.

*Anhingidae* : Darters. These Cormorant-like birds with extremely long necks capable of an "S" kink due to the structure of the neck vertebrae (the straightening of which lends a swift propulsive darting

movement to the bill when hunting) occur chiefly in the Americas, Africa, and the Indian and Australian regions. The bill is long and pointed; the plumage, attractively dotted and streaked, shows heavy ribbing (corrugations) on some feathers. Excellent swimmers and divers, the Darters also take crayfish and frogs. Their stick nests are placed in trees often over water and their three to five eggs are greenish white. Only one species occurs in Australia, *Anhinga novae-hollandiae*, and this may be seen typically round inland swamps.

*Fregatidae*: Frigate Birds. Pan-tropical seabirds, these are brownish-black species characterized uniquely by the furculum (wish-bone) being fused with both the sternum and the shoulder-girdle, and more generally by the bare throat, the long strongly hooked and cylindrical bill, the obsolete nostrils, and the deeply forked tail. The two Australian species, *Fregata minor* the Greater, and *F. ariel* the Lesser Frigate Birds have both on very rare occasions been recorded in Victoria.

*Ardeidae*: Herons, Egrets, and Bitterns. This practically world wide family of marsh frequenting, long legged birds is characterized by the bare tibio-tarsus, the "S" shape of the neck in flight, the comb-like preening teeth on the claw of the middle toe, and the presence of "powder-down" patches. These are feathers which continually crumble to provide powder of use in dressing the remaining plumage.

The so-called "Blue Crane" frequently seen round dams is *Ardea novae-hollandiae* (159), the White-faced Heron. The larger, more handsome White-necked Heron (*Ardea pacifica*) (158) is rather less common. Of Egrets, the two largest are *Egretta alba* and *intermedia*, the White and the Plumed Egrets. The smaller ones are *E. garzetta*, the Little, *E. sacra*, the rare coastal Reef Heron, and the Cattle Egret (*Bubulcus ibis*), a white form with golden buff plumes which has spread widely in many countries.

The Nankeen Night Heron (*Nycticorax caledonicus*) (160), a fawn cinnamon and black bird with white nuptial head plumes, typically skulks in trees during the day.

The Brown Bittern (*Botaurus poiciloptilus*) (161) is a skulker of the reed-beds and the caller of the booming note attributed to the "Bunyip". The Little Bittern (*Ixobrychus minutus*), seldom seen, also occurs widely in Victoria, its habitat choice being rather more catholic than the Brown's.

*Ciconiidae*: Storks. Differing from the Herons in tracheal structure, in lacking the powder-down patches and the serrated middle-claw and from the Ibis in skull structure, this widely spread family of Marsh and Savannah birds is represented in Australia by one species *Xenorhynchus asiaticus* the Jabiru of the Indian and Australian Regions. Fossil forms date from the Oligocene of 40 mill. years ago. Sight records of this species claimed for the north-east and south-west of Victoria cannot be ignored in the case of such a distinctive large black and white bird.



*Threskiornithidae* : Ibises and Spoonbills. Species of this family occur in most parts of the world. Both groups, typical of Marsh and Swamp, are long-legged, long-necked birds, the Ibises possessing a down-curved bill for probing in soft earth and the Spoonbills one that is spatulate at the tip for water-feeding.

The Straw-necked Ibis (*Threskiornis spinicollis*) (156) is a black and white bird with thin straw-like plumes on the neck. The Australian White Ibis (*T. molucca*), white with a black head, is slightly less common, while the smaller dark purple bronzy-green Glossy Ibis (*Plegadis falcinellus*), though widely distributed through other countries, is seen in Victoria only occasionally.

The two Australian Spoonbill species *Platalea regia*, the Royal (black-billed) and *P. flavipes*, the Yellow-billed, both occur in Victoria, the former being the rarer bird.

*Anatidae* : Ducks, Geese, and Swans. This ancient and frequently migratory or nomadic family of aquatic web-footed birds (the Magpie-Goose is only semi-webbed) can be divided into three main groups shown by the common names above. The classification of some species is still controversial.

Ducks : Typically, the plumage of the ducks ranges from brown to grey and black, some species possessing a metallic coloured speculum, or a white patch, or both, on the wing.

Surface feeders : These ducks comprising the Black Duck (*Anas superciliosa*) (169), the Teal (*Anas* spp.) (170, 171) and most other Victorian ducks "up end" to feed rather than dive and tend to take off straight out of the water. A rare Victorian species of this group is the Freckled Duck (*Stictonetta naevosa*).

Shelducks : Large, upstanding and handsome, the Australian Shelduck (*Tadorna tadornoides*) (168) is frequently seen on the Grassland of the S. and S.W. regions.

Pochards : Rather dumpy, dull-coloured ducks this group is represented by the fast-flying White-eyed Duck or Hardhead (*Aythya australis*) (173).

Perching Ducks : The attractively marked grey black and chestnut Maned Goose or Wood-duck (*Chenonetta jubata*) (167) is a tree-hole nesting representative of this group.

Whistling Tree Ducks : The two Australian species of this chestnut-coloured long-legged group are both on rare occasions seen in Victoria (*Dendrocygna* spp.).

Stiff-tailed (Diving) Ducks : Our two examples are the Blue-billed Duck (*Oxyura australis*) and the Musk Duck (*Biziura lobata*) (174). The stiff tails are frequently held in an upright position and the second species, in which the male possesses a strange fleshy appendage under the bill, rarely flies but dives expertly. The name "musk" refers to the scent produced by glandular secretion.

Geese : The two so-called Geese (Cape Barren Goose and Pied or Magpie Goose) on the Australian list are problems of classification. They are aberrant species and have occupied various positions usually

being separated from the true Geese. In this account they are regarded as Geese for convenience. The former (*Cereopsis novae-hollandiae*) nests on islands off the Victorian coast, and spends the summer on the mainland. Rarely swimming it grazes on herbage, is typical of islands, has a wing span of nearly six feet, and is grey with a green cere on the black bill. The latter, *Anseranas semipalmata*, a semi-web-footed black and white bird of northern Australia, was formerly to be seen regularly in northern and south-west Victoria.

Swans : Our single Australian species is the well-known and widely distributed Black Swan (*Cygnus atratus*) (166).

*Accipitridae* : Hawks, Eagles, Kites, Harriers. This family of diurnal birds of prey enjoys an almost world wide distribution. "Hawk" is the general term used for short or round-winged (and often long-legged) forms which lack the notch or "tooth" in the upper mandible. (Cf. *Falconidae*). In some species the female is distinctly larger.

The Spotted and Swamp Harriers (*Circus* spp.) (17, 18) are large, slow fliers, the latter typically over marsh land. The Goshawks and Sparrow-hawk (*Accipiter* spp.) (10 & 11, 12, 13) are predators of Forest and Woodland.

The Wedge-tailed Eagle (*Aquila audax*) (1) possessing the feathered tarsus of the true eagles, weighing about 8 lb., having a wing span of more than 9 ft., is not the world's largest eagle, but is nevertheless a magnificent bird found throughout the State. The White-breasted Sea Eagle (*Haliaeetus leucogaster*) (3) occurs on both coastal and inland water. The Little Eagle (*Hieraaetus morphnoides*) (2) is a fine looking small eagle, sparsely distributed. The Whistling "Eagle" is a Kite (*Haliastur sphenurus*) (4) and typically soars over Savannah-Woodland.

Of the remaining Kites, the attractive Black-shouldered (*Elanus notatus*) (15) given to hovering, is becoming less common in settled areas; the Letter-Winged (*E. scriptus*) (16) occurs occasionally; and the Black Kite (*Milvus migrans*) (14) invades Victoria from the north. Records of the Black-breasted Buzzard (*Hamirostra melanostrerna*) and the Square-tailed Kite (*Lophoictinia isura*) are claimed in Victoria from one or two localities.

*Pandionidae* : Ospreys. The coastal Osprey (*Pandion haliaetus*) of world-wide distribution is not numerous on Australian coasts and extremely rare in Victoria. It feeds upon fish which it takes by plunging into the water.

*Falconidae* : Falcons. Members of this widely spread family are characterized generally by their relatively long and pointed wings, dark brown eyes, and their possession of a notch in the upper mandible. The largest and most handsome Victorian species is the cosmopolitan, cliff nesting, swift-stooping Peregrine (*Falco peregrinus*) (5) renowned in falconry. The smaller Little Falcon (*F. longipennis*) (7) with longitudinal chest stripes is equally bold, and extremely fast flying. It lays its eggs in the deserted nests of Ravens and may be regarded as Victoria's truly typical falcon.

The Grey (*F. hypoleucus*) and the Black Falcon (*F. subniger*) (6) are swift-flying inland forms occurring occasionally in various parts of the State. The Brown Hawk (*F. (Ieracidea) berigora*) (8) typical

of Savannah country in all State regions and *F. cenchroides* (9), the cinnamon-coloured Nankeen Kestrel (often wrongly called Sparrowhawk) which is frequently seen hovering over Grassland, are both included here.

*Megapodiidae* : Mound-Builders. The Eyrean region Mallee Fowl or Lowan (*Leipoa ocellata*) is Victoria's only representative of a family which includes the Brush-turkey, Scrub-fowl and Maleo, and extends from southern Australia to Fiji, the Philippines, and Nicobar Islands. In all members incubation is achieved by heat from mound material within which the eggs are buried and this ranges from dry soil to steamy jungle humus and to hot volcanic sand. Confined in Victoria to the north-west, the Mallee Fowl formerly extended through Bendigo to the Brisbane Ranges, west of Melbourne. From 15 to 24 eggs may be laid in a mound prepared by the birds ; the incubation period averages about 60 but may extend to about 90 days. Temperature control is effected by opening and/or closing the mound according to prevailing conditions and incubation needs. Soil temperature appears to be measured by probing the bill in the sand. The species is a unique possession in Australian fauna and is in urgent need of habitat conservation.

*Phasianidae* : Pheasants, Quails, and Partridges. Only four species of true Quail (see also *Turnicidae*) are listed for Australia—*Coturnix pectoralis*—Stubble Quail (143) ; *Synoicus australis* (144) and *S. ypsilophorus* Brown and Swamp Quail ; and *Excalfactoria chinensis* (145), the King Quail.

Of these the Brown and Swamp Quail may yet prove to be forms of the one species and in Victoria all are found in Grassland, Heath, and Savannah regions. The Stubble Quail is the most commonly shot game bird. Quail are typically nomadic and fly strongly ; they run, scratch, feed and "dust-bathe" after the manner of fowls, and make grass nests on the ground, laying up to twelve eggs (Brown Quail). The King Quail of usually swampy habitat is not common. All are popular aviary birds.

*Turnicidae* : Bustard-Quails. Seven so-called "Quails" in Australia belong to this typically Indian, Australian, and Ethiopian Regions family in which the hallux (hind toe) is absent but a ground-dwelling habit and superficially Quail-like appearance have evolved. Behaviour as well as anatomy separate them from *Phasianidae*. Polyandry (mating of one female with several males) and brooding by the males typically occur. The crouching furtive gait of some species is unlike the upright stance of the true Quail.

Of the genus *Turnix* the Painted, Little (141), and Red-chested Quail occur in Victoria, and records of the Red-backed Quail are claimed for one or two localities. The Painted (*T. varia*) (140) is the largest, most attractive and commonest, being typically found in Dry Sclerophyll Forest. All have the ground feeding and ground nesting habits and the rapid direct flight of the true Quail, but none occur in flocks.

*Pedionomidae* : Plain-Wanderers. Australia possesses the only member of this family—*Pedionomus torquatus* (142), the Plain-wanderer, a species of puzzling relationships. A ground dwelling bird

of the Grasslands, it differs from *Turnicidae* in possessing a hind-toe. Rather Quail-like in plumage the female is the more brightly coloured ; it runs quickly ; stands up on its toes in an upright stance ; is hard to flush ; lays pointed eggs in a ground nest ; and has an unusual fluttering flight. Ancestral relationships with Bustard-Quail, Bustards, and Waders have all been suggested. The plains west of Melbourne have provided a typical Victorian habitat for the species though it occurs in other parts of the State. It is not frequently seen.

*Gruidae* : Cranes. Our only true Crane, the Brolga or Native Companion (*Grus rubicundus*) (157) is confined to Australia. Although associated with Australia's lonely spaces, Cranes are nevertheless an ancient family of almost world wide distribution. Stately dancing is a family characteristic of these bare headed long legged birds, and in most countries the species fight a losing battle for habitat. Anatomical characteristics of the family include the reduced supra-orbital impressions, the absence of basipterygoid processes, and the elaborately convoluted trachea which in some cases penetrates the sternum. The Brolga is now very sparsely distributed in Victoria ; it has a trumpeting call ; feeds on herbage, insects, frogs and other small animals ; and lays two sparsely spotted white eggs, sometimes on the ground and sometimes placed in grass platform nests in a swamp.

*Rallidae* : Rails, Crakes, and Allies. The widely-spread Rails, whose fossil ancestry dates back to Tertiary time of some 65 mill. years ago, remain, in part, among the least often seen of birds. They are essentially birds of the marshes, reed-beds, and swampy grassland, and of Australia's seventeen recorded species, nine occur in Victoria. The Lewin Water-rail and Banded Land-rail (165) (*Rallus* spp.) are furtive birds of the reed-beds though higher perching may occur ; of similar habitat are the diminutive Crakes, Spotted, Marsh, and Spotless (*Porzana* spp.). The Black-tailed Native Hen (*Tribonyx ventralis*) (163), superficially resembling the common Dusky Moorhen (*Gallinula tenebrosa*), occurs in sporadic flocks while the latter is a resident on the fringes of most Victorian swamps. The larger handsome Eastern Swamp-hen (*Porphyrio melanotus*) (162), with a distinctive purple chest and scarlet bill and forehead, was once called the Bald Coot. The true Coot (*Fulica atra*) (164), sooty black with lobed toes, has a white frons (forehead).

*Otididae*: Bustards. There is only one Australian representative of this ancient Old World, cursorial family and in settled areas it is sorely in need of help to survive. A bird of the plain country (Grassland and Savannah) which gave rise to its earlier name of Plains Turkey or Wild Turkey, the Australian Bustard (*Eupodotis australis*) (146) may still exist in one or more Victorian localities but in general has disappeared from the western and northern plains. A large handsome bird of finely barred brown plumage, the Bustard may attain a height of up to 4 feet and a weight of over 20 lb.

*Rostratulidae* : Painted Snipes. Only two species occur in this family, one in South America, the other ranging from Australia to Japan, India, and Africa. In the attractive latter species the female is rather more brightly coloured and has a convoluted trachea. The male incubates the four light, spotted eggs. The nest is placed in a stunted shrub or on the ground and the habitats selected by the species are marshes, salt-marshes, and swamp-woodland. It is rare in Victoria.

*Haematopodidae* : Oyster-catchers. A small family, the Oyster-catchers are found on the rocky coasts and more open beaches of most countries of the world. Australia's two species (*Haematopus unicolor*) the Sooty, and (*H. ostralegus*) the Pied Oyster-catcher, are both found on the Victorian coast, the Sooty tending to frequent offshore rocky outcrops. Their strong bills, deep and narrow, enable them to prise open shells and dislodge limpets.

*Charadriidae* : Plovers, Turnstones, Dotterels. Of this very large family, found almost throughout the world, too many species occur in Victoria to receive individual mention. Two main groups are involved, the Plovers and Dotterels. The grey, black and white Spurwinged Plover (*Lobibyx novae-hollandiae*) (148) with its plaintive ringing call is a familiar sight on pasture land throughout the year, and is our parallel to the European Lapwing. Migratory Plovers include the Golden and Grey Plovers of the genus *Pluvialis*. These are typically mottled birds which come to our coastal mudflats from their breeding home in northern Asia in our summer.

In the Dotterel group again there are the common residents, e.g., Black-fronted Dotterel (*Charadrius melanops*) (150), commonly seen round dams, and the Red-capped Dotterel (*C. alexandrinus*) (151) of both coastal and inland areas, and by contrast, summer migrants such as the Mongolian Dotterel (*C. mongolus*) and the Large Sand-Dotterel (*C. leschenaultii*) from the far north. An Eyrean representative in Victoria is the Red-kneed Dotterel (*Erythronyx cinctus*).

*Scolopacidae* : Snipe, Sandpipers, and others. This further large family contains various widespread Waders in which thin, straight, and sometimes long or downcurved bills are found. The plumage is usually grey-brown and often attractively striated. In this group are such exciting names to field students of the Waders as Curlew, Godwits, Greenshank, Tattlers, Whimbrels, Knots and others. Estuarine mudflats and salt marshes are the favoured habitats where they probe for food. Over twenty species are known in Victoria of which the Buff-breasted Sandpiper (*Tryngites subruficollis*), the Sanderling (*Crocethia alba*), the Broad-billed Sandpiper (*Limicola falcinella*), and the Pectoral Sandpiper (*Erolia melanotos*) are among the rarities. Almost all the species in this group breed in north-eastern Asia regularly making the long journey to Australia in the northern winter.

*Recurvirostridae* : Stilts and Avocets. A small but widely distributed family, these waders are birds of the swampy marshes and shallow salt lakes. All have extremely long spindly legs which protrude well beyond the tail in flight, long bills, and are black and white in their plumage. The White-headed Stilt (*Himantopus himantopus*) (152) is fairly widespread and utters a feeble yelping note.

The Banded Stilt (*Cladorhynchus leucocephalus*) with a chestnut band across the chest is less frequently seen and yet can occur in very large flocks. The Avocet (*Recurvirostra novae-hollandiae*) (153), possessing a chestnut coloured head and neck and a white body with black on the wings, uses its long upturned bill with a side-to-side motion when feeding in the shallows.

*Phalaropodidae* : Phalaropes. A well described Victorian sight record at present offers the sole claim for the occurrence of this Northern Hemisphere family in Australia. Three species exist in the family. Lobed toes enable the birds to swim well and a habit of spinning rapidly in the water (said to disturb floating organisms) is a characteristic feature. Only of the Red-necked Phalarope (*Phalaropus lobatus*) has a sight record been claimed.

*Burhinidae* : Stone-Curlews or Thick-knees. Several species exist in this fairly widely spread family of "waders" of the drier stony areas. The Southern Stone-Curlew (*Burhinus magnirostris*) (147) is equally at home in the moist Grassland of the south-western region, the Grey-Box Savannah of the north, and the red gravel outcrops and Red Ironbark of the north-east. Its melancholy and atmospheric "curlew" call, increasing in intensity as it proceeds, is reminiscent of still, moonlit country.

*Glareolidae* : Pratincoles. An aberrant Old World group of waders the Pratincoles are attractive slender birds with long pointed wings and forked tails. The migratory Oriental Pratincole (*Glareola pratincola*) has been recorded in southern Victoria. The indigenous Australian species (*Glareola isabella*) is typically a bird of the arid interior but, like some other Eyrean forms, it occurs on occasion in Victoria, chiefly in the north-west. It runs quickly, has an erratic flight and is chiefly sandy-rufous in colour.

*Stercorariidae* : Skuas. Of these gull-like birds, found in both the northern and southern hemispheres and nowadays grouped with the waders, two species are known along Victorian coasts, the Great Skua (*Catharacta skua*) a large, mottled brown bird (common on sub-antarctic islands) of which there are occasional records, and the Arctic or Richardson's Skua (*Stercorarius parasiticus*), a smaller falcon-like flier which may be seen at times in Port Phillip Bay. The latter species ranges to Arctic regions. Sight records are also claimed for the Pomarine Skua (*S. pomarinus*).

*Laridae* : Gulls and Terns. An extremely widely distributed family the web-footed Gulls and Terns are essentially birds of the coastline rather than of the open sea.

Three Gulls are known on Victorian coasts : the common Silver Gull (*Larus novae-hollandiae*) (176), the larger handsome blue-black and white Pacific Gull (*L. pacificus*) (175) of which immature birds are striated brown and buff, and occasionally, the very similar but rather more refined looking Dominican Gull (*L. dominicanus*), which lacks the black tail band of the former species and is common in New Zealand.

Of Terns, slim, long-winged, fork-tailed and often dainty birds, the commonest is the Crested Tern (*Sterna bergii*) (177) of our beaches. The large red-billed Caspian Tern (*Hydropogone caspia*) is less common ; the White-fronted (*S. striata*) is a winter visitor from New Zealand ; the dainty Little Tern (*S. albifrons*) occurs along the east Victorian coast, the Fairy Tern (*S. nereis*) chiefly to the west of Melbourne. The dumper red-billed Marsh Tern (*Chlidonias hybrida*) is commonly seen over inland swamps, the heavier Gull-billed Tern (*Gelochelidon nilotica*) more rarely, and the White-winged Black Tern (*Chlidonias leucoptera*) very rarely.

*Columbidae* : Pigeons and Doves, including Fruit Pigeons. The Indian and Australian regions are rich in species of this family. Two fairly distinct groups may be distinguished, the chiefly seed eating, ground frequenting species and the rather more arboreal Fruit (eating) Pigeons.

Victorian representatives are chiefly of the former kind, of which the crested Pigeon (*Ocyphaps lophotes*) illustrates the Eyrean type, the common Bronzewing (*Phaps chalcoptera*) (138) stands as a species of general distribution, and the Brush Bronzewing (*P. elegans*) (139) frequents chiefly the southern coastal Woodlands. The Peaceful and Diamond Doves (*Geopelia placida* and *G. cuneata*) are dainty northern Victorian forms ; the Green-winged Pigeon (*Chalcophaps chrysochlora*) awaits collection of a Victorian specimen but has been observed in Gippsland while the Wonga Pigeon (*Leucosarcia melanoleuca*) is typically found in Wet Sclerophyll and Rain Forest.

The introduced feral Domestic Pigeon (*Columba livia*) and Spotted Turtle Dove (*Streptopelia chinensis*), the former from Europe and the latter a native of the Indian Region, are common in Victorian cities.

Of the Fruit Pigeons, the attractive Top-knot (*Lopholaimus antarcticus*) has occasionally been recorded in the east and the Red and Purple-crowned Pigeons (*Ptilinopus* spp.) are accidental to the State.

*Psittacidae* : Parrots and Cockatoos. Distinctive anatomical features of this group include the prehensile zygodactylous feet adapted for both grasping and climbing, the hinged articulation of the maxilla with the frontal bones, and the weakness or absence of the furcula (wishbone).

Nectar and blossom feeding Lorikeets, Cockatoos, and a mixed group of broad-tailed and long-tailed Parrots are represented in Victoria. Of the Lorikeets (*Trichoglossus* and *Glossopsitta* spp.), "brush-tongued" followers of flowering Eucalypts, the Musk (135), Little (137) and Purple-crowned Lorikeets (136) are common, the Rainbow Lorikeet (134) less so.

The Cockatoos include the large Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*) (126) of leisurely flight and melancholy call over forest and Savannah-Woodland. Both the Red-tailed (*C. banksii*) and the Glossy Black (*C. lathami*) occur, the latter being confined to eastern forests. The White Cockatoo (*Kakatoe galerita*) (124) and the Galah (*K. roseicapilla*) (125) extend from the north to the Metropolitan Area ; the Gang Gang (*Callocephalon fimbriatum*) (127) visits the eastern Melbourne suburbs from the hills in winter ; the Long-billed Corella (*K. tenuirostris*) is common in the south-western region and the Major Mitchell (*K. leadbeateri*) in the north-west.

Of the broad-tailed Parrots the King Parrot (*Aprosmictus scapularis*) and the Crimson Rosella (*Platycercus elegans*) (129) are typical of Wet Sclerophyll Forest, the Eastern Rosella (*P. eximius*) (130) of Woodland, the Yellow Rosella (*P. flaveolus*) of Murray Swamp Woodland, and the Red-backed Parrot (*Psephotus haematonotus*) (131) of Savannah and Grassland. In the north-western Mallee, the Ringneck (*Barnardius barnardi*), the Mulga, and Blue-bonnet Parrots (*Psephotus* spp.) occur.

The long-tailed Regent and the Superb Parrot (128) (*Polytelis* spp.) are also handsome birds of the north-west. The Cockatiel (*Leptolophus hollandicus*) and the less predictable Budgerygah (*Melopsittacus undulatus*) are Eyrean Savannah visitors in summer, the Swift Parrot (*Lathamus discolor*) a Bassian migrant in winter from Tasmania. Of the dainty *Neophema* species, the Blue-winged (*N. chrysostoma*) (132? *chrysogaster* in error?) and the Elegant (*N. elegans*) are most commonly seen in southern Victoria, the Turquoise (*N. pulchella*) and the Orange-breasted (*N. chrysogaster*) are extremely rare. The Ground Parrot (*Pezoporus wallicus*) of limited coastal distribution urgently requires habitat preservation.

*Cuculidae*: Cuckoos. The family of cuckoos and their allies is spread throughout the tropical and temperate regions of the world. Their structural features include zygodactylous feet (the fourth toe being permanently directed backward) and the absence of basipterygoid processes.

In Victoria the Pallid Cuckoo (*Cuculus pallidus*) (119) a regular Spring visitor presumably from the north is a common grey cuckoo giving a monotonous but "Spring-suggestive" call of separate musical up-the-scale notes. It parasitizes open cup-shaped nests, especially those of honeyeaters. The Fan-tailed Cuckoo (*Cacomantis pyrrhophanus*) (120) with a slate grey back and rufous chest is less definitely migratory and utters a broken quavering, descending trill. It parasitizes chiefly dome-shaped nests as those, for example, of the Thornbills.

The Brush (*Cacomantis variolosus*) (121) and the Black-eared Cuckoos (*Misocalius osculans*) are rarer species; the Horsfield Bronze (*Chalcites basalis*) (123), dull bronze on the back with barring on the chest and rufous on some tail feathers, and the Golden Bronze (*C. plagosus*) (122) with green bronze on the back, brighter chest barring and no rufous on the tail, both have plaintive descending notes, the former's long drawn out, the latter's shorter. Both parasitize the nests of small birds, *C. basalis* laying a red-spotted egg and *C. plagosus* a bronze-brown one. Much remains to be learned of the methods adopted by the cuckoos in placing their eggs in foster parents' nests.

*Tytonidae*: Barn Owls. This and the next family comprise the owls, a group of chiefly nocturnal birds of prey, quite unrelated to Hawks and Eagles and widely spread throughout the world. Obvious characteristics are their raptorial bills and talons, their soft plumage, silent flight, forward set eyes, and flexible necks enabling the head to turn to the rear. The Barn Owls are further characterized by their distinct heart shaped facial discs, their usually light colour, their fairly long feathered legs; their single-notched sternum; their usually elliptical eggs, and the serrations on the claw of the middle toe. *Tyto alba* (21), the Barn Owl, also called Delicate Owl because of its marking, is white underneath and mottled grey buff above, cosmopolitan in distribution, and common in Victoria. The Masked Owl (*Tyto novae-hollandiae*) (19? *castanops* in error?) a rare, much larger, and more richly marked species is found in scattered Victorian localities, the Grass Owl (*T. longimembris*) (22), rather similar to the Barn Owl, has exceptionally long legs which dangle in flight, and is extremely rare in Victoria. The large, dark, Sooty Owl (*Tyto tenebricosa*) (20), is confined usually to Wet Sclerophyll and Temperate Rain



Forest (e.g., Dandenong Ranges) ; it is local in habit and little known. The eggs of these species are white and oval or round, the nests being in hollows, caves or on the ground.

*Strigidae* : Typical Owls (Hawk Owls). Lacking the heart-shaped facial disc and the pectinations on the middle talon of the *Tytonidae*, having a two-notched sternum, laying usually rounded eggs, and showing generally a darker plumage, this family is typified by the Boobook Owl (*Ninox novae-seelandiae*) (25), which is widely spread, roosts in foliage clumps, and gives the well-known "mopoke" call. Less common is the Winking or Barking Owl (*N. connivens*) (24), a larger, bright-yellow eyed owl typical of the Red Gum Swamp-Woodland and Grey/Yellow Box Savannah-Woodland. It utters a double note like a dog's bark and also is a source of the blood-curdling screaming call formerly attributed to *Ninox strenua* (23), the Powerful Owl. This latter and largest Australian owl is locally distributed in Sclerophyll Forest and tall Woodland areas, but has also roosted in the Royal Botanic Gardens, Melbourne.

*Podargidae* : Podargus or Frogmouth. This small family is confined to the Australian and Indian regions. The members are typically clothed in soft plumage of grey, black, and brown. They are crepuscular ("of twilight") and nocturnal species with very wide bills, feeding on large insects and very small mammals (e.g., mice) all of which are normally collected on the ground. In Victoria, *Podargus strigoides* (27), the Tawny Frogmouth or Podargus, is often wrongly called the "Mopoke". It utters a deep "oom", "oom", "oom", but may on occasion produce a double "boobook" like note.

*Ægothelidae* : Owlet-Nightjars. Not unlike the previous *Podargus* species in plumage, the one Australian Owlet-Nightjar (*Ægotheles cristata*) (26) has a relatively much slighter bill (though still wide) and is only eight or nine inches long. It also is nocturnal, resting in hollow limbs during the day, and feeding at night on insects caught both in the air and on the ground. It is a bird of the Woodland and Forest, is infrequently seen and lays its three to four white eggs in a hollow.

*Caprimulgidae* : Nightjars. This is the largest family of the Order and over 60 species are found throughout the tropical and temperate regions of the world, three occurring in Australia. The Nightjars are again wide billed, weak legged, nocturnal birds. Their plumage, strikingly marked (brown, grey, white, and rufous) serves them well as camouflage when they rest on the bare or rocky ground or among bark litter during the day. In Victoria are the White-throated Nightjar (*Eurostopus mystacalis*) and the Spotted Nightjar (*E. guttatus*) (28). Both show white throats and spots, but the Spotted has a distinct large (1 inch in diameter) white patch on each wing visible in flight. The Spotted Nightjar is a bird of inland Australia, the White-throated rather more of the eastern forest land.

*Apodidae* : Swifts. Swallow-like in appearance, the Swifts are probably the fastest flying of all birds, some species attaining an estimated speed well over 100 m.p.h. Two species occur in Victoria during Spring and Summer, the Spine-tailed (*Hirundapus caudacutus*) (29) and the Fork-tailed (*Apus pacificus*) (30) Swifts, both of which

breed in the northern hemisphere. They are usually seen on the wing, often in sultry weather conditions, and their unknown nocturnal "roosting" habits are a problem of current field research in Victoria.

*Alcedinidae* : Kingfishers. This cosmopolitan family is well represented in Australia. Four species regularly occur in Victoria ; the Kookaburra (*Dacelo gigas*) (35), the Azure Kingfisher (*Alcyon azurea*) (37), and the Sacred and Red-backed Kingfishers (*Halcyon sanctus* (36) and *H. pyrrhopygius*). The latter occurs chiefly north of the Divide. The Kookaburra has abandoned the fish catching habits of most Kingfishers.

*Meropidae* : Rainbow-birds. Representatives of this family (also called Bee-eaters) are typical of the African and Indian regions but are not confined to the tropics. The Australian species (*Merops ornatus*) returns to Victoria from the north each Spring to nest in tunnels excavated in sand banks. Brilliantly coloured the species has a distinctive gliding flight, is a sun-loving bird, and catches many insects on the wing.

*Coraciidae* : Rollers. Of this chiefly tropical family typical of the Ethiopian and Indian Regions, one species *Eurystomus orientalis* (34), the Broad-billed Roller, extends from India to Australia. The Roller is present in Victoria, chiefly in the north, during late Spring and Summer, and winters in New Guinea and the northern islands. Possessing a wide bill, the species feeds chiefly on larger insects, and occurs typically in swamp woodland.

*Menuridae* : Lyrebirds. Exclusively Australian, the Lyrebirds, a problem in bird classification, are placed with the smaller and numerous Perching Birds. Their anatomical features of interest include the syrinx and associated muscles, the number of tail feathers (16) and the shape of the sternum. They fly poorly, volplane efficiently, and scratch vigorously for food. The species found in Wet Sclerophyll and Temperate Rain Forest east of Melbourne (e.g., Sherbrooke Forest) and through the highlands of north-east Victoria is the Superb Lyrebird (*Menura novae-hollandiae*) (70). Renowned for its rich powerful voice and astonishing vocal mimicry, it is best heard in Winter when the male engages in territorial song and display on a shallow mound of scratched debris. While displaying, the bird frequently directs its elaborate tail forward over its head. The bulky nest is made by the female and she alone incubates the single egg which takes some six weeks to hatch. The Lyrebirds of Sherbrooke are unique in their tameness.

*Alaudidae* : Larks. Australia's only native representative of this typically Old World Grassland family is the Horsfield Bushlark *Mirafra javanica* (85), a nomadic species typically occurring in Victoria in Summer. Sparrowlike in size and plumage, the Bushlark sings in flight, sometimes nocturnally, practises vocal mimicry, occurs in flocks, nests on the ground, and shows a remarkable sub-specific colour variation throughout Australia. The introduced Skylark (*Alauda arvensis*) is commonest in the south and south-west.

*Hirundinidae* : Swallows. Cosmopolitan in distribution, superficially resembling but unrelated to the Swifts, the Swallows are a popular and appealing group of which all four Australian species occur

in Victoria. The largest, the Welcome Swallow (*Hirundo neoxena*) (31), frequently builds its mud nest under verandahs and most, but not all, individuals fly north in the winter. The beautiful White-backed Swallow (*Cheramoeca leucosterna*), an inland species, nests in sand-bank tunnels in northern Victoria, but remains through the winter only in the north-west; the Fairy and Tree Martins (*Hylochelidon* spp.) (32, 33) are typical of swamp woodland, the former constructing a bottle-shaped mud nest against banks, from which its vernacular name of "Bottle-Swallow" arose.

*Motacillidae* : Wagtails and Pipits. Found almost throughout the world, the most numerous members of the family are the Pipits, slim sandy coloured birds of open grassland. They run quickly, wag the tail up and down rapidly, nest on the ground and, in our one Australian species, have a weak song uttered in undulating flight. The Australian Pipit, often called Groundlark (*Anthus novae-seelandiae*) (82), like the Skylark shows a white shaft on each side of the tail in flight and is often seen by the roadside.

*Campephagidae* : Cuckoo-Shrikes. Typical of the African, Indo-Malaysian, and Australian regions, these birds are related neither to cuckoos nor to shrikes, but are a distinctive insect eating group. The Australian species are quiet birds of Savannah-Woodland. An undulating flight, subdued grey-blue and black colouration, a habit of refolding the wings after landing, and the building of small flat saucer-shaped nests on horizontal branches are general characteristics of our species. The genera *Pteropodocys*, *Coracina* and *Edoliisoma* (50) are represented in Victoria. The smaller White-winged Triller (*Lalage sueurii*) (51) is a summer Victorian breeding migrant. *Coracina novae-hollandiae* (49), the Black-faced Cuckoo-Shrike, is the common species in Victoria.

*Pycnonotidae* : Bulbuls. Of this family, of the African and Indian regions, the introduced Red Whiskered Bulbul (*Pycnonotus jocosus*) is locally distributed in some Melbourne suburbs. The Red-vented (*P. cafer*) has been recorded and collected round Melbourne in earlier years but possibly as an aviary escapee.

*Turdidae* : Thrushes. Although this family is a very large and widely distributed one, Australia possesses only two native Thrush species, the Ground Thrush or Mountain Thrush (*Turdus dauma*) (89), found chiefly in cool, moist Sclerophyll Forest and *Drymodes brunneopygia*, the Scrub-Robin of the Mallee. Two introduced species, the Song-thrush (*Turdus philomelos*) and the Blackbird (*Turdus merula*) are common in southern Victoria and the latter, an aggressive species, is rapidly spreading through the State.

*Timaliidae* : Babblers and Quail-Thrushes. An ill-defined family of wide distribution through Woodland and Scrub country chiefly in the Indian, Ethiopian, and Australian regions, the Babblers in general exhibit characteristics of noisy family-party flocking, soft plumage, strongly developed feet, and ground foraging habits. Three Babblers of the genus *Pomatostomus* (the Grey-crowned (94), White-browed (95), and Chestnut-crowned) are found in the State. The Quail-Thrushes of the genus *Cinlosoma* are quiet, elusive ground feeders.

The Spotted Quail-Thrush (*C. punctatum*) (88) is fairly widely distributed in the State, the Chestnut Quail-Thrush (*C. castanotum*) is found in the west and north-west (see also *Falcunculidae*).

*Sylviidae* : Warblers. This very large family of generally small, active, insect eating birds contains a variety of forms and presents problems of classification especially among Australian species. Some await further research. A compromise classification is adopted here. Those closest to the Old World warblers are the Speckled Warbler (*Chthonicola sagittata*) (81A), a chest-striped singer of dry undergrowth and scrub ; the Pilot-bird (*Pycnoptilus floccosus*) (74), a not frequently seen small brown bird of the Wet Sclerophyll and Temperate Rain Forest with a melodious call ; the Brown (83) and the Rufous Songlarks (*Cinclorhamphus* spp.) which come to Victoria in Spring and utter ringing songs over cropland and Savannah, the latter having a rufous rump and being given to singing while flying to a tree ; the Little Grassbird (*Megalurus gramineus*), an inconspicuous bird of reed beds which gives a monotonous four-syllable whistle ; the Australian Reed-warbler (*Acrocephalus australis*) (84), a plain looking migrant of our reed beds which breeds there and sets up a chorus of warbled "quarty-quarty-quarty" notes ; and the Fantail Warbler (*Cisticola exilis*) (75), a small bird of swampy areas with a buzzing note and one which stitches leaves onto the wall of its nest with spider web.

There are other Victorian species placed in the large *Sylviidae* family. The Striated Grass-Wren (*Amytornis striatus*) is an elusive bird of the Mallee where it typically darts between clumps of *Triodia* (Porcupine Grass). Two Bristle-birds (*Dasyornis* spp.) occur in the State, the Rufous often in coastal tussocks of the south-west and the Eastern in swampy heathland in the east ; both are sombre shy grey-brown birds, the former having a rufous crown and nape colouration. Two species of the elusively shy Emu-Wrens (so-called because of the "Emu-like" open barbs of the tail feathers) are found, the Southern (*Stipiturus malachurus*) (73) in coastal heath and the Mallee Emu-Wren (*S. mallee*) in the north-west. Of the better known "Blue Wrens" of the genus *Malurus*, four species occur in Victoria ; *M. cyaneus* (72), the well-known Superb Blue Wren of fairly wide distribution, the Black-backed and Purple-backed Wrens (*M. melanotus* and *M. assimilis*), the latter having chestnut scapulars, of the west and north-west, and the Blue and White Wren (*M. leuconotus*) of saltbush and saltmarsh habitat in the north-west.

A number of other "Warblers" sometimes placed in the family *Acanthizidae* are most appropriately included here. Three Warblers of the genus *Gerygone* occur : the White-throated (*G. olivacea*), a spring migrant of Sclerophyll Forest in the north and north-east ; the Western Warbler (*G. fusca*) which occurs in the north and north-east ; and the Brown Warbler (*G. richmondi*) of Wet Sclerophyll in the south-east.

The very small Brown Weebill (*Smicrornis brevirostris*) (63) is widely spread, the Eastern Whiteface (*Aphelocephala leucopsis*) is typical of the Tree Savannah country, while of the genus *Acanthiza* (Thornbills), seven forms are found. These are the Striated (78), Little (77), Brown, Chestnut-tailed, Dark, Buff-tailed, and Yellow-tailed (79). The last named is the familiar builder of the still puzzling

## *Birds of Victoria*



[Graham Pizze]y  
Little (Fairy) Penguin (*Eudyptula minor*).



[Graham Pizze]y  
Crested Terns (*Sterna bergii*).



[Graham Pizze]y  
Short-tailed Shearwaters (Mutton Birds) (*Puffinus tenuirostris*).



Black-browed Albatross  
(*Diomedea melanophris*).

[Graham Pizzezy

Australian Pelican  
(*Pelecanus conspicillatus*).

[Graham Pizzezy



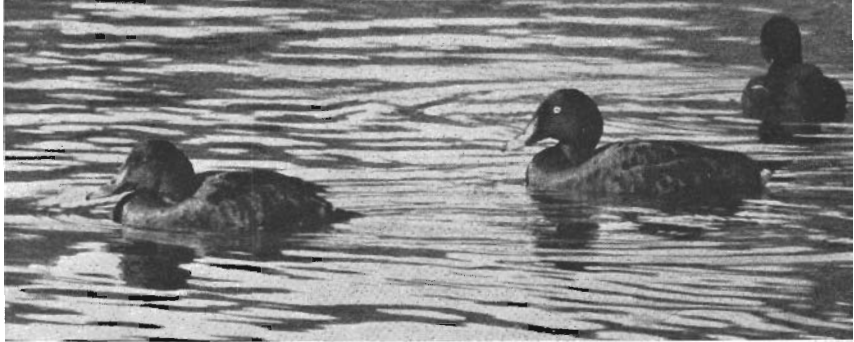
White Egret (*Egretta alba*).

[Graham Pizzezy

Australian White Ibis (*Threskiornis molucca*).

[Graham Pizzezy





[Graham Pizzev]

Hardheads (Australian White-eyed Ducks) (*Aythya australis*).



Swamp Woodland (Red Gum).

[Forests Commission of Victoria]



[Roy P. Cooper]

Australian Spur-winged Plover  
(*Lobibyx novae-hollandiae*).

Striated Pardalote (*Pardalotus striatus*).

[Roy P. Cooper]







[Graham Pizze] Silver Gulls (*Larus novae-hollandiae*).



[Graham Pizze] Arctic Skua (*Stercorarius parasiticus*).

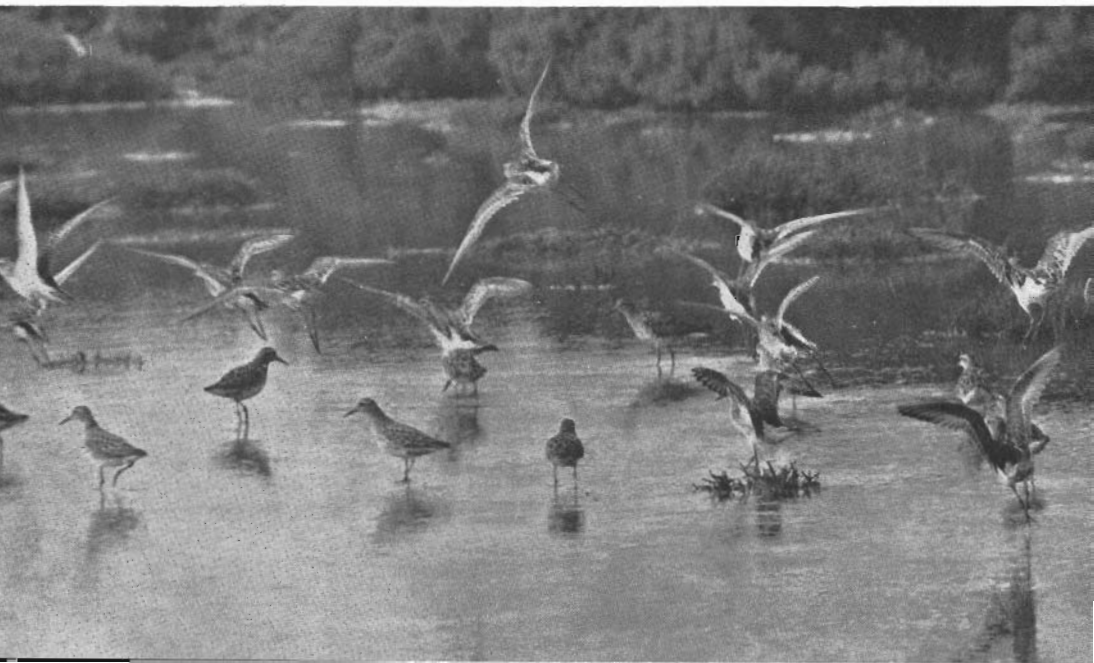


Cape Barren Geese (*Cereopsis novae-hollandiae*).

[Graham Pizze]

Sharp-tailed Sandpipers (*Erolia acuminata*).

[Graham Pizze]







[Graham Pizzev

Wedge-tailed Eagle (*Aquila audax*).



[Graham Pizzev

Australian (Brown) Goshawk (*Accipiter fasciatus*).



[Graham Pizzev

Australian Black-shouldered Kite (*Elanus notatus*).



[Roy P. Cooper

Eastern Rosella (*Platycercus eximius*).



[Graham Pizze

Tawny Frogmouth (*Podargus strigoides*).



Spotted Bower-Bird (*Chlamydera maculata*).

[Graham Pizze

Mallee-Fowls (*Leipoa ocellata*).

[Roy P. Coope





Wet Sclerophyll Forest—Temperate  
Rain Forest.

[Forests Commission of Victoria

Helmeted Honeyeater  
(*Meliphaga cassidix*).

[Roy P. Cooper



Crescent Honeyeater (Male) (*Phylidonyris pyrrhoptera*).

[Roy P. Cooper





[Roy P. Cooper

Grey Butcher-Bird (*Cracticus torquatus*).



[Roy P. Cooper

Flame Robin (Male) (*Petroica phoenicea*).



Australian Ground (Mountain) Thrush (*Oreocincla lunulata* (*Turdus dauma lunulata*)).

[Roy P. Cooper

Spotted Quail-Thrush (Male) (*Cinclosoma punctatum*).

[Roy P. Cooper



double-decker nest ; the Mallee form of the Brown Thornbill (*A. p. hamiltoni*) is held by some field workers to be worthy of species status ; the Dark Thornbill is confined to the west and north-west. Most species choose a habitat of Savannah-Woodland, the Chestnut-tailed constituting a dry inland form, the Buff-tailed filling a niche as a ground feeder. Of the Scrub-wrens of the genus *Sericornis*, small birds of scrub and undergrowth, the White-browed Scrub Wren (*S. frontalis*) (76) is common ; and the Large-billed Scrub Wren (*S. magnirostris*) extends from the east into the Dandenongs. The Red-throat (*Pyrrholaemus brunneus*), a charming small warbler with a rufous throat, is a dry country species of the north-western scrub ; the two Ground-Wrens (*Hylacola* spp.) are elusive undergrowth dwellers, the Chestnut-tailed (*H. pyrrhopygia*) in the south-west, south, south-east, and north, and the Shy (*H. cauta*) in the north-west and north. The Field Wren, a small striated species which typically sings from a bush-top probably exists only as one species (*Calamanthus fuliginosus*) (81) which has differentiated into a number of races. Distinctive forms occur in the south, the west, and north-western regions.

Of Australian Chats, sometimes placed in a separate family (*Epthianuridae*), three species occur in Victoria : the White-fronted (*Epthianura albifrons*) (80) common in Grassland, Savannah, and saltmarsh habitats of the south, and the striking Crimson (*E. tricolor*), and Orange (*E. aurifrons*) Chats which are nomadic visitors to the north-west. Injury feigning when eggs or young are in danger is characteristic of the genus.

*Muscicapidae* : Flycatchers. This family again constitutes a mixed assemblage, in this case of small insect eating birds, slower moving than the Warblers, frequently chiefly Forest and Woodland, and ranging in colour from black and white through greys and browns to the scarlet and yellows of robins.

Of the Fantails, the Grey (*Rhipidura fuliginosa*) (57) is commonly seen in aerobatics along Woodland fringes ; the popular Willie Wagtail (*R. leucophrys*) (59) is a fantail-flycatcher, not a member of the Wagtail family (see *Motacilidae*) ; and the Rufous (*R. rufifrons*) (58) frequents typically Wet Sclerophyll and Temperate Rain Forest but occurs in other habitats during its winter northward movement. All use spider web on their cup-shaped nests.

Of the Monarch Flycatchers in which a touch of metallic plumage typically occurs, the Leaden (61) and Satin (*Myiagra* spp.) (blue-grey and white and blue-black and white) usually frequent forest areas. The females have rufous throats. The Restless Flycatcher (*Seisura inquieta*) (60) differs from the Willie Wagtail by having a white throat. It hovers characteristically and occurs in a variety of habitats including Savannah and Swamp Woodland. The Black-faced Flycatcher (*Monarcha melanopsis*) occurs in Wet Sclerophyll and Temperate Rain Forest of the south-east in Spring and Summer. It is handsomely marked grey, black, and rufous.

A number of the robin-like Flycatchers are found in Victoria. A silent, flitting flight, perching in exposed positions and a wing drooping posture are group features. The Jacky Winter (*Microeca leucophaea*) (62), plain brown with pronounced white tail shafts,



utters a piping "Peter Peter Peter" along Woodland fringes and in Tree-Savannah. The "Robins" of the genus *Petroica* are represented by *P. multicolor* (65) and *P. phoenicea* (67), the Scarlet and the Flame, usually more widely spread in open country during winter, *P. goodenovii* (66) the Red-capped, an inland species typical of the north-west, north, and north-east, *P. rodinogaster* the Pink and *P. rosea* (64) the Rose, of Wet Sclerophyll in the south-east, south, and south-west, and finally, the widely spread black and white *P. cucullata* (68), the Hooded Robin. The Southern Yellow Robin (*Eopsaltria australis*) (69), confiding in habit, is plentiful in Wet Sclerophyll, but occurs also in drier areas.

*Pachycephalidae* : Whistlers and Shrike-thrushes. Six species of this Australian Region family occur in Victoria. In the genus *Pachycephala* are the Golden and Rufous Whistlers (*P. pectoralis* (52) and *P. rufiventris* (53)) of Forest and Woodland in all regions, the Olive Whistler (*P. olivacea*), chiefly found in moist southern and eastern scrub, the Black-lored (Gilbert) (*P. inornata*) of the west and north-west, and the Red-lored (*P. rufogularis*) confined to Mallee/Scrub of the north-west. The first two have rich songs ; all have the round-headed *Pachycephala* shape and upper-foliage frequenting habits. The related Grey Shrike-thrush (*Colluricincla harmonica*) (54), similar in habit, is widely spread and frequently heard in Forest and Woodland.

*Falcunculidae* : Shrike-tits and allies. All species here included are peculiar to Australia and of controversial relationship. The yellow-breasted and black and white crested Eastern Shrike-tit (*Falcunculus frontatus*) (55) fossicks among the bark of upper branches in Forest and Woodland. The Crested Bell-bird (*Oreoica gutturalis*) (56), which utters a ventriloquial bell-like note, occurs in Dry Sclerophyll, Woodland, or Mallee in the north-east, north, and north-west.

The Wedgebill (*Sphenostoma cristatum*), for which Victorian breeding has been claimed, is now very rare and/or local, in the north-west if it occurs at all. The Eastern Whipbird (*Pshopodes olivaceus*) (71) occurs in Temperate Rain Forest and moist scrub of the south-east and south, east of Melbourne. The Western (Mallee) Whipbird (*P. nigrogularis*) was first collected in Victoria (north-west) in 1932 but there has been no published record of the living bird for many years.

*Sittidae* : Nuthatches. The Australian Sittellas differ from typical Nuthatches in their nesting and flocking. Two Sittella species listed locally, the Orange-winged (*Neositta chrysoptera*) (118) and the Black-capped (*N. pileata*) of the western regions are probably races of one species. They descend tree trunks and can cling to the underside of horizontal limbs in feeding.

*Climacteridae* : Australian Tree-Creepers. A taxonomic problem, the Tree-Creepers spirally ascend tree trunks gathering insect food, move with a gliding flight, and utter shrill piercing notes. Four species occur here : *Climacteris picumnus* (116), the Brown, of Savannah-Woodland ; *C. leucophaea* (117), the White-throated, of Sclerophyll Forest ; *C. erythrops*, the Red-browed, of south-eastern Wet Forest ; and *C. affinis*, the White-browed, of the north-west.

**Dicaeidae** : Mistletoe Birds and Pardalotes (Flowerpeckers). The steel-blue and scarlet Mistletoe Bird (*Dicaeum hirundinaceum*) (114) is widely spread and feeds on the fruit of native mistletoe. Of the Pardalotes, small birds of the tree tops, *Pardalotus punctatus* (41), the Spotted Pardalote, ranges through most regions but is replaced in the north-west by *P. xanthopygus*, the Yellow-tailed. Other species are the Yellow-tipped, *P. striatus* (42), and the problematical Striated and Eastern Striated (*P. substriatus* and *P. ornatus*) (43) for which field workers claim interbreeding. Hole nesting is characteristic of the genus.

**Zosteropidae** : Silver-eyes. Ranging from the Ethiopian through the Indian to the Australian Region, the genus *Zosterops* is a fruit, insect, and nectar-feeding one of small greenish birds typically marked with a white eye ring. *Zosterops lateralis* (115), the Grey-breasted Silver-eye is common in Victoria. The true picture of races or other species present awaits the results of research.

**Meliphagidae** : Honeyeaters. This characteristically Australian Region family of brush-tongued, nectar and insect-eating, active and pugnacious smallish birds, ranging from grey-green to striking black and yellow, is well represented in a variety of Victorian habitats. Some, like the White-eared Honeyeater (*Meliphaga leucotis*) (100) and the White-plumed (*M. penicillata*) (102), are catholic in habitat taste; others are more selective. Typical but not exhaustive examples are :—

**FOREST AND WOODLAND** : The White-naped and Brown-headed (*Melithreptus lunatus* (111) and *M. brevirostris*) are widely spread, often forming flocks. Other species are the Yellow-faced (*Meliphaga chrysops*) (104), more common in the south; the rather plain Fuscous Honeyeater (*M. fusca*) (103); the showy yellow and black Regent Honeyeater (*Zanthoniza phrygia*) (105) seen in Spring and Summer; the raucous Red Wattle-bird (*Anthochaera carunculata*) (107); the striking Painted Honeyeater (*Grantiella picta*) of dry forest chiefly in the north; the localized and colony forming Bell-Miner (*Manorina melanophrys*) (113) of the south and south-east; the Helmeted Honeyeater (*Meliphaga cassidix*) which is the only bird confined to Victoria, being found in the Woori Yallock and Cardenia Creeks areas; the rather similar but more widely spread Yellow-tufted Honeyeater (*M. melanops*) (101); and, finally, the sombre-coloured Lewin Honeyeater (*M. lewinii*) (98) of Wet Sclerophyll and Rain Forest in the south-east. The Black Honeyeater (*Myzomela nigra*) of varied habitat is seen chiefly in the north and north-west.

**TREE SAVANNAH** : Here the Noisy Miner (*Myzantha melanocephala*) (112) is widely spread but localized and the Striped Honeyeater (*Plectorhyncha lanceolata*) occurs in the north-west.

**SWAMP WOODLAND** : In this habitat the handsome Blue-faced Honeyeater (*Entomyzon cyanotis*) is known both north and south of the Divide while the two Friar-birds, the Noisy (*Philemon corniculatus*) (109) and the Little (*P. citreogularis*) are found in the north-west, north, and north-east.

**MALLEE** : Chiefly in the north-west, the Yellow-plumed Honeyeater (*Meliphaga ornata*) and the Spiny-cheeked (*Acanthagenys rufogularis*) (106) are typical of the habitat; the Yellow-fronted (*Meliphaga*

*plumula*) occurs rarely ; the White-rumped Miner (*Myzantha flavigula*) is common ; and the Dusky Miner (*M. obscura*) isolated. The Singing Honeyeater (*Meliphaga virescens*) (99) and the White-fronted (*Gliciphila albifrons*) are characteristically inland species.

**HEATHLAND :** Especially where coastal, this region is typically selected by the attractive Tawny-crowned Honeyeater (*Gliciphila melanops*) and Eastern Spinebill (*Acanthorhynchus tenuirostris*) (110), the showy Yellow-winged (*Meliornis novae-hollandiae*) (96) and Crescent Honeyeaters (*Phylidonyris pyrrhoptera*) (97), and the noisy Little Wattle-bird (*Anthochaera chrysoptera*) (108) all of the southern regions. Finally, a summer visitor to the south-eastern region is the Scarlet Honeyeater (*Myzomela sanguinolenta*).

**Fringillidae :** Finches and Buntings. Victorian representatives of this family are the introduced European finches ; the Goldfinch (*Carduelis carduelis*) widely spread and successful in Grassland, Savannah, and Orchard Woodland, and the less common Greenfinch (*Carduelis chloris*) which is more common in the south of the State than the north.

**Estrildidae :** Grassfinches. An Old World Tropics and Australian Region group, this family is represented by the Beautiful Firetail (*Zonaeginthus bellus*) of the south-west and south ; the Diamond Firetail (*Zonaeginthus guttatus*) (87) found both north and south of the Divide ; (*Poephila (Taeniopygia) guttata*) the Zebra Finch found chiefly in northern regions ; and (*Ægitha temporalis*) (86) the Red-browed Finch of southern Scrub and Shrub Woodland ; *Donacola castaneothorax*, the Chestnut-breasted Finch, may be present in the south as an aviary escapee.

**Ploceidae :** Weaver-Finches. Two introduced European species occur : the House Sparrow (*Passer domesticus*) throughout the State and the less common, more local, chestnut-crowned, Tree Sparrow (*P. montanus*).

**Sturnidae :** Starlings. The aggressively successful and widespread Starling (*Sturnus vulgaris*) is a European introduction ; the Common Myna (*Acridotheres tristis*), an introduction from the Indian Region, is more confined to southern areas and human habitation.

**Oriolidae :** Orioles and Figbirds. The Victorian representative of this tropical and sub-tropical family is the Olive-backed Oriole (*Oriolus sagittatus*) (91), a greenish backed thrush-sized bird of Forest and Woodland, more common in Spring and Summer. For the southern Figbird (*Sphecotheres vieillotii*), a Queensland species, Victorian sight records have been claimed more than once.

**Dicruridae :** Drongos. This family of generally dark metallic plumaged, fork-tailed birds of tropical forests (chiefly in Africa, India, and Malaya) is represented in northern Australia by the Spangled Drongo (*Chibia bracteata*) which has occasionally reached east Victoria.

**Grallinidae :** Mud-nest Builders. Three exclusively Australian species whose relationships are controversial and problematical are included here. The Magpie-lark (*Grallina cyanoleuca*) (48) is one of Victoria's most widely spread and well-known species ; the grey



Apostle-bird (a name also given to Babblers) (*Struthidea cinerea*) occurs occasionally in the north-west and north-east; and the White-winged Chough (*Corcorax melanorhamphus*) (92), a black species with white wing patches occurring in flocks in Woodland where it utters a mournful whistle, is found in all regions. All build mud nests.

*Artamidae* : Woodswallows. Confined to the Indian and Australian Regions, Woodswallows exhibit the peculiarities of possessing powder down, being capable of prolonged soaring, and of clustering together at times to roost. Their relationships are unknown. Four species regularly occur in Victoria, the White-breasted (*Artamus leucorhynchus*), the Masked (*A. personatus*) (39), the White-browed (*A. superciliosus*) (40), and the Dusky (*A. cyanopterus*) (38). Sight records for a fifth, the Black-faced (*A. cinereus*) are claimed for the north.

*Cracticidae* : Australian Magpies and allies. Three characteristically Australian genera are included here. Of *Strepera*, the Currawongs, large grey/black and white birds of "floppy" flight and with melancholy calls, *S. graculina* (44 ? *fuliginosa* in error ?) the Pied, and *S. versicolor* (45) the Grey occur in open country more commonly in Winter. The Black-winged (*S. melanoptera*) occurs in the north-west.

In *Cracticus* the Butcher-birds, well known for their song, *C. torquatus* (47), the Grey Butcher-bird, is common and widespread and *C. nigrogularis*, the Pied, is found mainly in the north-west.

Australian Magpies are unrelated to the Palearctic Magpie. The White-backed (*Gymnorhina hypoleuca*) (46) is found chiefly south of the Divide, the Black-backed (*G. tibicen*) mainly north of it.

*Ptilonorhynchidae* : Bowerbirds. Two species of this remarkable and exclusively Australian Region family are found in Victoria. The Satin Bowerbird (*Ptilonorhynchus violaceus*) (90) occurs in Wet Sclerophyll Forest and Woodland in the south-east and south, and the Spotted Bowerbird (*Chlamydera maculata*) is confined to the north-west, where it is extremely rare. The bowers built by the birds are associated with display and are distinct from their nests.

*Corvidae* : Crows and Raven. The widespread and commonly seen "Crow" in Victoria is the Australian Raven (*Corvus coronoides*) (93). The Australian Crow (*Corvus cecillae*) is rare; it occurs in the north-west and possibly other regions, and is distinguished in part by the white rather than dusky down at the bases of the neck feathers. The Little Crow (*Corvus bennetti*), differing in habits, is confined to the north-west. Much is to be learned of calls and general habits of the species. The Ceylon Crow (*Corvus splendens*) has occurred in the State accidentally.

### Study of Birds

To the aborigines the significance of birds was partly culinary (e.g., waterfowl, bustard, brolga) and partly mythological (emu, wedge-tailed eagle, and others).

The earliest known recorded observations of birds in Victoria by Europeans were those of George Bass in 1797-8, when he brought a whaleboat south from Sydney and in January, 1798, noted swans and ducks at Westernport. Later in 1798, both Bass and Flinders observed mutton birds in Bass Strait. In 1801, Grant and Barrallier, with George Caley as naturalist, recorded at Westernport further species, including the Bell-Miner, and collected the first specimen of the Gang Gang on the Bass River. In 1802, Robert Brown, naturalist, with Flinders, noted and collected birds as well as plants on the shores of Port Phillip and, in later years, overland explorers made casual reference to bird species.

Following settlement in Victoria, one of the earliest recorded local bird lists was made by John Cotton for the Upper Goulburn comprising 140 species and dated March, 1848. In the 1850's, H. W. Wheelwright and C. J. Stafford shot birds for sport and for the Melbourne market. Wheelwright published "Bush Wanderings of a Naturalist", containing local bird notes, in 1861, and Stafford later supplied specimens from Gippsland to the National Museum.

Other collectors during the 1860's and 1870's were Batchelor, Broadbent, and Hennelle. The collections of the National Museum began in 1854, and the first collecting expedition was made in that year by Blandowski in the Mount Macedon and Goulburn River areas, and later in the same year to the River Murray and beyond.

Interest in natural history grew rapidly and in 1880 the "Field Naturalists' Club of Victoria" was formed and its journal, "The Victorian Naturalist", remained the main avenue for published bird notes for about twenty years. Victoria has had no ornithologist comparable with Baron von Mueller in botany; John Gould and his collectors worked on an Australian front. The energy and enthusiasm shown by early Victorian workers of the period (e.g., A. J. Campbell, R. Hall, and G. A. Keartland), however, are evident from perusal of the early volumes of "The Victorian Naturalist".

In 1901 the Royal Australasian Ornithologists' Union (R.A.O.U.), the senior Australian scientific society devoted to ornithology, was formed with its headquarters in Melbourne and "The Emu" as its official journal. Later, several naturalist-writers including Donald Macdonald and Charles Barrett did much to inculcate interest in birds among their youthful readers. Since the 1930's, field work has steadily increased to embrace, more recently, group projects (e.g., Altona Gull Survey by the Bird Observers' Club, Bird Field Census by the Victorian Ornithological Research Group), and the new field techniques of population counts and bird banding. Group activity is increasing, but the individual remains important.

In Victoria, as elsewhere, academic ornithology has kept in touch with both field ornithology as a serious hobby, and bird watching as a social event; scientific achievement being not always divorced from aesthetic reward. The amateur naturalist here, as in other fields, has been the tireless gatherer of indispensable data while following his chosen pursuit in his own right.

Traditional museum research in taxonomy and osteology is done on the large collections of the National Museum by staff and other workers. Field studies, collecting, and a diversity of activities (from those concerning the bird hazard on airfields to bird postage stamp design) also involve museum ornithology.

Extensive work has been done by the Fisheries and Wildlife Department for bird conservation and upon waterfowl distribution and ecology. University research in ornithology has virtually had its inception at Monash University where a varied research programme as well as the training of ornithologically minded zoologists is being undertaken.

In matters of conservation ornithologists have always been aware of the need for species protection and the preservation of habitat. Habitat destruction has been a major detriment to the native bird population and such destruction without attempted appraisal of all factors involved has occurred too often. The economic relationship between birds and man remains virtually unstudied, though ultimate compatibility between the aims of different people is well illustrated by current work undertaken to conserve ducks and quail for game. This in fact will ensure conservation of these and many additional bird species quite as effectively as could be achieved by protectionists. Birds are a significant element in such contrasting problems as, for example, the demand for National Parks and the demand for insecticides, and their study can assist the formation of a deeper and broader understanding of environment as a whole.

Ornithology in Victoria offers wide opportunity for discovery but at present there are few professional ornithologists. It is a broad field, touching on botany and entomology, involved in economics, the other humanities and ethnology, but owing allegiance throughout to its parent discipline, zoology.

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- (Note: This useful paper, broadly relating to an area bounded by Werribee, Melton, Donnybrook, The Dandenongs, and Carrum, comments on 186 species of which all but four (Keartland's Nos. 149, 154, 155 and 172) are included in the present account. The numbers herein bracketed against the species scientific name (usually), or the common name (where unavoidable), are the relevant species numbers used by Keartland and thus provide for the student both a species reference to Keartland's list and a revision of his early, and now generally disused, nomenclature. In three genera (*Tyto* (19), *Strepera* (44) and *Neophema* (132)), Keartland appears to have used incorrect, as distinct from outdated, species names, and these are noted. In one or two cases two of Keartland's species are now regarded as one and his numbers are linked thus: 184 & 185. Perusal of Keartland's notes on "Melbourne" species provides much of interest in terms of species population and distributional changes during the subsequent years.)
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## GLOSSARY\*

- Air Sacs*.—Thin-walled chambers, usually nine, in body cavity, containing air and connected to the air passages. Some extend into the hollow bones.
- Basipterygoid Process*.—In the present usage, an articular facet on each side of rostrum on under side of skull.
- Bassian*.—Sir Baldwin Spencer's name for the coastal region of south-east Australia (east and south of the Divide) as a region of characteristic fauna. 1896.
- Carpometacarpus*.—Partly equivalent to the "hand" formed by fusion of carpal and metacarpal bones.
- Cere*.—The fleshy covering across upper base of bill when it is soft as in parrots, hawks, and others.
- Clavicle*.—The two clavicles are the two halves of the furcula.
- Coracoid*.—Bone forming part of pectoral girdle articulating with the sternum below and with the scapula and clavicle above. (Cf. *furcula*.)
- Eyrean*.—Sir Baldwin Spencer's name for the drier interior of Australia (north and west of the Divide) as a region of characteristic fauna. 1896.
- Femur*.—Thigh or upper leg bone.
- Fibula*.—Small bone on side of upper portion of tibia.
- Frontal*.—Bone roofing the brain cavity and orbital socket.
- Furcula (Furculum)*.—The "wishbone" formed by fusion of the two clavicle bones.
- Gular Pouch*.—Distensible skin of throat beneath bill in some birds.
- Hallux*.—Hind toe. Toes are numbered as in illustration.
- Humerus*.—Upper "arm" (wing) bone.
- Lobed Toes*.—Toes with lobes or flaps of skin on each side of them.
- Mandible*.—Lower jaw (lower half of bill) comprising several fused bones. Upper mandible—upper half when speaking of feathered bird, but not in a skeleton. (Cf. *maxilla*.)
- Maxilla (Maxillary)*.—Together with premaxillary and nasal bones this bone forms the upper part of bill in a skeleton. (Cf. *mandible*.)
- Metabolic Rate*.—The rate of chemical change occurring in a living organism.

\* See also Figures 1 and 2.

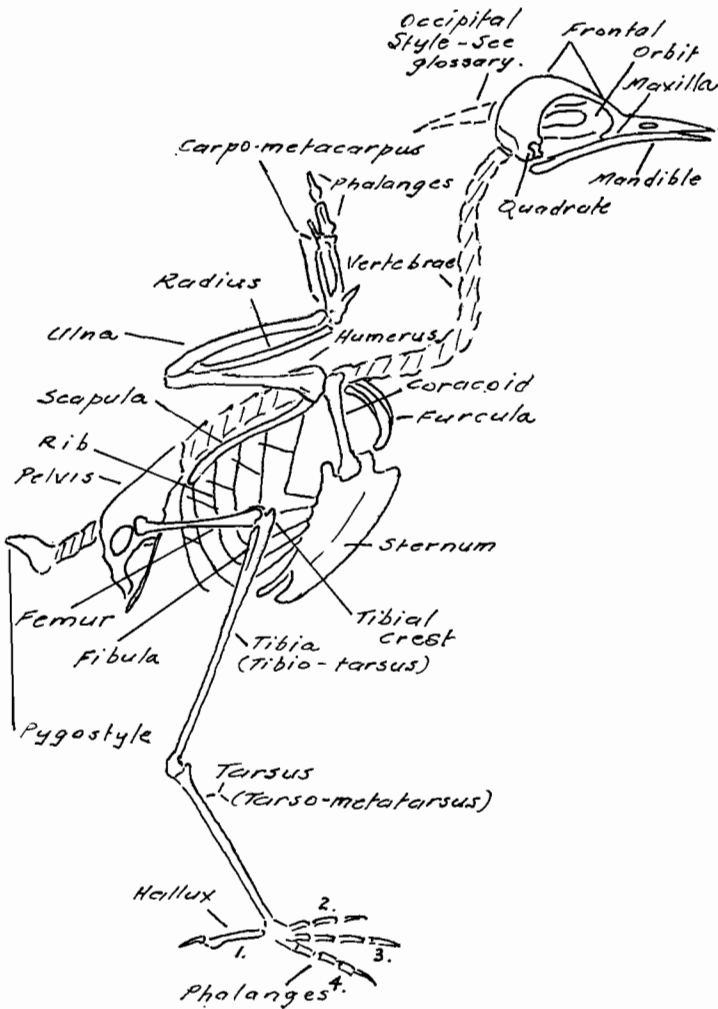


FIGURE 1.—Diagram of Bird Skeleton

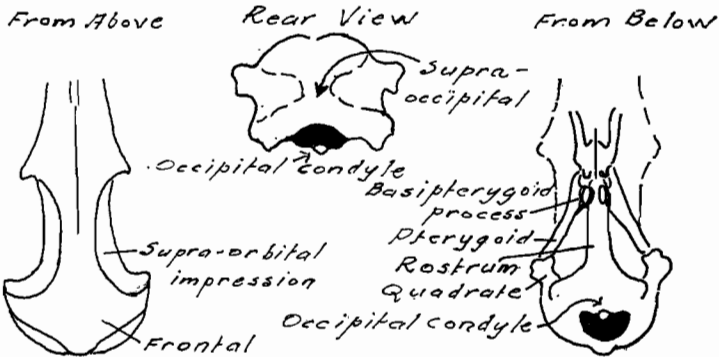


FIGURE 2.—Diagrams of Bird Skull

*Occipital Condyle*.—Small rounded process at base of skull by means of which skull articulates with backbone (vertebrae). Mammals have two.

*Occipital Style*.—A small bone protruding from region of supra-occipital in cormorants. See illustration for relative position where applicable.

*Orbit*.—Socket or cavity of skull housing eyeball.

*Oviparous*.—Egg-laying.

*Pelagic*.—Frequenting the (surface of) open sea or ocean.

*Pelvis*.—Consists of fused bones and supports the lower limbs.

*Phalanges*.—The separate bones of the digits, i.e., of the "fingers" and/or toes.

*Powder Down*.—The powder produced by feathers of a particular type which continually disintegrate at the tips. (Cf. *Ardeidae*—Hérons; *Artamidae*—Woodswallows.)

*Pterygoid(s)*.—Slender bones forming connexion between the quadrates and the palate in mid-line of skull.

*Pygostyle*.—The end bone of the tail consisting of fused vertebrae and supporting the tail feathers.

*Quadrate*.—A bone low on each side of the skull which articulates with the cranium, pterygoid and mandible, rocks in conjunction with the opening of the bill and in most birds is the sole suspensory support for the mandible. It does not exist as such in mammals.

*Radius*.—The more slender of the two forearm (wing) bones.

*Rib*.—Ribs form the sides of the thorax; some are joined to both the backbone and the sternum.

*Rostrum*.—Central axis of base of skull.

*Scapula*.—Shoulder blade.

*Scapulars*.—Feathers on each side of back in region of scapula bones.

*Sclerophyll*.—"Hard leaf", in the present case a term applied chiefly to Eucalypts.

*Speculum*.—Metallic or brightly coloured area of the wing as found in ducks.

*Sternum*.—Breastbone.

*Supraoccipital*.—A bone in back of skull above the foramen or opening.

*Supraorbital Impressions*.—Grooves on frontal rims of the orbits found in many water-birds and housing the supraorbital or nasal glands.

*Syrinx*.—"Voice box" situated at lower end of trachea.

*Tarsus*.—Properly the tarso-metatarsus; the lower leg bone.

*Tibia*.—Upper leg bone; properly tibio-tarsus.

*Tibial Crest*.—Crest or prominent ridge on front of upper end of tibia.

*Ulna*.—The stouter of the two forearm (wing) bones. Shows papillae where secondary feathers were attached.

*Vertebrae*.—The separate bones of the vertebral column or backbone.

*Wishbone*.—See furcula.

*Zygodactylous*.—Having two toes forward and two backward.

\* See also Figures 1 and 2.

## *Geographical Features*

### **Introduction**

Australia is situated in middle and lower-middle latitudes, with about two-fifths of its area lying between the Tropic of Capricorn and the Equator. It is, therefore, one of the warm continents and, since most of its area lies within the zone of the dry, sub-tropical anti-cyclones ("the horse latitudes"), it is for the most part a dry continent. Much of the continent has only small variation in temperature from season to season and receives low rainfall with marked concentration into either summer (in the north) or winter (in the south).

Victoria is, in these respects, not typically Australian. It has a cool to cold winter, and although there are hot periods in each summer, they are interspersed with pleasantly warm or even cool periods. Rainfall is rather low in the northern parts of the State, and particularly in the north-west, but the greater part is well watered with no marked seasonal concentration. Most of Australia is plateau or plain country with little relief; Victoria has a larger proportion of high country in its total area than any other State except Tasmania and its highest mountains reach over 6,000 feet above sea level. Not surprisingly, it could be called the "most English" part of the mainland, although a closer climatic and agricultural analogy is probably south-western and south-central France. Victoria is in fact transitional between the sub-tropical situation of New South Wales and the temperate situation of Tasmania, between the high rainfall character of the south-eastern Australian coastlands and the arid interior. One finds, then, year-round, open-air dairying and livestock-and-grass farming in Gippsland and the Western District, and dry-farming of grains and irrigated horticulture of citrus fruits and vineyards in the north. Its climatic conditions made no difficulties for the establishment of secondary industry and, once its power resource problem had been solved, Victoria reaped the advantages in interstate trade offered by its central position on coastal shipping routes.

Victoria has 2.96 per cent. of the area of Australia (mainland Australia and Tasmania, but not including external territories) and had 28.12 per cent. of the Australian population at 30th June, 1964. In relating population to area, Victoria is the most densely populated of the States with an average density at 30th June, 1964, of 35.63 persons per square mile and is exceeded only by the Australian Capital Territory (85.64 per square mile).

The Victorian population is growing rapidly; comparing the enumerated population of the Census of 30th June, 1961, with the estimate of 30th June, 1964, the population of Victoria increased by 6.85 per cent., being exceeded by Western Australia (7.23 per cent.), the Australian Capital Territory (36.69 per cent.), and the Northern Territory (19.27 per cent.).

The distribution of population over the State, however, is very uneven. At 30th June, 1964, it is estimated that 65.84 per cent. of the total population of the State was living in the Melbourne Metropolitan Area, a larger concentration of population in the metropolis than was to

be found in any other State of the Commonwealth. On the other hand, there are considerable areas of Victoria which are uninhabited or have only a very sparse and seasonal population ; these areas are mainly in the Eastern Highlands and in the western and north-western parts of the State along the South Australian border, as in the Mallee, where sandy soils and low, unreliable rainfalls inhibit agriculture. The non-metropolitan population is fairly evenly divided between the rural population (15 per cent. of the State's total in 1961) and the urban centres other than Melbourne (20 per cent. of the total in 1961). Both percentages refer to the Census of 1961.

In the rural areas, population is densest in the irrigation areas, in the dairying areas of Gippsland and the Western District, and in the livestock-and-crop farming areas between Ballarat and Bendigo. Lower densities are found in the wheat farming areas of the Wimmera, and still lower densities in the wheat areas of the Mallee and in the stock-raising areas generally.

Among the non-metropolitan cities four large centres stand out : these are Geelong (estimated population at 30th June, 1964, 98,920), Ballarat (57,290), and Bendigo (42,110), each of which has a variety of manufacturing industries as well as being marketing and transport centres, and the Latrobe Valley group of towns which together contain about 54,000 people and are mainly concerned with power generation and distribution. The next group, in order of population size, has between 12,000 and 17,000 people each and contains, in addition to the normal urban retail and service functions, fairly large-scale industries processing local products: Warrnambool (dairy products, textiles and clothing), Shepparton (fruit canneries), Wangaratta (a rather special case of decentralized industries), and Mildura (fruit and vegetable packing). Next there are a number of regional urban centres of between 7,000 and 10,000 people in which retail and service functions predominate; for instance, Hamilton, Colac, Horsham, Benalla, Ararat, Sale, Wodonga, Bairnsdale, Maryborough, and Castlemaine. Smaller towns serve more restricted areas and more local requirements.

Although European settlement in Victoria is little over one and a quarter centuries old, there have already developed distinctive regional characteristics in the various parts of the State, and most of these are recognized in popular speech by regional names. The Mallee is the north-western plain of ancient sand ridges, once waterless and covered with the distinctive dwarf eucalypt from which the name is derived, but now with extensive wheat fields and sheep paddocks and with water for stock and domestic purposes supplied through winding channels from storages outside the region. The Wimmera, with red-brown soils and tall eucalypts, with a denser pattern of farms and market towns, has the highest yielding wheat fields in Australia and a considerable sheep and cattle population as well. The Western District, with lush pastures on its well-watered volcanic plains, has both a long tradition of the growing of fine wools on sheep stations dating back to the early days of the pastoral expansion and a much more recent development of intensive dairying. The north-east has irrigated citrus and stonefruit orchards, market gardens, and pastures on the plains of the middle Murray and



its tributaries, which give way to cattle stations upstream where the valleys run back into the rugged slopes of the Australian Alps. Gippsland spells dairying and fodder-crop growing, timber extraction in the tall forests of the hills, off-shore and coastal fishing, and the industrial enterprises based on the power derived from the Morwell-Yallourn brown coal deposits in the Latrobe Valley. The Port Phillip Bay region holds Melbourne, the financial and administrative hub of the State and a fast growing port, metropolitan market, and industrial centre, while on the eastern shore commuters' and holiday homes stretch through the Mornington Peninsula to the ocean shores. On the west, secondary industry is extending through Williamstown and Altona to Geelong.

### **Area and Boundaries**

Victoria is situated at the south-eastern extremity of the Australian continent, of which it occupies about a thirty-fourth part, and contains about 87,884 square miles, or 56,245,760 acres.

Victoria is bounded on the north and north-east by New South Wales, from which it is separated by the River Murray, and by a straight line running in a south-easterly direction from a place near the head-waters of that stream, called The Springs, on Forest Hill, to Cape Howe. The total length of this boundary following the windings of the River Murray from the South Australian border along the Victorian bank to the Indi River, thence by the Indi or River Murray to Forest Hill and thence by the straight line from Forest Hill to Cape Howe, is 1,175 miles. The length of the River Murray forming part of the boundary is approximately 1,200 miles, and of the straight line from Forest Hill to Cape Howe, 110 miles. On the west it is bounded by South Australia, on the south and south-east its shores are washed by the Southern Ocean, Bass Strait, and the Pacific Ocean. It lies approximately between the 34th and 39th parallels of south latitude and the 141st and 150th meridians of east longitude. Its greatest length from east to west is about 493 miles, its greatest breadth about 290 miles, and its extent of coastline 980 miles, including the length around Port Phillip Bay 164 miles, Westernport 90 miles, and Corner Inlet 50 miles. Great Britain, inclusive of the Isle of Man and the Channel Islands, contains 88,119 square miles, and is therefore slightly larger than Victoria.

The most southerly point of Wilson's Promontory, in latitude 39 deg. 8 min. S., longitude 146 deg. 22½ min. E., is the southernmost point of Victoria and likewise of the Australian continent; the northernmost point is where the western boundary of the State meets the Murray, latitude 34 deg. 2 min. S., longitude 140 deg. 58 min. E.; the point furthest east is Cape Howe, situated in latitude 37 deg. 31 min. S., longitude 149 deg. 59 min. E. The westerly boundary lies upon the meridian 140 deg. 58 min. E., and extends from latitude 34 deg. 2 min. S. to latitude 38 deg. 4 min. S.—a distance of 280 miles.

The following table shows the area of Victoria in relation to that of Australia :—

**AREA OF AUSTRALIAN STATES**

State or Territory	Area	Per Cent. of Total Area
	sq. miles	
Western Australia .. .. .	975,920	32·88
Queensland .. .. .	667,000	22·47
Northern Territory .. .. .	520,280	17·53
South Australia .. .. .	380,070	12·81
New South Wales .. .. .	309,433	10·43
<b>Victoria .. .. .</b>	<b>87,884</b>	<b>2·96</b>
Tasmania .. .. .	26,383	0·89
Australian Capital Territory .. .. .	939	0·03
Total Australia .. .. .	2,967,909	100·00

**Mountain Regions**

The mountainous regions of Victoria comprise the Central Highlands and a belt known as the Southern Uplands lying to the south and separated from the Central Highlands by plains.

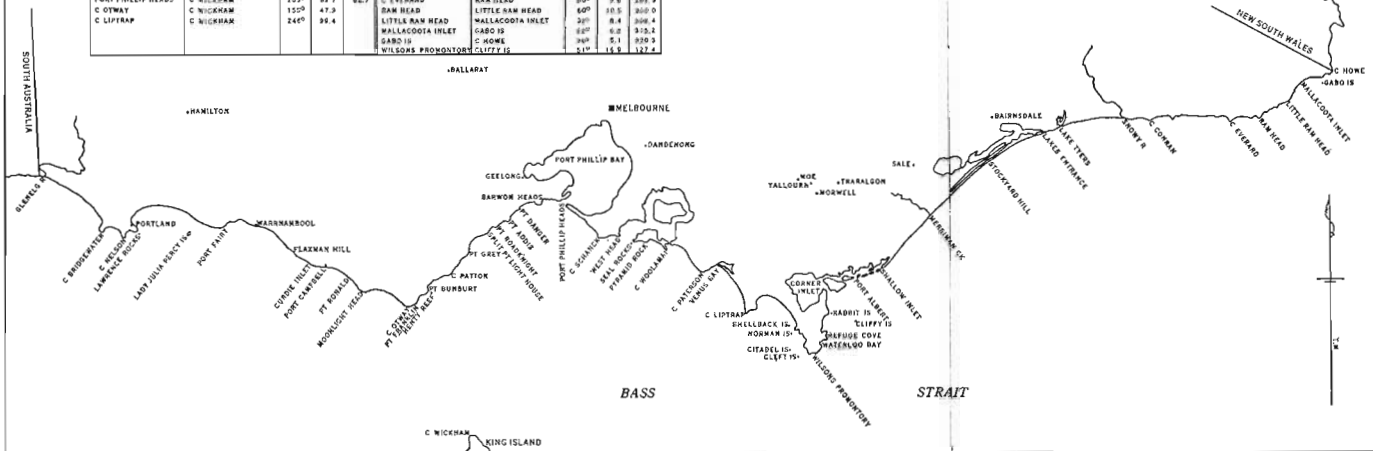
The Central Highlands form the backbone of Victoria, tapering from a broad and high mountainous belt in the east until they disappear near the South Australian border. In the eastern sector patches of Older Volcanic rocks occur and peaks rise more than 6,000 feet, while in the western sector the volcanic rocks belong mainly to the Newer Volcanic Series and the peaks reach 3,000 feet.

The Highlands descend to plains on their southern and northern flanks. On the south are the Western District Plains and the Gippsland Plains, and beyond these again rises a group of uplifted blocks constituting the Southern Uplands. The Otway Ranges and the hills of South Gippsland are composed of fresh-water Mesozoic sediments and Tertiary sands and clays with Older Volcanic rocks in South Gippsland, and the Mornington Peninsula is an upraised fault block of complex geology, including granites.

By 1875 the mountainous areas of the State were embraced by a geodetic survey which had been started in 1856. This was the first major survey, although isolated surveys had been carried out as early as 1844. Further surveys were carried out by the Australian Survey Corps during the Second World War, and by the Department of Lands and Survey, in the post-war years. Most recent values for some of the highest mountains in Victoria are Mount Bogong, 6,516 feet ;

FROM	TO	TIME MEASUREMENT	NAUTICAL MILES	FROM P.P. MEAS.	FROM	TO	TIME MEASUREMENT	NAUTICAL MILES	FROM P.P. MEAS.
PORT PHILLIP HEADS	BARWON HEADS	27 <sup>30</sup>	4.2	4.2	PORT PHILLIP HEADS	C SCHANCK	135 <sup>00</sup>	17.0	17.0
BARWON HEADS	PT DANGER	248 <sup>0</sup>	8.5	14.7	WEST HEAD	SEAL ROCKS	84 <sup>00</sup>	5.9	23.9
PT DANGER	PT ADDIS	227 <sup>0</sup>	4.7	19.4	WEST HEAD	SEAL ROCKS	129 <sup>00</sup>	4.0	27.9
PT ADDIS	PT ROADRIGHT	240 <sup>0</sup>	3.9	23.2	SEAL ROCKS	PYRAMID ROCK	302 <sup>00</sup>	8.8	33.7
PT ROADRIGHT	SPLIT PT LIGHT HOUSE	231 <sup>0</sup>	4.3	27.5	PYRAMID ROCK	C WOOLLAHAI	110 <sup>00</sup>	8.8	40.5
SPLIT PT LIGHT HOUSE	PT GREY	229 <sup>0</sup>	7.4	34.9	C WOOLLAHAI	C PATTERSON	120 <sup>00</sup>	13.8	54.3
PT GREY	C PATTON	219 <sup>0</sup>	10.9	45.7	C PATTERSON	VENUS BAY	50 <sup>00</sup>	9.3	59.6
C PATTON	PT BURBURY	241 <sup>0</sup>	8.6	54.3	C VENUS BAY	C LIPTRAP	340 <sup>00</sup>	17.8	77.4
PT BURBURY	HENRY REEF	152 <sup>0</sup>	1.9	56.1	C LIPTRAP	SHELLBACK IS	160 <sup>00</sup>	14.8	91.9
HENRY REEF	PT FRANKLIN	238 <sup>0</sup>	7.7	63.8	SHELLBACK IS	NORMAN IS	149 <sup>00</sup>	3.0	94.3
PT FRANKLIN	C OTWAY	264 <sup>0</sup>	2.1	65.9	NORMAN IS	CITADEL IS	130 <sup>00</sup>	5.5	100.4
C OTWAY	MOONLIGHT HEAD	294 <sup>0</sup>	12.1	73.0	CITADEL IS	CLEFT IS	119 <sup>00</sup>	3.6	104.0
MOONLIGHT HEAD	PT RONALD	302 <sup>0</sup>	8.2	81.2	C CLEFT IS	WILSONS PROMONTORY	79 <sup>00</sup>	6.8	110.8
PT RONALD	PORT CAMPBELL	302 <sup>0</sup>	9.3	14.5	WILSONS PROMONTORY	WATERLOO BAY	180 <sup>00</sup>	3.7	114.2
PORT CAMPBELL	CURDIE INLET	270 <sup>0</sup>	5.2	19.7	WATERLOO BAY	REFUGE COVE	32 <sup>00</sup>	2.8	117.7
CURDIE INLET	FLAXMAN HILL	306 <sup>0</sup>	7.8	107.2	REFUGE COVE	RABBIT IS	180 <sup>00</sup>	7.5	124.7
FLAXMAN HILL	WARRNAMBOOL	302 <sup>0</sup>	15.2	122.6	RABBIT IS	CORNER INLET ENT	59 <sup>00</sup>	5.5	129.7
WARRNAMBOOL	PORT FAIRY	214 <sup>0</sup>	10.4	132.0	CORNER INLET ENT	PORT ALBERT ENT	44 <sup>00</sup>	6.5	136.2
PORT FAIRY	LADY JULIA PERCY IS	263 <sup>0</sup>	12.2	148.2	PORT ALBERT ENT	SMALLON INLET	53 <sup>00</sup>	8.5	148.7
LADY JULIA PERCY IS	PORTLAND	284 <sup>0</sup>	18.8	164.0	SMALLON INLET	MERRIMAN CK	43 <sup>00</sup>	15.4	170.1
PORTLAND	LAWRENCE ROCKS	140 <sup>0</sup>	6.8	168.6	MERRIMAN CK	STOCKFORD HILL	40 <sup>00</sup>	27.1	197.2
LAWRENCE ROCKS	C WELSON	281 <sup>0</sup>	8.0	174.6	STOCKFORD HILL	LAKES ENTRANCE	60 <sup>00</sup>	20.3	217.9
C WELSON	C BRIDGEWATER	281 <sup>0</sup>	8.6	181.2	LAKES ENTRANCE	LAKE TYERS	73 <sup>00</sup>	6.0	223.5
C BRIDGEWATER	GLENELG R	310 <sup>0</sup>	28.1	209.3	LAKE TYERS	SNOWY R	83 <sup>00</sup>	21.4	244.9
KING ISLAND									
PORT PHILLIP HEADS	C WICKHAM	203 <sup>0</sup>	82.7	82.7	SNOWY R	C CORNHAM	24 <sup>00</sup>	9.0	253.5
C OTWAY	C WICKHAM	152 <sup>0</sup>	47.3		C CORNHAM	C EVERARD	91 <sup>00</sup>	28.0	279.9
C LIPTRAP	C WICKHAM	245 <sup>0</sup>	39.4		C EVERARD	BAR HEAD	60 <sup>00</sup>	10.5	300.0
					BAR HEAD	LITTLE BAR HEAD	20 <sup>00</sup>	8.4	306.4
					LITTLE BAR HEAD	MALLACOOTA INLET	82 <sup>00</sup>	6.2	312.4
					MALLACOOTA INLET	CORB IS	24 <sup>00</sup>	5.1	320.3
					CORB IS	C HOME	21 <sup>00</sup>	15.9	327.4
					WILSONS PROMONTORY	CLIFFY IS			

# COASTLINE OF VICTORIA



Mount Feathertop, 6,307 feet ; Mount Nelse, 6,181 feet ; Mount Fainter, 6,157 feet ; Mount Loch, 6,152 feet ; Mount Hotham, 6,101 feet ; Mount Niggerhead, 6,048 feet ; Mount McKay, 6,045 feet ; Mount Cobboras, 6,030 feet ; Mount Cope, 6,026 feet ; Mount Spion Kopje, 6,025 feet ; and Mount Buller, 5,919 feet.

#### **Further Reference, 1962**

### **Coastline**

#### *General*

The prominent features of the Victorian coastline are few. East of Mount Ruskin, on the South Australia-Victoria border, the first is that formed by Cape Bridgewater and Cape Nelson, with Danger Point and Lawrence Rocks jutting out to the east. Moonlight Head, over 500 feet high, and the bluff projection of Cape Otway constitute the second salient feature. One hundred and thirty-six miles east of Cape Otway lies the rugged and mountainous Wilson's Promontory, with its off-lying islands. The fourth and last salient feature of the Victorian coastline commences at Cape Everard and continues for 45 miles to the New South Wales boundary at Cape Howe with Ram Head\*, Sand Patch Point, Little Ram Head, and Gabo Island forming its most prominent features.

Generally, the coast from Cape Bridgewater, west of Portland, to Corner Inlet, Wilson's Promontory, consists of high land, and in many cases cliffs, whilst west of Cape Bridgewater and east of Corner Inlet, the coast is shelving, and sand dunes predominate. East of the Snowy River mouth, there are several more rugged headlands, formed as a result of exposure of granite masses, one of which has become detached from the mainland, to become Gabo Island. Because there is a slight downward movement of the coast east of the 144th meridian, the sea has encroached on the lower parts of stream valleys with the consequent formation of a number of indentations in the coastline, chief of which are Port Phillip, Westernport, Corner Inlet, the Gippsland Lakes system, and Mallacoota Inlet.

#### *Lighthouses*

Although there are nearly 300 lights in the State of Victoria, the majority of these consists of lights situated in harbours and sheltered waters; only 24 are seaward lights with powerful beams intended primarily for the guidance of ships passing along the coastwise tracks. Probably the first lighthouse to be established on the coast was on Shortland Bluff, Queenscliff. This consisted of a wooden tower erected in 1842 to guide ships through "the Rip".

Since the prominent features of the Victorian coastline are few, the basic lighthouse needs of coastal shipping off Victoria were met within twenty years of the establishment of the light at Queenscliff. However, much remained to be accomplished in defining the channels into and within Port Phillip, and the approaches and waters of the many

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\* Previously also known as Rame Head.

small ports along the coast which played such an important part in the transport of primary products during the nineteenth century. The establishment of lights on Cape Everard and on Split Point in 1890 and 1891 respectively practically completed the pattern of coastal navigational aids, although it was not until well into this century that the mariners' needs along the coast between Wilson's Promontory and Cape Schanck were adequately provided for by the establishment of several automatic lights.

#### *Mount Ruskin to Cape Otway*

Mount Ruskin, one and a half miles north-west from the mouth of the Glenelg River, is situated on Victoria's western boundary. From this point to Cape Howe (the border with New South Wales) the Victorian ocean coastline stretches some 682 miles. East of the Glenelg River the coast is marked by a succession of hummocks about 150 feet high. This part of the coast is generally avoided by small craft on account of the heavy swell that invariably rolls in. Discovery Bay, 38 miles long and eight miles deep, is situated between Cape Northumberland and the west side of Cape Bridgewater. The Bay is rendered hazardous by an onward setting tide and the break of a heavy swell that rolls in over the eastern half of the bay.

Towards the east along the coast, lie Cape Bridgewater and Cape Nelson. Both Capes are conspicuous in that they are composed of jagged limestone and basaltic cliffs. Together with Cape (Sir William) Grant, Danger Point and Lawrence Rocks, they form the first prominent feature of the Victorian coastline observed when sailing eastward. Beyond Danger Point, the coast, comprising beach dunes and low dune limestone cliffs, recedes to form Portland Bay with the town of Portland at its western end, and Lady Julia Percy Island, visible from passing ships, at its eastern end, Port Fairy and Armstrong Bays, and Lady Bay on which Warrnambool is situated.

South-eastward from Warrnambool, the coast is of a cliffy character and presents an almost unbroken appearance for 22 miles, thereafter becoming bold and studded with rock stacks, the land at the back gradually rising for sixteen miles to Moonlight Head. So named by Matthew Flinders, bold, rounded and densely timbered, and rising to a height of 546 feet, the Head, together with Cape Otway, 250 feet high, fourteen miles further to the south-east, forms the termination of the Otway Ranges and constitutes the second most prominent feature of the coast. Cape Otway marks the northern side of the western entrance to Bass Strait, separating Victoria and Tasmania.

#### *Cape Otway to Wilson's Promontory*

From Cape Otway the coast trends in a north-easterly direction to Barwon Head and thence runs eastward to the entrance to Port Phillip. From Franklin Point to Addis Point, the coast is characterized by high, dark coloured cliffs. The towns of Apollo Bay and Lorne can be seen from passing ships. Between Addis Point and Barwon Head lies the town of Torquay. Barwon Head is a saddle shaped scrubby hummock, 122 feet high. From Barwon Head to Point Lonsdale, the coast consists of sand dunes bound with wind shorn scrub at a general elevation of about 85 feet.

Port Phillip is an extensive bay with a tidal area of 725 square miles. The entrance to the Bay, with Point Lonsdale on its western side and Point Nepean on its eastern side, is almost 2 miles wide; however, the navigable channel is only about seven-tenths of a mile wide. From Point Nepean to Wilson's Promontory the coast tends in a south-easterly direction. Cape Schanck, which forms the southern extremity of the Mornington Peninsula between Port Phillip and Westernport, is a narrow cliffy headland, 278 feet high. The eastern and western entrances to Westernport are separated by Phillip Island, twelve miles long and four and three-quarter miles across. The most prominent feature of the coast in this region is Cape Woolami, the south-east extreme of Phillip Island. The Cape is a remarkable helmet-shaped red granite headland rising abruptly from the sea to a height of 358 feet. Inside the eastern entrance, the fishing port of San Remo is situated on the eastern shore.

From Phillip Island, the coast again runs south-eastward as a succession of sand dunes mostly covered with scrub for fourteen miles to Cape Patterson, low and ill-defined, and the least conspicuous point along this stretch of coast. Thence it recedes to form Venus Bay, on the eastern shore of which is Anderson Inlet, whence a range of sand hills, mostly bare, extends along the coast for eighteen miles south south-eastward to Cape Liptrap, 297 feet high and nearly vertical. Thence the coast curves round to the northward and then eastward to form Waratah Bay before resuming its south-easterly trend along the western side of Wilson's Promontory. With its off-lying islands, the Promontory forms the most prominent feature of the Victorian coastline.

#### *Wilson's Promontory to Cape Howe*

The east coast of Wilson's Promontory runs northward for 21 miles to Corner Inlet, the entrance to the fishing centres of Port Welshpool and Port Franklin, and to the broad but shallow expanse of Corner Basin. Latrobe Island forms the other shore of the entrance and extends eastward for seven miles to the main entrance to Port Albert, a harbour used by fishing boats. Eight miles further east-north-eastward, the low coastline is broken by Shallow Inlet, the eastern entrance to Port Albert, and the beginning of the Ninety Mile Beach, so named by Surgeon Bass in 1797. From Shallow Inlet, the coast, running north-eastward, is low and consists of monotonous sand hummocks which form the barrier between the sea and the extensive waterways of the Gippsland Lakes. Seventy-two miles from Shallow Inlet, access to the Lakes is gained through an artificial channel, beside which lies the fishing port of Lakes Entrance.

East of Lakes Entrance, the coast, similar in appearance though the sand hummocks are higher and for the most part backed by hills and dense forest, trends in an east by north curve for 28 miles to the Snowy River, the mouth of which is obstructed by a sand bar. From the Snowy River eastward to Cape Howe, there is no part of the coast that is not defined by some conspicuous mountain or hill. Cape Everard is easily recognized by Sandy Peak, which is over 500 feet high. The Cape, which projects nearly one and a half miles from the line of the coast, was the first sighting of the Australian Coast made by Captain Cook in H.M.S. *Endeavour* in 1770. Ram Head, which lies ten

miles from Cape Everard, is of granite, and rises to an elevation of 369 feet. Northward of this Head the land becomes lower, but again rises gradually to a range of 1,000 feet in height, the highest point of which is Genoa Peak, 1,607 feet high. Sand Patch Point about five and a half miles north-eastward of Ram Head is a very conspicuous large mass of drift sand. The point is about 270 feet high. From Sand Patch Point the coast veers northward to Little Ram Head, forming a rocky bight, with sandy beaches backed by country 300 feet high.

From Little Ram Head the coast continues in a northerly direction to Mallacoota Inlet, a lake consisting of two portions, called the Upper and Lower Lakes. Some six miles from the Inlet, Gabo Island is passed. The island, one and a half miles long and about half a mile wide, is composed of red granite and has little vegetation. From Telegraph Point, on the mainland abreast the north extreme of Gabo Island, the coast is comprised of sand-hillocks, bare and white. Cape Howe, Victoria's boundary with New South Wales lies about four and a half miles from Telegraph Point. Cape Howe is a low point composed of stones and sand, covered with ti-tree. The land behind the Cape is timbered, and a deep cutting in the trees visible from seaward is the State boundary line.

### **Hydrography in Victoria**

#### *Historical Development*

Much of Victoria's coastline is forbidding and all of it stormy. Port Phillip lies almost in the middle and contains the two major ports towards which lead some of the busiest shipping routes in Australia. Outside Port Phillip the only commercially large port is the artificial one of Portland.

The Victorian coastline westward of Port Phillip is relatively free of off-shore dangers; but it is, nevertheless, a dangerous iron-bound coast, the location of many disastrous shipwrecks, especially in the days of sail. To the eastward of Port Phillip, there exists a number of off-lying dangers, principally between Wilson's Promontory and the Furneaux Group. However, the shipping route between Port Phillip and Cape Howe is now a safe, well surveyed route, free of complicated navigation.

During the nineteenth century, Victorian waters received considerable hydrographic attention. In 1801-2, surveying began in Bass Strait with surveys by H.M. Brig *Lady Nelson* and Port Phillip followed in 1803-4 when Captain Woodriff in H.M.S. *Calcutta* carried out surveys. This work continued during the ensuing 60 years and was terminated in 1878, when the coast of Victoria was probably better surveyed than any other part of Australia. After this, apart from surveys by port authorities and the Public Works Department, no further hydrographic surveys were carried out in Victoria until 1931, when a boat party re-surveyed Port Melbourne, Hobson's Bay, and the Yarra River—the first Australian hydrographic survey in Victoria.

This, then, was the situation when the Second World War broke out. Admiralty charts of 1938 show the waters out to about 10 miles off-shore well sprinkled with soundings, all of which had been obtained with the hand lead. This meant that no continuous profile had been obtained, as is possible with the modern echo sounder, leaving the possibility of dangers lurking between casts. Outside 10 miles, where accurate fixing was almost impossible, only scattered and haphazard soundings were charted with large areas of "white paper". This was a totally unacceptable situation in waters frequented by deep draft ships.

In 1948, H.M.A.S. *Warrego* carried out a modern survey of Westernport and its approaches and this was followed in 1949 to 1951 by surveys of Hobson's Bay and Geelong by H.M.A.S. *Tallarook*.

*Warrego* began off-shore sounding in 1952 and in 1953 H.M.A.S. *Barcoo* joined in the work surveying first from Cape Everard to Cape Howe then Port Phillip to Wilson's Promontory. This latter work was completed in 1954 whilst *Warrego* surveyed from Port Phillip to Cape Otway. This survey was extended west to Moonlight Head in 1955. In 1961 H.M.A.S. *Bass* surveyed Portland Harbor and *Barcoo* sounded the approaches to the port.

Thus the survey of Victorian waters was brought up to date this time beyond the 10 miles ; in fact, right across Bass Strait to Tasmania. The coast from Moonlight Head to Portland and west to South Australia remains to be surveyed.

Unfortunately the survey of Bass Strait had to come just before the advent of modern electronic position finding equipment now in use in the R.A.N. Surveying Service, known as "Lambda". Because of this, these off-shore surveys had to be controlled by endless lines of moored floating beacons. The surveys showed Bass Strait to have a sea bed as flat as a billiard table but holding its surprises such as Warrego Rock, which rises sheer from 25 fathoms to lurk only 7 feet below the surface.

Whilst these surveys were being undertaken, the land control was advanced by the Division of National Mapping and carried across Bass Strait to Tasmania via Wilson's Promontory, Deal Island, and Flinders Island. The numerous rocks and islands off Wilson's Promontory were scaled, marks erected, and survey parties were transported. Tidal streams and currents were recorded and studied and a detailed survey made of the beach south-east of Port Phillip for a projected sewer outlet.

### *Hydrographic Information*

The R.A.N. Hydrographic Office at Garden Island, New South Wales, is the charting authority responsible for the promulgation of hydrographic information. It is accomplished by the means of Notices to Mariners, which amend the charts, both Australian and Admiralty, affected by the new information. The Hydrographic Office derives its data from the Harbour Authorities, the Ports and Harbours Branch, from merchant ships, or ships of the R.A.N., and in the case of detailed surveys, from the ships of the R.A.N. Surveying Service. In some cases the new information is extensive and this usually requires the publication of a new edition of the chart of that locality. Details of the Australian and Admiralty charts of Victorian waters can be obtained from the



*Catalogue and Index of Australian Charts, &c.*, issued by the R.A.N. Hydrographic Office. This catalogue also contains details of sailing directions, light lists, and tide tables, and other navigational aids for the Victorian waters.

### Rivers

#### Length

The characteristics of rivers which relate to land are fixed, whereas those relating to water are variable. The land or geographic features include :—

- (1) The length, and
- (2) the catchment.

The following table shows the main river basins of Victoria and flows of the main streams :—

#### VICTORIA—SCHEDULE OF FLOWS OF MAIN STREAMS

Basin No. *	Stream	Site of Gauging Station	Catchment Area (Square Miles)	Year Gauged from	Annual Flows in 1,000 Ac. Ft.			
					Mean	No. of Years	Max.	Min.
1	Murray ..	Jingellic ..	2,520	1890	1,974	71	4,978	549
2	Mitta ..	Tallandoon ..	1,840	1886	1,138	75	3,460	203
3	Kiewa ..	Kiewa ..	450	1886	527	75	1,684	146
4	Ovens ..	Wangaratta ..	2,100	1887	1,229	74	3,991	141
5	Broken ..	Goorambat ..	740	1887	208	74	886	15.3
6	Goulburn ..	Murchison ..	4,140	1882	2,385	79	6,139	516
7	Campaspe ..	Elmore ..	1,240	1886	194	75	667	0.6
8	Loddon ..	Laanecoorie ..	1,613	1891	207	70	659	8.9
9	Avoca ..	Coonooer ..	1,000	1890	62	71	321	3.8
11	Wimmera ..	Horsham ..	1,570	1889	106	72	479	0
12	Glenelg ..	Balmoral ..	606	1889 (a)	117	60	439	2.5
14	Hopkins ..	Wickliffe ..	460	1921 (b)	27	29	102	1.3
15	Carlisle ..	Carlisle ..	30	1930 (c)	37	26	89	14.8
17	Barwon ..	Winchelsea ..	369	1922 (d)	116	28	412	25
18	Moorabool ..	Batesford ..	434	1908 (e)	57	16	147	2.5
19	Werribee ..	Melton ..	446	1917 (f)	64	43	190	5.3
20	Maribyrnong ..	Keilor ..	264	1908 (g)	92	30	265	3
21	Yarra ..	Warrandyte ..	899	1892	726	41	1,215	334
22	Bunyip ..	Bunyip ..	268	1908 (h)	124	47	247	55.7
24	Latrobe ..	Rosedale ..	1,604	1901 (i)	788	42	2,633	361
25	Thompson ..	Cowwarr ..	421	1891	335	68	1,050	142
25	Macalister ..	Glenmaggie ..	730	1919	478	42	1,277	181
26	Mitchell ..	Gleneladale ..	1,530	1938	814	23	1,779	368
27	Tambo ..	Bruthen ..	1,030	1906 (j)	179	29	575	50
28	Snowy ..	Jarrahmond ..	5,100	1907	1,682	42	3,254	766

Note	Years Excluded in Estimating Mean
(a) ..	1933-34 to 1938-39
(b) ..	1933-34 ,, 1943-44
(c) ..	1943-44 ,, 1946-47
(d) ..	1933-34 ,, 1943-44
(e) ..	1921-22 ,, 1945-46

Note	Years Excluded in Estimating Mean
(f) ..	1952-53
(g) ..	1933-34 to 1955-56
(h) ..	1951-52
(i) ..	1919-20 ,, 1936-37
(j) ..	1924-25 ,, 1937-38

\* 10 Mallee Basin, no rivers.

23 South Gippsland Basin } Short term records only. These are not suitable for inclusion in  
29 East Gippsland Basin } the table.

A table showing the lengths of streams and rivers will be found on pages 31 to 35 of the 1963 Victorian Year Book.

### Catchments

Another useful characteristic of streams is their "catchment" which may be defined as the area from which there is run-off to the stream. Catchments may be regarded as the hydrologically effective part of a "basin". Thus, the whole of any area may be subdivided into basins, but part of some basins may be regarded as non-effective, being either too flat or the rainfall too small to contribute to normal stream flows. There is little or no contribution in the north-west of the State where the annual rainfall is less than 18 in. to 20 in. Above this amount, roughly half the rainfall appears as stream flow.

Figure 3 shows the 29 basins into which Victoria has been divided by the State Rivers and Water Supply Commission for hydrologic purposes.

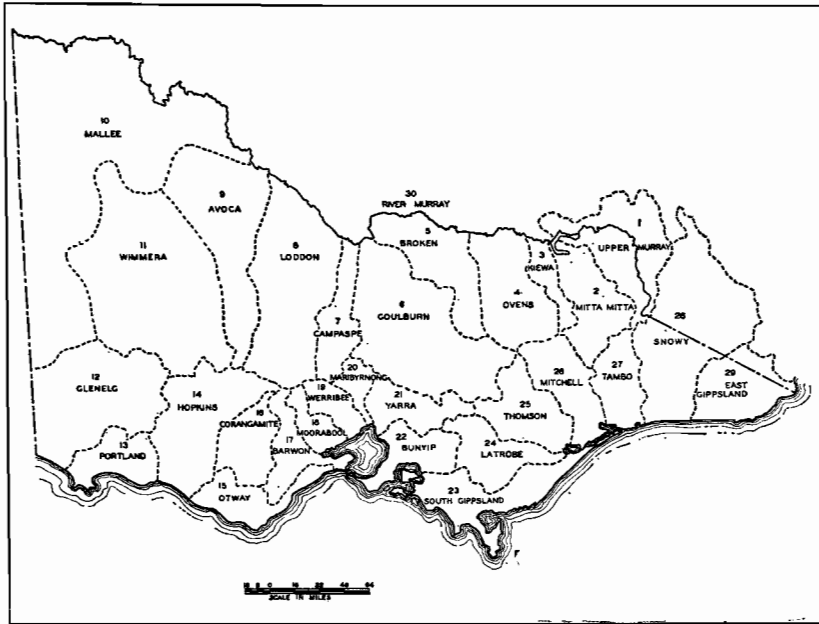


FIGURE 3.—Victoria's water resources showing key plan to river basins.

### Total Flow

The current estimate of mean annual flow is 17 million acre ft. per annum, about half of which flows into the Murray; the other half flowing southward to the Victorian coast. The geographic distribution of flow is heavily weighted towards the eastern half where the total flow is about 14 million acre ft. (with about 8 million acre ft. in the north-east and 6 million acre ft. in the south-east) and hence leaving 3 million acre ft. in the western half.

### Location of Streams

The location of about 2,500 streams in Victoria may be obtained by referring to the "Alphabetical Index of Victorian Streams" compiled by the State Rivers and Water Supply Commission in 1960. Owing to the replication of names for some streams there are over 2,900 names; these have been obtained by examining Department of Lands and Survey, and Commonwealth Military Forces maps, so as to

include names which have appeared on them. There are, in addition, many unnamed streams, those with locally known names, and those named on other maps or plans. No attempt was made in the Index to suggest a preferred name, as it was considered that further legislation is necessary before any such action can be made effective.

#### **Stream Reserves, Flows, Floods, and Droughts, 1964**

### **Lakes**

For lakes to form, there must be suitable physiographic features and sufficient water supply to offset evaporation and seepage losses. Although the water supply in the western part of the State is comparatively poor, the majority of Victorian lakes occur in the west because of suitable physiography which is attributable to volcanic activity. Some extinct volcanoes carry crater lakes, and on the volcanic plains numerous lakes have been formed, the largest being Lake Corangamite. Lakes on the plains are relatively shallow, their depth and hence volume varying considerably with climatic trends in rainfall.

Lakes also occur in the north-west plains, some of which are intermittently replenished by effluents from rivers. Another type of lake is that which occurs along the coast by sand bars forming across the mouth of a stream. The Gippsland Lakes constitute the main lake system of this type.

Although lakes are often described as "salt" or "fresh", such a classification is misleading in shallow lakes as salinity varies inversely with the volume of water in the lake. Certain Victorian lakes are so shallow that salt is deposited in the summer when evaporation is high and in some cases, such as Lake Tyrell, it is harvested.

#### **Further Reference, 1965**

### **Survey and Mapping**

The Department of Crown Lands and Survey is responsible for survey and mapping for the State. Assistance is given to the Commonwealth Department of National Development and the Royal Australian Survey Corps, who also carry out surveys and prepare maps in Victoria as part of the defence and national mapping programmes. The work is co-ordinated by the National Mapping Council of Australia.

Complete information of survey and mapping activities is obtainable from the Central Plan Office situated in the New Treasury Buildings, where maps, plans, and aerial photographs are available for purchase by the public. A new map of Victoria at a scale of 1/500,000 is being published by the Department, and a series of 1/250,000 topographic maps covering the State is being published by the Survey Corps and National Mapping.

The well-known topographic map series at scales of 1/31,680 and 1/63,360 is being discontinued, and gradually replaced by 1/50,000 and 1/100,000 coverage. Aerial photography is available where maps do not exist, and may be obtained as single photographs or in the form of photomaps.

Cadastral plans and large-scale base maps are the sole responsibility of the State. Cadastral plans are prepared at various scales and show information concerning the alienation of Crown lands. Base maps are published at a scale of 400 feet to 1 inch and show title boundaries, contours, and drainage. These maps are prepared for town planning and the supply of services to newly developed areas. Published maps cover the outer suburbs of Melbourne, and the Mornington Peninsula. The future programme includes areas at Ballarat, Geelong, and Bendigo.

In addition to mapping, aerial photography is now being applied to engineering surveys. Modern photogrammetric equipment is being used to plot accurate large-scale maps for road location, new housing estates, sewerage design, and quantity surveys.

#### Natural Resources Conservation League, 1965

### *Physical Geography*

#### Physical Divisions

This article should be read in conjunction with the articles on geographical features, area, and climate.

The chief physical divisions of Victoria are shown on the map (Fig. 4). Each of these divisions has certain physical features which distinguish it from the others, as a result of the influence of elevation, geological structure, climate, and soils, as is recognized in popular terms such as Mallee, Wimmera, Western District and so on. The following is a table of these divisions :—

1. *Murray Basin Plains* :
  - (a) The Mallee
  - (b) The Murray Valley
  - (c) The Wimmera
  - (d) The Northern District Plains
2. *Central Highlands* :
  - A. The Eastern Highlands, within which—
    - (a) the Sandstone Belt and
    - (b) the Caves Country may be distinguished from the remainder
  - B. The Western Highlands :
    - (a) The Midlands
    - (b) The Grampians
    - (c) The Dundas Highlands
3. *Western District Plains* :
  - (a) The Volcanic Plains
  - (b) The Coastal Plains
4. *Gippsland Plains* :
  - (a) The East Gippsland Plains
  - (b) The West Gippsland Plains

## 5. Southern Uplands :

- (a) The Otway Ranges
- (b) The Barabool Hills
- (c) The Mornington Peninsula
- (d) The South Gippsland Highlands
- (e) Wilson's Promontory

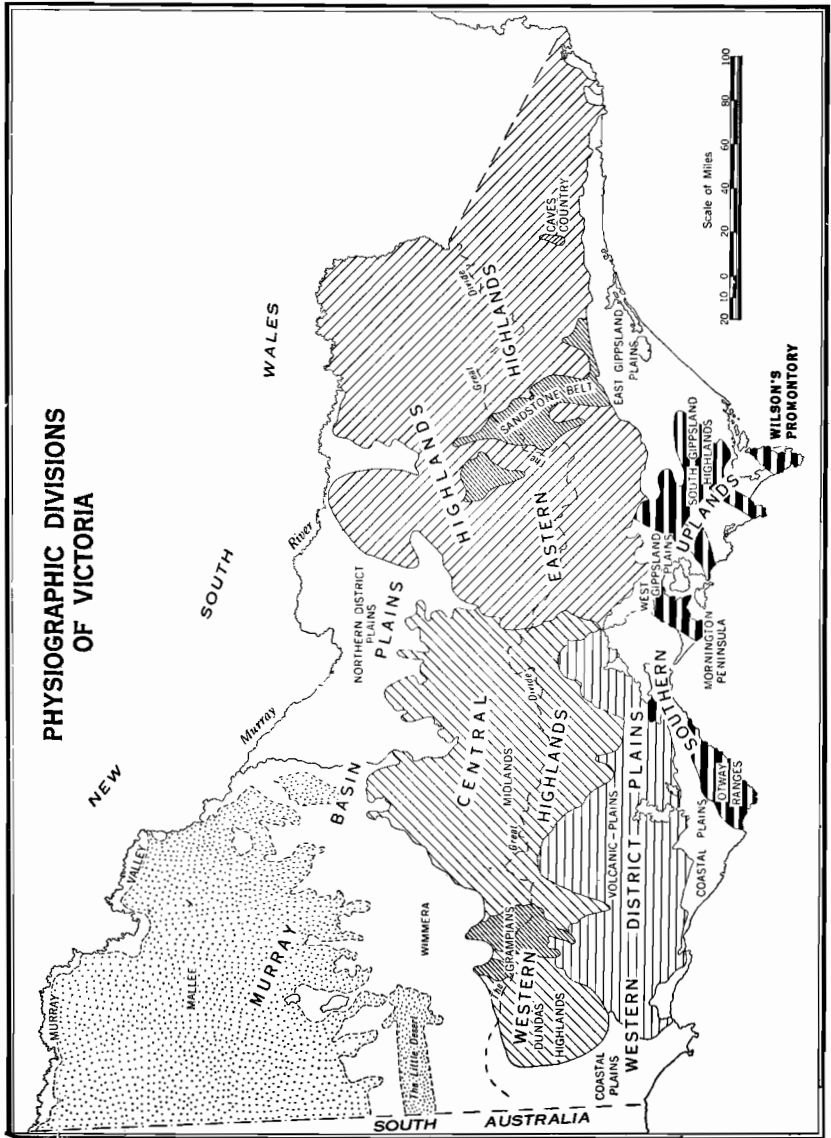


FIGURE 4.

### *Murray Basin Plains*

These plains include the Mallee, the Wimmera, the Northern District Plains and the Murray Valley itself. The most noticeable distinguishing features of the Mallee are the soils, vegetation, and topography. It is not a perfect plain, but exhibits broad low ridges and depressions which appear to be due to folding and faulting of the rocks. Sand ridges trending due east and west are an indication of a former more arid climate, but they are now fixed by vegetation. When cleared, the sand distributes itself irregularly without forming new ridges. There is evidence of a succession of former wet and dry periods in the Mallee, but at the present time all the streams that enter it lose so much water by evaporation and percolation that they fail to reach the Murray and terminate in shallow lakes, many of which are salt. The Murray Valley itself is cut into the higher Mallee land and is subject to periodical flooding by the river.

The Northern District Plains are formed from the combined flood plains of rivers flowing to the Murray, with an average gradient of between 3 and 5 feet to the mile, the surface being almost perfectly flat except where small residual hills of granite rise above the alluvium as at Pyramid Hill.

The Wimmera lies between the Western Highlands and the Mallee and is also composed mainly of river plains except to the north of the Glenelg where old abandoned river channels contain a succession of small lakes. Most of the lakes of the Murray Basin Plains have crescentic loam ridges (lunettes) on their eastern shores.

### *Central Highlands*

The Central Highlands form the backbone of Victoria, tapering from a broad and high mountainous belt in the east until they disappear beyond the Dundas Highlands near the South Australian border. They were formed by up-warping and faulting. The Eastern Highlands differ from the Western in their greater average elevation, with peaks such as Bogong, Feathertop, and Hotham rising above 6,000 feet, while the Western Highlands are generally lower, the peaks reaching above 3,000 feet, and the valleys being broader. Also, in the Eastern Highlands patches of Older Volcanic rocks occur, whereas in the Western the volcanic rocks belong mainly to the Newer Volcanic Series. Several well-known volcanic mountains are still preserved, Mounts Buninyong and Warrenheip near Ballarat being examples.

Because of the great variety of geological formations in the Central Highlands and the effects of elevation and deep dissection by streams, the features of the country are very varied and there are many striking mountains and gorges. The severe winter climate, with heavy snow on the higher land, is also a special feature of the Eastern Highlands. Included in the area are several high plains such as those near Bogong and the Snowy Plains. Caves are well known in the limestone around Buchan.

In the Western Highlands the Grampians, with their striking serrate ridges of sandstone, may be compared with the belt of sandstones stretching from Mansfield to Briagolong in the east.

The Dundas Highlands are a dome which has been dissected by the Glenelg and its tributaries, the rocks being capped by ancient laterite soils which form tablelands with scarps at their edges.

#### *Western District Plains*

Many of the surface features of the Western District Plains are a result of volcanic activity, very large areas being covered with basalt flows of the Newer Volcanic Series above which prominent mountains rise, many of them with a central crater lake. Some of the youngest flows preserve original surface irregularities practically unmodified by erosion, thus forming the regions known as "Stony Rises".

The coastal plains of the Western District are for the most part sandy, the soils being derived from Tertiary and Pleistocene sedimentary deposits, which in places attain a thickness of some 5,000 feet, and yield considerable quantities of artesian water.

#### *Gippsland Plains*

Continuing the east-west belt of plains on the eastern side of the drowned area represented by Port Phillip Bay and Westernport Bay are the Gippsland Plains. These are underlain by marine and non-marine Tertiary and Pleistocene sedimentary deposits, including the thick seams of brown coal of the Latrobe Valley. A notable feature is the Ninety Mile Beach and the lakes and swamps that lie on its landward side. This beach is an off-shore bar on which aeolian sand ridges have accumulated.

#### *Southern Uplands*

Lying to the south of the plains above mentioned is a group of uplifted blocks for which faulting is mainly responsible, these constituting the Southern Uplands. The Otway Ranges and the South Gippsland Highlands are composed of fresh-water Mesozoic and Tertiary sediments with Older Volcanic basalts in South Gippsland, and the Mornington Peninsula is an upraised fault block of complex geology, including granites. The Sorrento Peninsula is entirely composed of Pleistocene calcareous dune ridges which have been responsible for practically blocking the entrance to Port Phillip Bay.

#### **Further References**

##### **Land Surface of Victoria, 1964**

##### **Geology of Victoria, 1961**

E. S. HILLS *The Physiography of Victoria* : Whitcombe and Tombs, Melbourne, Fourth Edition, 1959.

*Resources Surveys—Preliminary Reports* : Published by the Central Planning Authority, Premier's Department, Melbourne.

*Climate***Climate of Victoria***General*

The State of Victoria experiences a wide range of climatic conditions ranging from the hot summer of the Mallee to the winter blizzards of the snow-covered Alps, and from the relatively dry wheat belt to the wet eastern elevated areas where many of Victoria's permanent streams spring.

*Temperatures*

February is the hottest month of the year with January only slightly cooler. Average maximum temperatures are under 75° F. along the coast and over elevated areas forming the Central Divide and North-East Highlands. Apart from these latter areas, there is a steady increase towards the north, until, in the extreme north an average of 90° F. is reached. Values decrease steadily with height, being under 70° F. in alpine areas above 3,000 feet and as low as 60° F. in the very highest localities.

Temperatures fall rapidly during the autumn months and then more slowly with the onset of winter. Average maximum temperatures are lowest in July; the distribution during this month again shows lowest values over elevated areas, but a significant feature is that apart from this orographically induced area, there is practically no variation across the State. Day temperatures along the coast average about 55° F. in July; much the same value is recorded over the wheat belt, and only a few degrees higher in the far north-west under conditions of few clouds and relatively high winter sunshine. The Alps experience blizzard conditions every year with minimum temperatures 10° F. to 20° F. less than at lowland stations.

Conditions of extreme summer heat may be experienced throughout the State except over the alpine area. Most inland places have recorded maxima over 110° F. with an all time extreme for the State of 123·5° F. at Mildura on 6th January, 1906. Usually such days are the culmination of a period during which temperatures gradually rise, and relief comes sharply in the form of a cool change with rapid temperature drops of 30° F. at times. However, such relief does not always arrive so soon and periods of two or three days or even longer have been experienced when the maximum temperature exceeds 100° F. On rare occasions extreme heat may continue for as long as a week with little relief.

Night temperatures, as gauged by the average minimum temperature, are, like the maximum, highest in February. Values are below 50° F. over the elevated areas, but otherwise the range is chiefly 55° F. to 60° F. The highest night temperatures are recorded in the far north and along the coast. In mid-winter, average July minima exceed 40° F. along the coast and at two or three places in the far north. The coldest point of the State is the north-east alpine section, where temperatures frequently fall below freezing point. Although



three or four stations have been set up at different times in this area, none has a very long or satisfactory record. The lowest temperature on record so far is 9° F. at Hotham Heights (station height 5,776 feet) at an exposed location near a mountain. However, a minimum of minus 8° F. has been recorded at Charlotte Pass (station height 6,035 feet)—a high valley near Mount Kosciusko in N.S.W.—and it is reasonable to expect that similar locations in Victoria would experience sub-zero temperatures (i.e., below 0° F.), although none has been recorded due to lack of observing stations.

### *Frosts*

With the exception of the exposed coast, all parts of Victoria may experience frost, but frequencies are highest and occurrences usually more severe in elevated areas and valleys conducive to the pooling of cold air. All inland stations have recorded extreme screen temperatures less than 30° F., whilst at a large number of stations extremes stand at 25° F. or less. Thus frost may be expected each year over practically the whole of the State, but the bulk of the occurrence is restricted to the winter season. Spring frosts may constitute a serious hazard to agriculture, and in some years a late frost may result in serious crop damage. Periods of frost lasting for more than three or four consecutive days are unusual.

### *Rainfall*

Rainfall exhibits a wide variation across the State and although not markedly seasonal, most parts receive a slight maximum in the winter or spring months. The relatively dry summer season is a period of evaporation, which greatly reduces the effectiveness of the rainfall. Average annual totals range between 10 inches in the driest parts of the Mallee to over 60 inches in parts of the North-Eastern Highlands. An annual total exceeding 140 inches has been reported from Falls Creek in the north-east; however, with the sparse population and inaccessibility of the highland localities, it is not practicable to obtain a representative set of observations from this area. Most areas south of the Divide receive an annual rainfall above 25 inches, with over 40 inches in the Central Highlands, Otway Ranges, and South Gippsland. The wheat belt receives chiefly between 12 and 20 inches. With the exception of Gippsland, 60 to 65 per cent. of the rain falls during the period May to October. This proportion decreases towards the east, until over Gippsland the distribution is fairly uniform with a warm season maximum in the far east. All parts of the State have on rare occasions been subjected to intense falls, and monthly totals exceeding three times the average have been recorded. Monthly totals exceeding 10 inches have been recorded on rare occasions at most places on and south of the Divide; the chief exception being over the lowlands extending from Melbourne to the Central Western District. Occurrences are more frequent, but still unusual, over the north-east and East Gippsland and isolated parts such as the Otways. This event has, with few exceptions, never been recorded over the north-west of the State. The highest monthly total ever recorded in the State was a fall of 35·09 inches at Tanybryn in the Otway district in June, 1952.

### *Floods*

Floods have occurred in all districts, but they are more frequent in the wetter parts of the State such as the north-east and Gippsland. However, although a rarer event over the North-West Lowlands, they may result from less intense rainfall and continue longer owing to the poor drainage in this section of the State. In many instances the frequency of flooding is increased by valley contours and damage is often greater because of the higher density of adjacent property and crops.

### *Snow*

Snow in Victoria is confined usually to the Great Dividing Range and the alpine massif, which at intervals during the winter and early spring months may be covered to a considerable extent, especially over the more elevated eastern section. Falls elsewhere are usually light and infrequent. Snow has been recorded in all districts except the Mallee, Wimmera, and Northern Country. The heaviest falls in Victoria are confined to sparsely populated areas and hence general community disorganization is kept to a minimum. Snow has been recorded in all months on the higher Alps, but the main falls occur during the winter. The average duration of the snow season in the alpine area is from three to five months.

### *Winds*

The predominant wind stream over Victoria is of a general westerly origin, although it may arrive over the State from the north-west or south-west. There are wide variations from this general description, however, and many northerlies and southerlies are experienced. The latter is the prevailing direction from November to February with a moderate percentage of northerlies often associated with high temperatures. Easterly winds are least frequent over Victoria, but under special conditions can be associated with some of the worst weather experienced over the State. Wind varies from day to night, from season to season, and from place to place. Examples of the diurnal variation are the sea breeze, which brings relief on many hot days along the coastline, and the valley or katabatic breeze, which brings cold air down valleys during the night. The latter is well developed in many hilly areas of Victoria, being the result of differential cooling after sunset. It springs up during the night, often suddenly, and continues after sunrise until the land surfaces are sufficiently heated again. The sensitive equipment required to measure extreme wind gusts has been installed at only about five or six places in the State and to date the highest value recorded is just slightly over 90 m.p.h. There is no doubt, however, that stronger gusts have been experienced over the State, although not in the vicinity of a recording anemometer. A number of tornadic squalls have been experienced and from the severe local damage engineers have estimated wind strengths over 100 m.p.h. It is considered that any place in Victoria could feasibly experience at some time a local gust of 100 m.p.h. or more.

### *Droughts*

Since records have been taken, there have been numerous dry spells in various parts of Victoria, most of them of little consequence but many widespread enough and long enough to be classified as droughts.

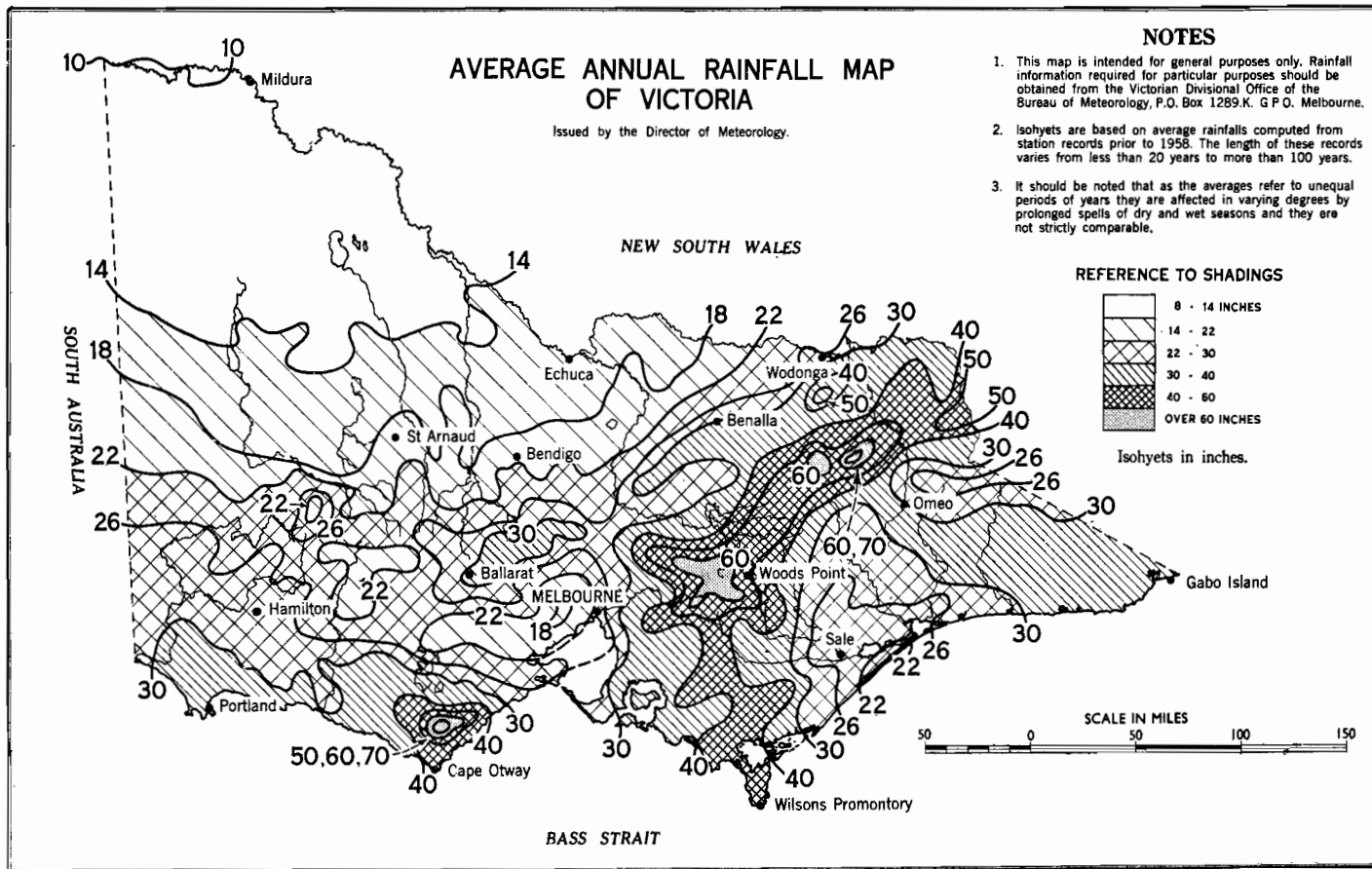


FIGURE 5.

The worst drought since white settlement in Australia occurred in the period 1897 to 1902. Since 1945 there have been no serious droughts in Victoria, nor serious dry spells with a duration greater than twelve months. The severity of major drought or dry spells is much lower in Gippsland and the Western District than in Northern Victoria. An approximate idea may be formed of the liability of these areas to drought or dry spells from the following table which shows the figures for total duration of unbroken dry periods. An unbroken dry period is one of three or more consecutive months where the rainfall over the area concerned is markedly below average.

Northern Victoria : 412 months in 98 years of records.

Western Victoria : 222 months in 94 years of records.

Gippsland : 291 months in 77 years of records.

Of the above totals, 88 per cent. are due to droughts of a duration of twelve months or more in the North, 77 per cent. in the West, and 69 per cent. in Gippsland.

The figures are taken from the publication "Droughts in Australia", Bulletin Number 43 of the Commonwealth Bureau of Meteorology, published in 1957. Readers are referred to this publication for a definitive treatment of the subject of droughts in Victoria.

### *Thunderstorms*

Thunderstorms occur far less frequently in Victoria and Tasmania than in the other two eastern States. They occur mainly in the summer months when there is adequate surface heating to provide energy for convection. On an average, more than 20 per year occur on the North-Eastern Highlands and in parts of the Northern Country, but particularly in the north-east. Melbourne has an average of less than three per month from November to February. Isolated severe wind squalls and tornadoes sometimes occur in conjunction with thunderstorm conditions, but these destructive phenomena are comparatively rare. Hailstorms affect small areas in the summer months; and showers of small hail are not uncommon during cold outbreaks in the winter and spring.

### *Humidity*

By and large, humidity in the lower atmosphere is much less over Victoria than in other eastern States. This is because the extreme south-east of the continent is mostly beyond the reach of tropical and sub-tropical air masses. For several periods in the summer, however, air from the Tasman Sea has a trajectory over Bass Strait and other parts of the State, and it is then that the moisture content rises to show wet bulb temperatures above 65° F. The incidence of high humidity is important to the vine and fruit industry, tobacco growers, and wheat farmers.

### *Evaporation*

Measurements of evaporation in Victoria are made with the standard form of evaporation tank at about 27 stations, about half of which are owned by the Commonwealth Bureau of Meteorology. Results from these stations show that evaporation exceeds the average annual rainfall in inland areas, especially in the north and north-west, by about 40 inches. In all the highland areas and the Western District the discrepancy is much less marked, and in the Central District and the lowlands of East Gippsland annual evaporation exceeds annual rainfall by 8 to 15 inches. Evaporation is greatest in the summer months in all districts. In the three winter months, rainfall exceeds evaporation in many parts of Victoria, but not in the north and north-west.

As a consequence of the awakening of various authorities to the vital importance of evaporation in agricultural and hydrological studies, the Australian network of recording stations has almost doubled during the past twenty years.

### **Rainfall Reliability**

It is not possible to give a complete description of rainfall at a place or in a district by using a single measurement. The common practice of quoting the annual average rainfall alone is quite inadequate in that it does not convey any idea of the extent of the variability likely to be encountered. Examination of rainfall figures over a period of years for any particular place indicates a wide variation from the average; in fact it is rare for any station to record the average rainfall in any particular year. Thus for a more complete picture of annual rainfall the variability or deviation from the average should be considered in conjunction with the average.

Rainfall variability assumes major importance in some agricultural areas. Even though the average rainfall may suggest a reasonable margin of safety for the growing of certain crops, this figure may be based on a few years of heavy rainfall combined with a larger number of years having rainfall below minimum requirements. Variability of rainfall is also important for water storage design, as a large number of relatively dry years would not be completely compensated by a few exceptionally wet years when surplus water could not be stored.

Although variability would give some indication of expected departures from normal over a number of years, variability cannot be presented as simply as average rainfall.

Several expressions may be used to measure variability, each of which may have a different magnitude. The simplest measure of variability is the range, i.e., the difference between the highest and lowest annual amounts recorded in a series of years. Annual rainfall in Victoria is assumed to have a "normal" distribution. These distributions can be described fully by the average and the standard deviation.

To compare one distribution with the other, the coefficient of variation  $\left( \frac{\text{standard deviation}}{\text{the average}} \times 100 \right)$  has been used. The coefficient of variation has been calculated for the fifteen climatic regions of Victoria (see Fig. 6) for the 30 years 1931 to 1960 and the results are tabulated below in order of rainfall reliability :—

### VICTORIA—ANNUAL RAINFALL VARIATION

District	Average Annual Rainfall*	Standard Deviation	Coefficient of Variation
	inches	inches	per cent.
1. West Coast .. .. .	31·38	4·96	15·8
2. West Gippsland .. .. .	37·90	6·13	16·2
3. Volcanic Plains .. .. .	25·91	4·18	16·1
4. East Central .. .. .	35·64	5·88	16·5
5. East Gippsland .. .. .	32·37	5·88	18·2
6. West Central .. .. .	24·29	4·55	18·7
7. Wimmera South .. .. .	19·90	3·98	20·0
8. Wimmera North .. .. .	16·78	3·50	20·9
9. North Central .. .. .	29·92	6·48	21·7
10. Upper North-East .. .. .	44·36	10·30	23·2
11. Mallee South .. .. .	13·75	3·48	25·3
12. Lower North-East .. .. .	30·85	8·30	26·9
13. Mallee North .. .. .	12·09	3·28	27·1
14. Upper North .. .. .	20·55	5·69	27·7
15. Lower North .. .. .	16·92	5·06	29·9

\* Average for a standard 30 years' period 1931–1960.

The higher the value of the coefficient of variation of the rainfall of a district, the greater the departure from the average and hence the more unreliable the rainfall.

Most of the elevated areas of eastern and southern Victoria normally receive over 40 inches and over 60 inches in some wetter sections. Interspersed between these wet mountainous areas are sheltered valleys which are deprived to some extent of their rainfall by neighbouring highlands. Along practically the whole south coastline of Victoria the average number of wet days (0·01 inches or more in 24 hours) is over 150, with an average rainfall below 30 inches. The average number of wet days a year is reduced to 100 at a distance of approximately 100 miles inland from the coast.

The variability of annual rainfall is closely associated with the incidence of drought. Droughts are rare over areas of low rainfall variability and more common in areas where this index is high.

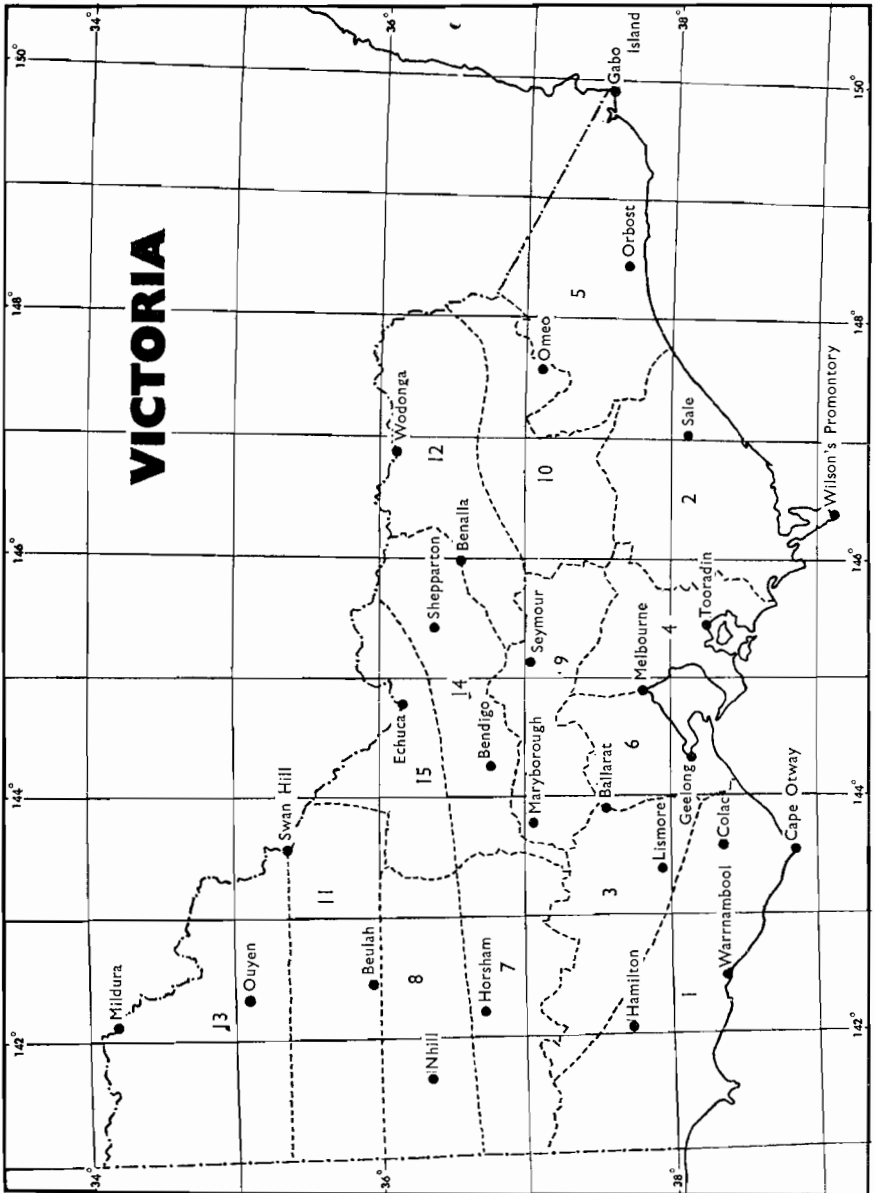


FIGURE 6.—Relative Rainfall Variability based on District Annual Rainfall. Names of Districts are shown in Table on page 51.

## Maritime Meteorology

### *General*

The services provided by the Bureau of Meteorology to the public broadly fall into four groups: warnings, forecasts, information, and consultation. The basis of these groups is a network of observation posts on land and on ships at sea. The data is received at least twice a day at the forecasting offices where it is analyzed to establish a three dimensional picture of the current weather. For the purpose of producing storm warnings and weather forecasts, this analysis of the atmosphere is projected to obtain a prediction of its probable development in the following 24-hour period. This prediction is used to forecast wind, temperature, cloud pattern, and rain.

### *Shipping*

As well as providing a general service which gives the forecast for an area in broad terms, the Bureau provides operational services of a specialized nature, such as the operational service used for aviation purposes. The Bureau's service to shipping is both general and specific. Under international agreement, Australia has been allotted responsibility for the area 70° E. to 160° E. longitude, and 15° S. to 45° S. latitude extending to the equator between 140° E. and 160° E. To provide an adequate service to ships at sea, this area is divided into four sectors. Forecasts for these sectors are issued at Brisbane, Darwin, Melbourne, and Perth, and broadcast on multi-wave by the Sydney and Perth long distance ship-shore radio stations. A current weather chart and a forecast of the chart for the following 24 hours is broadcast in an international code, enabling ships' captains to plot their charts. Recently, broadcasts of weather charts by facsimile have been introduced and ships equipped with facsimile receivers have reported clear reproductions of these charts from considerable distances.

To supplement the data of its established observational network, the Bureau receives regular weather reports from a selected number of ships every six hours. Special weather reports are also made by ships when weather conditions become serious. Generally speaking, data received from ships is most valuable, but is sparse away from regular shipping routes. The Bureau has established Port Meteorological Agents at Melbourne, Sydney, and Perth to maintain a liaison with the reporting officers on ships, to inspect meteorological equipment, and to instruct, enlist, and equip ships with the necessary instruments needed to provide regular reports.

The provision of warnings is by far the most important shipping requirement of a meteorological service, since its purpose is the protection of human life and property. Gale warnings are issued from the appropriate office of the Bureau whenever a disturbance is expected to



result in a mean wind between 34 and 47 knots. If the mean wind is expected to exceed 48 knots, a storm warning is issued. Any storm warning received from an adjoining area that is likely to affect shipping proceedings through that area is re-broadcast.

Warnings of tropical cyclones are issued by the offices of the Bureau at Brisbane, Darwin, and Perth. The warnings are renewed at least every six hours, or more frequently if required by the situation, until the final warning is issued. These warnings are broadcast on receipt and repeated at eighteen minutes past every even hour (Greenwich Mean Time).

In recent years, the Bureau has introduced a special type of shipping warning into its maritime services, namely, "strong wind warning". These warnings are issued whenever the mean wind is expected to be between 27 and 33 knots. They were designed specifically for the benefit of smaller craft which can be troubled by such winds.

#### *Bulletins*

Regular bulletins are issued from all Divisional offices of the Bureau twice daily. The advice issued from the Victorian Office consists of the following items :—

- (1) A routine forecast for the area ranging from longitude 138° E. to 160° E. and latitude 36° S. and 41° S. is broadcast at 0048 G.M.T. At 1318 G.M.T. the longitude is the same, but the area is extended to cover between latitude 36° S. and 45° S.;
- (2) a collection of coastal reports is included with both broadcasts ; and
- (3) a selection of the latest ships' reports received around the forecast area is transmitted.

Forecasts are also issued about 9.00 a.m. and 5.00 p.m. Eastern Standard Time each day by the Victorian Divisional Office for Bass Strait. This caters for ships in this area through radio telephone. The messages comprise a forecast for Bass Strait and a collection of coastal reports. The messages are sent out through the Overseas Telecommunications Channels.

The service provided for small craft and coastal fishing fleets is an operational service. In Victoria the forecast areas are defined as follows:—

West Coast ..	..	From the South Australian border to Port Campbell and 50 miles to seaward.
---------------	----	--

- West Central Coast .. From Port Campbell to Queenscliff and seaward to the latitude of King Island.
- Port Phillip Bay .. Within Port Phillip Bay.
- East Central Coast .. From Queenscliff to Wilson's Promontory seaward to the latitude of King Island.
- West Gippsland Coast .. From Wilson's Promontory to Lakes Entrance and seaward to the latitude of Flinders Island.
- East Gippsland Coast .. From Lakes Entrance to Gabo Island and 50 miles to seaward.
- Bass Strait .. .. Between the Victorian and Tasmanian coasts bounded by King Island on the west and Flinders Island on the east.

Forecasts accompanied by a brief description of the circulation pattern and its expected development are issued twice daily for these coastal areas. Also included is a statement of any significant weather, followed by a forecast of wind direction, speed, and the associated state of the sea. Dissemination of this information is carried out by commercial and national radio stations, and Overseas Telecommunication Commission (Station VIM) at regular times.

In this way, the Bureau also provides a service for pleasure craft, such as sailing yachts and motor boats. General forecasts are issued by the press, radio, and television. Direct broadcasts made from the Bureau also refer to the needs of small craft. Other avenues of dissemination are the automatic telephone service available throughout the Metropolitan Area, which mentions any occasions when wind gusts are likely to exceed 30 m.p.h. on Port Phillip Bay.

### Climate of Melbourne

#### Temperatures

The proximity of Port Phillip Bay bears a direct influence on the local climate of the Metropolis. The hottest months in Melbourne are normally January and February when the average is just over 78° F. Inland, Watsonia has an average of 81° F., whilst along the Bay, Black Rock, subject to any sea breeze, has an average of 77° F. This difference does not persist throughout the year, however, and in July average maxima at most stations are within 1° F. of one another at approximately 55° F. The hottest day on record in Melbourne was 13th January, 1939, when the temperature reached 114.1° F. which is the second highest temperature ever recorded in an Australian Capital City. In Melbourne, the average number of days per year with

maxima over 100° F. is about four, but there have been years with up to twelve and also a few years with no occurrences. The average annual number of days over 90° F. is just on nineteen.

Nights are coldest at places a considerable distance from the sea such as at Watsonia, which has a good open exposure and where average minima are a few degrees lower than those observed in the City, where buildings may maintain the air at a slightly higher temperature. The lowest temperature ever recorded in the City was 27° F. on 21st July, 1869, and likewise, the highest minimum ever recorded was 87° F. on 1st February, 1902.

In Melbourne, the average overnight temperature remains above 70° F. on only about two nights a year and this frequency is the same for nights on which the air temperature falls below 32° F. Minima below 30° F. have been experienced during the months of May to August, whilst even as late as October, extremes have been down to 32° F. During the summer, minima have never been below 40° F.

Wide variations in the frequencies of occurrences of low air temperatures are noted across the Metropolitan Area. For example, there are approximately ten annual occurrences of 36° F. or under around the bayside, but frequencies increase to over twenty in outer suburbs and probably to over 30 a year in the more frost susceptible areas. The average frost-free period is about 200 days in the outer northern and eastern suburbs, gradually increasing to over 250 days towards the City, and approaches 300 days along parts of the bayside.

### *Rainfall*

The range of rainfall from month to month in the City is quite small, the annual average being 25·97 inches over 143 days. From January to August, monthly averages are within a few points of two inches; then a rise occurs to a maximum of 2·71 inches in October. Rainfall is relatively steady during the winter months when the extreme range is from half an inch to seven inches, but variability increases towards the warmer months. In the latter period totals range between practically zero and over eight inches. The number of wet days, defined as days on which a point or more of rain falls, exhibits marked seasonal variation ranging between a minimum of eight in January and a maximum of fifteen each in July and August. This is in spite of approximately the same total rainfall during each month and indicates the higher intensity of the summer rains. The relatively high number of wet days in winter gives a superficial impression of a wet winter in Melbourne which is not borne out by an examination of total rainfall.

The highest number of wet days ever recorded in any one month is 27 in August. On the other hand, there has been only one rainless month in the history of the Melbourne records—April, 1923. On

occasions, each month from January to May has recorded three wet days or less. The longest wet spell ever recorded was sixteen days and the longest dry spell 40 days. Over four inches of rain have been recorded in 24 hours on several occasions, but these have been restricted to the warmer months, September to March. No fall above 2 inches in 24 hours has ever been recorded in the cooler months. Fogs occur on four or five mornings each month in May, June, and July, and average 21 days for the year. The highest number ever recorded in a month was twenty in June, 1937.

### *Cloud and Sunshine*

Cloudiness varies between a minimum in the summer months and a maximum in the winter, but the range like the rainfall is not great compared with many other parts of Australia. The number of clear days or nearly clear days averages two to three each month from May to August, but increases to a maximum of six to seven in January and February. The total number for the year averages 47. The high winter cloudiness and shorter days have a depressing effect on sunshine in winter and average daily totals of three to four hours during this period are the lowest of all capital cities. There is a steady rise towards the warmer months as the days become longer and cloudiness decreases. An average of nearly eight hours a day is received in January; however, the decreasing length of the day is again apparent in February, since the sunshine is then less in spite of a fractional decrease in cloudiness. The total possible monthly sunshine hours at Melbourne range between 465 hours in December and 289 in June under cloudless conditions. The average monthly hours, expressed as a percentage of the possible, range between 55 per cent. for January and February to 34 per cent. in June.

### *Wind*

Wind exhibits a wide degree of variation, both diurnally, such as results from a sea breeze, etc., and as a result of the incidence of storms. The speed is usually lowest during the night and early hours of the morning just prior to sunrise, but increases during the day especially when strong surface heating induces turbulence into the wind streams, and usually reaches a maximum during the afternoon. The greatest mean wind speed at Melbourne for a 24 hour period was 22.8 m.p.h., whilst means exceeding 20 m.p.h. are on record for each winter month. These are mean values: the wind is never steady. Continual oscillations take place ranging from lulls, during which the speed may drop to or near zero, to strong surges which may contain an extreme gust, lasting for a period of a few seconds only, up to or even over 60 m.p.h. At Melbourne, gusts exceeding 60 m.p.h. have been registered during every month with a few near or over 70 m.p.h., and an extreme of 74 m.p.h. on February 18, 1951. At both Essendon and Ascendale wind gusts over 90 m.p.h. have been measured.

There have been occurrences of thunderstorms in all months ; the frequency is greatest during November to February. The greatest number of thunderstorms occurring in a year was 25. This figure was recorded for both 1928 and 1932.

#### *Hail and Snow*

Hailstorms have occurred in every month of the year; the most probable time of occurrence is from August to November. The highest number of hailstorms in a year was seventeen in 1923, and the greatest number in a month occurred in November of that year when seven hailstorms were reported. Snow has occasionally fallen in the city and suburbs; the heaviest snow storm on record occurred on 31st August, 1849. Streets and housetops were covered with several inches of snow, reported to be 1 foot deep at places. When thawing set in, floods in Elizabeth and Swanston streets stopped traffic causing accidents, some of which were fatal. One report of the event indicates that the terrified state of the aborigines suggested they had never seen snow before.

### **Victorian Weather Summary for 1964**

#### *Summer*

January was cool and dry with mean temperatures generally below normal, and rainfall well below normal in most parts of the State. February mean temperatures were near normal, and although rainfall in the north of the State was again below normal, substantial falls were received in the south, where monthly totals were well above normal. A severe storm struck southern Victoria on the 22nd February, with gales, heavy rain, hail, and thunder. Structural damage occurred in the Central District.

#### *Autumn*

March was a very dry month. Several bushfires broke out and there were widespread duststorms in the Mallee on the 23rd March. However, general rain on two occasions in April brought monthly totals above normal everywhere. Rainfall in May was below average in all districts except Gippsland. Mean temperatures for autumn were close to normal.

#### *Winter*

Rainfall was well above average everywhere except in the Mallee and East Gippsland. July was a particularly wet month, many places recording their highest July rainfall on record, and snowfalls on the Alps were the heaviest for many years. Flooding occurred in north-eastern rivers during July, and in the middle reaches of the Murray in August.

The winter was very windy, and in Melbourne gusts reached gale force on 41 days compared to an average of 21 days. A tornadic storm struck Numurkah on 10th August, causing considerable damage. Mean minimum temperatures were above normal, particularly in southern Victoria and the incidence of frost was less than usual.

### Spring

The heavy rainfall of winter continued into Spring, with the seasonal rainfall above average everywhere. Wet conditions continued in December in southern Victoria. Many Victorian rivers were at critical levels in September and flooding occurred in the Wimmera, Loddon, and Avoca Rivers.

The mean temperature for Spring was below normal in all districts, mean maxima being up to 7 degrees below normal. December was also cold with the mean maximum temperature at most places being the lowest on record.

### Meteorological Records

The above particulars about climate have been furnished by the Commonwealth Bureau of Meteorology, and some figures are given in the following tables. In the first is shown the rainfall for each district and for the whole State for each of the years 1955 to 1964, together with the average rainfall covering a period of 30 years :—

#### VICTORIA—RAINFALL IN DISTRICTS (Inches)

Year	Districts							
	Mallee	Wimmera	Northern	North Central	North Eastern	Western	Central	Gippsland
1955 .. ..	17.68	22.44	26.00	35.99	49.05	32.40	34.12	33.86
1956 .. ..	20.85	24.31	31.45	41.17	55.59	34.02	34.29	44.25
1957 .. ..	9.67	14.87	13.55	23.01	27.32	26.82	24.85	31.98
1958 .. ..	15.45	17.65	21.40	31.57	37.78	29.05	28.99	35.42
1959 .. ..	9.97	15.16	16.56	26.09	27.69	24.46	26.53	33.63
1960 .. ..	18.08	24.75	22.70	38.45	40.16	36.01	34.98	37.26
1961 .. ..	13.44	15.07	14.90	25.27	27.60	24.03	22.90	33.04
1962 .. ..	11.29	17.69	18.85	27.77	33.78	25.99	26.07	31.41
1963 .. ..	16.15	18.55	20.66	30.46	35.49	25.87	28.36	35.61
1964 .. ..	16.14	25.02	20.93	34.40	40.27	38.69	35.40	37.99
Averages* ..	13.07	18.51	18.91	29.90	35.14	29.53	29.73	35.69

\* Averages for a standard 30 years' period 1931-1960.

The heaviest rainfall in the State occurs in the Eastern Highlands (from the Yarra watershed to the Upper Murray), in the Cape Otway Forest in the Western District, and in the South Gippsland, Latrobe and Thomson Basin sections of the Gippsland District. The lightest rainfall is in the Mallee District, the northern portion of which receives on the average from 10 to 12 inches only per year.

The following table shows the average monthly rainfall and mean temperatures recorded in various Victorian country centres and is followed by a graph of the district monthly rainfall for 1964 :—

VICTORIA—WEATHER CONDITIONS IN SELECTED VICTORIAN TOWNS: AVERAGE VALUES

Locality		Legend No.*	January	February	March	April	May	June	July	August	Sept.	October	Nov.	Dec.
MALLEE ..	Mildura ..	1	97	96	71	62	106	101	112	98	81	129	98	53
		2	89·8	90·0	84·4	74·5	66·9	60·4	59·5	63·9	69·9	76·5	83·2	88·2
		3	61·0	61·7	57·2	50·5	45·6	41·3	40·5	42·5	46·1	50·9	55·4	59·6
	Ouyen ..	1	92	104	77	88	118	126	130	128	105	168	111	90
		2	89·4	86·0	82·1	73·1	65·7	59·4	58·7	62·8	68·9	74·1	79·9	86·7
		3	58·7	58·4	54·1	47·8	44·5	40·7	39·8	40·6	43·3	47·2	52·6	56·0
WIMMERA ..	Horsham ..	1	111	129	98	146	170	193	183	192	154	177	133	102
		2	85·1	86·3	80·2	70·7	63·0	56·6	56·0	59·0	64·1	70·2	77·2	82·7
		3	55·2	55·9	51·9	47·0	42·9	40·2	38·8	39·9	41·9	45·1	49·6	53·2
	Nhill ..	1	106	117	89	128	158	178	180	186	148	162	130	122
		2	84·3	85·0	79·6	70·5	63·3	57·0	56·5	59·4	64·4	70·4	76·9	82·2
		3	55·2	56·3	52·8	47·6	43·9	40·4	38·6	40·1	42·5	45·7	49·7	53·8
WESTERN ..	Ballarat ..	1	139	195	177	259	269	261	275	304	282	295	247	211
		2	75·7	76·9	71·6	63·0	56·3	50·4	49·8	52·5	57·1	62·4	67·4	72·5
		3	50·5	52·9	50·1	45·8	42·6	39·5	38·4	39·4	41·2	43·6	46·0	49·3
	Hamilton ..	1	149	163	188	260	254	261	291	318	276	259	216	177
		2	77·3	78·7	74·2	66·3	60·1	55·1	54·1	56·2	59·9	64·8	69·1	74·0
		3	50·7	52·4	49·9	46·3	43·2	40·2	39·3	40·4	42·3	44·0	46·3	49·2
Warrnambool	1	137	139	212	252	270	282	321	345	257	255	211	173	
	2	69·9	70·9	69·1	64·6	60·5	56·3	55·6	56·9	59·4	62·6	64·8	67·9	
	3	54·7	56·0	54·2	51·0	47·8	44·8	43·6	44·4	46·2	48·1	50·2	53·0	
NORTHERN ..	Bendigo ..	1	125	164	127	177	205	211	247	209	194	228	168	123
		2	83·0	83·9	78·1	68·8	61·3	54·8	54·2	57·0	62·5	68·9	75·2	80·5
		3	56·5	58·3	54·0	48·2	43·7	40·7	39·4	40·2	43·0	46·7	50·9	54·9
	Echuca ..	1	105	126	141	143	139	163	195	150	136	188	124	96
		2	86·2	86·8	80·7	71·1	63·6	56·7	56·0	59·0	64·7	71·7	78·5	84·1
		3	58·9	60·1	55·9	49·3	44·5	41·3	40·2	41·2	44·3	48·6	52·7	56·9

NORTH CENTRAL ..	Alexandra ..	1	174	172	208	244	236	269	301	307	250	292	259	182
		2	84.6	85.3	78.8	69.1	61.3	53.9	53.6	57.3	62.6	69.2	75.7	81.9
		3	52.5	53.7	49.1	43.8	39.7	37.5	36.8	37.8	40.3	43.3	46.7	50.7
	Kyneton ..	1	143	201	146	237	251	309	354	330	265	288	223	186
		2	81.2	81.5	74.7	65.0	57.5	51.0	50.1	53.1	59.1	65.2	72.3	77.5
		3	49.8	50.5	47.2	42.3	38.5	36.2	34.8	35.3	37.9	40.4	44.1	47.6
CENTRAL ..	Geelong ..	1	117	180	137	213	185	210	207	217	199	245	243	176
		2	76.2	77.3	73.9	67.6	62.1	57.2	56.5	59.0	62.8	67.3	70.3	73.8
		3	55.4	56.9	54.7	50.7	46.6	43.1	42.0	42.9	45.0	47.5	50.4	53.7
	Mornington	1	148	215	172	261	264	264	274	262	269	289	261	203
		2	76.5	77.1	73.9	66.8	61.5	56.3	54.9	56.7	60.6	64.4	69.0	73.6
		3	55.2	55.9	54.4	50.5	47.8	44.5	52.9	43.8	45.9	48.4	51.1	53.4
NORTH EASTERN ..	Omeo ..	1	199	251	224	229	207	246	209	228	222	317	290	243
		2	77.8	78.7	73.0	65.2	57.9	51.4	50.5	54.0	59.7	65.4	71.2	75.9
		3	48.3	48.9	45.8	40.2	35.8	33.0	31.9	33.2	37.3	39.7	43.2	47.1
	Wangaratta ..	1	160	167	190	215	196	272	263	242	221	268	204	167
		2	86.7	87.5	80.9	71.3	63.5	56.4	55.2	58.3	63.8	70.2	78.2	84.1
		3	58.5	59.3	54.0	46.9	41.9	39.3	38.1	39.7	42.8	46.7	51.4	56.3
WEST GIPPSLAND ..	Wilson's Promontory	1	168	230	314	364	398	437	433	505	353	390	327	237
		2	66.7	68.2	66.4	62.3	58.6	55.1	53.9	55.1	57.3	60.3	62.2	65.1
		3	56.9	58.7	57.4	54.7	52.1	49.0	47.7	47.7	48.8	50.3	52.2	55.1
	Yallourn ..	1	194	272	198	241	419	360	344	399	364	380	344	266
		2	77.7	77.4	74.3	65.8	60.7	55.3	54.9	57.3	62.0	66.3	70.2	75.3
		3	53.7	54.7	49.1	48.2	43.9	40.5	38.8	40.5	42.5	45.7	49.1	52.3
EAST GIPPSLAND ..	Bairnsdale ..	1	245	223	263	238	193	246	182	181	194	281	298	284
		2	75.3	76.1	73.0	67.5	62.5	57.5	57.0	59.5	63.2	67.5	70.6	74.0
		3	53.5	54.5	51.7	46.9	42.5	38.8	38.1	39.6	42.7	46.1	49.0	52.4
	Orbost ..	1	286	256	298	335	255	382	263	224	241	324	316	317
		2	76.5	75.6	73.1	67.5	62.5	57.9	58.0	60.0	64.0	66.4	70.2	74.3
		3	54.3	54.5	52.5	48.2	44.2	40.3	38.5	39.7	42.1	45.9	49.7	52.0

(Points : 100 = 1 inch).

\* Legend :—1. Average Monthly Rainfall in Points.  
(For 30 years 1931-60).2. Average Daily Maximum Temperature (°F.).  
(For 30 years 1911-40).3. Average Daily Minimum Temperature (°F.).  
(For 30 years 1911-40).



VICTORIA—DISTRICT MONTHLY RAINFALL :  
AVERAGE AND 1964

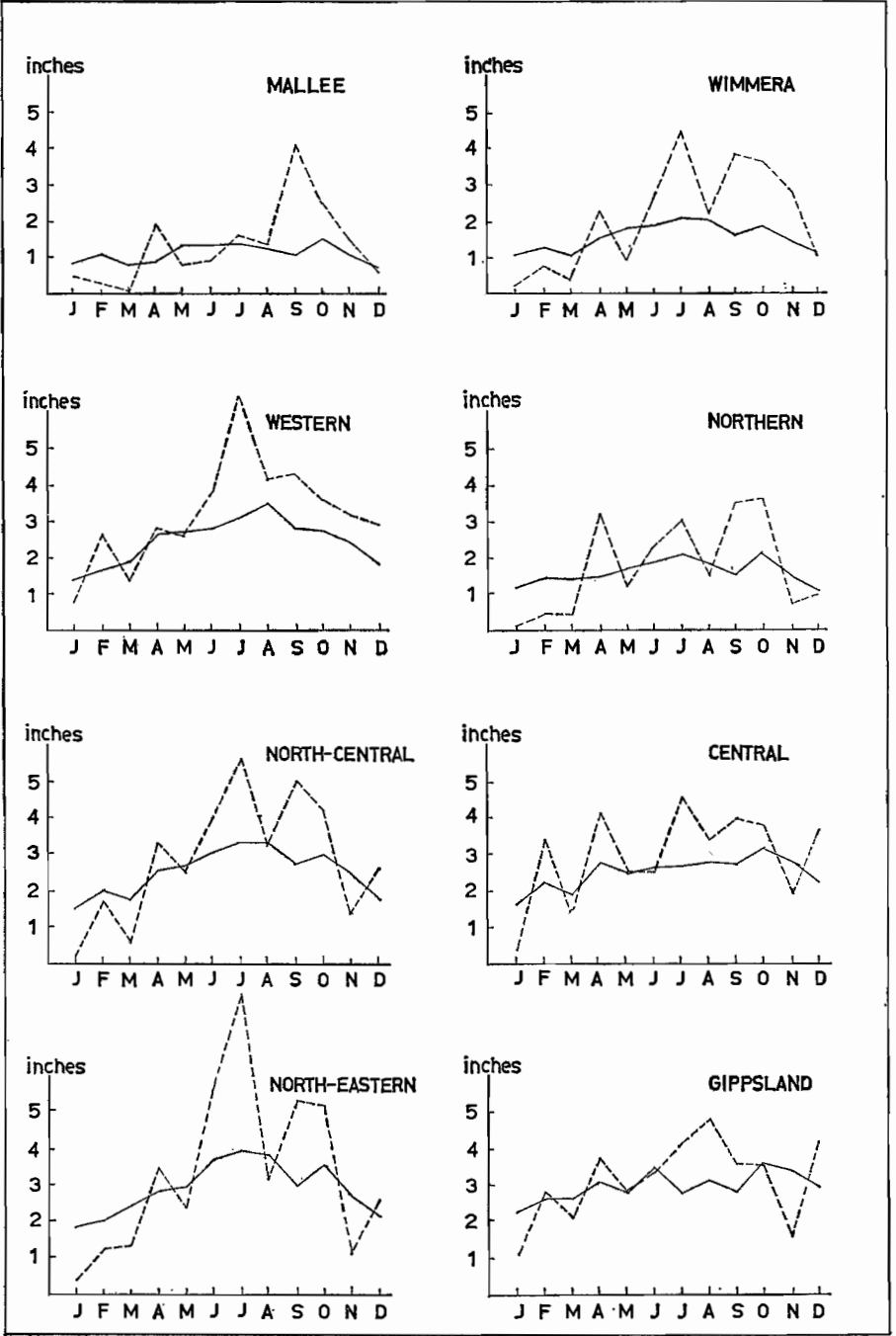


FIGURE 7. AVERAGE ——— 1964 - - - - -

The means of the climatic elements for the seasons in Melbourne computed from all available official records are given in the following table :—

## MELBOURNE—MEANS OF CLIMATIC ELEMENTS

Meteorological Elements	Spring	Summer	Autumn	Winter
Mean Pressure of Air (Inches) .. ..	29·974	29·924	30·077	30·077
Monthly Range of Pressure of Air (Inches)	0·891	0·758	0·814	0·976
Mean Temperature of Air in Shade (°F.) ..	57·8	66·7	59·5	50·1
Mean Daily Range of Temperature of Air in Shade (°F.)	18·7	21·1	17·4	14·0
Mean Relative Humidity (Saturation = 100)	64%	59%	68%	74%
Mean Rainfall (Inches) .. ..	7·39	6·09	6·63	5·88
Mean Number of Days of Rain .. ..	40	25	35	44
Mean Amount of Evaporation (Inches) ..	10·25	17·32	8·12	3·79
Mean Daily Amount of Cloudiness (Scale 0 to 8)* .. ..	4·9	4·2	4·8	5·2
Mean Number of Days of Fog .. ..	1·4	0·6	6·5	7·8

\* Scale 0 = clear, 8 = overcast.

In the following table are shown the yearly means of the climatic elements in Melbourne for each year 1960 to 1964. The extreme values of pressure and temperature in each year are also included.

## MELBOURNE—YEARLY MEANS AND EXTREMES OF CLIMATIC ELEMENTS

Meteorological Elements	1960	1961	1962	1963	1964
Atmospheric Pressure (Inches)—					
Mean .. ..	29·996	30·050	30·010	30·012	29·953
Highest .. ..	30·570	30·620	30·594	30·597	30·580
Lowest .. ..	29·157	29·367	29·366	29·315	28·970
Range .. ..	1·413	1·253	1·228	1·282	1·610
Temperature of Air in Shade (°F.)—					
Mean .. ..	58·8	61·1	60·1	59·5	58·6
Mean Daily Maximum .. ..	67·6	70·4	68·6	68·0	66·5
Mean Daily Minimum .. ..	50·0	51·9	50·7	51·0	50·7
Absolute Maximum .. ..	105·0	107·0	104·0	99·0	103·3
Absolute Minimum .. ..	31·3	33·4	31·8	29·3	36·0
Mean Daily Range .. ..	17·6	18·5	17·9	17·0	15·8
Absolute Annual Range .. ..	73·7	73·6	72·2	69·7	67·3
Terrestrial Radiation .. ..					
Mean .. ..	45·9	48·2	47·3	48·5	47·7
Minimum (°F.) .. ..	33·50	22·05	23·06	29·04	27·80
Rainfall (Inches) .. ..	162	129	140	149	166
Number of Wet Days .. ..	41·44	42·17	43·21	37·79	35·54
Year's Amount of Free Evaporation (Inches) .. ..	65	65	61	67	66
Mean Relative Humidity (Saturation = 100) .. ..	4·9	4·4	4·5	4·7	5·1
Cloudiness (Scale 0 to 8)* .. ..	21	18	9	20	12
Number of Days of Fog .. ..					

\* Scale 0 = clear, 8 = overcast.

An estimate of the areas of the State subject to different degrees of average annual rainfall, and the actual distribution of rainfall in Victoria as shown by area for 1963 and 1964 are shown in the following table :—

**VICTORIA—DISTRIBUTION OF AVERAGE AND ANNUAL  
RAINFALL**

Rainfall (Inches)	Area ('000 Square Miles)		
	Average	1963	1964
Under 10 .. .. .	Nil	Nil	Nil
10-15 .. .. .	19·7	7·8	5·7
15-20 .. .. .	13·4	21·6	17·7
20-25 .. .. .	15·7	17·9	12·0
25-30 .. .. .	15·8	14·9	12·3
30-40 .. .. .	14·2	14·2	23·1
Over 40 .. .. .	9·1	11·5	19·1