Part 1

PHYSICAL ENVIRONMENT

Land Flora of Victoria

History of Investigation

The first European to note or collect any plants within the area now constituting Victoria was Robert Brown, naturalist on Captain Matthew Flinders' voyage of discovery in the "*Investigator*". After the ship entered Port Phillip Heads, a landing was made near Dromana on 26th April, 1802, when Brown ascended Arthur's Seat. During the week that Flinders remained in this large land locked bay, Brown doubtless made other exploratory sorties around the northern shores of Mornington Peninsula, but he was absent from the party which climbed Station Peak (You Yangs) on the western side of Port Phillip. Little could be found in bloom so late in the autumn, and it is not surprising that very few botanical specimens were taken. Brown returned to Port Phillip (from the Tamar, Tasmania) on 18th January, 1804, and spent another week in the vicinity of present-day Sorrento during the abandonment of Collins' attempt to found a settlement there; he left for Hobart on the "*Lady Nelson*" with the last party of evacuees on 27th January. Among the specimens pressed on this latter occasion was an original sample of the showy, summer-flowering Blue Pincushion (genus *Brunonia,* a latinized form of Brown's name).

The full extent of these earliest botanical collections is not known, but there is evidence that Brown gathered from (or noted) about 100 species, eighteen of which provided the type material of undescribed plants. Owing to the brevity of his two visits, that great botanist unfortunately collected far less from Victorian soil than from any of the other Australian States.

Allan Cunningham, who devoted almost twenty years to constant collecting trips around the coasts of Australia and New Zealand (from 1817 until the time of his death in 1839), apparently by-passed Victoria. Hume and Hovell's epic overland journey from Sydney to Corio Bay late in 1824 was quite unproductive botanically. The Tasmanian botanist Ronald Gunn (1842) mentions his "own collection during a short visit to the south coast of New Holland in March, 1835", and James Backhouse, a visiting Quaker missionary who spent ten days in the environs of Melbourne during November, 1837, may have secured a few plant specimens—his published narrative (1843) certainly refers to several trees noted near the Yarra mouth.

After Brown, it was more than 32 years before any significant attempt was made to unveil the vegetation of Victoria. Between June and October, 1836, Major T. L. Mitchell crossed the western half of the State from Swan Hill to Portland via Pyramid Hill, the Grampians, and Lower Glenelg River, returning to the Murray at Wodonga by a line through the Pyrenees, Mount Alexander, Nagambie and Warby Range. During the four months approximately 1,100 miles were covered and at least 150 numbers of plants collected. Professor John Lindley worked over this collection in London, describing 40 items as species new to science.* Several of Mitchell's plants had already been discovered around Port Phillip Heads by Brown, so that no more than about 180 species accrued from the combined efforts of these pioneer investigators.

F. M. Adamson, an early settler near Melbourne, collected specimens of local plants between 1840 and 1855, sending them to Sir William Hooker at Kew, England. Simultaneously J. G. Robertson, who managed a pastoral holding in the Casterton district, accumulated a collection of some 4,000 dried specimens which were also presented to Kew upon his return to Britain in the mid-1850's. These, apparently, were the first botanical contributions by residents within the Colony, but none of their material remained here—there was no local repository to receive it.

Probably no more than about 500 plant species had ever been collected in Victoria up to 1852; but early in the winter of that year, a young German migrant, Dr. Ferdinand Mueller, came from Adelaide to the newly discovered Victorian goldfields where he had thoughts of establishing a pharmaceutical business in the Castlemaine district. He arrived with the reputation of a sound botanist, for during the previous four and a half years his extensive travels and collecting trips through South Australia had given him a wide knowledge of the indigenous flora, and important contacts had been made with leading European authorities. At this time, Lieutenant-Governor La Trobe was looking for a capable man to act as colonial botanist and to begin a thorough survey of the country's vegetation. Mueller, recommended by Sir William Hooker of Kew, received the appointment which took effect on 26th January, 1853. This choice could hardly have proved more propitious, and from then until Mueller's death 43 years later, the investigation of Victorian plant life became almost identical with the activities of this extraordinary man. He was virtually alone in the field, confronted with the most meagre information and equipment (all the few prior collections of Victorian plants being overseas and quite inaccessible), so it was necessary to build up a local reference herbarium for indigenous flora.

Within six weeks of appointment, Mueller was away exploring the alpine regions of Mounts Buffalo and Buller by packhorse. After collecting at the highest altitudes, he crossed the rugged intervening terrain to the Latrobe River sources, travelled down to Wilson's Promontory, and so back to Melbourne along the coast—a three-months' trip of about 1,500 miles. Before the same

* *See* T. L. Mitchell, *Three Expeditions into the Interior of Eastern Australia* Vol 2 : pages 127 to 301 (1838).

year was out, he set off on a more ambitious journey, embracing 2,500 miles and lasting five and a half months. This was westward from Melbourne to the Grampians, across to the Avoca River sources and down that stream almost as far as the Murray River, then west again to Lake Lalbert and through Mallee scrub to Swan Hill, down the Murray to Wentworth and then back along that river to Albury, up the Mitta Mitta to Omeo and the high Cobboras peaks (6,000 feet), down the Snowy River and then west across the various Gippsland waterways to Melbourne again. He had been practically all around the Colony, the combined 4,000-mile treks of 1853–54 acquainting him with 1,500 species of higher Victorian plants, many being unknown to science and requiring formal publication with descriptions. These were the forerunners of many botanical journeys undertaken within and beyond the boundaries of Victoria.

Books and papers on botanical subjects flowed from Mueller's facile pen, to the number of more than 800 at the time of his death in October, 1896 ; included were colonial floras, large monographs on eucalypts, acacias, saltbushes, &c., and 94 fascicles of the *Fragmenta Phytographiae Australiae* (1858-82) which has the distinction of being the only Australian scientific periodical entirely in Latin. Between 1858 and 1861, Mueller's herbarium collection grew from 45,000 to 160,000 specimens. By 1868, his estimate was of 350,000—a phenomenal result for one man in just 15 years. So thoroughly did he browse over his "Australia Felix" that remarkably few species were left for subsequent collectors to discover.

Yet Mueller gladly received and acknowledged help from residents in distant places : from pastoralists, miners, clergymen, school teachers, surveyors, local naturalists, &c., whose novelties he often named after their discoverers. Mueller's labours in the cause of science earned a hereditary barony from the King of Würtemberg in 1869, and a K.C.M.G. from Queen Victoria in 1879.

The Field Naturalists' Club of Victoria, founded in 1880, enjoyed the patronage of Baron von Mueller who was a frequent writer for the Club's journal (*Victorian Naturalist*), laying the foundation of a botanical tradition that has lasted up to the present time. Indeed, after the Baron's death, systematic studies of the Victorian flora were very largely carried on by amateur naturalists who roamed the State, collecting and describing their findings in the *Victorian Naturalist*. More than 200 new species of plants have now been published in this journal which has served as a most useful medium for disseminating botanical information.

Physical Environment

The natural distribution of plant life must be considered against a background of geography and geology; for the vegetative cover of any land surface is governed primarily by climate (viz., average weather at a given place over a long period of years) which, in turn, is a reflection both of geographical position and physiography. Over vast flat expanses of territory the maximum and minimum temperatures will become regularly lower with increasing distance from the Equator; but in mountainous terrain, the isotherms will be strongly influenced

by altitude, following topographic contours instead of retaining a normal east-west trend. The interception of oceanic winds by any lofty mountain chain inevitably means higher precipitation on the windward slopes, whether the latitude be torrid or temperate: either tropical or cool-temperate rain forests may be anticipated on one side of the barrier, and sclerophyllous woodland, scrub, savannah, or even desert on the other.

Changes of soil within a climatic belt commonly result from geological construction; they play an important, if more local and secondary, role in determining vegetational characteristics. For instance, wind-blown sand of low water-holding capacity or gravel deposits will carry a plant community differing markedly in floristic composition and physiognomy from that inhabiting a nearby tract of waterlogged clay. Saline soils favour communities with special adaptations (e.g., leaf succulence). In the Alps, where all soils are frozen for months in succession, underlying rock structure—whether granitic, basaltic, or sedimentary—has little influence on vegetation, being entirely subordinate to the modifications imposed by a vigorous climate.

Such environmental effects are well exemplified within Victoria where, despite its relatively small size of 87,884 square miles (less than 3 per cent. of the whole Australian continent), a surprising diversity of topography, weather, and soil-type is involved : from near desert conditions, with a rainfall of under 10 inches, in the hot lowland interior to alpine meadows, above 5,000 feet, where snow may lie for six months or longer. A rich, varied flora exists at and between these climatic extremes, so that Victoria can claim about 16 per cent. of the 15,000 ($\pm$) species of vascular plants indigenous to Australia.

Geographically Victoria lies entirely south of the 34th parallel of austral latitude (and chiefly south of the 36th), sharing with Tasmania a predominantly temperate climate and flora; but the island State completely lacks the hot, dry continental climate obtaining in Victoria's north-western quarter. The extensive coastline of Bass Strait, coming under the influence of cool water from the Southern Ocean, enjoys a mean maximum summer temperature 15 to 20 degrees lower than in the far north-west, while in the extreme east a warm southward moving ocean current tempers the climate of coastal East Gippsland where frosts are rare.

During the wetter months of winter and spring (May–October), north-westerly winds prevail over Victoria and Tasmania; but in summer and autumn (November–April), when trade winds move down from the tropics, the depressed westerly system is deflected so as to blow into Bass Strait from the south-west. Another feature of Victorian summers is an occasional very hot wind from the northern interior, which desiccates foliage and aids the rapid spread of disastrous fires. Under consistently hot, dry conditions the plant formations become strikingly dissimilar from those characteristic of cool, moist places, e.g., the Mallee scrub in contrast to wet sclerophyll forest with its wealth of ferns.

The major physiographic feature in Victoria is the so-called "Dividing Range" and its ancillary north-south mountain spurs. Entering from New South Wales on a wide front of about 190 miles (between Albury and Cape Howe) this highland wedge extends westward, and gradually contracts, for almost 400 miles through the centre of the State until it terminates rather abruptly at the Grampians; two small detached ridges of similar geological structure (Black and Dundas Ranges) occur 8-14 miles farther west, while the actual "Divide" becomes lost on the plain country near Edenhope which has an elevation of only 400 to 600 feet. A low constriction at Kilmore Gap, only 30 miles north of Melbourne, cuts the mountain backbone into eastern and western portions of which the former is much larger, higher, wetter and colder—alpine conditions exist only to the east, attaining maximum development in the north-east (Bogong region).

Two isolated upland areas, near Cape Otway and in South Gippsland (including the detached mountain mass of Wilson's Promontory), have a rainfall in excess of 50 inches and, although at lower altitude, their climatic and vegetational affinities are with wetter parts of the eastern massif. High average rainfalls are restricted to the highlands; and in three small districts of Victoria (viz., Laver's Hill–Beech Forest in the Otways, Bright–Buckland, and the Bogong High Plains) mean annual precipitation exceeds 70 inches, the highest average for the State being 95·5 inches on the Bogongs where an actual maximum of 169 inches was recorded in 1956—chiefly in the form of snow.

Almost surrounding the Central Highlands are plain tracts: the drier Murray Basin Plains and Wimmera Plains to the north and west, better watered Gippsland Plains to the south-east and basaltic Western District Plains of great extent in the south-west, the last merging into small, sandy, coastal plains near Portland and Peterborough. The northern and coastal plains represent sedimentary basins, chiefly of marine deposition during Tertiary times.

The only other physiographic feature of consequence is that large north-western area (about 20,000 square miles) of sand hills, gypsum flats, and salt pans, collectively known as the Mallee and grading rather imperceptibly into the Wimmera Plains. It lies mostly below the 300-ft. contour and also below the 16-in. isohyet of annual rainfall, the Murray River forming a natural northern boundary. Here the mean maximum temperature for summertime (December–March) is between 84°F. and 92°F., with an actual maximum of 123·5°F. recorded at Mildura.

Vegetation Provinces

General

With the broader environmental pattern thus briefly sketched, its relationship to the natural distribution of plants may now be discussed. In such a complex region as Victoria, where many types of vegetation overlap each other, merge or blend, it is almost impossible to provide

clear-cut boundaries for even the major communities. The extreme formations of forest and grassland are easily recognizable, but connecting them are woodland, savannah, and scrubs of varying degree.

In the accompanying map, all timbered areas are indicated by horizontal shading; these include forests (Reserved Forest and unalienated Crown lands), woodlands, and mallee, but not open heath or scrub of any kind.

Ecologists differ in their interpretation of the higher floristic units of classification, but the largest widest unit recommended for use in Australia is the *alliance* (equivalent to " association " of some writers). This category takes the name of one or two dominant plant species which impart a distinctive physiognomy—for instance, a *Eucalyptus camaldulensis—E. largiflorens* Alliance embraces the characteristic forestal and woodland growth still dominating the flood plain of the Lower Murray and Wimmera Rivers, while a *Themeda australis-Danthonia caespitosa* Alliance formerly occupied much of the grassland formation on the Keilor basaltic plains near Melbourne. It has been found convenient to divide Victoria into ten " vegetation provinces " which, while defined in the main by topography and soil, do indicate the larger structural groupings of plant-life. These provinces are listed below, with appropriate comments.

Eastern Highlands

The 600-ft. contour has been taken as the approximate boundary for highland Victoria. Since the State's great mountain wedge is pinched near its centre by the low Kilmore Gap (almost due north of Melbourne and along the 145th meridian), splitting of the former into eastern and western sections is a useful expedient, if quite arbitrary. Before the white man's arrival, the whole east highland region was forested up to an altitude of about 5,500 feet, above which were, and still are, limited areas of alpine grassland, herbfield and sphagnum bog (see pages 22–23). On favourable, moister aspects the tall valuable forests of wet sclerophyll type may even approach true temperate rain forest, whereas lower, more open forests on the northern foothills pass into savannah or grassland—formations now radically altered through grazing and agriculture. Reference to the map facing this page will show that far more forested country survives in this highland province than to the west of Kilmore Gap, probably because steeper slopes, rockier terrain, more persistent scrub, and long winter cold have precluded normal farming.

The important eucalypt alliances on these eastern mountains, from higher to lower altitudes, are : *Eucalyptus pauciflora* var. *alpina* (Snow Gum—usually above 4,500 feet), *E. delegatensis—E. dalrympleana* (Alpine Ash and Kindlingbark—at 3,000-4,500 feet), *E. regnans* (Mountain Ash—chiefly south of the Divide, and usually below 3,000 feet), *E. obliqua—E. radiata* (Messmate and Peppermint—very widespread), *E. sieberiana—E. scabra* (Silvertop and White Stringybark—chiefly East Gippsland), *E. macrorrhyncha—E. polyanthemos* (Red Stringybark and Red Box—drier northern ridges where rainfall is below 40 inches). Other trees which may form

Prepared for Victorian Year Book No. 76
Published by the Commonwealth Bureau of Census and Statistics, Victorian Office
A.C. Brooks, Government Printer, Melbourne 1961

NOTE

Results of the 1961 Census as available at the time of printing can be found in the Special Supplement following the Index.

extensive societies are *Eucalyptus stellulata* (Black Sallee—damp sub-alpine flats and gullies), *E. dives* (Broad-leaved or Blue Peppermint —drier, stony ridge-tops), *E. viminalis* (Manna Gum—moist valley slopes and stream banks), *E. bicostata* (Eurabbie, leaves of which may attain 30 inches in length), *E. elaeophora* (Bundy or Long-leaf Box), *E. bridgesiana* (But-But or Apple Box), *E. maculosa* (White Brittle Gum) and *E. rubida* (Candlebark). *E. neglecta* is endemic in gully-heads of the Eastern Highlands, while the Monaro species *E. kybeanensis* and *E. glaucescens* are small mallee-like trees restricted in Victoria to a few mountain peaks.

Species of *Acacia* form a prominent under-storey almost throughout the forest communities, and other leguminous shrubs (e.g., *Pultenaea, Daviesia, Oxylobium, Goodia* and *Indigofera* species) may dominate local societies. Representatives of *Pomaderris, Pimelea, Leptospermum, Zieria, Tieghemopanax, Prostanthera* (chiefly *P. lasianthos*), *Coprosma, Olearia, Cassinia* and *Helichrysum* are usually abundant, forming scrubs of varying composition wherever fire has opened up the forest. Conspicuous among the larger herbaceous plants are several members of *Senecio* (groundsels and fireweeds) and *Veronica* (speedwells). Ferns are more frequent in this province than elsewhere, and of these *Pteridium esculentum* (Bracken) is ubiquitous. Two noteworthy grasses are the harsh scrambling *Tetrarrhena juncea* (Forest Wire-grass), which may form tangles to 10 feet, among gully trees, and robust erect *Festuca dives* (Giant Mountain Grass) of similar height; the incidence of both is much increased by bushfires. *Wittsteinia vacciniacea* (Baw-Baw Berry) is a procumbent epacrid of damp, shady places in montane to subalpine forests; it has large pendent berries, and the monotypic genus is one of two that are endemic in Victoria.

The fern-gully is a specialized community within mountain forests, chiefly on and south of the Divide, and has a very distinctive facies. Abundant moisture, mild temperatures, and protection from wind are the factors responsible for the variety and luxuriance of ferns that cover the ground in deep sheltered valleys. There may be three distinct canopies above the floor of a typical fern-gully, viz.: tall eucalypts such as Mountain Ash, a mixture of smaller trees (Blackwood, Silver Wattle, Blanket-leaf, Musk Daisy-bush, Sassafras, and sometimes, Myrtle Beech), and beneath these a dense canopy of tree-ferns. So much light is excluded by these successive tiers of foliage that only about one-fiftieth of the possible intensity (in full sunlight) reaches earth, where maximum illumination is comparable with a greenish twilight. Delicate terrestrial or epiphytic ferns, mosses, fungi, and a few very shade-tolerant herbs (such as *Uncinia tenella, Chiloglottis cornuta* and *Australina muelleri*) are the principal inhabitants of the gully floor. The best development of fern gully vegetation, with deep humus, is to be found either in association with *Nothofagus cunninghamii* (Myrtle Beech)—toward the south-east of the province—or in East Gippsland where subtropical " jungle " trees and climbers often replace the usual upper storey of eucalypts and acacias.

Within such a large provincial area as the Eastern Highlands certain regions, by virtue of their climate or geological structure, have peculiar floristic features that warrant separate mention. Of such are the Alps (above 4,200 feet), also East Gippsland where pockets of near-coastal jungle contrast with drylands along the Upper Snowy River; both of these are discussed in the next section—" Some Regions of Special Interest." Pine Mountain, in the far north-east near Tintaldra, marks the only Victorian locality for a few noteworthy shrubs, while *Acacia triptera* and *A. decora* are unknown in Victoria beyond the Warby Range—an isolated granitic ridge close to Wangaratta and noted for its rich colourful flora. Immediately west from Warby Range are several detached highland outliers in the Northern Plains, but they lack any particular floristic interest.

Western Highlands

No part of this hilly sector attains 4,000 feet, and only at Mount Macedon, Mount Buangor and several parts of the Grampians do points exceed 3,000 feet. Consequently, with its lower relief, gentler slopes, and virtual absence of alpine conditions, the flora is deficient in many eastern species and relatively poorer. Far more of the original forestal growth has been removed and the land turned over to grazing. Such fern-gullies as occur are small and very scattered, but larger fungi become conspicuous after autumn rains.

Messmate–Peppermint is again a very widespread eucalypt alliance, passing into Red Stringybark–Red Box on drier northern slopes of the Divide and finally into *Eucalyptus microcarpa—E. sideroxylon* (Grey Box and Red Ironbark) where rainfall passes below 25 inches on many parts of the western goldfields—at Bendigo, Maryborough, St. Arnaud, Stawell, &c.; in these places Red Stringybark tends to follow the crests of ridges, with Ironbark on the flatter terrain. *Acacia* species (*A. pycnantha, A. diffusa, A. acinacea, A. aspera,* &c.) and other legumes are still prominent components of the forest undercover, orchids being usually conspicuous during spring.

The transition to savannah of the Northern Plains is often gradual; but a more abrupt change of formation obtains along the southern boundary where Western District lava flows impinge on the older sedimentary hills, bringing grassland against forest. Some points of eruption were in the heart of the highlands, so that elevated sheets of basalt occur as isolated inliers; the two most extensive of these are from Ballarat to Maryborough, and between Daylesford and Kyneton. Such higher-level basalts probably supported a savannah woodland, with *Eucalyptus camaldulensis* (Red Gum) and *E. viminalis* (Manna Gum) variously dominant.

North of Bendigo an interesting extreme of forest carries diminutive, often stunted eucalypts having Mallee affinities, but growing on low ironstone ridges of sedimentary origin. The four chief components are *Eucalyptus behriana, E. viridis, E. fruticetorum* and *E. froggattii* which have been exploited locally for the extraction of oil. This formation is the so-called " whipstick scrub " which is floristically very rich, in springtime affording a pageant of colour

from numerous undershrubs (species of *Grevillea, Acacia, Melaleuca, Loudonia, Prostanthera* and *Dampiera*), with many orchids and other seasonal herbs.

The Grampians, a large circumscribed mountain system of parallel sandstone ranges that rise to above 3,000 feet, has so many botanical points of interest that it is discussed separately (see under "Some Regions of Special Interest").

Northern Plains

Between the Highlands and Murray River, a vast level expanse stretches east and west for about 360 miles (from the Hume Reservoir near Wodonga to the South Australian border near Edenhope). Undulating Mallee country adjoins it to the north-west, and the south-western boundary is rather indefinite by virtue of a gradual transition to timbered coastal plains of the Lower Glenelg drainage system. In general, the region is delimited by the 15-in. and 25-in. isohyets of annual rainfall (which is more effective at the western extremity). The most frequent soils are neutral silty loams overlying alkaline clays which owe their origin to flood-plain deposition by streams flowing into the Murray. Over much of the Wimmera district (west from Donald) the plains are characterized by heavier grey calcareous clays that swell when wet and crack deeply upon drying (the *gilgai* or "crab-hole" structure in areas of poor drainage).

Before settlement, extensive grasslands alternated with savannah and savannah-woodland in which *Eucalyptus microcarpa Casuarina luehmannii* (Grey Box and Bull-oak) was an almost universal alliance, these two dominants each sometimes occurring alone. *Santalum acuminatum* (Quandong), *Acacia homalophylla* (Yarran) and *Melaleuca lanceolata* (Moonah) appeared here and there, the last on shallower soil. The few watercourses were marked by narrow woodlands of *Eucalyptus camaldulensis* (Red Gum), joined by *E. largiflorens* (Black Box) in the Wimmera where Myall (*Acacia pendula*) occurred rarely —it is now almost extinct. Sandy rises supported open groves of Cypress-pine or "Murray Pine" (*Callitris columellaris*), while occasional residuals of bedrock that rise above the alluvium (e.g. Mount Major near Dookie, Mount Hope, Pyramid Hill, and The Terricks, Mount Jeffcott between Charlton and Donald, Mount Arapiles) carried woodlands or scrub. In spring many seasonal herbs made a bright display, viz., certain orchids and lilies, species of *Ptilotus, Ranunculus, Swainsona, Eryngium, Convolvulus, Wahlenbergia, Goodenia,* and *Compositae* (*Brachycome, Minuria, Helipterum, Calocephalus* &c.). In swampy depressions nearer the Murray, *Craspedia globosa* (Drum-stick Buttons) was a striking feature, its large yellow and spherical heads often borne on stems 3-4 feet high.

Virtually all the Northern Plains are now grazed or under cultivation; it is the State's great "wheat bowl", irrigated parts (as in the Goulburn Valley) being turned to orchards and dairy farms. Thus the native vegetation has been either profoundly disturbed or replaced altogether, and only remnants of it now exist along roads, railway lines, creek frontage reserves, in cemeteries, and a few plots of unalienated Crown land.

Mallee

Occupying almost the whole arid north-western quarter of Victoria, and typifying many thousands of square miles in southern Australia, the Mallee formation consists of small, highly drought resisting eucalypts having a characteristic life-form, but the region is by no means botanically homogeneous. Its southern boundary with the Wimmera is irregular and now obscured through extensive clearing for crop land; the northern limit, however, is marked by a fringing forest of River Red Gum and Black Box along the flood-plain of the Murray, where swampy tracts may be completely dominated by tangles of *Muehlenbeckia cunninghamii* (Lignum). *Acacia stenophylla* (Eumong), *A. salicina* (Cooba) and *A. victoriae* (Bramble Wattle) are small trees of the river forest where *Glycyrrhiza* (Southern Liquorice), *Trigonella* (Sweet Fenugreek), *Swainsona* and *Psoralea* species are sometimes abundant on open inundated flats. Interspersed throughout the Mallee are areas of dry heath, grassland, saltbush, and halophytic communities on the salt-encrusted beds of dry shallow lakes—a prominent feature of the " Raak " country west from Kulkyne National Park.

The aboriginal name " mallee " refers not to any particular species of tree, but to a habit of growth: a large underground ligno-tuber (" mallee root ") that gives rise to several slender spreading trunks with umbrella-like clusters of branchlets and sparse foliage at their extremities. The canopy resulting from many trees is very even and horizontal at about 10 to 30 feet above the ground, heights depending upon soil quality. True mallee scrub, in which several co-dominant species may be involved, occurs on sandy ground usually underlain by travertine limestone at varying depths. The eucalypts (in Victoria chiefly *E. oleosa* with numerous forms, *E. dumosa, E. incrassata, E. leptophylla and E. gracilis*) are popularly designated by such colour adjectives as Red, Yellow, Blue, White, or Green Mallee. Other small trees frequently associated are *Callitris verrucosa, Acacia ligulata, Exocarpos aphyllus* and *Dodonaea attenuata,* together with shrubs of great variety (notably *Acacia* and *Olearia* spp.). The curious unisexual Bell-fruit Tree or " Native Poplar " (*Codonocarpus continifolius*) is occasional, but very conspicuous from its pyramidal habit, smooth pinkish bark and bright green oval leaves —with a burning taste like horse-radish. Succulent *Zygophyllum apiculatum* (Twin-leaf) is a common ground cover in more stunted mallee on nodular limestone ; stock avoid it.

On ridges of deeper, reddish-brown sand the culminating alliance is *Callitris preissii—Casuarina cristata* (Pine and Belah); these two important trees are associated with other smaller kinds, notably *Heterodendron oleifolium* (Cattle-bush), *Pittosporum phillyreoides* (Weeping Pittosporum), *Myoporum platycarpum* (Sugarwood, or locally " sandalwood "), *Eremophila oppositifolia* (Weeooka, an emu-bush), *Hakea vittata* and *H. leucoptera* (needlewoods), *Santalum acuminatum* and *S. murrayanum* (quandongs).

Mallee-heath formation has developed on the white, less consolidated sand dunes of apparently more recent origin; it includes a few shrubby species that are common to coastal heaths (e.g., in *Aotus,*

Leptospermum, and *Hibbertia.*) There is a more varied assortment of shrubs than elsewhere in the province, members of *Grevillea, Exocarpos, Acacia, Comesperma, Lasiopetalum, Baeckea, Loudonia, Westringia, Prostanthera, Eremophila, Dampiera,* and *Olearia* contributing to the colourful springtime facies; some *Acacia* blossoms are deliciously scented. The hummock-forming, very spiny *Triodia scariosa* and *T. irritans* (Porcupine Grass) are frequent, heightening the interest of this formation, and three xeromorphic sedges may be locally common, viz., *Schoenus subaphyllus, Gahnia lanigera* and *Lepidosperma viscidum.*

Natural grassland areas are rather poor in species, representatives of *Danthonia* (wallaby-grasses), *Stipa* (spear-grasses), *Eragrostis* (love-grasses), *Chloris* (windmill-grasses) and *Bromus arenarius* (Sand Brome) being significant. Diminutive ephemerals of the *Cruciferae, Crassulaceae* and *Compositae* are very abundant during early spring. This formation has been radically changed through grazing and agriculture, the small introduced *Schismus barbatus* (Arabian Grass) becoming almost ubiquitous and many alien weeds—chiefly from the Mediterranean—exceedingly abundant.

Salt pans, gypsum and clay flats are remarkable for the strong development of succulent vegetation, chiefly low shrubby members of *Chenopodiaceae* in the genera *Atriplex* (saltbushes), *Kochia* (bluebushes), *Bassia, Salsola, Arthrocnemum* (glassworts) &c., with *Disphyma australe* (Rounded Noon-flower or Pigface) as a carpet-forming pioneer. *Frankenia* and *Plagianthus* species intermingle with the other halophytic shrublets. In the farthest north (between Mildura and Boundary Point) and adjoining the flood-plain forest of the Murray are Mallee-fringed flats that may open out into extensive plains. These areas carry a saltbush formation, sometimes described as "shrub steppe"; its main alliance is *Kochia pyramidata—K. sedifolia* (Shrubby and Hoary Bluebushes), with other *Kochia* species, *Bassia* and *Atriplex* in admixture.

There is an appreciable floristic difference between the far north-west and the Big Desert (of higher rainfall) to the south. These major regions of the Mallee are separated by a strip of more fertile country along the Ouyen-Murrayville railway line. Many *Chenopodiaceae* are restricted to the northern sector which is not invaded by several southern eucalypts (e.g., *E. baxteri, E. leucoxylon, E. porosa, E. calycogona*) and *Acacia* species (*A. acinacea, A. myrtifolia, A. farinosa,* and *A. trineura*). Differences are also apparent among the lower semi-shrubs and seasonal herbs.

The total number of indigenous vascular plants in the far north-west has been estimated as approximately 600 species, mosses as about 30 spp. Among fungi, agarics are poorly represented, but the more drought-tolerant gasteromycetes (puffballs, earth-stars, &c.) are both numerous and varied—20 spp. at least. Such very remarkable fungi as *Montagnites candollei, Phellorinia strobilina, Chlamydopus meyenianus, Geastrum fornicatum* (Arching Earth-star) and *Polyporus basilapiloides* (Stone-making Fungus) are restricted in Victoria to the Mallee.

Little Desert

This circumscribed area of about 700 square miles, west from Dimboola to the South Australian border, is almost surrounded by Wimmera plains. It consists of deep " podzolised " sands in low hillocks, intervening sandy flats and clay pans, with outcroppings of ferruginous sandstone here and there. The flora is closely related to that of the Big or Great Desert (lying about 30 miles farther north), with which it actually links up in the vicinity of Keith, South Australia. A double deficiency of copper and zinc affects these " desert " sands. Some plants of more southern range, e.g., in the Grampians, enter, but do not extend beyond the Little Desert, viz.: *Calectasia cyanea* (Tinsel Lily), *Orthoceras strictum* (Horned Orchid), *Grevillea aquifolium* (Prickly Grevillea), *Acacia mitchellii* (Mitchell Wattle), *Pultenaea d'altonii* (Hoary Bush-pea), *Boronia pilosa* (Hairy Boronia), *Eucalyptus viminalis* (Manna Gum), *Epacris impressa* (Common Heath), &c.

Woodland, mallee, and mallee-heath are the principal formations. On the deeper, leached, white sands the chief alliance is dominated by *Eucalyptus baxteri* (Brown Stringybark), associated often with *Callitris rhomboidea* (Oyster Bay Pine) on the crests of sandhills ; this woodland community also extends far into the Big Desert north of Serviceton. Within the Brown Stringybark alliance damp hollows of sandy loam may support small stands of *Eucalyptus leucoxylon* (Yellow Gum). Another widespread eucalypt alliance is *E. incrassata—E. leptophylla* (Yellow and Slender-leaf Mallee), developed on shallow sand—to 6 inches deep—overlying deep " solonized " clay; it is usually accompanied by dense shrubberies of *Melaleuca uncinata* (Broom-bush) which may form a pure society.

The most varied, floristically rich, and interesting formation is the mallee-heath, with *Banksia ornata—Xanthorrhoea australis* (Desert Banksia and Austral Grass-tree) as a ubiquitous, if somewhat unstable, alliance; other shrubs (viz., *Banksia marginata, Leptospermum myrsinoides* and *Casuarina pusilla*) may be co-dominant in places. The whole community is based on a pyric succession, and the present dominance of certain species depends on regular burning—after 25 fire-free years the ultimate dominants would probably be *Xanthorrhoea* and *Banksia marginata.* Fires at intervals of less than five years have been found to eliminate species of *Banksia, Casuarina* and *Leptospermum;* shrubs could not reach maturity and produce seed in such a short span. Such wholesale destruction is very apparent in parts of the Little Desert that are repeatedly burnt over—presumably for the sake of grazing interests. Colour effects produced in spring by a multitude of orchids, lilies, numerous wattles, bush-peas, guinea-flowers and heaths, species of *Correa, Baeckea, Calytrix, Loudonia, Goodenia, Stylidium, Olearia* and *Helichrysum* are reminiscent of a Western Australian sand-plain, to which the mallee-heath is indeed ecologically akin.

No less than 560 species of indigenous vascular plants and 24 mosses have been collected within this province.

Western Volcanic Plains

Stretching for 190 miles between Melbourne and Heywood (with a narrow constriction near Bannockburn), and delimited to the north and south by Palaeozoic rocks of the Western Highlands and sandy or calcareous Coastal Plains, respectively, are some 6,700 square miles of relatively flat lava flows, tuffs, and scoria. Although by no means uniform in age, extending as they do from Middle Pliocene to Recent (some within the last 10,000 years), these deposits may be conveniently grouped together as a "Newer Volcanic Series"—one of the largest unbroken areas of vulcanicity in the world. The gently undulating surface is dotted with lava or cinder cones, to 1,000 feet in altitude, and there are sundry depressions of internal drainage which may form lakes—Lake Corangamite is more than 80 square miles in area and in 1936 its shallow waters were three times as salt as the sea. Basaltic rock and scoria have produced the richest agricultural and pastoral soils of western Victoria, almost the whole plain tract passing early into private ownership and being farmed from the 1840's and 1850's.

The indigenous vegetation has probably suffered greater changes than in any other province, and it is now possible to walk for miles without seeing an Australian plant. Over much of the region, natives have been entirely replaced by alien crop and pasture species or weeds, so that it becomes a difficult matter to visualize the old ecological pattern. Some species may have suffered extinction; others are now extremely rare.

Rainfall varies from less than 20 inches near the You Yangs to more than 30 inches in the south-west, and the plains appear greenest during winter when many plants begin to flower. Growth is practically dormant throughout summer, the dried clay soil opening in numerous cracks.

The basalt grasslands were always deficient in trees and taller shrubs; Hume and Hovell in 1824 remarked on the paucity of arboreal growth over the plains west of Port Phillip. The severities of exposure to wind, and the frequent shallowness of soil derived from underlying rock, have made conditions generally unfavourable for large woody plants. Introduced windbreaks of Monterey Cypress, pine, or various eucalypts are now a landscape feature on many private holdings.

Surviving pockets of indigenous flora indicate a dominance of *Themeda australis* (Kangaroo Grass) and *Danthonia* spp. (Wallaby-grasses) over considerable areas of grassland, with *Poa australis* (Tussock-grass) and *Stipa variabilis* (Variable Spear-grass) each forming an alliance on moister and drier ground respectively. These perennial grasses do not form a continuous turf, but occur in isolated tufts with much bare ground between individuals. Herbs abound everywhere, their life-form being a dense tussock with reduced leaf surfaces, a mat or rosette plant (pussy-tails, bear's-ear, &c.), a low semi-shrub (bluebushes and rice-flowers), perennating tuber (lilies and orchids), or small ephemerals.

About 450 vascular species have been recorded from basaltic areas near Melbourne ; they include a high percentage of monocotyledons and *Compositae* (daisies), but such characteristically Australian families as *Proteaceae, Epacridaceae* (heaths), *Mimosaceae* (wattles), *Dilleniaceae* (guinea-flowers), *Stylidiaceae* (trigger-plants), and *Goodeniaceae* are very poorly represented or absent altogether. The massed colour of flowers during springtime is similar to that on the Northern Plains, and even the uniform brownness obtaining at the height of summer is relieved by late-flowering blue-bells (*Wahlenbergia bicolor*) or blebs of pink from Blushing Bindweed (*Convolvulus erubescens*).

Occasionally *Eucalyptus camaldulensis, E. ovata, Casuarina stricta, Banksia marginata* and *Acacia melanoxylon* are present as scattered trees in a savannah, the first eucalypt commonly following the courses of streams. Wherever sizeable gorges or canyons have been cut through the basalt, *Hymenanthera dentata* var. *angustifolia* (Tree Violet) takes advantage of the shelter to form dense thickets 8-12 ft. high. It is often accompanied by prickly *Bursaria spinosa* (Kurwan), *Urtica incisa* (Scrub Nettle) and tender *Sambucus gaudichaudiana* (White Elderberry), sometimes also by *Callistemon paludosus* (River Bottle-brush) at the water's edge. *Asplenium flabellifolium* (Necklace Fern) and *Pleurosorus rutifolius* (Blanket Fern) are widespread crevice plants of basalt escarpments and cliff faces, where *Rhagodia nutans, Pelargonium australe, P. rodneyanum* and *Bulbine bulbosa* also frequently perch. Under the micro-climate provided in collapsed lava tunnels and caves, fern growth may be spectacular—at the Byaduk Caves twenty species have been noted, including tree-ferns. With development of basalt barriers (" stony rises "), as between Colac and Camperdown, *Eucalyptus viminalis* may appear abundantly in pure stands, but this woodland is atypical of the province as a whole. Certain points of eruption (e.g., Mount Napier) became well timbered, but others (e.g., Red Rock near Colac) remained quite treeless, until the white man's arrival. Saline areas afford a few succulent species that are more characteristic of a coastal salt marsh, especially *Salicornia australis, Chenopodium glaucum, Selliera radicans* and *Pratia platycalyx*.

Coastal Plains

Tertiary sediments, to a mile thick, underlie an irregular belt of flat country extending from the extreme south-west almost to Mallacoota, and reaching inland for distances up to 50 miles. This near-coastal tract is discontinuous, being broken at several places by later flows of basalt that reach the sea (around Portland and Warrnambool), by the Otway Ranges, the Port Phillip sunkland, South Gippsland hills and a few granite outcrops in East Gippsland. The rainfall gradient descends from about 40 inches in the vicinity of the Otway and South Gippsland Ranges, to less than 25 inches in a rain-shadow area surrounding Sale district and the Ninety-mile Beach. Temperatures throughout are rather uniform, as might be expected from the maritime situation, except that mean minimums in the far east are as much as 6° F. higher than those obtaining in the west. Soils in general are sandy, leached, and copper deficient, those derived from eolianite being calcareous.

In the far south-west of the State it is difficult to fix any definite boundary between Coastal Plains and the West Wimmera section of the Northern Plains. There is a complete mingling of elements; but an arbitrary line, dividing the Glenelg River's northern and western tributaries from streams flowing into South Australia, has been adopted. In East Gippsland the 600-ft. contour conveniently separates plains from highlands. So heterogeneous is the vegetation of this long, effused province that it will be considered in four geographical segments, thus :—

Far South-West

Between Portland Bay and the South Australian border lies a mixture of forest, woodland, heath, swamp, and now, much open farmland. Originally the major part of the area was forested, with *Eucalyptus baxteri* (Brown Stringybark) as the most important alliance, *E. obliqua* (Messmate) and a peppermint, dubiously referred to *E. vitrea*, being frequent associates. The gums *E. ovata* and *E. viminalis* become dominant on wetter sites, while Gippsland Mallee (*E. kitsoniana*) reappears in a few low-lying parts of this district. South Australian Coast Gum or Soap Mallee (*E. diversifolia*) attains its eastern-most limit at Cape Nelson. River Red Gum occurs along major water courses and as a spreading tree in savannah formation to the north.

Damp heathland soils are exceedingly rich in orchids, more than 80 species being on record for the Portland district. Of exceptional interest botanically is the gorge tract of the Lower Glenelg River which flows between impressive limestone cliffs for several miles; an eastern tributary, Little Moleside Creek, includes the western-most treefern gully on the Australian continent, and the whole Lower Glenelg forest region contains no fewer than 23 fern species, 80 mosses, about 50 orchids and many shrubs with decorative flowers. A small detached strip of coastal plain (between Port Fairy and Tyrendarra) is drained by the Eumerella and Shaw Rivers, but has few outstanding vegetational features; dense thickets of *Leptospermum lanigerum* (Woolly Teatree) normally cover flat swampy ground along streams.

West Otways

Extending from Warrnambool to Barwon Heads (west and north of the Otway Ranges, but south of the basalt plains) is another region of coastal heath, swamp, forest, and woodland, repeating many features of the far south-west but less diversified. Brown Stringybark is again an important alliance of the western portions, but is subordinate to Messmate in the east. Much of the land has been, or is now being, cleared for settlement.

West Gippsland Plains

This broken series embraces the once extensive heath along the eastern shores of Port Phillip Bay, the Koo-Wee-Rup Swamp region north of Western Port, French and Phillip Islands, heaths and coastal forests of South Gippsland (west of Corner Inlet). Stunted *Eucalyptus viminalis* is a dominant tree on deep sand, providing the main food

for koalas; it associates in places with *E. cephalocarpa* (Silverleaf Stringybark) or *E. obliqua, E. pauciflora* being occasional and now rare. *E. consideniana* (Yertchuk) and *E. kitsoniana* enter the province near Corner Inlet. *E. ovata* is typical of damp flats, while very waterlogged areas rich in humus carried a dense growth of *Melaleuca ericifolia* (Swamp Paperbark).

The Port Phillip heathlands were remarkably diverse in composition and floral attractiveness, orchids being frequent; but settlement has brought them almost to vanishing point. The ericoid type of foliage (small, narrow, rigid, and often spine-tipped leaves) was a manifest feature throughout most heathland associations, whether dominated by *Leptospermum laevigatum* (Coast Tea-tree), *L. myrsinoides* (Silky Tea-tree), *Olearia ramulosa* (Twiggy Daisy-bush), *Ricinocarpos pinifolius* (Wedding Bush), *Acacia oxycedrus* (Spike Wattle), *Aotus villosa* (Aotus), *Casuarina paludosa* (Swamp She-oak) or other shrubs.

East Gippsland Plains

In their western parts, near Morwell and Port Albert, the plains of this fourth series carry stringybark woodlands intermingling with patches of heath; *Banksia serrata* (Saw Banksia) becomes conspicuous near the coast—stocky, picturesque trees. Around Sale and Bairnsdale are wide park-like areas of savannah dominated by *Eucalyptus tereticornis* (Forest Red Gum), but much of the land is now cleared; *Casuarina littoralis* (Black She-oak) may sometimes be locally plentiful. There is a clay sub-soil and, despite the relatively low rainfall, water may lie in places for long periods. Swamp Gum is occasional on these wetter sites, where ponds may yield the curious, yellow-flowered, rush-like *Philydrum lanuginosum* (Woolly Waterlily) among prevailing species of *Juncus* (true rushes). The Gippsland Lakes themselves are fringed with *Melaleuca ericifolia* and the tall semi-aquatic grass *Phragmites communis* (Common Reed).

Farther east the province is largely wooded with stringybarks (*Eucalyptus scabra, E. muelleriana* and *E. obliqua*), but considerable areas of open, often swampy, heath are dominated by *Xanthorrhoea hastilis* (Spear Grass-tree) and known as " grass-tree plains "; orchids are abundant over the latter formation, numbering several species that are absent from other parts of Victoria (*Glossodia minor, Caladenia aurantiaca, Cryptostylis hunteriana, C. erecta, Pterostylis baptisti,* &c.). Conspicuous in places are the three small trees *Persoonia linearis* (with bark laminating in thin papery shales), *P. levis* and *Leptospermum attenuatum* which enter the province from New South Wales, while *Eucalyptus gummifera* (Bloodwood) and *Angophora floribunda* (Gum Myrtle) appear in the extreme east—between Wingan Inlet and Mallacoota. The only known Victorian occurrence of the giant trigger-plant, *Stylidium laricifolium* (to 4 feet high), is at Wingan Inlet.

Otway Ranges

Mount Sabine, the highest point of this small maritime province, is only 1,900 feet ; but rainfall is high (40–80 inches per annum) and wet sclerophyll forest covers a large portion. Luxuriant fern-gully vegetation

is developed beneath a canopy of *Nothofagus* (Myrtle Beech) in the climax alliance of *Eucalyptus regnans* (Mountain Ash); *E. obliqua* (Messmate), *E. goniocalyx* (Grey Gum) and *E. globulus* (Blue Gum) are very large trees that may be associated with *E. regnans* or form distinct communities that extend into drier country. Northern parts of the ranges are much drier, with lower forests of stringybark and peppermint. Ecological affinities with wetter areas in the Eastern Highlands are strong, and many gully species are common to both—even the uncommon epiphytic orchid, *Sarcochilus australis,* and endemic tree-fern, *Cyathea marcescens.* However, several floristic features of the Otways deserve mention. The small handsome tree, *Phebalium squameum* (Satinwood), is frequent here but unknown elsewhere in the State, although it does extend into Tasmania, New South Wales, and Queensland. There is a deficiency of *Grevillea* species, only a form of *G. aquifolium* occurring in a limited area near Anglesea.

Stands of *Eucalyptus sideroxylon* (Red Ironbark) exist in the drier foothills around Anglesea and Airey's Inlet, an isolated occurrence of a valuable tree. Even more remarkable is the re-appearance, on this eastern side of the Otways, of some Victorian plants, otherwise found only toward the far west (notably the Grampians and Lower Glenelg), e.g., *Schoenus breviculmis* (a low, matted bog-rush), *Thysanotus dichotomus* (Branching Fringe-lily), *Conospermum mitchellii* (Victorian Smoke-bush), *Daviesia brevifolia* (Leafless Bitter-pea), *Spyridium vexilliferum* and *Ixodia achilleoides.* In the vicinity of Anglesea no less than 63 species of orchids have been collected, but outside the strictly highland zone of the peninsula.

South Gippsland Highlands

Except for slightly lower rainfall, these hills are an eastern counterpart of the Otways, having similar geology (Jurassic mudstones, &c.), height (to 2,000 feet), and proximity to the ocean. The dominant floral types, too, were virtually identical, but land clearance has robbed the Strzelecki Ranges of far more forest cover than in the Otways—fern gullies now exist only in a few isolated pockets (as at the Bulga and Tarra Valley National Parks, where there is a spectacular development). One of the springtime features of this province is the massed display of *Clematis aristata* on the crowns of trees (Blackwood, &c.) that the creeper has ascended.

Wilson's Promontory

A granitic mountain mass, to 2,400 feet high at Mount Latrobe, the Promontory is tied to the mainland by a low neck of sand. Thus physiographically circumscribed, it is worthy to rank as a distinct, if very small, vegetation province. Much is shared with the South Gippsland Highlands that face it across Corner Inlet: there are mountain forests of *Eucalyptus regnans, E. globulus* and *E. baxteri,* fern-gullies and groves of *Nothofagus,* with a basal selvage of sandy heathland and paper-bark swamps. But Wilson's Promontory has a number of peculiar botanical attractions. Among its remarkably rich assemblage of higher plants (about 700 species), at least three have

never been found elsewhere in the State, although they extend to Tasmania, viz., *Lindsaya cuneata* (Oval Wedge-fern), *Lepidium praetervisum* (Island Pepper-cress) and *Pimelea drupacea* (Cherry Rice-flower).

Here too is the western limit of several plants having sub-tropical affinities, notably: *Microsorium scandens* (Fragrant Fern), *Pittosporum undulatum* (Sweet Pittosporum), *Elaeocarpus reticulatus* (Blue Olive-berry), *Eugenia smithii* (Lilly-pilly), also the larger wood-inhabiting fungi *Hexagona tenuis* and *Cymatoderma elegans* var. *lamellatum*. *Kunzea ambigua* (White Kunzea) is an extremely common, honey-scented shrub or small tree, but unknown farther west, while *Melaleuca armillaris* (Giant Honey-myrtle) which covers Rodondo Island (8 miles south of the Promontory) is also typical of far East Gippsland coasts, ranging thence into Queensland. The rare Coast Crimson-berry (*Cyathodes juniperina*) is restricted to a few rocky headlands and off-shore islets, its sole remaining Victorian habitat being Cape Woolamai. A prominent alliance on northern heaths at the foot of Vereker Range is *Banksia serrata* (Saw Banksia) which in places may form a pure woodland community; *Casuarina stricta* (Drooping She-oak) dominates high sand hillocks along the narrow neck south of Yanakie. Ferns and mosses are prolific in shaded gullies, 84 species of the latter having been noted; but this whole National Park of 160 square miles has been devastated, from time to time by severe bushfires, the last in January, 1951.

Some Regions of Special Interest

Coast

In its 682 miles the coast line of Victoria exhibits great variety. There are ocean cliffs of Pleistocene dune-limestone (eolianite), mesozoic mudstone, sandstone, basalt and granite, sandy beaches and dunes, shingle beaches, tidal mud flats and salt marshes (see also pages 40–41). Varied also is the plant-life which, in general, comes under the influence of salt-laden winds, sometimes of direct sea spray. The strand flora is manifestly halophytic, with fleshiness as the most obvious adaptation to such an environment. Dispersal of seed by gales, water currents and ocean-roving birds tend toward a wide distribution for many shore plants, not only around the coasts of southern Australia but also in other temperate parts of the globe. At least ten genera of vascular plants and 33 species are restricted in Victoria to the coast; others (e.g., *Banksia integrifolia*) are principally coastal.

No Victorian tree is more remarkable than *Avicennia marina* (White Mangrove), a tropical species that reaches its farthest south on the sheltered tidal mud-flats of Western Port Bay; there it forms narrow belts around Quail Island, &c., extending for short distances along the banks of tidal creeks. A notable occurrence of mangroves at the mouth of Kororoit Creek, between Williamstown and Seaholme, was destroyed in recent years through the effects of oil discharged into Port Phillip Bay. White Mangrove is an intricate bush to small tree (10–20 feet high), with broad rounded crown. Horizontal roots grow for long distances through the surrounding black saline mud,

Some Native Flora of Victoria

[*H. T Reeves.*

Acacia dealbata (Silver Wattle) on banks of Yarra River, Victoria

[*H. T Reeves.*

Helichrysum secundiflorum (Cascade Everlasting) in Sub-alpine parts of Eastern Highlands.

[*H T Reeves.*

Eucalyptus camaldulensis (River Red Gum) widespread in Lowlands.

[*H. T. Reeves.*

Calytrix alpestris (Snow Myrtle) Grampians to Wyperfeld National Park.

[*H. T Reeves.*

Trochocarpa clarkei (Lilac-berry) Sub-alpine moss beds.

[*J. H. Willis.*

Clumps of endemic Silky Daisy (*Celmisia sericophylla*) along cascades near Spion Kop, Bogong High Plains, Victoria—at 5,600 feet.

[*H. T. Reeves.*

Pandorea pandorana (Wonga Vine) Gullies in Eastern Highlands.

[*H T Reeves*

Telopea oreades (Gippsland Waratah) Far Eastern Highlands.

[*H. T. Reeves.*

Thysanotus tuberosus (Common Fringe-lily).

[*H. T. Reeves.*

Cryptostylis leptochila (Small Tongue-orchid).

[*H. T Reeves.*

Grevillea barklyana (Gully Grevillea) Eastern Sources of Bunyip River.

[*H. T Reeves*

Oxylobium ellipticum var. *angustifolium* (Gully Oxylobium).

[*H. T Reeves*

Correa lawrenciana (Mountain Correa).

which is permanently waterlogged and poorly aerated, and from these there arise at intervals vertical peg-like structures that are corky or spongy in texture; these specialized breathing roots ("pneumatophores") project several inches above the mud and are exposed to the air twice daily during tidal recessions. Another interesting feature is the vivipary of mangrove seeds, germination taking place on the parent tree and the embryo plant falling into salt water for dispersal.

Mangrove woodland commonly passes into salt marsh, above the limit of high tides, but the latter formation often exists quite independently. Coastal salt marshes in Victoria are usually dominated either by *Arthrocnemum arbusculum* (Shrubby Glasswort) or an alliance of *A. halocnemoides* (Grey Glasswort) and *Salicornia australis* (Austral Glasswort), with other succulent *Chenopodiaceae* in association (e.g., *Atriplex, Suaeda* and *Hemichroa* spp.) and sundry small annuals. *Frankenia pauciflora* (Sea Heath) is a frequent dwarf semi-shrub of ericoid appearance; Salt Plagianth (*Plagianthus spicatus*) and Austral Sea-lavender (*Limonium australe*) are occasional components of the marsh flora, both semi-succulent rosette plants. Carpet-forming *Disphyma australe* (Rounded Noon-flower) not only invades any bare ground fringing the salt marsh proper, but is also a pioneer colonizer with *Salicornia* on littoral platforms and spray drenched ledges of rock ; it is one of the most salt-tolerant Australian plants, but the sap in its highly succulent foliage maintains an osmotic pressure of only 34–38 atmospheres.

Two noteworthy shrubs peculiar to sea cliffs are *Calocephalus brownii* (Cushion Bush), which forms very dense, rounded, white clumps to several feet wide, the minute appressed leaves being inconspicuous, and *Alyxia buxifolia* (Sea Box) with round, shiny, opposite leaves and red berries. *Asplenium obtusatum* (Shore Spleenwort) is a leathery littoral fern inhabiting only a few spots along the Victorian coast—viz., granite cliffs at Ram Head, Capes Everard and Woolamai, islets off Wilson's Promontory, and the basalt escarpments of Lady Julia Percy Island, but it is more frequent in Tasmania.

Coastal dunes afford a limited but highly interesting flora adapted to withstand strong salt-laden winds and deep humus-deficient sands. Succulent *Cakile maritima* (Sea Rocket) and *Atriplex cinerea* (Coast Saltbush) are typical beach plants, succeeding on bare sand just above the influence of tides; but the chief pioneer of loose and often mobile sand is *Spinifex hirsutus* (Hairy Spinifex), a long-rhizomic grass with silvery foliage and globular seed heads (to 6 inches wide) that break loose and roll about in the wind. Another dominant of unstable dunes is the wiry sedge *Scirpus nodosus,* while a native perennial thistle (*Sonchus megalocarpus*) and Coast Groundsel (*Senecio spathulatus*) may be associated. On the crest and down the fixed landward slopes of dunes a dense shrubbery commonly develops, with the following species in mixture or locally dominant: *Acacia longifolia* var. *sophorae* (Coast Wattle), *Leptospermum laevigatum* (Coast Tea-tree), *Leucopogon parviflorus* (Coast Beard-heath), *Rhagodia baccata* (Seaberry Saltbush) and *Helichrysum gunnii* (Coast Everlasting). Amongst them the honey-scented Bower Spinach (*Tetragonia implexicoma*) or

Little-leaf Clematis (*C. microphylla*) may commonly scramble, and in open glades the tall Coast Sword-sedge (*Lepidosperma gladiatum*) is often conspicuous. Probably the climax vegetation on most old, stabilized and humified dunes is a woodland having *Casuarina stricta* (Drooping She-oak) as an important dominant.

A vast assemblage of marine algae (in the red, brown, green, and blue-green groups) can be observed and studied in coastal rock pools at low tide or dredged from deeper water; but these fascinating, if primitive, cryptogams of the sea lie outside the scope of this essay.

Grampians

Between the northern and southern terminal peaks of Mount Zero (near Horsham) and Mount Sturgeon (at Dunkeld) the Grampians extend as a wide crescent for 50 miles. Each of the four parallel ranges in this large sandstone belt (Mount William, Serra, Victoria, and Black Ranges) has a bold escarpment on the eastern face but gentler slopes to the west, differential erosion (not block-faulting) being responsible for the arresting topography. The highest, and most easterly, point is Mount William (3,830 feet), where there is an approach to sub-alpine conditions. Farther west lie the Dundas Range and Mount Arapiles, isolated outcroppings of the same hard Carboniferous sandstone but much lower in elevation. Very lofty in comparison with other parts of the Western Highlands, from which they stand aloof, the Grampians make a noble southern terminus to the Great Divide that began at Cape York. Major T. L. Mitchell, who ascended and named Mounts William, Zero, and Abrupt in 1836, was the first white man to visit the region; he was impressed by its great beauty and scientific interest, as were Baron von Mueller in 1853 and many subsequent botanists.

The area is renowned for the great variety, wealth and attractiveness of its flora. About 750 different flowering plants and ferns (almost one third of the State's entire flora) are to be found on or between these ranges, to which the Victorian occurrence of at least three genera and 30 species is restricted. Twenty species are endemic here, including five shrubs in the genus *Pultenaea;* the Rosy Bush-pea (*P. subalpina* of mountains tops) is unique in having rosy-purplish blooms, all of its many other congeners throughout Australia being yellow or reddish-flowered. Other endemics are *Eucalyptus alpina* (Grampians Gum, with large warty buds and fruits), *Bauera sessiliflora* (a tough wiry scrambler with showy magenta flowers in long spikes), and *Stylidium soboliferum* (a trigger plant with compact bristly offshoots of the "hen-and-chicken" type, usually on wet peaty ground). Among the fifteen eucalypts *E. obliqua–E. goniocalyx* is a major forest alliance in the higher moisture parts, where Soft Tree-fern (*Dicksonia antarctica*), King Fern (*Todea barbara*) and other components of the fern-gully community may occur in deep sheltered valleys. *E. viminalis* and *E. ovata* are frequent along streams and on wet flats; *E. camaldulensis* enters broader valleys (e.g., Victoria Valley) from the surrounding plains where it is dominant, while *E. baxteri* is often accompanied by peppermint eucalypts or *Callitris rhomboidea* (Oyster Bay Pine) on drier exposed ridges.

Scrub is often thick, especially following fires which have been heavy and disastrous over much of the Grampians. Heath formation is abundantly developed on sandy slopes and flats, and it is the colourful beauty of so many heathland shrubs that give the Grampians its irresistible charm—wattles, bush- and bitter-peas, heaths, honey-myrtles, guinea-flowers, boronias, correas, grevilleas, &c. There are also numerous kinds of lilies (including *Calectasia cyanea* with satiny-lustrous purple flowers of the dry "everlasting" type) and some 70 orchids. In swampy ground there is a wealth of sedges (*Cyperaceae*), rope-rushes (*Restionaceae*) and true rushes (*Juncaceae*).

A highly intriguing aspect of the Grampians concerns past geological history and the origins of the diverse elements that now compose its rich flora. For instance, the isolated occurrence of Coast Banksia (*B. integrifolia*) high up on Mount Rosea is suggestive of a former maritime environment. There is indeed strong evidence that in Miocene times the Grampians massif was a promontory marking the southern limit of a great Murray-Darling gulf over what is the present Mallee and Wimmera. Several Tasmanian plants occur here, but nowhere else in Victoria, notably *Leptospermum nitidum* and *Pomaderris apetala* ('sensu stricto'). Equally remarkable is the disjunction shown by a group of rare Grampians plants that otherwise range only from East Gippsland through the eastern sandstone areas of New South Wales into the sub-tropics, viz., *Psilotum nudum, Davallia pyxidata, Howittia trilocularis, Dodonaea truncatiales, Westringia glabra* and *Swainsona brachycarpa;* the last species is unknown between the Grampians and north-eastern New South Wales.

The most interesting link of all is furnished by a number of plants having undoubted Western Australian affinities, e.g., the endemic trigger-plant *Stylidium soboliferum, Thryptomene calycina* and the two *Trymalium* species. (*T. d'altonii* and *T. ramosissimum*), *Calectasia cyanea* and *Prostanthera spinosa* which do occur in a few other parts of far western Victoria and South Australia, and the extremely rare *Borya nitida* (Pincushion Lily) which is abundant in south-western Australia but otherwise known solely from one peak in the northern Grampians. Did the ancestors of these relict species once range widely across Australia? It is presumed that some plants have existed continuously in the Grampians from very remote times—from the Middle or even Early Tertiary.

Brisbane Ranges

The Rowsley Scarp north of Geelong consists of intricately folded Ordovician slates and sandstones with intrusions of auriferous quartz. Its generally steep eastern face has been dissected into several narrow winding gorges by lateral stream action, but the western slopes are gentle and there are extensive cappings of Tertiary sand or gravel. This whole system of small complex ridges occupies roughly the triangle between Anakie, She-oaks and Mount Wallace, with Steiglitz as a centre; it is called the Brisbane Ranges and is clearly demarked from surrounding, very sparsely timbered to treeless basalt plains. Soils are poor and for the most part shallow ("skeletal") but there is an astonishing diversity of native plants—420 vascular species,

including 54 orchids. Messmate (*Eucalyptus obliqua*) covers the few better quality sites, intermixing with peppermints (*E. radiata* and *E. dives*) on drier terrain; but the most widespread forest alliance on stony ground is *E. macrorrhyncha* and *E. polyanthemos* (Red Stringybark and Red Box), with *E. sideroxylon* (Red Ironbark) as a frequent co-dominant. Numerous ericoid shrubs enter into the composition of heath on the more level sandy tracts; this formation is very similar floristically to the heaths along the Otway and Port Phillip coasts except that *Xanthorrhoea australis* has here become almost a weed, increasing at the expense of the smaller ground shrubs with each successive bush fire.

Grevillea steiglitziana and *Choristemon humilis* are the only species known to be endemic in the Brisbane Ranges, the latter an extremely rare epacrid constituting one of Victoria's two endemic genera—*Wittsteinia* (also of *Epacridaceae*) being the other. Several uncommon Victorian plants (e.g., *Grevillea chrysophaea, Pultenaea graveolens, Tetratheca glandulosa, Phebalium lamprophyllum, Prostanthera decussata, Poranthera corymbosa* and *Pomax umbellata*) have an isolated, western-most occurrence in this area, all other localities being widely scattered over the east and north-east.

Alps

Altitudinal effects upon plant life become strongly marked on the elevated mountain plateaux or " High Plains " of eastern Victoria, above about 5,000 feet. These are the alpine and sub-alpine tracts of the State, where snow lies continuously for several months each year, and where the vegetation is exposed not only to freezing winter temperatures but to gale-force winds and high insolation during summer. Here arboreal growth diminishes in height and finally gives way to low shrubberies, herbfields or grassy meadows, interspersed with heaths and moss bogs along shallow drainage channels. The only tree extending into the Alps proper is *Eucalyptus pauciflora* var. *alpina* (Snow Gum) which is ubiquitous, silvery and often very picturesque. Plants of different families commonly assume the carpet forming or rosetted habit of growth. Another conspicuous life-form is the " espalier " type, in which long-lived shrubs cling like mats to the surfaces of boulders and produce only short unilateral shoots; notable in this respect are *Podocarpus lawrencei* (Mountain Plum-pine), *Baeckea gunniana, Kunzea muelleri* and a remarkably depauperate condition of the lowland Tree Violet (*Hymenanthera dentata*). Brilliancy of colour is another feature of alpine flowers, and in late summer attractive berries appear on several perennials, e.g., *Astelia, Drimys, Leucopogon, Pentachondra, Nertera* and *Coprosma* species. The flowering season extends over three months (December to February), but growth may continue until checked by late autumn frosts. Some species bloom very early, for example, shrubby *Hovea longifolia* (a purple-flowered pea) and the herbaceous *Caltha introloba* (Alpine Marsh-marigold) which may actually open its handsome, white, scented flowers in little caves of ice at the melting edge of snowdrifts.

Although occupying such a relatively small and mostly fragmented area, the Victorian Alps are of great floristic interest, supporting as they do twenty genera and at least 133 vascular species that are

restricted entirely to high moors or rocky summits above 4,200 feet; many of these mountain plants are shared with Tasmania and some with New Zealand. Widespread lowland species (such as *Montia australasica, Viola sieberiana, Pimelea ligustrina, P. axiflora, Stylidium graminifolium* and *Helipterum albicans*) are sometimes represented by shorter, stockier, or broader-leaved alpine forms of distinctive appearance. The daisy family (*Compositae*) is richly developed and exemplified by species of the large genera *Brachycome, Olearia, Helichrysum* and *Senecio,* as well as by endemic species in several small groups—the handsome riparian *Celmisia sericophylla* is apparently confined to rocky creek banks on the Bogong High Plains. Members of *Ranunculus* and *Carex* are frequent, and a boreal element is discernible in the occurrence of some other genera of limited range (*Botrychium, Cystopteris, Caltha, Geum* and *Seseli*). The isolated Baw Baw Plateau furnishes certain Tasmanian species, not found in other parts of the Victorian Alps (viz., *Actinotus bellidifolius, Euphrasia gibbsae* and blue-fruited *Coprosma moorei*), while *Coprosma pumila* and the clubmoss *Lycopodium scariosum* are almost confined to the Baw Baws on the Australian mainland. Cushion plants are nowhere as well developed in Victoria as on high moors of Tasmania.

East Gippsland

Far eastern Victoria, including the whole County of Croajingalong, has many peculiar features but is difficult to define as a botanic province separate from the Eastern Highlands (which comprise a major part of the region) or the East Gippsland Plains. Interest centres chiefly in the patches of jungle, which are small outliers of sub-tropical rain forest and perhaps relics of a much wider development in southern Australia during a milder, wetter period in the Pliocene. Victorian jungle pockets, although chiefly coastal, may penetrate the mountains. They are very clear-cut from the enveloping eucalypt forest, and are dominated by such smaller trees as *Eugenia smithii* (Lilly-pilly), *Tristania laurina* (Kanooka) and *Pittosporum undulatum* (Sweet Pittosporum) which form a dense closed canopy. Stout vines are numerous, their stems often hanging from the branches of trees like coils of rope; these lianes belong chiefly to the genera *Smilax, Geitonoplesium, Eustrephus, Sarcopetalum, Cissus, Marsdenia* and *Passiflora.* Ferns are abundant, many being epiphytes and a few not extending to other parts of the State. Four of the five epiphytic orchids in Victoria are not to be found west of the Mitchell River. Five small trees of eastern New South Wales just enter Victoria but do not range beyond the Genoa River; these are *Ficus coronata, Trema aspera, Santalum obtusifolium, Alectryon subcinereus* and *Eucryphia moorei*—the first and last only in the Howe Ranges. *Angophora floribunda* penetrates a little farther, and *Eucalyptus gummifera* reaches Wingan Inlet. The State's only palm, lofty *Livistona australis,* is extremely localized and limited to a few small colonies on the Cabbage Tree Creek and Lower Brodribb River near Orbost. *Callistemon citrinus* (Crimson Bottle-brush) is a showy bush on wet flats of the near-coastal forests.

A rain shadow east of the Upper Buchan–Snowy River watershed, near the geodetic border with New South Wales, has been responsible for a dryland flora along the valleys of the Suggan Buggan, Upper

Snowy and Deddick Rivers. Here light forests of cypress-pine (*Callitris columellaris*) merge into box woodland (chiefly *E. albens* and *E. melliodora*) or savannah woodland. The occurrence of xeromorphic grasses (*Cymbopogon, Paspalidium, Enneapogon, Aristida, Stipa,* &c.), of *Gypsophila, Papaver, Blennodia* and *Calotis* species is reminiscent of the Mallee or Northern Plains and quite unusual among high mountains. Several plants from the Monaro tableland, New South Wales, intrude into Victoria at this low, dry corridor where *Brachychiton populneus* (Kurrajong) is a scattered but conspicuous tree. The Snowy River Gorge near Gelantipy yields two endemic species (*Westringia cremnophila* and *Hibbertia spathulata*), also showy violet-flowered *Boronia ledifolia* which comes no farther west but is plentiful enough in many parts of New South Wales.

It is possible to recognize an East Gippsland floristic division of the State, that will accommodate all the known scattered pockets of jungle, if the following somewhat arbitrary boundary line be established: north from Metung (on the Lakes) along the western margin of forest land to the Tambo River; then westward around the northern edge of the East Gippsland Plains as far as Stockdale, north again to the junction of Dargo and Wonnangatta Rivers, down the latter to its confluence with the Wentworth River and up the Wentworth to its source on the Divide; thence north-easterly along the crest of the Divide into New South Wales. By this means, no less than 37 genera and 200 species of flowering plants and ferns may be confined to the region east from the line.

Principal Families and Their Uses

General

The uniqueness of the Australian flora has often been exaggerated in popular writings. Only six (or perhaps eight) very small families are peculiar to this continent, and the great majority have a wide distribution in both hemispheres. Those family groups which are largest numerically in Australia are, with few exceptions, also the largest in most other countries. It is at the generic and, particularly, the specific levels that endemism is pronounced.

The latest estimate places the native vascular flora of Victoria at 616 genera and 2,440 species. No less than 32 plant families are represented by only a single species. The twelve families having largest specific representation are as follows, bracketed numbers referring to the known species in Victoria:—

Compositae (262)	*Chenopodiaceae* (83)
Gramineae (174)	*Mimosaceae* (80)
Orchidaceae (172)	*Proteaceae* (64)
Cyperaceae (152)	*Epacridaceae* (59)
Papilionaceae (131)	*Liliaceae* (51)
Myrtaceae (130)	*Rutaceae* (50)

Rhamnaceae and *Umbelliferae* follow closely, with 49 and 46 indigenous species respectively. To the former belong 32 local species of *Pomaderris,* hazel-like shrubs with a strong representation in East

Gippsland. Another large Victorian genus is *Hibbertia* (guinea flowers), in the *Dilleniaceae;* golden blooms of many of the State's twenty species are conspicuous on southern heathlands. Endemic species account for only about 4 per cent. of the total flora—*cf.* 16 per cent. in Tasmania, where long isolation has doubtless been an important factor. Following are brief descriptive notes on the twelve main families listed above :—

Compositae

Embracing more than 20,000 species, this is the most widely ranging and numerically the strongest family of flowering plants in the world. It is considered to be young geologically. Infinite variety of form and colour exists within this vast assemblage which includes all daisies and thistles, also such well known garden subjects as lettuce, artichoke, sunflower, dahlia, chrysanthemum, marigold, aster and cornflower. The so-called " flower " throughout this group is a composite structure—hence the family name—and is made up of several to many minute, stalkless, one-seeded flowers (or florets) that are closely packed into heads for maximum fertility. The whole flower head (" capitulum ") may be surrounded by a ring of enlarged female florets or coloured bracts that create an illusion of petals; sometimes even the heads of flowers are clustered to form compound heads of great complexity. Seeds are, in general, small and extremely light, being adapted to dispersal by the wind and often provided with a parachute of fine spreading hairs (the " pappus "); thus they may cross mountains, deserts, or even stretches of ocean, and some species of *Compositae* now occupy almost every habitable region.

Species are either *liguliflorous,* with all the florets strap-shaped, or *tubuliflorous* in which the central florets at least (and sometimes all) are regularly tubular. The first category is poorly represented in Australia, except by dandelion, flatweed, skeleton weed, chicory, salsify and a few other introductions, all with a milky latex. The most familiar Victorian member is *Microseris lanceolata,* the so-called yam or " murrnong " of aborigines who used its tuberous roots for food; this herb has yellow dandelion-like heads and is abundant in most parts of the State, from sea-level to the Alps. The overwhelming majority of Australian *Compositae* belong to the *Tubuliflorae,* of which eight tribal divisions are present in Victoria. The State's two largest genera, *Olearia* (daisy-bushes, with 36 local species) and *Brachycome* (daisies, 33 spp.) are both in the aster tribe, the latter being herbaceous and the former consisting of shrubs or even small gully trees. Each genus extends to New Zealand, but not beyond Australasia.

Helichrysum, the genus of everlastings, has 29 Victorian species, both herbaceous and shrubby, but it is abundantly represented also in Asia and Africa; *H. bracteatum,* a native herb with large brightly coloured heads, has been brought into garden culture and is popular for dried work (wreaths, &c.). Sunray is the collective name for species of the closely related genus *Helipterum,* mainly of small annuals in the drier northern parts of the State. *Humea elegans* is a tall biennial of humid gullies, and has been called " incense plant "

from the powerful spicy aroma of its big tobacco-like leaves; the inflorescence (to several feet long) is reddish, plume-like, and gracefully drooping.

All but one of the 24 Victorian species of *Senecio* (groundsels) are herbs, and some are known as "fireweeds" from the rapidity with which they colonize burnt-over areas; the genus is extremely large, ranging throughout the world. A few exotic members, e.g., the noxious *S. jacobaea* (Ragwort), have become weeds in Victoria. Very few native *Compositae* have any economic value, but the figured timber from large butts of *Olearia argophylla* (Musk Daisy-bush) has been used in cabinet work. Allergic people may suffer severe dermatitis by contact with certain aromatic species, such as *Centipeda cunninghamii* (Sneezeweed) and *Cassinia aculeata* (Common Cassinia or Dogwood) which is responsible for "dogwood itch" among forest workers. Objectionable burs are produced by native species of *Calotis* (bur-daisies) and several alien weeds, e.g., Bathurst and Noogoora Burs in the genus *Xanthium.*

Gramineae

The grass family has been estimated to contain about 10,000 species, and new kinds are constantly being described. They are by far the most important economic plants in the world, comprising all cereal crops (rice, wheat, maize, oats, barley, rye, &c.), providing the bulk of sheep and cattle fodder, straw, sugar cane, some sources of paper, perfumery oils, and even building material (from giant bamboo species). In Victoria native and imported grasses are the backbone of the pastoral industry.

Usually a grass is recognizable as such upon sight, the family hallmarks being briefly: hollow stems with hard nodes at intervals, a raised rim (or "ligule") separating the leaf-blade from its split sheathing base, the aggregation of flowers into a spikelet which becomes the unit of floral structure and the chief basis for classification into tribes, absence of sepals and petals. Grass flowers are greenish, simple, but highly specialized structures adapted to wind pollination. The spikelets of flowers may be clustered into heads, carried on long narrow spikes or widely diffused in loose panicles. The grass grain or "seed" is actually a hard one-seeded fruit.

Some indigenous grasses occur in every possible Victorian habitat, from the Mallee and coasts to the highest Alps, but the family is least conspicuous in shaded forests and jungles. Largest genera in the State are *Danthonia* (wallaby-grasses, 24 spp., all being useful fodder plants), *Stipa* (spear or corkscrew-grasses, 22 spp. with long-awned "fruits" that may injure the jaws and skins of sheep), and *Deyeuxia* (bent-grasses, 16 spp. of which thirteen are mountain plants). Forms of *Poa australis* (Tussock Grass) are almost ubiquitous, except in the drier north; those on the High Plains furnish summer feed for cattle. *Themeda australis* (Kangaroo Grass) is also a widespread perennial and of great fodder value, but rabbits have seriously reduced its potential. *Triodia irritans* and *T. scariosa*

(porcupine grasses) are exceeding tough, rigid plants with spine-tipped leaves; on Mallee sand-hills their spherical tussocks may attain widths of 6 feet. Creeping *Cynodon dactylon* (Couch) ranges widely through warmer parts of the globe and has been much used as a drought-resistant lawn grass. *Tetrarrhena juncea* (Forest Wire-grass) is one of the few species that will thrive in shaded mountain gullies; there its wire-like stems may scramble to heights of more than 10 feet by means of tiny siliceous teeth, making progress painful for the bush-walker. *Echinopogon ovatus* (Hedgehog Grass) is another much lower shade lover, having dense, ovoid, bristly heads. *Hierochloë redolens* and *H. rariflora* of eastern mountains are noteworthy for their cumarin-scented foliage, and *Puccinellia stricta* (Saltmarsh Grass) for its tolerance of high soil salinity.

Orchidaceae

The number of orchid species in the world is approximately 20,000, with some kinds in almost every region except the coldest and driest places; but the chief centres of development are both warm and humid (e.g., New Guinea, Malaya, Central America, parts of Brazil). Orchids of the tropics are predominantly epiphytic, perching on trees or rock surfaces, but those in cooler temperate zones are almost entirely terrestrial. These quaint flowers have always been extremely popular, not only by virtue of their delightful colours or perfumes but also by the extraordinary and often fantastic modifications in floral structure that are concomitant to pollination by special insects —elaborate mobile traps, see-saws, sex mimicry, deep-seated nectar supplies, &c. The distinctive characters of an orchid flower are: three sepals alternating with three petals at the summit of a three-celled ovary, one of the petals being modified to form a lip (or labellum), and the single anther surmounting a central column with which the stigma is fused and often obscure. Seeds are always very minute and borne in prodigious quantities—appearing like dust.

Only five of the 172 known Victorian orchids are epiphytes. With two exceptions (summer flowering *Spiranthes* and *Gastrodia*), the remaining terrestrials all belong to genera that are chiefly or exclusively Australasian. Largest genera in the State are *Pterostylis* (greenhoods, 38 spp.), *Prasophyllum* (leek-orchids, 29 spp.), *Thelymitra* (sun-orchids, 23 spp.) and *Caladenia* (spider-orchids &c., 22 spp.). The greenhoods usually lack gay colours, but have gracefully curved, shell-like flowers in which three segments are connivent to form a galea; the paired lateral sepals may be erect, or deflexed, and in the latter type of greenhood the hinged labellum is always extremely mobile. There is no season when some species may not be found in bloom, and few districts that have no representative, but they are scarcest in the arid north. Flowers of leek-orchids are " reversed ", so that the labellum appears upside down; they are often small and very numerous along the spike, and a group of leafless, autumn flowering species with densely massed dark flowers is distinguished as " midge-orchids ".

Sun-orchids are unique in having almost regular flowers, with a labellum scarcely differentiated from other segments; the species are distinguished by ornate appendages that crown the column, and

by colour (commonly blue, but sometimes pink or yellow). The blooms of some kinds expand only in exceptionally hot weather, hence the vernacular name " sun-orchid ". Spider-orchids possess long tentacular segments (sometimes 2-3 inches) and have singular elegance. Other remarkable Victorian orchids are the fleshy, leafless *Dipodium punctatum* (Hyacinth Orchid) and *Gastrodia sesamoides* (Cinnamon Bells or Potato Orchid) which may exceed 4 feet in height, gregarious *Corybas* species (helmet-orchids) with a low cowl-like bloom almost as big as the solitary circular leaf, *Caleana* (Flying Ducks) and *Spiculaea* (Elbow Orchid) with bizarre insectiform flowers, and *Diuris* species (double-tails or " donkeys ") with predominantly yellow flowers. No Australian orchid is known to yield any commercial product (such as the genus *Vanilla* in America) and, apart from their considerable aesthetic appeal or ornamental value, Victorian orchids do not have the slightest economic importance.

Cyperaceae

Sedges number about 4,000 species and, although related to grasses, they show an obvious preference for damp situations. Their major points of departure from the *Gramineae* are solid stems, entire (not split) leaf-sheaths without any definite ligule at the summit, and florets each subtended by a *single* glume (not a paired " lemma " and " palea " as in grasses). A few species, notably in the large genus *Carex,* are known to be useful forage plants and some with long pliant culms have been occasionally employed in basketry or mat-weaving, otherwise Victorian sedges are valueless economically, and some tend to be troublesome farm or garden weeds, e.g., *Cyperus rotundus* (Nut-grass). The importance of turf-forming kinds in preventing erosion of mountain catchments should not be overlooked. The principal genera in the State are *Carex* (true sedges, 27 spp.), *Scirpus* (club-rushes, 26 spp.), *Cyperus* (flat-sedges, 22 spp.), *Lepidosperma* (sword- and rapier-sedges, 17 spp.) and *Schoenus* (bog-rushes, 14 spp.). The first three genera are of world-wide range, *Carex* being one of the largest known (about 1,700 spp.). *Lepidosperma* and *Schoenus* are very largely Australian; members of the former group often have knife-sharp margins to their leaves and, together with the saw-edged species of *Gahnia,* are collectively known as " cutting-grass " in Tasmania. *Gahnia clarkei,* of shaded swamps or wet gullies in the south, has a palm-like aspect ; in Victoria it may attain heights of 10 to 15 feet, with hard woody trunks to an inch in diameter—surely one of the biggest sedges in the world. The small, red, pendulous nuts of this, and other tall *Gahnia* species, are rather decorative, contrasting with the blackish plume-like inflorescence (1-3 feet long). *Gymnoschoenus sphaerocephalus* (Button Bog-rush or " button grass ") is a tufted swamp-lover, with drumstick-like culms rising to 6 feet; it covers many square miles of country in western Tasmania.

Papilionaceae

The pea family is a large assemblage of some 6,000 species, widely dispersed over the globe and abounding in Victoria where the majority of native species are shrubs. It includes garden beans and

peas, the peanut, ornamental brooms and lupins, and such valuable forage plants as clovers, medicks and lucerne. Gorse (*Ulex europaeus*) is one of the few alien species that have proved to be pernicious weeds; it was introduced originally for hedges, but soon escaped. The butterfly-like flowers are very characteristic in this family: a large dorsal petal (the " standard "), two equal laterals (" wings "), and two parallel, fused or adhering petals between them (the " keel "). They are frequently yellow with red or brownish tints, which have earned for them the fatuous popular sobriquet " eggs-and-bacon ". Tribal classification is based upon the arrangement of the ten stamens (whether free or variously fused), the type of pod (opening longitudinally or fragmenting like a string of beads) and foliage (simple, compound, with or without tendrils, &c.).

Conspicuous Victorian genera are *Pultenaea* (bush-peas, 46 spp.), *Bossiaea* (bosseas, 12 spp.), *Swainsona* (swainson-peas, 12 spp.), *Dillwynia* (parrot-peas, 11 spp.), and *Daviesia* (bitter-peas, 8 spp.), none of which extends beyond Australia. In the large group of bush-peas, species range from mat-formers to tall forest shrubs, many bearing showy masses of golden or orange-red bloom. Swainson-peas are procumbent, rarely tall, herbs with purplish flowers in racemes and rather inflated pods. They are chiefly plants of open sandy ground, and some are known to cause a wasting sickness in stock that are addicted to grazing them; the toxic principle is cumulative, sheep and horses at last becoming " pea-struck "—emaciated, with general stiffness and defective sight. *Swainsona lessertiifolia* (Coast Swainson-pea) has caused trouble on Bass Strait islands; it is not uncommon also on littoral dunes of Victoria. *S. procumbens* (Broughton Pea) favours wet depressions in heavier soils of northern and western plains; the large bluish flowers have twisted yellow keels and are as attractive as garden sweet-peas.

Lotus cruentus (a diffuse herb of arid places, with tiny red flowers) and *Goodia lotifolia* (Golden-tip, a forest shrub of broom-like appearance) both secrete cyanogenetic glycosides and are reputed poison plants. Species of *Daviesia,* with triangular pods, have bitter tasting flattish leaves that have sometimes been infused for a bushman's tonic; all are highly floriferous, with trusses of small yellow-and-brown or reddish flowers. One of the most strikingly decorative plants in Victoria is the widespread climber *Hardenbergia violacea* (False Sarsaparilla or Purple Coral-pea) which brightens many an open forest in early spring; some forms are in garden culture.

Myrtaceae

Consisting entirely of shrubs or trees, and centred chiefly in the Pacific region, the myrtle family contains more than 3,000 species—only one reaches Europe, and South Africa has about twenty kinds. Important features are the simple, rather leathery and often opposite leaves that are dotted with oil glands, and the inferior ovary. Two well-marked subfamilies are thus definable: the invariably opposite-leaved *Myrtoideae* with fleshy, rather berry-like fruits, and the *Leptospermoideae* with dry capsular fruits that are sometimes woody. Only a single Victorian species, *Eugenia smithii* (Lilly-pilly) belongs

to the former group which is principally tropical; it is a jungle tree of East Gippsland, but much planted for ornament in parks and private gardens, the clusters of fruit varying from white to lilac or rosy-purple.

Eucalyptus embraces more species (the " gum trees ") than all other Victorian genera of *Myrtaceae* combined. It is by far the most important and valuable genus in the State's whole flora, furnishing the bulk of building and structural timbers, fencing, firewood, paper pulp and such lesser products as oil and honey. Specialists differ somewhat in the limits assigned to eucalypt species, one authority raising to the specific level a population that others would regard as a mere variety or perhaps a hybrid, and *vice-versa.* With such divergencies in mind, it would be safe to say that Victoria has about 70 " good " species, seven of which are endemic.

All eucalypts have only rudimentary petals that never expand; they are fused (often with the sepals also) in a variously shaped cap (" operculum ") that circumscisses and falls off at floral maturity. It is the massing of innumerable, sometimes coloured stamens that give character to " gum blossom ". Accurate classification has proved extremely difficult; leaves, anthers, fruits, bark, and even oils have been emphasized by various writers, but a satisfactory natural scheme still waits to be devised. Baron von Mueller, more than a century ago, employed a popular sorting based on easily observable bark features. With certain modifications, this is still of use in the field; foresters group the species known to them as *gums* (smooth-barked), *stringybarks* or *peppermints* (fibrous-barked, the latter also with peppermint-smelling foliage), *boxes* (scaly- or flaky-barked), *ironbarks* (with hard, deeply furrowed bark), &c. Space does not permit reference to individual species in this large genus ; suffice it to say that *E. regnans* (Mountain Ash) is the tallest flowering plant in the world—a few specimens in the 640 acre reserve at Cumberland Falls near Marysville just overtop 300 feet, but their height is exceeded by a 322-ft. tree in the Styx Valley near Maydena, Tasmania.

Next to *Eucalyptus,* the main myrtaceous genera in Victoria are *Leptospermum* (tea-trees, 16 spp.), *Melaleuca* (paper-barks and honey-myrtles, 12 spp.) and *Callistemon* (bottle-brushes, 7 spp.). Many are highly attractive subjects, brightly-flowered, quite hardy and admirable for garden culture. Some produce nectar of good quality, valuable to apiarists; other straight-growing kinds provide stakes for brushwood fencing. One of the most popular Victorian bushes for cut flowers is *Thryptomene calycina,* endemic in the Grampians but widely cultivated; its long feathery sprays of massed white blossom last remarkably well indoors. Numerous coloured and double-flowered cultivars of *Leptospermum scoparium* (Manuka) are now on the market, but these have been developed from New Zealand forms of the species.

Chenopodiaceae

Comprising about 1,400 species and distributed through lowland regions of the world, the goosefoot family is well adapted to flourish on saline ground, e.g., in salt marshes near the sea or fringing salt

pans of the arid interior. They are mostly small shrubs or herbs, rarely trees. Some members accumulate quantities of salt in their sap and may have very succulent foliage. None is known to be poisonous. The botanical characteristics are small, green, herbaceous (sometimes mealy) flowers with a single whorl of one to five segments, and minute one-seeded fruits with curved embryos. Despite this rather simple structure, there is considerable variety in the fruiting envelope which may become extraordinarily enlarged. No less than 50 of the 83 indigenous Victorian species are restricted to the Mallee province, the State's largest generic representations being in *Atriplex* (saltbushes, 19 spp.), *Kochia* (bluebushes, 16 spp.), *Bassia* (prickly bluebushes, 14 spp.), and *Chenopodium* (goosefoots, 9 spp.).

All these genera range far beyond Australia, but *Kochia and Bassia* find their richest development here. *Atriplex* species are recognized by their curiously modified fruiting valves, viz., a pair of spongy flaps (fused at the base), and *Kochia* by the horizontal, hyaline wings surmounting its fruit-bearing envelope. Members of both genera are very nutritious to stock, and regarded highly by pastoralists in the hot dry interior; but some valuable species have unfortunately been displaced through over-stocking and rabbit infestation, notably *Atriplex nummularia* (Old-man Saltbush). *Kochia georgei, K. erioclada* and *K. pentatropis,* with exceptionally large, bronze or rosy fruit-wings, are among the most handsome plants of saline flats and lake beds in the far north-west. Spiny fruits of *Bassia* species are frequently a nuisance in wool clips, *B. birchii* (Galvanized Bur) of western New South Wales and Queensland being a serious offender. *Rhagodia spinescens* (Thorny Saltbush) is a useful hedge plant, if one can disregard its rather fishy odour. *Enchylaena tomentosa* (Barrier or Ruby Saltbush) has brightly coloured, succulent fruits of yellow, red, or amethyst hue; its foliage was used as an effective "green" and antiscorbutic by explorer Charles Sturt in his retreat from the drought-stricken interior during 1845.

Mimosaceæ

This family of probably 2,500 species is widely dispersed through tropical and warmer countries. The fruit is a pod, as in *Papilionaceae;* but the small regular flowers, with long-protruding stamens, are densely clustered in globoid heads or spikes. All Victorian species belong to the wattle genus, *Acacia,* which is the largest in the State (and in the Commonwealth—about 600 species); they vary from low scramblers on the ground to giant forest trees, and, except for the open plains, every vegetation province has its suite of representatives. Seven of the 80 Victorian species retain their bipinnate foliage throughout life (e.g., Silver and Black Wattles), but the remainder discard it in the seedling stage and become completely phyllodinous. The leaf-like phyllodes exhibit great diversity (terete or broadly flattened, one-nerved or with several parallel veins) and have been used in classification; nectiferous glands are usualy prominent on the upper edges of phyllodes.

At no time of the year is it impossible to find any wattles in bloom, but early spring is the optimum season for most species. These highly ornamental plants lend beauty to the countryside, some being

excellent garden subjects. A few trees, notably *A. melanoxylon* (Blackwood), yield cabinet timbers of great beauty; other may provide firewood (e.g., *A. dealbata,* Silver Wattle) or tan-bark (*A. mearnsii,* Black Wattle, &c.). Following serious forest fires, the heavy growth of wattle scrub forms a first line of defence against soil losses and deterioration; it also improves the nitrogen status in the soil, by means of root nodules that contain nitrogen-fixing bacteria. *A. longifolia* var. *sophorae* (Coast Wattle) is important in the stabilization of coastal sand dunes, and most species provide pollen for bees.

Proteaceae

Almost entirely restricted to the southern hemisphere, shrubs and trees of this assemblage probably number at least 1,500 species, half being Australian and at the same time endemic. The family takes its name from a Greek sea deity, Proteus, who could assume any form at will, and the aptness of this derivation is apparent in the astounding range of form and colour among flowers in even a single Australian genus; species of waratah, banksia, grevillea, hakea and cone-bush rank with the nation's most spectacular floral treasures. *Proteaceae* is a very ancient group of plants, with no close relationships to other living families. The sexual anatomy is relatively simple: four stamens situated opposite and often fused with the four nearly equal, valvate, flower-segments, a superior ovary with single compartment and one to several seeds that may be winged.

The two natural sub-families are *Proteoideae* (with indehiscent nut or drupe) and *Grevillioideae* (having a capsule or follicle that splits to release the seeds). The former group alone occurs in Africa, the latter in South America, but both are well represented in Australia. Some Australian species of *Banksia, Hakea* and especially *Xylomelum* have exceedingly woody follicles (often 1-2 inches thick) and natural seed dispersal is completely dependent upon fire, evidence that conflagrations had been occurring for millions of years before man's advent. In Victoria, the principal genera are *Grevillea* (24 spp.), *Hakea* (13 spp.), and *Persoonia* (11 spp., known as "geebungs"); they tend to favour poor sandy or stony terrain and have little economic importance apart from floral beauty. *Banksia* species, in which myriads of rather wiry, yellowish flowers are packed into dense cylindrical "cones", yield copious nectar; but their honey is rankly flavoured and inclined to candy quickly. The larger trees (e.g., *Banksia integrifolia, B. serrata, Hakea vittata* and *Telopea oreades*) have attractively grained timbers of some value for turnery, but are in short supply; that of *H. vittata* (Hooked Needlewood) has also been used in pipe manufacture. *Telopea oreades* (Gippsland Waratah), with large crimson heads of flowers during early summer, is the State's most impressive protead, but it is confined to far eastern mountains and unfamiliar to most Victorians.

Epacridaceae

Except for a very few species that penetrate to Malaysia, Hawaii and South America, this family of heaths is entirely indigenous to Australasia where about 360 species are known (33 being in New Zealand). It is replaced in Africa and the northern hemisphere by

the closely related *Ericaceae*. These two families have five-partite, bell-shaped flowers; but in *Epacridaceae* the stamens are equal in number to the petals (not twice as many), the anthers one-celled and opening by long slits (not pores). Epacrids fall naturally into two major groups, viz., *Stypheliae* with fleshy berry-like fruits having a single seed to each compartment, and *Epacreae* with dry capsules having several seeds in each loculus. Both sections are exemplified in Victoria where the largest genera are *Leucopogon* (beard-heaths, 26 spp.) and *Epacris* (true Australian heaths, 7 spp.). Beard-heaths are so named from the fuzz of white hairs on the inner sides of their little petals, giving the whole inflorescence a feathery aspect; some are prostrate on the ground, others almost tree-like (e.g., white-berried *L. parviflorus,* Coast Beard-heath).

Epacris includes the very popular Common Heath (*E. impressa*), the State's official floral emblem; it blooms for a long period (May to October), and the handsome flower-spikes may be white, pale pink, rose or deepest red. Flame Heath (*Astroloma conostephioides*) of far western heathlands has large scarlet flowers with a satiny sheen, both flowers and fruits being a favourite food of emus. Cranberry Heath (*A. humifusum*) forms carpets, with flowers and greenish drupes hidden under the foliage. *Acrotriche serrulata* is known as " Honey-pots ", because the bulging greenish flowers are full of nectar; these appear during winter in clusters on the old wood of this common dwarf shrub (to 1 foot high). *Richea continentis,* of moss beds in the Alps, is the only mainland representative of a striking genus with eight species in Tasmania. Their leaves are the largest among Australian epacrids, and the fused white petals fall away together, as a cap, from the massed spikes of bloom. Most, and perhaps all, Victorian *Epacridaceae* are self-pollinated, and there are no species of any commercial significance.

Liliaceae

Some recent authorities have split the *Liliaceae* into several smaller families, but in its wider traditional circumscription about 2,500 species are involved and are widely dispersed over the world. They include some familiar garden bulbs, e.g., liliums, tulips, hyacinths and squills. The common characteristics are six white or coloured flower segments in two series, six stamens and a three-celled superior ovary that becomes a berry or capsule in fruit. The largest Victorian genus is *Lomandra,* with ten local species ; these mat-rushes are harsh, tough perennials, several being confined to dry northern districts. Each individual plant is unisexual, and their small waxy yellowish flowers are often tightly clustered in spikes or heads. *L. longifolia* (sometimes called " sagg ") is very widespread, its rigid inflorescence bearing spiny bracts.

Bulkiest of Victorian " lilies " are the three species of grass-tree (genus *Xanthorrhoea*), all densely tufted plants with wire-like, angled leaves 1 to 4 feet long; the flowers are extremely numerous in hard, compact, cylindrical, upright spikes that may attain several feet in length and appear like massive, bronzy kangaroo tails. The copious resin that exudes from between the leaf-bases in *X. australis* has a fragrant aroma and has been exploited as a source of picric acid

(15 per cent. to 20 per cent.); it may also be used as a spirit varnish. No other Victorian members of *Liliaceae* appear to have any commercial potentialities, but the yellow-flowered *Bulbine bulbosa* (Bulbine Lily) and *B. semibarbata* (Leek Lily) cause severe gastric irritation when eaten by stock; both are widespread plants of open country. The five local species of *Thysanotus* (fringe lilies) have purple frilly flowers to 1 inch wide and are very attractive; *Dichopogon strictus* (Chocolate Lily) has deliciously caramel-scented blooms, while the large blue berries of *Dianella tasmanica* (Tasman Flax-lily) adorn hilly forests in late summer. Probably the most popular native lily is *Anguillaria dioica* (Early Nancy or " Harbinger-of-Spring "), a small perennial herb with honey-scented, star-like white flowers that are often ringed with purple; it commences to bloom in winter, and may cover loamy ground in open pastures or heaths like a sheet. Major Mitchell was captivated by *Anguillaria* at Mount Hope in June 1836, and suggested for it the name " Australian Snowdrop."

Rutaceae

The rue family, including all citrus fruits, has a wide distribution in warmer countries and embraces approximately 1,000 species of trees and shrubs (rarely herbs). An outstanding feature, as with *Myrtaceae,* is the presence of copious oil glands in the leaves which exhale an aromatic, sometimes pungent odour. There are five sepals, five petals and four or five superior fruiting carpels that are often almost free from each other. The chief genera affecting Victoria are *Phebalium* (13 spp.), *Boronia* (11 spp.), *Eriostemon* and *Correa* with 5 spp. each. *Eriostemon* species are called wax-flowers from their thickish white and pink petals; they grow naturally in poor rocky situations, but make excellent garden shrubs if afforded good drainage. Boronias are delightfully coloured, floriferous subjects, one Victorian species (*B. muelleri* of mountain forests) sometimes attaining 10 or even 15 feet in height; however, no eastern examples of this large genus ever develop the powerful, delicious perfume of West Australian *B. megastigma* (Brown Boronia). *Correa* species have long, tubular, pendulous flowers and are frequently called " native fuchsias." Apart from their undoubted horticultural merit, and adornment of the landscape, no Victorian *Rutaceae* are economically important.

Botanical Research Work at the University of Melbourne

A pioneer of botanical work in Victoria was Professor A. J. Ewart, F.R.S., who came to Australia from Liverpool University to take up the combined posts of Professor of Botany and Government Botanist. His first class at the University in 1906 consisted of six students and extended for only one term. By 1921 the School was large enough to make it necessary to separate the University post from that of Government Botanist, and in 1929, a separate Botany School building was opened. Ewart died in 1937 while still holding office.

He was a plant physiologist by training, but during his early years in Victoria he devoted much time to a study of the flora of the State. He published several books (including one on the weeds and poison plants of Victoria) and 34 papers entitled " Contributions to the Flora of Australia ", and his work in this field culminated in the appearance of his *Flora of Victoria* (1931).

The botanical work of the State is not, of course, concerned only with the mapping of the vegetation and the identification of species. Since Professor Ewart's arrival, the Botany School at the University of Melbourne has been responsible for the training of professional botanists as well as for a considerable part of the training of agricultural students and forestry students.

There are now over 700 students, fourteen members of the staff, eight technical staff, twelve post-graduate workers and a librarian; a new wing of the building is being erected to accommodate the teaching and research facilities now needed. Since 1940, members of the Department have published 169 research papers in a great variety of research journals. The School has specialized along four main lines, apart from collaborating with the National Herbarium on taxonomical problems. The first deals with the distribution of the main plant communities in the State, and a book on this subject is about to be published.

Another major contribution to plant ecology in Victoria has been the long-term study of the ecology of the Bogong High Plains, one of the objects of which was to assess the effect of grazing on the vegetation and the soils. In the course of this work some important new techniques for the accurate analysis of vegetation were developed. Another ecological study has been that of the forests of Victoria, particularly those of the Dandenong Ranges and of the *Eucalyptus regnans* (Mountain Ash) forest at Wallaby Creek. This included work on the hydrology of the area and on the regeneration of this very important timber species. At the present time the enlarged ecological staff is beginning work on the heathlands of the State.

Allied to this work has been an intensive study, with the help of the Commonwealth Scientific and Industrial Research Organization, the State Electricity Commission, and the Gas and Fuel Corporation, of the microfossils of the brown coal and more recent peats of Victoria. The remains of plants in the Yallourn brown coal have been identified, and in particular it has now become possible, as a result of this work, to identify the various stratigraphical levels of the deposits by means of the minute microfossils contained in them. This work is throwing a good deal of light on the past history of the Australian flora.

In the field of mycology and plant pathology the Department has also been active, and a very representative collection of the fungi of the State has been developed. Many professional men and women have also been trained in plant pathology. One applied aspect which has received a good deal of attention over the last fifteen years has been the study of the effect of fungi in causing damage to timber in mines. A typical problem now under way is a study of the important disease causing the brown rot of stone fruit.

The study of genetics, which is carried out in collaboration with the Zoology School, is a comparatively recent addition to the programme of the Botany School. Most of the work done to date has concerned the study of the genetics of the Maize plant and of the fungus *Neurospora crassa*. Here again, both schools are playing an important part in training geneticists in science and agriculture.

In the field of plant physiology, research papers have dealt with the subjects of transpiration, respiration, photosynthesis, the hormone control of growth and flowering and the mechanism of the movement of sap in plant stems and roots. Research work in these fields has recently been intensified because it has been possible to obtain funds from the Rural Credits Development Fund and from the wheat industry. At the present time three research students and one member of staff are actively engaged in a study of the physiology of the wheat plant.

During the Second World War the Department was largely mobilized under the Optical Munitions Panel to study the effect of fungal damage caused to optical instruments. This work resulted in the publication of a booklet on the tropic proofing of optical instruments and the development of a highly successful technique which was used by the Army and the Royal Australian Air Force.

Members of the Department have recently been active in studying the biology of our National Parks, and an experimental field laboratory is to be constructed at Tidal River, Wilson's Promontory, in 1961.

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*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.

* Excluding the mountain regions, which are described in detail on pages 43 to 67.

Rainfalls are 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 is often 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 was estimated to have 28·13 per cent. of the Australian population at 30th June, 1960. In relating population to area, Victoria is the most densely populated of the States with an average density at 30th June, 1960, of 32·9 persons per square mile and is exceeded only by the Australian Capital Territory (55·77 per square mile).

The Victorian population is growing rapidly ; comparing the enumerated population of the Census of 30th June, 1954, with the estimated population of 30th June, 1960, the population of Victoria increased by about 17·9 per cent., being exceeded only by South Australia (18·6 per cent.), the Australian Capital Territory (72·7 per cent.), and the Northern Territory (32·4 per cent.).

The distribution of population over the State, however, is very uneven. At the 1954 Census no less than 62·15 per cent. of the total population of the State was living in the Melbourne Metropolitan Area, a larger concentration of population into 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 (some 18 per cent. of the State's total in 1954) and the urban centres other than Melbourne (some 19 per cent. of the total in 1954).

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, 1960, 90,380), Ballarat (54,800) and Bendigo (42,120), 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 probably about 50,000 people and are mainly concerned with power generation and distribution. The next group in order of population size has between 12,000 and 15,000 people each and contain, 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 in which retail and service functions predominate ; for instance, Hamilton, Colac, Horsham, Ararat, Sale, Maryborough, Benalla 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 997 miles, of the Indi or River Murray, 68 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, Western Port 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	32·85
Queensland	667,000	22·45
Northern Territory	523,620	17·62
South Australia	380,070	12·79
New South Wales	309,433	10·42
Victoria	**87,884**	**2·96**
Tasmania	26,215	0·88
Australian Capital Territory	939	0·03
Australia (Total)	2,971,081	100·00

Coastline

The Victorian ocean coastline stretches some 682 statute miles from the South Australian border to the New South Wales border. Small stations of whalers and sealers were operating along the coast, mainly at Westernport, Portland, and Wilson's Promontory long before the advent of Henty and Batman.

The coastline is now well served with lighthouses, though in the early days it proved hazardous to navigation and no fewer than six ships were wrecked at Port Fairy before 1850. Port Phillip Bay is a safe harbour for shipping and the cities of Geelong and Williamstown afford excellent facilities. The Bay was the first place where settlement was made, at Sorrento in 1803, by a party under Lieutenant-Colonel Collins. In January, 1804, the settlement was abandoned.

Wilson's Promontory is the most southerly part of the State of Victoria ; it was rounded by Lieutenant Grant in the *Lady Nelson* in 1801. The original entrance to Lakes Entrance was, owing to silting, closed in 1889, and a new entrance opened 1½ miles to the west.

When Lieutenant Grant called at an island in Western Port in 1801, he named it Churchill Island (after an English Government official, who supplied a small amount of seed). Wheat was planted and when Lieutenant Murray in the *Lady Nelson* visited the island some months later, the wheat was growing vigorously, being 6 feet high. It was the first wheat planted in Victoria.

The main features of the coastline are as follows :—

Nelson to Cape Bridgewater	Sandy beach backed by dunes.
Cape Bridgewater to west end of Portland Bay	Cliffs of basalt tuff dune limestone and miocene limestone.
Portland Bay to Port Fairy	Sandy beach backed by dunes with low cliffs of basalt and dune limestone near Port Fairy.
Port Fairy to Warrnambool	Beach dunes and dune limestone.
Warrnambool to Childers Cove	Cliffs of dune limestone.
Childers Cove to Point Ronald	Bold cliffs of tertiary limestone.
Point Ronald to Cape Volney	Cliffs of lower tertiary sandstone and dune limestone.
Cape Volney to Castle Cove	Bold cliffs of mesozoic sandstone.
Castle Cove to Point Flinders	Bold cliffs of dune limestone.
Point Flinders to north of Lorne (Eastern View)	Cliffs of mesozoic sandstone.

Eastern View to Torquay	Cliffs of tertiary sandstone and limestone interspersed with bays and sandy beaches.
Torquay to Cape Schanck	Sandy beach backed by dunes with intermittent low cliffs of dune limestone.
Cape Schanck to Nobbies	Bold cliffs of basalt.
South coast of Phillip Island	Sandy beaches backed by dunes with granite at Pyramid Rock and Cape Woolamai.
Cape Woolamai to Anderson's Inlet	Cliffs of mesozoic sandstone.
Anderson's Inlet to Cape Liptrap	Sandy beach backed by dunes with low cliffs of dune limestone at south end.
Cape Liptrap Promontory	Cliffs of lower palaeozoic sediments and diabase.
Waratah Bay as far east as Tongue Point	Sandy beach backed by dunes.
Tongue Point to Mount Hunter	Granite headlands interspersed with bays with sandy beaches backed by dunes.
Mount Hunter to Conran	Sandy beach backed by dunes with lagoons behind dunes.
Cape Conran (granite) to Cape Howe	Granite headlands with beaches between them and some local cliffs of metamorphosed lower palaeozoic sediments at Cape Everard, Little Ram Head and near Mallacoota.

The area of Port Phillip Bay is 762 square miles and the coastline of the bay stretches for some 164 statute miles.

Rivers

The Main Dividing Range may be regarded as dividing the river basins or catchments in Victoria into two main groups. Of the rivers draining the northern basins the Loddon is the westernmost river that normally reaches the Murray. Except for the internal drainage basin of Lake Corangamite, the rivers south of the Divide flow into the sea.

If we also divide the State into an eastern and western area by a line joining Melbourne and Echuca we have four areas conveniently termed the north-east, north-west, south-east, and south-west. Streams in these four areas whose flows average more than about 100,000 ac. ft. per annum are tabulated on the following page.

For more detailed information concerning stream flows, reference should be made to " River Gaugings ", normally published at six-year intervals by the State Rivers and Water Supply Commission.

The total flow in the State is about 17,000,000 ac. ft. per annum, including about 1,000,000 ac. ft. from New South Wales. Although the northern streams contribute about the same flow as those in the south, the flow in the eastern part of the State is about six times that in the west. Differences in average stream flow in the four sectors are primarily a reflection of mean annual rainfall. All streams exhibit pronounced seasonal variation, but the greater rainfall and higher incidence of summer rains in the east give those streams a more regular flow during the year than those in the west.

VICTORIA—MAIN RIVERS

Area	River	Station	Mean Annual Flow	
			100,000 ac. ft.	
North-east ..	Goulburn	Murchison ..	23	
	Murray ..	Jingellic ..	18 *	
	Mitta ..	Tallangatta ..	11	
	Ovens ..	Wangaratta ..	11	
	Kiewa ..	Kiewa ..	5	
	Broken ..	Benalla ..	2	
		Sub-Total ..	—	70
North-west ..	Campaspe..	Rochester ..	2	
	Loddon ..	Laanecoorie ..	2	
	Wimmera	Horsham ..	1	
		Sub-Total ..	—	5
South-east ..	Snowy ..	Orbost ..	18 *	
	Yarra ..	Warrandyte ..	9	
	Latrobe ..	Rosedale ..	7	
	Mitchell ..	Bairnsdale ..	6	
	Macalister	Glenmaggie ..	4	
	Thomson ..	Heyfield ..	3	
	Tambo ..	Bruthen ..	2	
	Bunyip ..	Bunyip ..	1	
		Sub-Total ..	—	50
South-west ..	Glenelg ..	Dartmoor ..	6	
	Barwon ..	Geelong ..	2	
	Hopkins ..	Allansford ..	2	
		Sub-Total ..	—	10
				135
		Other Rivers		35 (Estimate)
		Total ..		170

* Includes flow from New South Wales.

In addition to seasonal variation, streams are subject to large variations in annual flows. In very wet years, such as in 1870, the total stream flow would be about three times the mean flow, whereas in drought years, such as in 1914, the flow would only be about a quarter of the average. Although this variability may appear high, it is relatively mild compared with streams in other parts of Australia, excluding Tasmania.

By far the major use for water in Victoria is for irrigation in rural areas (see pages 479 to 484). Storages with a capacity of about 6,000,000 ac. ft., i.e., about one-third of the mean annual flow, enable a

million acres of land, nearly all in northern Victoria, to be irrigated annually. The use of water for urban areas is, by comparison, small.

The amount of water used by urban populations in Victoria is only about 10 per cent. of that used for irrigation—or about equal to that lost by evaporation from storages built for irrigation.

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.

State Aerial Survey

Information about the State Aerial Survey and a list of available printed maps will be found on pages 35–36 of the Victorian Year Book 1961.

Physical Geography and Geology

Articles on the physical geography and geology of Victoria will be found on pages 36 to 56 of the Victorian Year Book 1961. A map and description of the vegetation provinces are shown on pages 5 to 18 of this volume.

Victoria's Mountain Regions

Introduction

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 beyond the Dundas plateau near the South Australian border. They were formed by up-warping and faulting. The eastern sector differs

from the western in its greater average elevation, with peaks such as Bogong, Feathertop and Hotham rising above 6,000 feet, while the western mountains are generally lower, the peaks reaching above 3,000 feet and the valleys being broader. Also in the east patches of older volcanic rocks occur, whereas in the west 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 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 sector. 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 west the Grampians, with their striking serrate ridges of sandstone, may be compared with the belt of sandstones stretching from Mansfield to Briagalong in the east.

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

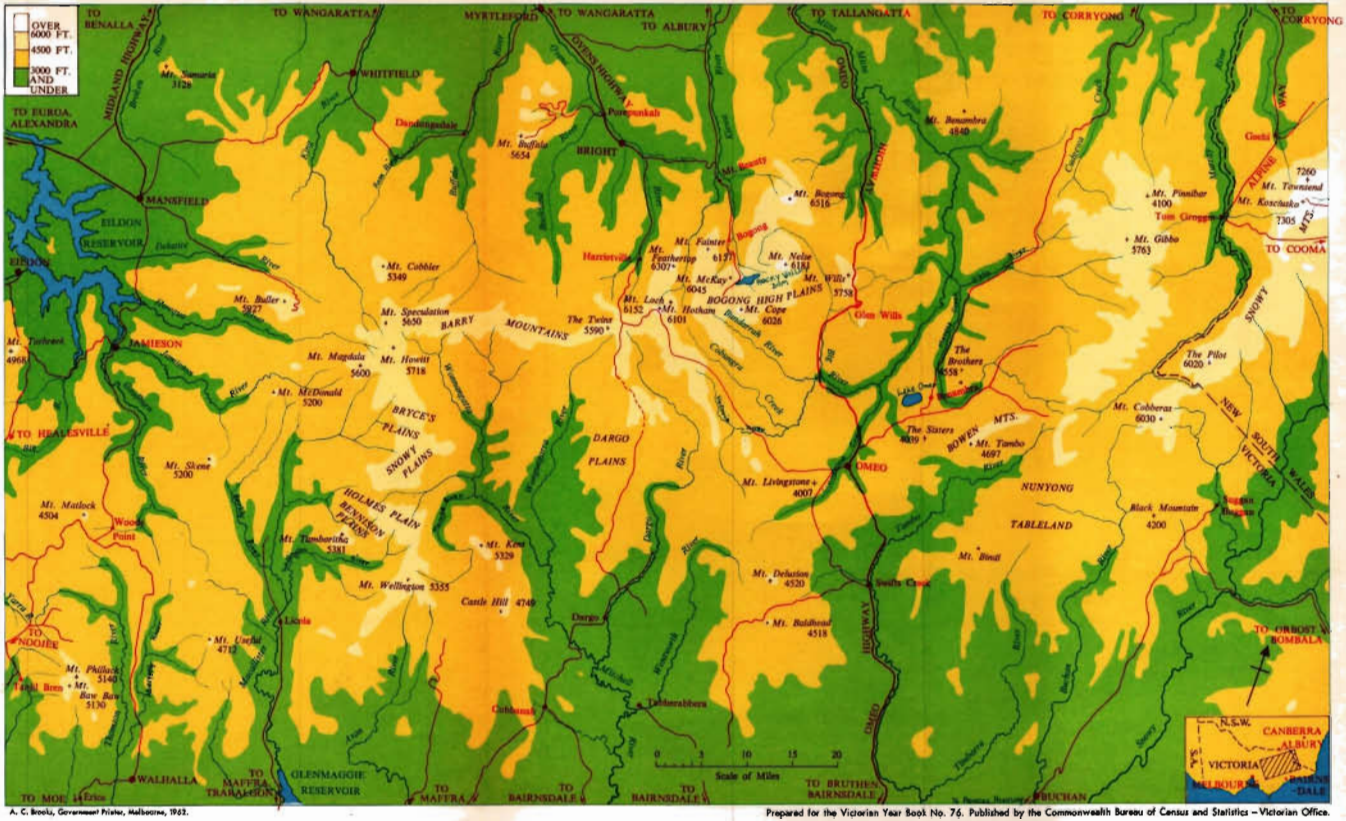
The highlands descend to plains on their southern and northern flanks. On the south are the Western District Plains and the Gippsland Plains, and beyond these again rises a group of uplifted blocks for which faulting is mainly responsible, these constituting the Southern Uplands. The Otway Ranges and 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.

The highest mountain in Victoria is Mount Bogong, situated in the county of the same name, 6,516 feet above sea-level. Other mountains over 6,000 feet in height are shown on page 46. These, so far as is known, are the only peaks which exceed 6,000 feet in height, although there are numerous peaks between 4,100 and 6,000 feet high. It is known, moreover, that there are many peaks rising to upwards of 4,000 feet above the level of the sea whose actual heights have not yet been determined. Although, during the winter, the peaks and higher plateaux are covered with snow, it is not perpetual and disappears during the spring.

Mountain Surveys

In 1844, the Crown Lands Commissioner for the district of Gippsland, Mr. C. J. Tyers, forwarded a report to Mr. La Trobe (later Lieutenant-Governor of the Colony) together with a map of the district

ALPINE REGIONS OF VICTORIA



A. C. Brooks, Government Printer, Melbourne, 1962.

Prepared for the Victorian Year Book No. 76. Published by the Commonwealth Bureau of Census and Statistics – Victorian Office.

under his administration showing the extent of the different land holdings and their occupants at the time. Apart from the settlement boundaries, this map embraced mountainous areas from Mount Buller near Mansfield to the Omeo district, and such prominent features as the Baw Baw Ranges, Mounts Useful, Wellington, Kent and the lower features skirting the settled districts were depicted. Isolated surveys such as this were effected in many parts of the " Port Phillip " district until the year 1856, when the Government of Victoria determined to make a geodetic survey of the State, based on an origin of latitude and longitude determined astronomically at the Melbourne Observatory. Mr. R. J. L. Ellery was appointed Director of the Geodetic Survey in addition to being responsible for operations at the Observatory. He was also a qualified surgeon but never practised in the Colony.

The geodetic survey of an area involved the observation, by use of precision theodolites, of the angles of triangles formed between intervisible survey stations usually sited at the summits of mountains—a process also referred to as triangulation. The observed triangles generally form part of more complex geometric figures, the mathematical conditions of which provide useful checks on the accuracy of the original field observations. From the known length of any triangle side, the lengths of all other sides can be calculated throughout the area making due allowance for the shape of the earth and these are used for the purpose of establishing the relative positions of all subsidiary surveys, for the accurate plotting of all features presented on topographic maps, and for determining the extent of the area generally.

The length of the first triangle side presents a problem unique to triangulation. It is determined by a special technique of ground measurement referred to as " base line " measurement. In 1859, such a base line, 26,100 feet in length, was measured near Werribee by the use of specially constructed and calibrated metal bars each 10 feet long. The measurement took four months to complete and the result is quite accurate in accordance with modern standards.

In the early days the tasks of selection of suitable mountains, the movement of pack horses and drays through unexplored country, the cutting of sight lines through massive stands of timber and the erection of large rock cairns (to be visible from other mountains) over the survey station was most arduous. Neatly built cairns may still be found at Smeatons Hill and at Mount Alexander, whilst the remains of cairns originally 20 feet high and 20 feet diameter can be seen at Mount Taylor and at Mount Torbreck. The early surveyors were responsible for these geodetic observations, including several astronomical observations for difference in longitude by use of the revolutionary aid, the electric telegraph. Many of the original reports to the Director of Geodetic Survey written by these surveyors in the field are still preserved.

Calculation of this triangulation was made through the principle of major triangles and the auxiliary or minor stations subsequently computed. As the fundamental mathematical basis for these calculations, the theoretical figure (shape) of the earth, the " spheroid of revolution ",

as determined by Captain A. R. Clarke, R.E., in 1858 from his investigations of data originating in England, India, Denmark, Russia and Peru was adapted. At the present time, similar geodetic calculations in Australia are based on the same " figure " while some other countries use Clarke's later 1866 figure of the earth. A more refined theoretical figure has recently been calculated from observations made to the several earth satellites now in orbit.

In the years 1869 to 1872, surveyors Black and Allan undertook the marking of the border line between New South Wales and Victoria from the headwaters of the Murray River to Conference Point (Cape Howe). This survey was carried out through difficult mountainous country and the speed and completeness with which it was accomplished is a tribute to the diligence of the surveyors concerned. After 1875, when the mountainous areas of the State had been embraced by the geodetic survey, only isolated triangulation tasks, involving connexion to the major network, were undertaken and the precise theodolites were packed away until the present time. They are now in the custody of the Museum of Applied Science and are only of historic value.

During the Second World War, the Australian Survey Corps extended a more modern chain of triangles through the mountainous country occupying some old and some new survey stations. This was joined to similar geodetic surveys in the eastern States and calculated in terms of the origin of latitude and longitude at Sydney observatory. An additional " base line " was measured near Benambra using more modern methods and equipment, particularly long Invar bands, for the purpose.

In the years following the war, geodetic surveys for mapping and control of land boundary surveys have been carried out by the Department of Lands and Surveys, Victoria. Many new techniques have been introduced, particularly electronic distance measuring equipment of two types : one, the Geodimeter using pulses of light operated at night time ; the other the Tellurometer using modulated radio waves operated during daylight hours. With the latter type of equipment distances up to 50 miles in length can be determined in a few hours with accuracy as good as that achieved in the measurements of base lines taking many weeks to complete. Geodetic survey procedures have been revolutionized by the introduction of such apparatus. Very accurate light-weight precision theodolites, having optical reading of their scales, are now used for modern triangulation observations which can be completed in a fraction of the time formerly required.

Since the general opening up of the country by road systems, it is now possible to establish a more dense network of survey control resulting in greater accuracy of position fixation and more accurate reduction of the heights above sea level of the various triangulation stations. Most recent values for some of the high mountains in Victoria are Mount Bogong, 6,516 feet ; 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.

Climate of Victoria's Mountain Regions

General

Victoria's mountains include part of the " Australian Alps ", which is the coldest and one of the wettest regions in Australia. The only snow fields in Australia are found, in winter, in the mountains of eastern Victoria, south-east New South Wales, and in central Tasmania, all of which are being developed as sources of hydro-electric power because of their steep terrain and abundant snow and rain.

Temperatures

However, the climate is far from strictly alpine because these mountains are much lower in altitude and nearer the equator than the well-known mountain regions of the Northern Hemisphere. The lowest temperature recorded in Victoria is 9° F. at Hotham Heights (5,776 feet). However, a minimum of minus 8° F. has been recorded in the New South Wales section of the Alps at Charlotte Pass (6,035 feet) and no doubt sub-zero temperatures occur in Victoria, but they have not been recorded because of the lack of observing stations in the mountains. The lowest temperatures are likely to occur, not on the tops of high mountains, but in elevated valleys forming " frost hollows " where cold air can collect during calm clear winter nights, and at one such station, Omeo (2,133 feet), a minimum of 14° F. has been recorded. Apart from this orographic effect, average daily minimum temperatures in the coldest month, July, are below freezing point at stations above 4,000 feet. Average daily maximum temperatures in July are below 40° F. above 4,000 feet. The mean freezing level for July, found by averaging temperatures at all times of the day at each station, is at about 5,000 feet. Daily maximum temperatures below 30° F. are frequently recorded at Hotham Heights.

In the mountain regions, January is slightly warmer than February at most stations. Below 2,000 feet, altitude tempers the effect of the summer sun only slightly, but from 2,000 to 3,000 feet the average January maximum temperature is about 75° F., much the same as at Victorian coastal stations where the sea breeze is effective. Above 3,000 feet, day temperatures are appreciably lower, falling to an average of about 60° F. on the highest mountains, 20 to 30 degrees lower than stations on the plains. Extreme summer temperatures do not affect the highlands, and temperatures over 90° F. are rare above 2,000 feet. Available records indicate that altitude has little effect on average summer night temperatures, as stations with 5,000 feet difference in altitude have only about 10 degrees difference in January average minimum temperatures. However, extreme minimum temperatures in summer are much lower at higher altitudes (as low at 22° F. in January at Hotham Heights) and even in the warmest months frost may occur at stations above about 1,000 feet, particularly in frost hollows.

Rain

Rain in Victoria's mountain regions falls mainly in winter and spring, as it does in most other parts of the State. Other things being equal, the rainfall at a given station will be higher the greater its altitude, but other factors may introduce big variations in this simple relation. There is no broad rain shadow in the Victorian mountains because there are

rain-bearing winds from both north and south, although of two mountains of the same height, the one nearer the coast will have the higher rainfall. The local terrain may affect rainfall to a great extent. Some localities favourable for high rainfall are those at the head of valleys which open towards a prevailing rain-bearing wind, and those on exposed mountains and ridges. Places receiving less rainfall are located in the lee of mountains, and in high country in the centre of a mountainous region.

The heaviest rain in Victoria is in the main mass of the eastern ranges, where the 40-in. rainfall line corresponds very roughly with the 2,000-ft. contour, enclosing an area extending from the hills around Mount Dandenong and Kinglake to the high mountains of the north-east. A number of stations within this area have average annual rainfalls over 70 inches, and the highest rainfall on record in any one year was 131 inches at Mount Buffalo. Nearer the coast, the Strzelecki and Otway Ranges are almost as wet as the higher mountains, and in these regions the 50-in. rainfall line corresponds with the 1,500-ft. contour. Some stations in the Otway Peninsula have average annual rainfalls over 70 inches, and daily rain totals of over 10 inches have been recorded in the Strzelecki Range.

VICTORIA—TEMPERATURES AND RAINFALL AT MELBOURNE AND SELECTED HIGHLAND STATIONS

Location	Altitude	Temperature—°F.						Average Annual Rainfall
		Extreme		January Average		July Average		
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	
	feet							inches
Hotham Heights	5,776	82	9	61	44	32	25	58·54
Mt. Buffalo ..	4,370	94	18	67	51	38	31	76·57
Rubicon ..	2,700	94	24	75	51	45	35	61·76
Omeo ..	2,133	107	14	80	49	50	32	25·78
Mt. Beauty ..	1,250	103	25	84	52	53	34	52·95
Myrtleford ..	686	114	20	87	53	55	36	34·80
Melbourne ..	140	114	27	78	57	56	42	25·91

Snow

Every winter snow covers the highest mountains in Victoria, remaining on the ground for a few months down to a snow line at 3,000 to 4,000 feet. The snow season is usually three to five months, beginning about June, and the average depth of snow is 1 to 3 feet above 5,000 feet. In some years there is good snow coverage on the high mountains as early as April, and snowdrifts in sheltered places may last well into the

summer. Blizzards (strong winds carrying falling or drifting snow) are regular occurrences during the snow season. Snow falls have been recorded on the high mountains in all months of the year, and in winter snow sometimes lies on the ground for several days at altitudes below 2,000 feet.

Hydro-Electric Resources

The total Victorian hydro-electric resources, based on a comprehensive survey of feasible schemes, is estimated at 5,000 million kWh. of energy per annum. Included in this total is the Victorian share of output from the Hume hydro-electric power station because the catchment above the Hume Dam is partly in New South Wales and partly in Victoria.

Hydro-electric power resources are dependent upon the quantity of water available and the difference in head. Water quantity is determined by precipitation and evaporation. The head of the water is related to the topography of the country.

Victorian topographic conditions are characterized by the Great Dividing Range which rises to peaks of over 6,000 feet in north-eastern Victoria.

The high ranges on both sides of the Great Dividing Range are greatly affected, particularly during the winter months, by the prevailing westerly winds. The lifting of the air on the western and north-western slopes causes condensation and heavy precipitation on the highlands on both sides of the Great Dividing Range, from the Kinglake Ranges north of Melbourne to the head of the River Murray on the New South Wales border.

These highlands with an average rainfall of 45 to 85 inches per annum form the most valuable catchments in Victoria. As a result, 90 per cent. of the hydro-electric resources are concentrated in this area. The only other areas with significant hydro-electric potentialities are the lower Snowy River basin (including run-off contributed from the New South Wales catchment below Jindabyne) with 6 per cent., and the miscellaneous high areas such as the Otways, Grampians, Strathbogie, South Gippsland and the far eastern portion of East Gippsland with 4 per cent. of the total.

The energy output from the Hume scheme (230 million kWh. per annum) is shared equally between Victoria and New South Wales. In addition, Victoria is entitled to receive one-third of the output from the Snowy Mountains hydro-electric scheme after the Commonwealth has reserved sufficient energy to satisfy the estimated requirements of the Australian Capital Territory. At the completion of the initial Snowy–Tumut stage (about 1963) the Victorian share will amount to a little over 500 million kWh. per annum, rising to 1,200 million kWh. after the completion of the Snowy–Murray stage about 1970.

The degree of development of the Victorian hydro-electric resources by 1960 is indicated below :—

VICTORIA—HYDRO-ELECTRIC RESOURCES

Existing Hydro-electric Development	Average Annual Output	Purpose of Scheme
	mill. kWh.	
Rubicon Scheme..	75	Power generation
Kiewa Scheme	336	Power generation
Eildon Scheme	227	Irrigation and power generation
Cairn Curran Scheme	3	Irrigation and power generation
Hume Scheme (Victorian share)	115	Irrigation and power generation
Total hydro-electric power developed ..	756	
Percentage of developments	15%	

[Source : State Electricity Commission.]

In reading this table, it should be noted that :—

(1) The above averages are based on the output of completed schemes. In the Kiewa scheme the latest and largest of the power stations (McKay Creek, 96,000 kW.) was not in full production until the end of 1960. Additional aqueduct diversions at Kiewa for increasing the flow available for electricity generation will be brought into service progressively up to 1962. The Cairn Curran scheme did not start operating until the latter months of 1960.

(2) The table does not include Victoria's entitlement to Snowy output. Transmitted supply to Victoria began in November, 1959, and the total transmitted up to the close of the 1959–60 financial year was 56 million kWh.

(3) Due to limited plant capacity pending completion of McKay Creek Power Station and incomplete aqueduct diversions in the Kiewa scheme, the availability of Snowy power for only part of the year and general climatic conditions, actual hydro-electric production available to Victoria in the 1959–60 financial year totalled 594 million kWh., about 9·6 per cent. of the total power from all sources generated in the State Electricity Commission's system and by other undertakings outside the State system.

Approximately half of the undeveloped hydro-electric resources of the State occur in the Mitta Mitta catchment area and in adjacent catchment areas of streams draining the northern and southern slopes of

the Great Dividing Range. Estimates of resource potential have been made by assuming that the most economic form of development would be achieved by diverting water from these adjacent areas for power development in the Mitta Mitta Valley and subsequent use of this water for irrigation.

Other remaining resources include extension to existing projects together with a number of areas where small amounts of hydro-electric power could possibly be developed. Much of the power from this last-mentioned group would, however, be very costly to develop.

Considerable scope still exists for the utilization of undeveloped catchment areas by means of multi-purpose hydro-electric projects that provide both irrigation and power supply benefits. However, the hydro-electric resources of the State are small in relation to expected electrical energy requirements and can never be regarded as more than a secondary source for power supply. The primary power and energy requirements will continue to be supplied from thermal generating plant using the extensive brown coal resources of the State. Generally, the extent to which the remaining hydro-electric potential of the State should be exploited will depend on the cost of alternative supply from these thermal generation sources.

Mountain Forests

Introduction

Almost one-third of Victoria has forest cover of one sort or another. Of Victoria's land area of 56·2 million acres, some 16·8 million acres or 30 per cent. are forested, of which 14·1 million acres represent State forest (reserved forest and protected forest) and 2·7 million acres are in private and commercial ownership.

A glance at a map of Victoria giving the distribution of State forests shows that more than half of such forested areas are situated on or close to the Main Dividing Range. These areas extend from the Grampians State forest in Western Victoria through Beaufort, Ballarat, Daylesford, Trentham to Broadford, which is about 45 miles north of Melbourne, and thence in a north-easterly direction through the Upper Yarra and Upper Goulburn areas into the highest regions of the north-east of Victoria such as Mount Buller, Mount Hotham, Mount Feathertop, Mount Bogong and continuing on into the Australian Alps of New South Wales. There are two other isolated areas of mountain forest in the Otway Ranges towards Cape Otway in south-west Victoria, and in the Strzelecki Ranges towards Wilson's Promontory in the south-east.

If we consider these mountain forests as a whole, including the foothills both north and south of the Main Divide, practically all our forest species are represented. The only major groups of species not included are the boxes and red ironbark of the dry northern plains, the red-gum forests of the flood plains of the River Murray and its tributaries, and the numerous dwarf mallee eucalypts and cypress pines in the far north-west of the State. Perhaps, however, the principal forest types usually recognized as constituting the mountain forests are the snow-gum areas of the higher mountain regions, the mountain ash and alpine ash forests with their associated gully species of blackwood, myrtle beech,

&c., below the snow-gum belts, and at lower elevations, where good rainfall and soil conditions still exist, the messmate, manna gum, and other mixed species forests.

A much simplified diagram of the occurrence of mountain species is as follows. Variable conditions of aspect, soil, and rainfall cause considerable modifications in the distribution.

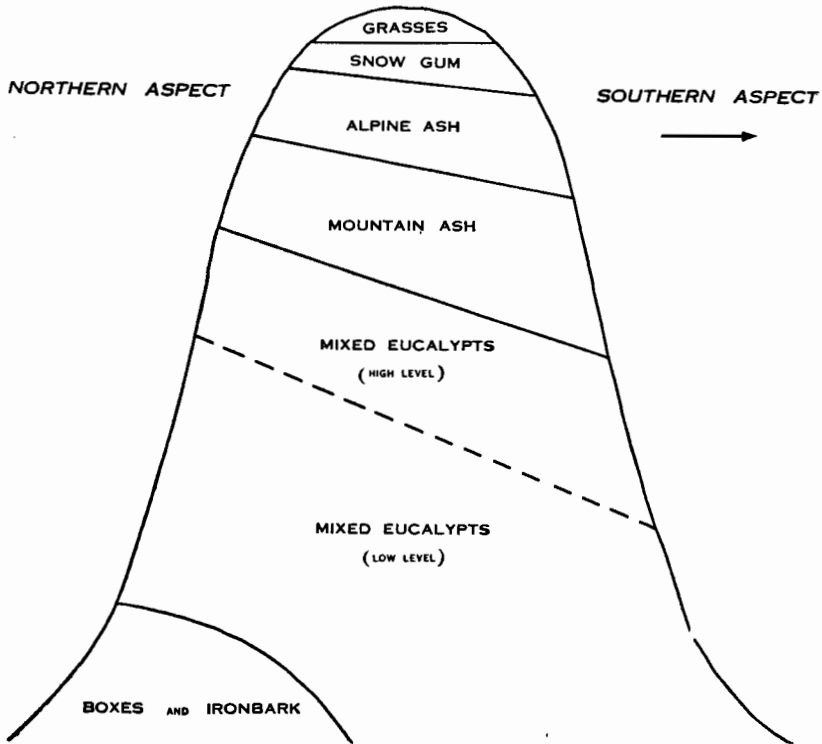


FIGURE 1.—Diagram showing occurrence of main types of mountain species in Alpine Area.

Snow-gum Forests

These forests generally take over from the ash forests at the upper limit of the occurrence of ash with a distinct break, so that there is a noticeable transition into the much shorter, often dwarf-like and multi-stem habit of the snow-gum. Snow-gum forests are generally pure with no admixture of other tree species. They are slow growing because of the harsh climatic conditions and generally poor stony soils, and they produce no commercial timber. They perform a most important function, however, in binding the soil on steep exposed slopes and generally in promoting soil stability. They also have a vital role in holding the snow fall so that, in the spring, the water is more gradually released into springs and streams than would otherwise be the case. Care is taken in alpine villages, such as Mount Buller, to see that the minimum amount of damage to, or removal of, snow-gums occurs in the siting of ski-lodges, ski-tows and other installations. It is also particularly necessary in this high country to prevent over-grazing. In some parts cattle grazing has been severely restricted or prohibited.

Alpine Ash and Mountain Ash Forests

These forests include the tallest and fastest growing of the eucalypts. Mountain ash is recognized as being the tallest hardwood species in the world, specimens of over 300 feet in height with over 100 feet of straight clear bole being not uncommon. Alpine ash is of similar good form and general characteristics, but is slower growing and does not attain the large dimensions of its close relative, mountain ash. Silvertop is often associated with ash stands and also shining gum, particularly in the North-Eastern Highlands.

The ash species occur with a minimum rainfall of approximately 50 inches and on deep soils usually of granitic, but sometimes of volcanic origin, although in both the Otway and Strzelecki Ranges the soils are derived from Jurassic sandstones and shales. The ash species are among the most valuable commercial timber species in Australia, producing hardwood timber equal to the world's best for furniture, joinery, weatherboards, internal fittings and similar uses, and they are valuable species for the wood pulp and paper industry. The output of sawmill logs of ash species from State forests is approximately 80 million superficial feet, and pulpwood the equivalent of an additional 40 million superficial feet Hoppus log volume* per year.

As distinct from all other eucalypt forest types in Victoria which are sclerophyllous or adapted to survive hot dry summers, the ash types are classified as temperate rainfall forests. Associated with them is a prolific understorey of vegetation particularly in the gullies, some of the species of which attain diameters of 2 to 3 feet and heights approaching 100 feet. The principal associated understorey species are blackwood, myrtle beech, silver wattle, sassafras, blanket leaf, musk, hazel and satin box, with masses of tree ferns in the moist sheltered gullies.

Regeneration in eucalypt forests can be obtained from three sources—seed, coppice shoots, and ligno-tubers, each playing a significant part in natural regeneration following cutting operations and fire, with two marked exceptions. Alpine ash and mountain ash do not produce coppice shoots or regenerate from ligno-tubers—their sole source of reproduction is from seed. This is the reason why fire-killed veterans are seen standing in ash forests like giant candles among the young growth which has sprung up since the fires. Eucalypt forests of other species have been subjected to as severe and often more repeated fires, but the trees are not killed—they sprout new shoots along the trunk and main branches from dormant buds. The ash species cannot do this and furthermore they have a thin bark so that the cambium layer is easily damaged and killed by fire. This is almost certainly the reason why ash forests occur in pure even-aged stands over extensive areas—they have originated as a result of the destruction of the previous crop by fire, with natural regeneration being subsequently produced from seed which was on the trees and not consumed by the fire.

Management of these forests presents different problems from those of mixed species. Growing as they do in pure even-aged crops, these forests have generally been worked under a clear felling system either with or without seed trees to provide a source of seed for regeneration.

* Hoppus log volume expresses the content of timber in a log which is approximately 78·5 per cent. of true volume.

A selection system of management is not suitable for these species. They need adequate light for establishment of regeneration and consequently reasonably large canopy openings are necessary. Clear felling in small groups, or patches, or, alternatively, a form of shelterwood fellings are likely to meet the silvicultural requirements of the species in the best way, as well as meeting soil stability and water supply considerations in mountain areas.

A technique has been developed for raising mountain ash in nursery beds for subsequent afforestation works. For planting of gaps in burnt over areas and plantation establishment in cleared areas which were formerly ash sites, young seedlings are transferred from seed beds into small wood veneer or metal tubes. When they are about 6 to 9 inches tall, they are planted in their final position at spacings of from 6 to 8 feet apart. Frost and vermin damage can cause difficulties in plantation establishment with these species in certain areas if proper precautions are not taken.

Mixed Species Forests

Occurring in the mountains, although not generally in the higher areas, are mixed forests of messmate, manna gum, narrow-leaved peppermint, mountain grey gum, blue gum and several other species. By far the largest area of forested land in Victoria is occupied by the mixed species forests. They represent possibly 3½ to 4 million acres of the 5½ million acres of reserved forest.

Particularly at their upper elevations on good sites, these forests form valuable timber-producing stands. Mount Cole and Mount Disappointment State forests in the Beaufort and Broadford districts contain examples of excellent mixed species stands. Undergrowth conditions are less dense and luxuriant than in the ash forests. The species are more fire resistant and have the ability to sprout following fire so that those mixed stands normally have a different structure to the ash stands. They are generally all-aged, ranging from young seedlings which have developed in small openings, through patches of saplings and pole-size trees following past utilization operations, to mature and over-mature trees.

Management of these mixed forests has usually been, and is likely to be, continued on a selection felling basis, removing small groups of older trees in utilization fellings and creating relatively small openings in which natural regeneration becomes established. Generally, seedling regeneration is obtained without difficulty, but in the event of failure of regeneration, e.g., in a poor seed year, coppice re-growth and seedlings developed from ligno-tubers can usually be depended upon to take its place.

Fire Protection

Due to a combination of weather conditions with hot, dry summers, and inflammable vegetation, Victoria's mountain forest areas are among the world's worst fire hazards. From the early days of settlement they have been subjected to periodic severe fires culminating in the conflagration of 1939 in which 71 lives were lost, great damage to

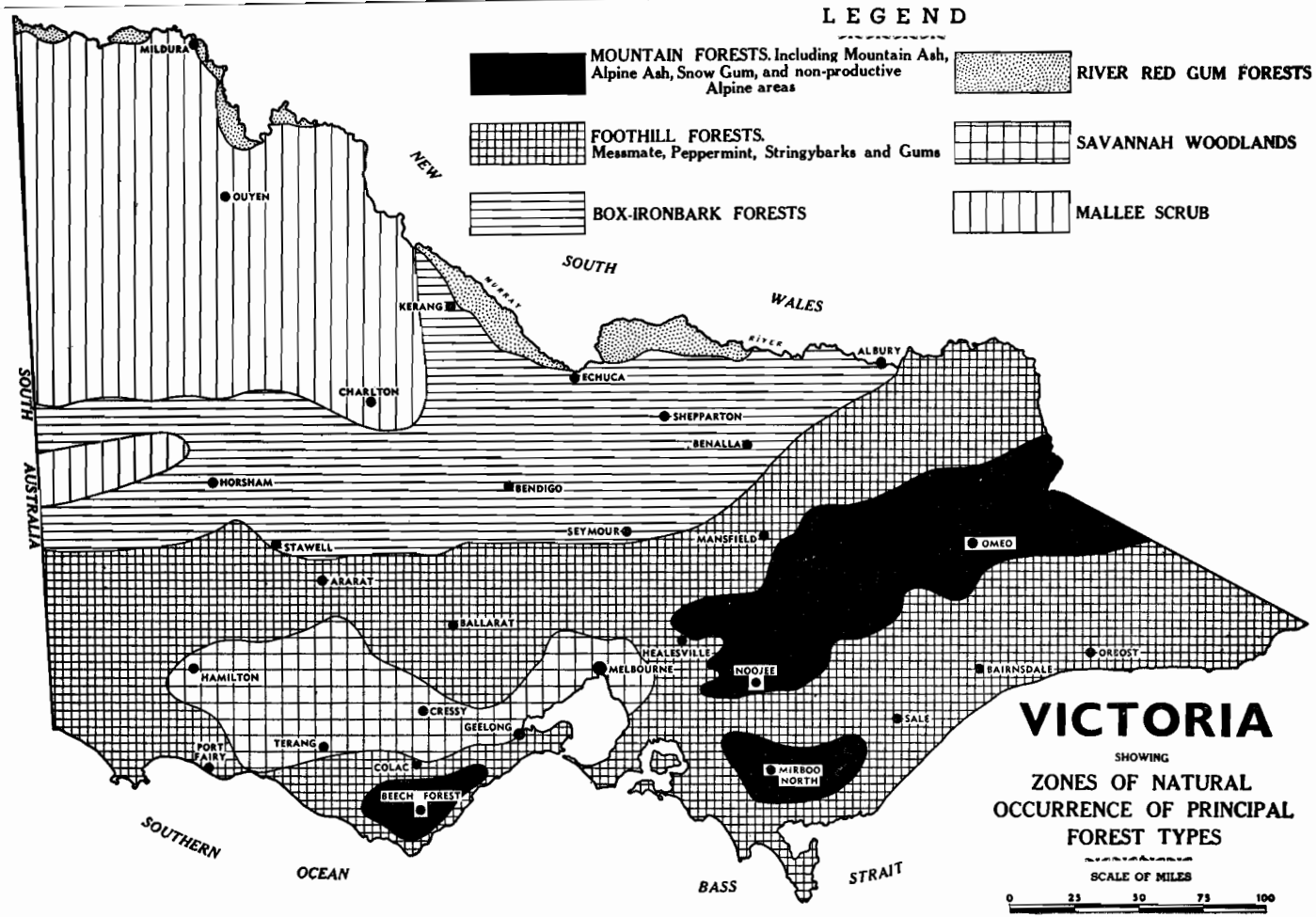

LEGEND
MOUNTAIN FORESTS. Including Mountain Ash, Alpine Ash, Snow Gum, and non-productive Alpine areas
RIVER RED GUM FORESTS
FOOTHILL FORESTS. Messmate, Peppermint, Stringybarks and Gums
SAVANNAH WOODLANDS
BOX-IRONBARK FORESTS
MALLEE SCRUB
MILDURA
OUYEN
KERANG
CHARLTON
ECHUCA
ALBURY
SHEPPARTON
BENALLA
HORSHAM
BENDIGO
SEYMOUR
MANSFIELD
OMEO
STAWELL
ARARAT
BALLARAT
HEALESVILLE
NOOJEE
BAIRNSDALE
ORBOST
HAMILTON
MELBOURNE
CRESSY
GEELONG
SALE
PORT FAIRY
TERANG
COLAC
MIRBOO NORTH
BEECH FOREST
NEW SOUTH WALES
SOUTH AUSTRALIA
MURRAY RIVER
SOUTHERN OCEAN
BASS STRAIT
VICTORIA
SHOWING
ZONES OF NATURAL OCCURRENCE OF PRINCIPAL FOREST TYPES
SCALE OF MILES
0 25 50 75 100

FIGURE 2

property sustained, and an estimated minimum of 2,000 million superficial feet of merchantable timber, principally of ash species, killed. Since that date fire detection and suppression measures have been greatly improved and hundreds of miles of roads and tracks covering large portions of the mountain areas constructed for access of men and equipment to the scene of fires. Much remains to be done, however, to obtain complete protection from fire, both natural and man-made. Early detection, access tracks, modern equipment and trained fire-fighting personnel are essential and are now available in extensive areas of our forested mountains.

Success in fire prevention is essential for the preservation of the State's forest wealth and also for maintenance of regularity of stream flow in water catchments and for soil stability.

Water Supply and Hydro-Electric Power

The vital importance of mountain forests in relation to water supply has already been referred to. Water is used from the forested catchments of streams flowing both north and south of the Main Divide for domestic, irrigation, and hydro-electric purposes. The preservation of these catchments in efficient condition is a vital aim in fire protection. Within domestic water supply catchments, forest management practices have been introduced in all State forests which provide for prescriptions to regulate and control carefully the thinning, utilization fellings, and general harvesting operations of the forest crop so that water supply interests are not adversely affected. Research work is in progress in several catchment areas by various Government authorities to help in determining the effect of various forest management practices on water yields.

Forest Recreation

With the construction of new and better roads throughout much of our mountain country, the grandeur and beauty of Victorian mountain scenery is attracting more and more tourist interest. The attraction of the mountain fern gullies has long been known. The Alpine Highway from Omeo to Bright and the roads to Mount Buller and Mount Buffalo open up vistas of mountain forest, snow gums, and open grassy plains above the timber line with their wealth of spring and summer wildflowers.

It is probable that the area of snow country in Victoria suitable for snow sports exceeds that of Switzerland. At Mount Buller and Falls Creek, alpine villages have been established as first-class tourist and ski resorts. It is certain that other alpine areas will be similarly developed since the popularity of this winter sport is growing rapidly each year.

Glossary

The following are the common and botanical names of species referred to in the section above :—

Common Name	*Botanical Name*
Alpine Ash	*Eucalyptus delegatensis*, R. T. Baker (Syn. *E. gigantea*, Hook.f.)
Blackwood	*Acacia melanoxylon*, R. Br.
Blanket Leaf ..	*Bedfordia salicina*, DC.

Common Name	*Botanical Name*
Blue Gum	*E. bicostata* maiden et al.
Hazel	*Pomaderris aspera* Sieb. ex DC.
Manna Gum	*E. viminalis,* Labill.
Messmate	*E. obliqua,* L'Herit.
Mountain Ash . .	*E. regnans,* F. v. M.
Mountain Grey Gum . .	*E. goniocalyx,* F. v. M. ex Miq.
Musk	*Olearia argophylla,* Benth.
Myrtle Beech . .	*Nothofagus cunninghamii,* Oerst.
Narrow-leaved Peppermint	*E. radiata,* Sieb. ex DC.
Red Gum	*E. camaldulensis,* Dehn. (Syn. *E. rostrata,* Schlecht).
Red Ironbark . .	*E. sideroxylon,* A. Cunn. ex W. Woolls
Sassafras	*Atherosperma moschatum,* Labill.
Satin Box	*Phebalium squameum,* Engler
Shining Gum . .	*E. nitens,* Maiden
Silvertop	*E. sieberiana,* F. v. M.
Silver Wattle . .	*Acacia dealbata,* Link
Snow Gum	*E. pauciflora* var. *alpina,* Ewart
Tree Fern (common) . .	*Dicksonia antarctica,* Labill.

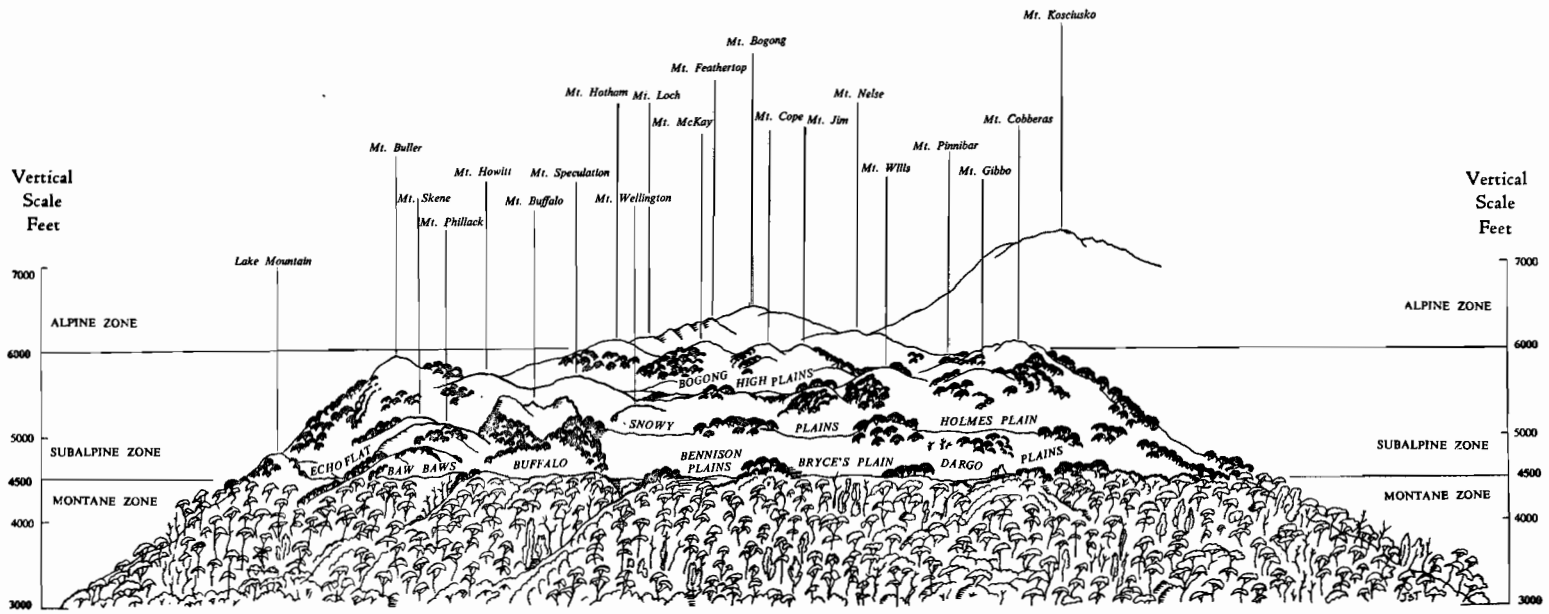
Victorian High Catchments

Introduction

In the north-east corner of Victoria lies a wild, mountainous and heavily forested region, where few roads run, settled by only a handful of people. Within it, mostly on the Great Divide, there is an area of about 900 square miles with an elevation greater than 4,500 feet, which lies under snow in the winter months. Here are the Victorian Alps, the high catchments in which rise the tributaries of our major rivers—the Mitta Mitta, Kiewa, Ovens, King and Broken, flowing north to the Murray ; the Delatite, Howqua and Jamieson in the Eildon Catchment ; the Thomson, Avon, Macallister and the Tambo which run south to the Gippsland Lakes.

The high catchments were exploited by the pioneers—the gold prospectors and the graziers—but it is only since 1925 that the State authorities have come to realize their vital importance for water and power production, forestry, nature conservation and the tourist industry. The Victorian mountains lack the usual features of true alps—extensive rocky peaks—and are very largely covered with a deep mantle of soil. Over-grazing and recurrent fires have damaged the protective vegetative cover and soil erosion has become a threat to the catchments. Since 1941, grazing has been restricted by the Soil Conservation Authority, and since 1958, by Government direction, this Authority controls the use of all land above 4,000 feet (see page 62).

The vegetation of the alpine catchments is extremely complex and has not yet been adequately described in scientific papers. It will be convenient to distinguish three major environmental zones—the alpine, sub-alpine, and montane (fig. 3).



A highly simplified diagram of the Victorian Alps seen from the south, showing the three major climatic and vegetational zones, the heights of the major mountains and of the larger plains. The vertical scale is exaggerated and the location of the mountains is only approximate (see Figure 1). The Alpine zone, of small extent in Victoria, is treeless ; the Sub-Alpine zone carries Snow Gum (in black), snow grass, heathy shrub communities, and moss beds. The Montane zone is heavily forested ; the tree species comprise Woolly Butt, Mountain and Manna Gums, Peppermints and White Sallee, all hardwoods of the genus *Eucalyptus*.

FIGURE 3

Environmental Zones

(1) The true *alpine zone* in Victoria is restricted to the summits of the highest mountains above the tree line. The precipitation ranges from 70–100 inches per annum and snow may lie for four months of the year. The major vegetation community is a " herbfield ", comprising many showy species of which the Snow Daisy (*Celmisia longifolia*) is the best known. Although this plant community is better represented on the high peaks of the Snowy Mountains in New South Wales, and although it has been damaged by over-grazing, characteristic examples may still be found on Mount Bogong (6,516 feet), Mount Nelse (6,181 feet), Mount Hotham (6,101 feet), Mount Pinnabar (5,811 feet) and Mount Howitt (5,718 feet).

(2) The *montane zone* is the extensive area surrounding the snow country proper at elevations less than 4,500 feet, with an annual rainfall of 40–70 inches. It is largely covered with mixed hardwood forest, although there is a high belt dominated by the Woollybutt or Alpine Ash (*Eucalyptus delegatensis*), a tree of great importance to the timber industry. Many other tree species occur, including the Mountain Gum (*E. dalrympleana*), the White Gum (*E. pauciflora*), the Manna Gum (*E. viminalis*) and the Peppermints (*E. dives*, *E. radiata*). The best of these forests originally had an open grassy floor, but a century of over-grazing by sheep, cattle, and rabbits and frequent recurrent fires have induced a dense scrub vegetation. Soil erosion is extensive and the rehabilitation of this part of the catchment now presents a very difficult problem.

(3) Between these two zones (4,500–6,000 feet) is the *sub-alpine zone*, with a total annual precipitation of 50–80 inches, much of it in the form of snow, which may lie for one to four months of the year. All this region is below the natural tree line, but is by no means uniformly covered with trees ; its shallow valleys and gentler slopes form the characteristic High Plains known to skiers and walkers as one of the most delightful of Victorian landscapes.

Within the sub-alpine zone, four major plant communities have been distinguished :—

(*a*) Woodland, in which the major species is the Snow Gum (*E. niphophila*), which is probably only an alpine form of *E. pauciflora* ; the Black Sallee (*E. stellulata*) and the Dargo Gum (*E. perriniana*) may accompany it. In their natural state most of these woodlands had an open grassy floor, with snow grass (*Poa australis*) extending right up to the bases of the trunks, but fire has encouraged the growth of shrubs. Many of the larger trees are bare skeletons, regenerating very slowly from the basal ligno-tubers.

(*b*) A heath-like community of shrubs, many of them legumes (*Oxylobium, Bossiaea, Hovea*), with others belonging to characteristic Australian genera (*Epacris, Prostanthera, Kunzea*). It appears that originally this community was more or less confined to the stonier and poorer soils, but it is now spreading into the damaged grasslands. It is not regarded as good catchment cover.

(*c*) Moss beds. In all the wetter parts of the zone are the moss beds or bogs, carrying a rich and varied flora, rooted in an acid peat made up of the moss *Sphagnum cristatum* and the dead remains of higher plants. The smaller mossbeds occur below springs and along the courses of the streams ; more extensive moss beds cover the flats of the larger valleys. Here the streams flow on stony beds between banks of peat up to 10 feet thick. The peat tends to slow down stream flow and to retain water even in the height of summer ; the moss beds regulate the flow of water and add considerably to catchment efficiency. It is most unfortunate that the trampling of grazing animals and recurrent fires have destroyed so many of them.

(*d*) Grassland. This is a very extensive treeless community dominated by the Snow Grass (*Poa australis*) or, in snow-patch areas, by a sedge (*Carex hebes*), but containing up to 40 species of herbaceous plants.

The grassland communities of the sub-alpine region present a problem to botanists which has not yet been completely solved. One would normally expect the Snow Gum to occupy all these areas, and it is often found on the higher and rockier peaks within the High Plains. It is usually considered that the absence of trees on the plains is due to cold air drainage during the growing season, leading to heavy frosts at night which cause the soil to heave, and prevent establishment of all but the hardiest seedlings. However, as grassy plains are found on rounded slopes as well as in valleys, there may be other factors at work in restricting the growth of trees, such as strong winds or certain features of the soil.

Utilization

It seems almost certain that the High Plains were grazed very sparingly by indigenous animals, but since 1850 they have been utilized for summer grazing by sheep, horses, and cattle. The grazing intensity was exceptionally high in drought years and it has steadily become more important as the grass disappeared from the burned montane forests and as the home paddocks suffered from the rabbit and from inadequate fertilization. The deterioration of the vegetative cover, especially in the grasslands and the moss beds, began with periodic over-stocking and has been accelerated by the increased amount of burning since the white man came to Australia. It is not generally realized that the cattle and sheep graze mainly on the young grass shoots and the herbs of the grassland, rather than on the old tussocks, and cattlemen have usually found it necessary to burn in order to encourage the growth of sweeter feed. Accidental and man-made forest fires have also swept into the High Plains and damaged the grasslands.

Soil Erosion

A first warning that all was not well with the catchments was given in 1893 by Helms in articles on the similar Kosciusko snow leases, but this warning was not heeded. It was not until 1920 that the real dangers of soil erosion in Victoria were brought under notice. The urgent necessity of paying attention to the conservation of soil in the alpine catchments was pointed out in 1941.

Since 1944, the Botany School of the University of Melbourne has organized regular expeditions to the Bogong High Plains, assisted by the Soil Conservation Board* and the State Electricity Commission, and has carried out a long term study of the vegetation of grazed and ungrazed areas. This work, like that on Kosciusko, has confirmed the earlier opinion that the High Plains are by no means in a natural state, that incipient surface soil erosion is widespread, and that recovery from the effects of grazing, burning and trampling is likely to be a very slow and uncertain process. In 1957, a valuable survey was made of the whole of the Victorian high catchments, and the account clearly shows the urgent need for the control of grazing and the elimination of fire.

Catchment Control

Other Authorities which have stimulated official interest in catchment control include the State Electricity Commission, which is responsible for the Kiewa Hydro-electric Scheme on which some £40 million have been expended to date, the State Rivers and Water Supply Commission, and the Forests Commission. The catastrophic bushfires of 1939 led to the appointment of Mr. Justice Stretton as Royal Commissioner to investigate the causes of bushfires, and in the second of his two reports, which still merit close attention, he commented on the erosion in the alpine catchments. Conservation research in the alpine catchments has also been carried out in New South Wales in the much more extensive Snowy Mountains region, where the great hydro-electric scheme is being operated. The entry of the engineers into the catchments has undoubtedly accelerated the movement towards conservation. In 1956, the Australian Academy of Science appointed a committee of four scientists to report on the condition of alpine catchments in both States. The report was published in 1957, and strongly supported the views of the engineers and of many State conservationists that all grazing above 4,500 feet should be discontinued. This recommendation has been adopted by the New South Wales Government, and grazing has also been withdrawn from the highest and most damaged parts of the Victorian catchments.

Potential of Alpine Region

There is no doubt that the whole region should be regarded as one with multiple uses for the State. Parts of it can be developed for forestry purposes ; other large areas must be preserved for the production of hydro-electric power and for increased irrigation potential ; the whole area has a tremendous skiing and tourist potential. There are very good arguments for the creation in Victoria of an alpine national park similar to that created by the Government of New South Wales in 1944—the Kosciusko State Park of 923,000 acres.

Further References

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* The Board was replaced by the Soil Conservation Authority in 1950.

Responsibility of Soil Conservation Authority in Alpine Areas

Statutory Control

The Soil Conservation Authority has the legislative responsibility to determine the most suitable use in the public interest of all lands in catchment areas and the conditions under which various forms of land use may be permitted.

The Land Utilization Advisory Council consists of the heads of five Departments all concerned with the use of land—Department of Crown Lands and Survey, Department of Agriculture, State Rivers and Water Supply Commission, Forests Commission, and Soil Conservation Authority. This Council is available to the Authority for consultation in regard to the determination of land use in proclaimed water supply catchments.

The Governor in Council has, at the request of the Soil Conservation Authority, proclaimed most of the important catchments of the State, including those supplying the Hume, Eildon and Glenmaggie Reservoirs. The remainder of the high catchment country in north-eastern Victoria will be proclaimed progressively.

After a catchment area has been proclaimed, the Authority carries out a soil and ecological survey and, with the aid of this and other information, makes a Determination defining the way in which each part of the catchment may be safely used. The objective is to use every parcel of land at a high level of production without loss of soil or impairment of catchment efficiency.

To ensure that all government instrumentalities whose activities take them into alpine areas are aware of the over-all control by the Authority, the Government has directed that the Soil Conservation Authority shall have supervisory control of all grazing and earthworks and the decision as to the use of all land above 4,000 feet elevation.

In its control of the Bogong High Plains, the Authority has been helped materially by the Bogong High Plains Advisory Committee, a body consisting of three cattlemen representing the cattle graziers in the Omeo district, Kiewa, and Ovens Valleys and representatives of the State Electricity Commission, Lands Department and the Soil Conservation Authority. The Committee examines the area towards the end of each grazing season and recommends the grazing intensity to be permitted in the following year. It also recommends to the Authority other measures that should be taken to safeguard the area.

The State Electricity Commission and the Soil Conservation Authority have assisted the Botany School, University of Melbourne, to maintain a continuous survey in Rocky Valley of changes that are taking place in that area, both where the vegetation is grazed at the present controlled intensity and within enclosed areas where grazing does not occur. Improvement in the sward and soil cover has occurred under both conditions, but is more marked within the ungrazed enclosures.

Soil Conservation In Catchments

Victoria's expanding population is creating an ever-increasing demand for water, the natural resource which is commonly recognized as the single factor most likely to limit Australia's development. Over large areas of the State, settlement has resulted in forms of land use which have impaired the water-holding capacity of the soil. The too-drastic clearing of trees, over-grazing, and over-cropping have not only upset the ecological balance, but frequently resulted in ever diminishing production. The loss of soil fertility is accompained by a breaking down of soil structure and inevitably erosion has followed. The twin evils of too frequent flash-flooding and silting of streams and water-courses are a natural consequence.

It is only since the Second World War, that a serious endeavour has been made in Victoria to restore the damaged areas and introduce improved methods of land use which not only protect the soil and lift production, but use the rain which falls to best advantage. Despite the short period, the practice of soil conservation has provided excellent results which have been widely recognized.

One important aspect of this recognition has been the approach by organizations responsible for water supplies to the Authority for the proclamation of catchments as water supply areas. Following such proclamations, which are necessarily provided for by legislation, the Authority determines the most suitable use in the public interest of all lands in catchment areas.

While there are many small catchments operating on this basis, the principle was extended during 1960 when the Government decided that the fourth largest reservoir in the State should be built on the Campaspe River in Central Victoria at a cost of £3 million. The catchment to this reservoir, which is known as the Eppalock Catchment, covers 820 square miles, and the northern part of it is in a severely eroded condition. For the first time in Australia a government has provided funds simultaneously for building a reservoir and soil conservation work throughout the catchment to protect this valuable asset and it is planned to spend £50,000 a year for ten years in a dual approach to the latter problem.

The first approach, which is made urgent by the fact that the reservoir is already being built, is the prevention of silt movement by mechanical means such as concrete structures and groynes in gullies. Gullies will be fenced and planted with trees as further erosion control measures. Termed non-productive, these works are vital and widespread in the early stages of the Eppalock Catchment project.

However, the more important and enduring positive approach of soil conservation is well under way. With pasture improvement over the broad acres as the dominant aspect of control, farm planning for soil conservation purposes has been introduced. As this work proceeds, the necessity for erosion control structures as such will lessen, because of reduction in both the quantity and rate of surface run-off water and consequent reduction of silt.

The aims of soil conservation in catchment control are to stabilize the soil through replacing the original, irretrievably lost, ecological balance by another balance with, if possible, a higher productive level and to ensure that excess water is as pure as possible. The improved land use will result in more rainfall entering the soil and there will be an increased sub-surface flow spread over longer periods and an inevitable and drastic lessening of silt.

Control of Grazing

The high country of Victoria has been used for grazing for about 100 years. In the early days the grass lands and herb fields were grazed mostly by horses. Later, as the surface of the land became more consolidated, more cattle were introduced and in the drought years, particularly of 1901 and 1914, large numbers of sheep were taken to the Bogong High Plains and other high country areas. As these areas are snow covered during the winter months, grazing has always been restricted to the summer, but it was common practice prior to 1944 for stock to be moved from the lower timbered country into the more open snow gum and high plains country immediately after the thaw commenced.

During the years of uncontrolled grazing, it was common practice for the country to be burnt, particularly in the timbered areas. Whilst this practice resulted in a quick growth of palatable vegetation, the result was a heavy development of scrub and young forest to the detriment and virtual destruction of the grazing potential. This habit of burning was not so common on the more open high country, but in bad bushfire years such as 1939, practically the whole of the high mountain country of the north-east of Victoria was swept by fire.

Recovery of the alpine vegetation after fire and severe overgrazing is very slow, bare areas of soil remain exposed and sheet, gully and wind erosion commence.

Since 1944, the Soil Conservation Authority has exercised control over the grazing on the Bogong High Plains. The controls exercised have included a substantial reduction in the number of stock grazed each year, the allocation of specific numbers to each licence holder and run and determination of the date of entry to and departure from the High Plains depending on seasonal conditions. The grazing season is now limited to the period between the middle of December and the middle of April. In late snow years, entry is not permitted until January.

Recently two areas have been completely closed to grazing. These are Mount Bogong and its surrounds, particularly on the Kiewa fall, and a large area surrounding Mount Hotham.

Substantial improvement in vegetative cover has occurred throughout most of the Bogong High Plains since grazing control has been exercised. This is not always by native species, nor by the particular species once inhabiting the particular area, but the over-all effect on improving catchment efficiency is satisfactory.

Most of the cattlemen use the area for grazing of breeding cows and calves, as this is the most profitable line to them. The demand for calves and young stock grazed on alpine areas is keen and this is reflected in the successful autumn calf sales which are held annually in towns near to the high country. Nevertheless, the number of cattle grazed in these areas is small by comparison with the total number of beef cattle in the State.

Tourist Attractions

In the north-east of Victoria, the Alps provide both a summer and a winter tourist playground. In this great alpine region of which the Dividing Range forms a backbone, there are 870 square miles of mountainous country which is covered every year from June until October with a mantle of deep snow.

Here and there the Alps are crossed by roads. By far the greater part, however, is uninhabited and may be visited only on foot or on horseback. In late spring, after the snows thaw, herds of beef cattle are taken up into the Alps and turned out to graze on areas of grassland known as High Plains. The cattle are returned to pastures below the snowline in autumn, when the onset of snow again blankets the countryside.

The Victorian Alps are ideal for winter sports. They possess the gentle rolling configuration which is particularly suitable for alpine skiing. Winter sun reaches the slopes and penetrates into the valleys without detracting from the perfect snow sports conditions. One of the outstanding features of Victoria's skiing terrain is the entire absence of avalanches.

In the heart of the Alps are chalets, hotels, and alpine villages where informal companionship and comfort is accompanied by slopes that cater for the expert and the beginner. A feature of alpine village life is the club lodges which are built by ski clubs. The lodges are erected on Crown Land which is made available at a nominal rental. Control of village affairs is in the hands of local committees of management on which there is representation of all organizations and official bodies concerned.

There are ski tows and lifts on the principal slopes and expert instructors are present throughout the snow season to give skiing tuition. All resorts are accessible by approach roads which are kept clear of snow during the winter months.

The major ski resorts in the Victorian Alps are at Mount Buller (5,919 feet), Mount Buffalo (5,654 feet), Mount Hotham (6,101 feet) and Falls Creek (5,250 feet).

The chalets that cater for skiers in most cases remain open to cater for summer tourists. Clubs also take advantage of the snow-free months to effect improvements to lodges, and members enjoy summer touring throughout the mountains, using the lodges as bases.

As soon as the warm days of late spring and early summer farewell the great mass of snow, the alpine flora come to life. However, not all of the snow disappears and frequently deep drifts remain on the highest peaks throughout the year.

In spring, summer and autumn, the mountain summits and high plains are covered with carpets of alpine daisies. In the sheltered valleys and on the sunlit banks of swamps and streams, a host of native flowers and trees burst into bloom.

Many roads traverse the foothills of the Alps, following mountain-girt valleys and crossing the ranges at low gaps. There are, however, several major roads that penetrate into the very heart of the mountains, (see map opposite page 45). Principal of these are the Alpine Road—the highest through motor road in Australia—which crosses Mt. Hotham at a height of 5,806 feet; the Omeo Highway which follows the valleys of the Mitta Mitta and Tambo Rivers which have their sources high in the Alps and flow north and south from the Dividing Range, and the Bonang Highway skirting the eastern extremity of the alpine region. Other lesser roads are of interest to the admirer of rugged mountain scenery and the tourist who is conscious of history and enjoys visiting the old mining townships which are so closely linked with the exploration of the Alps.

For the walker, there are hundreds of miles of rugged mountains and valleys with only the minimum of contact with habitation.

Mount Buffalo National Park

Hume and Hovell, the Australian explorers, were the first white men to see Mount Buffalo. They viewed the towering plateau from an angle that brought the shoulder of The Hump close behind the upthrust peak of the horn and gave the rugged outline of the great tableland of granite the appearance of a huge buffalo. It was the inspiration for the name they gave it—Mount Buffalo.

That was in 1824, but it was not until the discovery of gold in Victoria 30 years later that the first white men set foot on the plateau, and many years later, that the scenic fame of Mount Buffalo spread throughout Victoria and mountaineering enthusiasts began to come from Melbourne to holiday in the Alps and explore the precipitous cliffs and walls of The Gorge.

For a long time there was no accommodation for tourists on the plateau. A syndicate had built a primitive house between the Hump and the Horn, but it lasted only one summer and was then abandoned. Later a small hospice that became known as " Bousteads ", as well as a number of sleeping huts, were built not far from where the Monolith stands today.

The first Chalet was built on the site of the existing Chalet in 1910, two years after the opening of the road that was constructed by the Victorian Government when it assumed control of the Mount Buffalo plateau as a national park. The road—later graded and widened for

two-way traffic by the Country Roads Board—was built by Mr. C. Catani, Engineer-in-Chief of the Public Works Department. He was also responsible for work on the lake that bears his name.

The Victorian Railways took control of the Chalet in 1924, and two years later started remodelling the famous guest house. This work continued until 1937, when most of the major additions and extensions were completed. Since then the policy of progressively improving the Chalet has been continued, with the result that it now ranks with the world's best mountain holiday resorts.

Mount Buffalo is an ideal vacation spot. Situated at 4,450 feet, the plateau has a climate that tempers summer heat to around 75° F., while in winter a carpet of crisp snow awaits the skier.

The nursery slopes of Dingo Dell, with its rope tow, is suitable for skiing beginners; for the experienced there are the more exhilarating runs at the Cathedral and Cresta.

Mount Buffalo unfolds a never-ending panorama of vistas stretching over the Ovens Valley to the distant blue haze of the Australian Alps. The plateau has numerous fantastically shaped rocky outcrops, winding walks, and breathtaking views of the Alps—many within easy walking distance of The Chalet. Some of the geological curiosities are the Hump, the Horn, the Monolith, the Leviathan (a giant rock estimated to weigh about 30,000 tons), the Cathedral, Egg Rock, Kissing Stone, Table and Loaves, Stonehenge, the Sentinel, the Torpedo, Mahomet's Coffin and the Woolpack.

Over 360 species of wildflowers have been discovered in the National Park—a reservation of more than 27,000 acres. In the flower season, a walk, that takes in the shores of Lake Catani, will reveal at least 60 species in bloom. The bird life in this alpine region includes the lyre bird which, on some days, can be seen within a few hundred yards of the Chalet.

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-Eastern 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 season with minimum temperatures 10° F. to 20° F. less than at lowland stations. (See pages 47 to 49.)

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 up to 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 over Victoria longer than three or four days are most 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 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

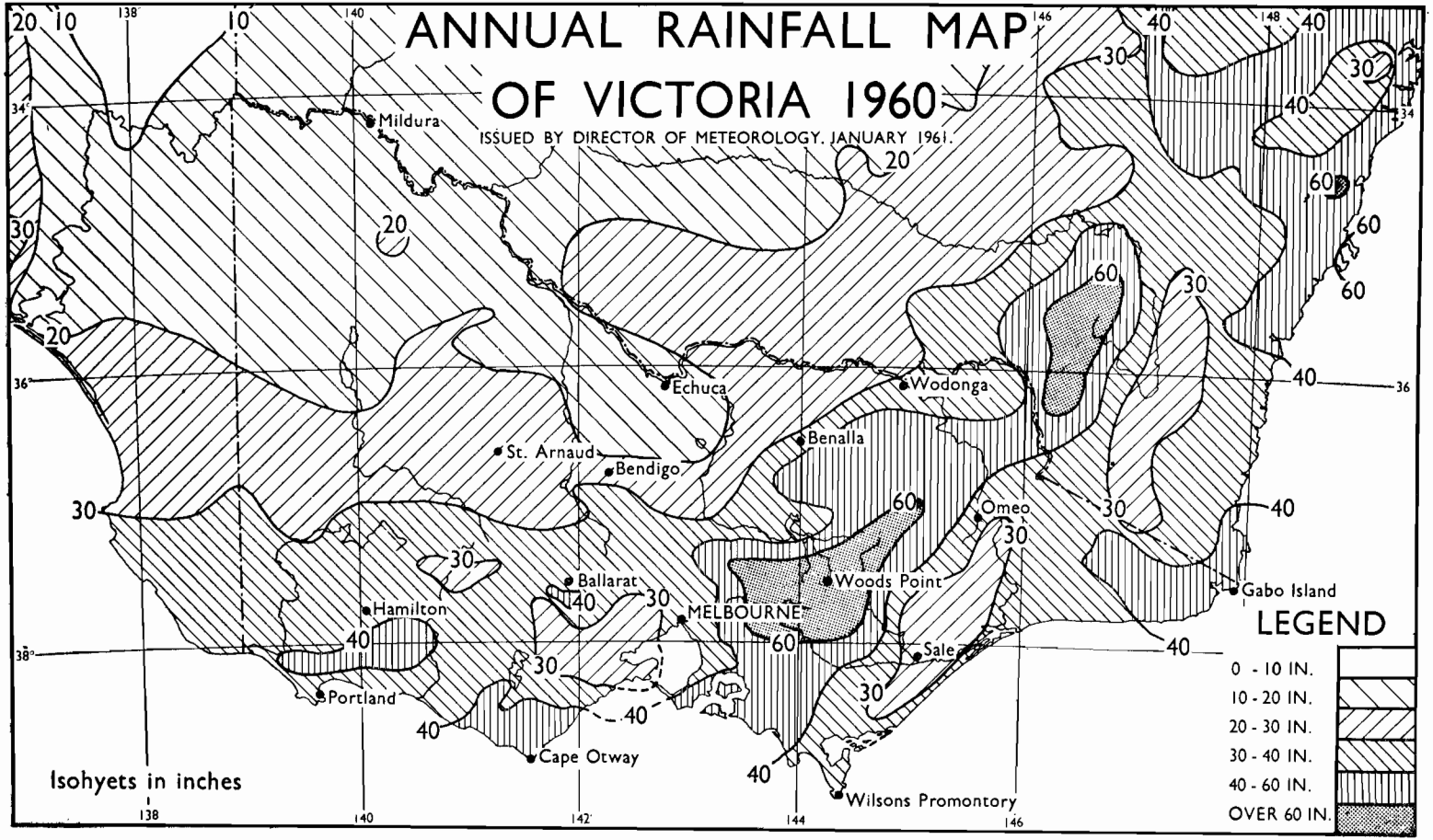
ANNUAL RAINFALL MAP
OF VICTORIA 1960
ISSUED BY DIRECTOR OF METEOROLOGY. JANUARY 1961.
Mildura
Echuca
Wodonga
Benalla
St. Arnaud
Bendigo
Omeo
Ballarat
Woods Point
Gabo Island
Hamilton
MELBOURNE
Sale
Portland
Cape Otway
Wilsons Promontory
Isohyets in inches
LEGEND
0 - 10 IN.
10 - 20 IN.
20 - 30 IN.
30 - 40 IN.
40 - 60 IN.
OVER 60 IN.

FIGURE 4

light and infrequent. Snow has been recorded in all districts except the Mallee, Wimmera, north, and lower north. 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 four 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

There have been numerous dry spells over the State, most of them of little consequence, but many long enough to be classified as a drought. The latter was recognized as an agricultural hazard in Victoria from the middle of the previous century when population was extending into drier areas of the State. There have been less than ten significant drought periods during the last fifty years. The State of Victoria is situated on the northern fringe of the belt of prevailing westerly winds, which results in fairly uniform and reliable rainfall throughout the year. By and large, Victoria has a rather equable climate. Although severe droughts, devastating floods, scorching bush fires and severe storms are experienced from time to time, compared with other places in Australia and elsewhere over the world, the climate of Victoria is well behaved.

Developments in Meteorology

In recent years new electronic equipment has come into use in the Commonwealth Bureau of Meteorology. For example, there is a device used for the " spotting " of lightning discharges, as an aid to the analysis and forecasting of weather. This is called " sferics ", short for " Atmospherics Direction Finding System ", and the system comprises a network of three or four stations. At present a Southern Ocean network is being set up and the stations participating are Laverton, near Melbourne ; Wilkes, on the Antarctic coastline ; and Guildford, near Perth.

Australia has been prominent in the field of Antarctic Meteorology for some years. At present the Bureau of Meteorology plans to place automatic weather stations at two remote localities near the Antarctic coastline, as well as to maintain its three manned stations on the continent.

Other electronic equipment in use is of the radar type, used for wind-finding and storm-watching, and in Victoria this equipment is also located at Laverton.

A new organization called a hydro-meteorological service is being formed within the Bureau of Meteorology to study the State's river habits. In Victoria, a preliminary study has been made of the Morwell River in Gippsland, with the help and co-operation of local authorities.

Weather observations made by ships are still the only source of information of meteorological conditions over the ocean areas. In 1960, the Bureau appointed a Port Meteorological Agent for the Port of Melbourne, and in this way hopes to improve its liaison with over-sea and Australian shipping.

The Melbourne Office of the Bureau is also endeavouring to improve its network of observation stations near and around Port Phillip Bay so that it can provide more accurate information for maritime interests, yachtsmen, and fishermen. New observations have begun at Dandenong, Warragul, Mornington, and Cape Schanck, and it is hoped that regular observations will be despatched from Point Lonsdale.

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 January 13, 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 the 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 87.0° F. on February 1, 1902.

In Melbourne, the average overnight temperature remains above 70° F. on only about two nights per 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 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 per 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 25.89 inches on 156 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 five inches, but variability increases towards the warmer months. In the latter period totals range between practically zero and over seven and a half 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 per month in January and a maximum of seventeen in 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—in 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 per 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

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 98. 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 per 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 also 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 stream 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 with lulls, during which the speed may drop to or near zero, and 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 Aspendale wind gusts up to 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 states that the terrified state of the aborigines suggested they had never seen snow before.

Victorian Weather Summary for 1960

Summer 1960

The highest reported temperature of the year for Victoria was 114° F. at Mildura on 2nd January. Thunderstorm activity was very marked and was associated with hailstorms, duststorms, and torrential downpours. Most of the severe activity occurred in northern Victoria where Chiltern recorded 510 points in 24 hours in one case, and in another a severe tornadic squall in the Tallangatta area damaged buildings, uprooted trees and caused loss of life. A severe heat wave about the middle of the month indirectly caused 31 deaths; about this time the most serious fire of the season raged in the Grampians burning out 5,000 acres of forest country. Summer rains were near average or above over the State except for the eastern districts where East Gippsland reported the greatest deficiency.

Autumn 1960

This season began on a rather dry note with rainfall mostly below average. Bush fires destroyed thousands of acres of forests and grasslands, and at times widespread thunderstorm activity associated with hail smashed glass windows and damaged fruit and vegetable crops. In the latter half of the season, record rainfall was reported from many stations in all districts except East Gippsland. Autumn ended on a cold and very wet note and May was the first month in which all districts registered above average rainfalls. Six large towns (Mildura, Nhill, Echuca, Bendigo, Wangaratta and Sale) experienced the lowest mean temperature ever recorded for May.

Winter 1960

Victoria, along with the southern parts of Australia experienced a cold winter. August was the fifth successive month when mean maximum temperatures failed to reach the average. The rainfall for the State as a whole was very close to normal and although local flooding did occur, none of it was serious. Frosts were reported on a number of mornings each month, some of them severe. Fogs were fairly frequent,

disrupting transport and causing the Melbourne Airport to close on several occasions. Snow fell at many elevated areas from the Grampians to the Alps during July and August and some places reported snow for the first time in 50 years.

The worst gales of the year occurred towards the end of July when power, telephone, and transport services were disrupted, structural damage was reported, and a freighter was blown ashore near Williamstown.

Spring 1960

Spring began with above average rainfall in September and below average temperatures continued. Towards the latter end of this month, a violent storm developed with the passage of a cold front. Winds estimated at 70 m.p.h. in the Numurkah district unroofed buildings, snapped off large trees at the base and flattened sheds during a tornadic storm which lasted five minutes. Roofing iron was whirled up to 3 miles away, power blackouts occurred and damage was estimated at £20,000. Wet conditions were so marked this year that most places had exceeded their normal annual rainfall by September. Flooding occurred in some rivers in each district during the month.

October, which is normally one of the wettest months of the year in southern districts, was dry over most of the State and the driest for Victoria since March. Temperatures also showed a return to more normal conditions after being below the average for six successive months.

November mean temperatures were lower than those in October. Although November, 1960, was not the coldest, it ranks as one of the coldest November months for Victoria. The whole State received above average rain for spring, and almost all places recorded about one fifth above their average totals.

The year came to a close with a heat wave that continued from Christmas day to New Year's Eve and many stations over Victoria recorded temperatures of a century and above on two or three days.

Meteorological Records

Particulars about climate and weather conditions have been furnished by the Commonwealth Bureau of Meteorology, and are given in the following tables. In the first are shown the rainfall for each district and for the whole State for each of the years 1951 to 1960, together with the average rainfall covering a period of 30 years.

VICTORIA—RAINFALL IN DISTRICTS
(Inches)

Year Ended 31st December—	Districts								Whole State
	Mallee	Wimmera	Northern	North-Central	North-Eastern	Western	Central	Gippsland	
1951 ..	12·09	19·61	20·26	31·87	37·45	33·32	34·71	41·78	27·91
1952 ..	15·22	21·87	21·86	35·56	46·24	39·30	40·66	48·71	32·75
1953 ..	12·27	19·62	16·81	28·69	35·57	30·40	30·75	35·29	25·38
1954 ..	13·41	17·68	21·22	29·88	35·58	25·92	30·93	34·02	25·02
1955 ..	17·68	22·44	26·00	35·99	49·05	32·40	34·12	33·86	30·24
1956 ..	20·85	24·31	31·45	41·17	55·59	34·02	34·29	44·25	34·69
1957 ..	9·67	14·87	13·55	23·01	27·32	26·82	24·85	31·98	21·03
1958 ..	15·45	17·65	21·40	31·57	37·78	29·05	28·99	35·42	26·35
1959 ..	9·97	15·16	16·56	26·09	27·69	24·46	26·53	33·63	21·70
1960 ..	18·08	24·75	22·70	38·45	40·16	36·01	34·98	37·26	30·42
Averages*	12·49	17·52	18·09	28·16	34·81	27·59	28·89	33·47	24·30

* Averages for a standard 30 years' period 1911–1940.

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.

An estimate of the areas of the State, subject to different degrees of average annual rainfall is contained in the following table :—

VICTORIA—DISTRIBUTION OF AVERAGE ANNUAL RAINFALL

Rainfall	Area
inches	square miles
Under 10	Nil
10 to 15	19,686
15 to 20	13,358
20 to 25	15,731
25 to 30	15,819
30 to 40	14,150
Over 40	9,140

The means of the climatic elements for the seasons in Melbourne deduced 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)	29·971	29·920	30·075	30·076
Monthly Range of Pressure of Air (Inches)	0·889	0·763	0·816	0·973
Mean Temperature of Air in Shade (° F.) ..	57·7	66·7	59·4	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	69	74
Mean Rainfall in Inches	7·36	6·10	6·58	5·86
Mean Number of Days of Rain	40	25	34	44
Mean Amount of Spontaneous Evaporation in Inches	10·23	17·33	8·09	3·79
Mean Daily Amount of Cloudiness (Scale 0 to 8)*	4·8	4·2	4·7	5·1
Mean Number of Days of Fog	1	1	6	12

* Scale : 0 = clear, 8 = overcast.

In the following table are shown the yearly means of the climatic elements in Melbourne for each year 1956 to 1960. The extremes between which the yearly mean values of such elements have oscillated in the latter periods are also included.

MELBOURNE—YEARLY MEANS AND EXTREMES OF CLIMATIC ELEMENTS

Meteorological Elements	1956	1957	1958	1959	1960
Atmospheric Pressure (Inches)—					
Mean	29·915	30·018	30·015	30·080	29·996
Highest	30·490	30·650	30·522	30·669	30·570
Lowest	29·233	29·452	29·451	29·233	29·157
Range	1·257	1·198	1·071	1·436	1·413
Temperature of Air in Shade (°F.)—					
Mean	58·6	58·7	58·3	59·5	58·8
Mean Daily Maximum ..	67·0	68·1	66·6	68·4	67·6
Mean Daily Minimum ..	50·3	49·4	49·8	50·7	50·0
Absolute Maximum	101·0	103·0	101·7	109·0	105·0
Absolute Minimum	31·3	30·8	32·3	29·5	31·3
Mean Daily Range	16·7	18·6	16·7	18·4	17·5
Absolute Annual Range ..	69·7	72·2	69·4	79·5	73·7
Terrestrial Radiation Mean Minima (°F.)	47·8	46·0	46·8	47·5	45·9
Rainfall (Inches)	30·96	20·86	26·98	25·84	33·50
Number of Wet Days	188	146	156	131	162
Year's Amount of Free Evaporation (Inches)	35·59	41·40	38·75	38·43	41·44
Percentage of Humidity (Saturation = 100)	69	62	66	65	65
Cloudiness (Scale 0 to 8)* ..	5·0	3·7	4·8	4·6	4·9
Number of Days of Fog ..	13	18	21	24	21

* Scale : 0 = clear, 8 = overcast.