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MANUAL

OF

PHYSICAL GEOGRAPHY

OF AUSTRALIA

BY

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GEORGE ROBERTSON

MELBOURNE, SYDNEY, AND ADELAIDE

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TO

ROBERT L. J. ELLERY, ESQ., F.R.S., F.R.A.S., &c.,

WHO STANDS IN THE FIRST RANK

OF THE

DISTINGUISHED MEN WHOSE LEARNED RESEARCHES

HAVE GAINED FOR AUSTRALIA A NAME

IN THE WORLD OF SCIENCE,

THIS WORK IS DEDICATED

BY

THE AUTHOR.

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PREFACE.

This little volume is written for the purpose of imparting to the young people of Australia some knowledge of their own country. I hope that the method adopted will not only be successful in instructing them, but even in interesting those of maturer years who may read these pages. The greatest difficulties which I have had to contend against have been (1) that of reducing to so small a compass the vast mass of interesting matter which has been published from time to time on Australian exploration, discovery, and natural history; and (2) that of obtaining accurate information about very many points of paramount importance to a writer on physical geography. Notwithstanding the care which I have taken, inaccuracies cannot but be found in a book written on a subject up to the present unattempted. These inaccuracies will, I hope, be pointed out to me by my readers.

I return my thanks, for their valuable assistance and suggestions, to Messrs. R. L. J. Ellery, F.R.S., F.R.A.S., &c., T. Brodribb, M.A., J. Cosmo Newbery, B.Sc. and C.M.G., W. J. Malpas, J. F. Bride, LL.D., Captain Pasco, R.N., and the Trustees of the Public Library.

H. B. DE LA POER WALL.

Lansmere, Alma-road, St. Kilda.

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MANUAL

OF

PHYSICAL GEOGRAPHY OF AUSTRALIA.

CHAPTER I.

Australia, the smallest of the continents, is situated in the south-western portion of the Pacific Ocean, between the parallels of 10° 40′ and 39° 11′ of south latitude, and the meridians of 113° and 153° 16′ east of the longitude of Greenwich.

It is bounded on the North by the Torres Strait, the Gulf of Carpentaria, and the Timor Sea; on the East by the Pacific Ocean; on the South by Bass' Straits and the Southern Ocean; and on the West by the Indian Ocean. It is the only continent entirely detached from another continent; yet the coincidence noted by geographers, that between neighbouring continents lie belts of islands, is admirably illustrated by the numerous and important islands on the north of Australia. These, without doubt, connect Australia with Asia. Most of them are, in physical features, in botanical and zoological characteristics, more closely connected with the latter; but Papua is, in all respects, as intimately connected with Australia on the north as Tasmania is connected with it on the south.

If roughly described, the shape of the continent may be said to be a pentagon, with sides of unequal length. The coasts resemble in general outline those of Africa and South America, having few indentations of great size, no large inland seas, and but few promontories.

In succeeding pages it will be seen that Australia, "that land of wonders," reverses in many instances the physical laws which govern the rest of the world. Its very outline does so; for, unlike the other great masses of land, which are broad on the north and taper to one or more great promontories on the south, it is broader on the south than on the north, its two greatest promontories point north, and its outlying islands are not restricted to its southern side; in fact, Papua on its northern coast is larger and more closely allied to it than Tasmania.

Although the coasts present in many places, especially on the north-west, a dangerous and precipitous aspect to the mariner, they are in general beaches sinking rapidly into deep water, fringed with low and shifting sandhills, and exposed to the full force of the winds and currents. The east coast of Queensland alone is sheltered. From Cape York to Keppel Bay, in a direction almost parallel to the shore, lies the Great Barrier Reef. Its length is a thousand miles, broken only where the streams from the Pacific Slope discharge their muddy waters into the ocean; its width varies from 200 yards to a mile; its average distance from land is about 30 miles; the depth of the sea between it and the coast varies from 10 to 50 fathoms, and its depth on the ocean side is not less than 150 fathoms. Peaceful water prevails between the reef and the land; while, without, the heavy swell of the ocean beats incessantly against this grandest of coral structures. Very accurate directions have long since been published by the Admiralty for the navigation of the reef. It will be necessary to enumerate in this

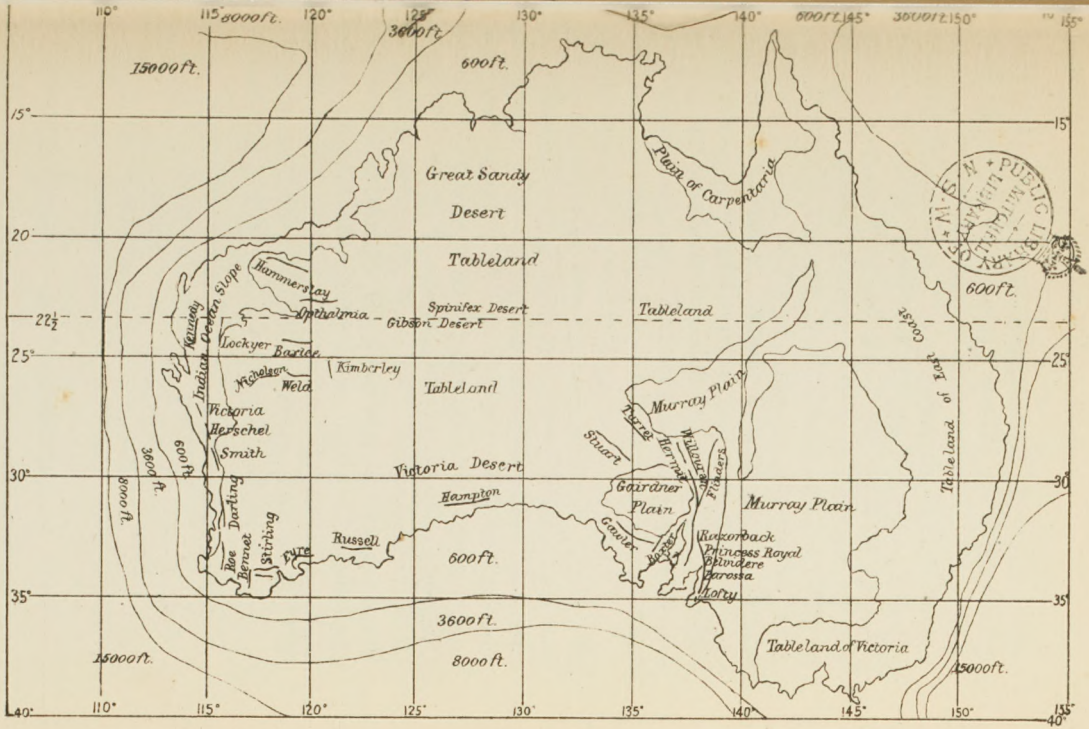

8000ft.
3600ft.
15000ft.
600ft.
Great Sandy Desert
Plain of Carpentaria
Tableland
Hummerday
Ophthalmia
Spinifex Desert
Gibson Desert
Tableland
600ft.
Lockyer
Barrier
Kimberley
Nicholson
Weld
Tableland
Victoria
Herschel
Smith
Indian Ocean Slope
Kennedy
Coast
Murray Plains
Tableland of East
Victoria Desert
Stuart
Forrest
Hermas
Wilson
Flinders
Hampton
Gardner Plain
Murray Plain
Darling
Bore
Bennet
Stirling
Russell
Fitzroy
Gregory
Barrier
Rickerback
Princess Royal
Belvidere
Carossa
Thorby
600ft.
3600ft.
8000ft.
Tableland of Victoria
15000ft.
110°
115°
120°
125°
130°
135°
140°
145°
150°
155°
15°
20°
22½
25°
30°
35°
40°

Plate I

work the most important channels only. By vessels sailing from the Pacific the leading entrances are those through which Torres Strait may be reached by the outer route. In order, beginning at the north, they are—Yule Entrance, Olinda Entrance, Pandora Entrance, Blackwood Channel, Stead's Passage, Safe Entrance, Quoin Island Entrance, Second Three Mile Opening, First Three Mile Opening, One-and-a-half Mile Opening, Endeavour Opening, opposite the Endeavour river, Trinity Opening, opposite Barron river, and Flinders Passage, opposite the Burdekin. Through these openings the tidal currents are very strong when the wind blows for even two or three days from the east; and, after great storms, the accumulated waters sweep with such tremendous impetuosity as to render the navigation of most of these channels eminently dangerous.

The dimensions of Australia are—length, from Cape York to Wilson's Promontory, 1,970 miles; width, from Cape Moreton to Dirk Hartog Island, 2,400 miles; and area, 2,944,628 square miles. In estimating the area, there are many difficulties to be encountered, and inaccuracies must be expected; but the figures just given approximate very closely to absolute correctness, for in the "Bevölkerung der Erde" the area calculated by the planimeter is 2,945,227 square miles—only 599 square miles more. In the official catalogues of the various colonies, prepared for the Melbourne Exhibition of 1880, the sum of the areas amounted to 2,972,032 square miles. The total, 2,944,628, is made up thus :—

Area of Queensland... ...	668,224	square miles.
,, New South Wales...	309,175	,, ,,
,, Victoria	87,884	,, ,,
,, South Australia ...	903,425	,, ,,
,, Western Australia...	975,920	,, ,,
Total Australia	2,944,628	,, ,,

CHAPTER II.

THE VERTICAL RELIEF OF THE CONTINENT.

DEFINITION.—Vertical relief is the elevation of land above the level of the ocean.

ON vertical relief depend the climate and the luxuriance of life, vegetable and animal. A change of level amounting to 100 feet of ascent leads to a sensible alteration of temperature, which falls almost equally for every 100 feet up to 2,000 feet, where it amounts to 4° Fahrenheit. Above 2,000 feet the fall is much more rapid. From this general law, which, it must be remembered, is subject to many variations, it follows that—1st. The low-lying country is warmer than the high country in the same latitude ; 2ndly. The higher altitudes are extremely cold ; 3rdly. Even a slight rise in elevation will exclude many genera, perhaps a whole family, from residence ; and 4thly. The hardiest plants and animals only will be found on the tops of ranges.

The distribution of the vertical relief is an important factor in the variations of climate, and in the increase or decrease in the number of species of flora and fauna. If a country be divided by ranges into natural departments, we shall find a marked difference in the climates of distinct localities, numerous species of plants and animals restricted to limited areas, and distinct evidence from the changes of formation that geological disturbance has been intense.

But if a country be of uniform elevation, its very sameness of outline and relief stamps a corresponding sameness on everything. The climate will vary little from local causes, the varieties of life will be limited, and there will be even a paucity of individuals.

Australia is of uniform elevation. There are no moun-

tain chains in it piercing the clouds and presenting the gorgeous spectacle of a hundred peaks dazzling with perennial snow. Its highest point in the Muniong range is only 7,308 feet, and it is not improbable that the mean elevation is below 1,500 feet. The mountain systems, with one or two exceptions, are parallel with the coasts and adjacent to them. The interior is a great plateau, dotted here and there with short ranges of low elevation, and having a very gradual fall from the north-east of Queensland to South Australia.

But though our country has now an average elevation so low that even Africa is higher, there have been pre-historic epochs when the face of the land presented a very different appearance to what it does at present. In the chapter on the geology of Australia we shall see reasons for concluding that lofty mountain chains once occupied the centre of the continent, as it then existed ; and in the existence of the Barrier Reef we have direct evidence that, since Australia assumed its present shape, it has sunk 2,000 feet below its former level on the north-eastern coast. The following facts in connection with coral formations will convince the student of this.

If the condition necessary for the reef-building corals exists—viz., a mean winter temperature of 66° Fahrenheit—it will be almost certain that the structures of coral actinozoa will be present, either as Fringing reefs, Atolls, or Barrier reefs.

The earliest of these structures, in point of time, is the fringing reef, for the polypes cannot exist at a higher level than extreme low water, or a lower level than 200 feet. How, then, can the two questions—"Are not coral formations seen above the level of the ocean?" and "Are they not also found at great depths?" be answered?

To the first question—"Are not coral formations seen above the level of the ocean?"—the answer is : The agency

by which reefs are raised above the surface of the sea is the denuding power of the breakers which constantly fall upon their outer margins. These detach large masses of coral, and heap them above the living coral, to which they become cemented. In this way the upper surface of the reef, along a line of greater or less breadth, is more or less completely raised above the level of high water. It is obvious, however, that the reef might be entirely destroyed by a continuation of this process, unless some counteracting force were brought into play. This counteracting force is found in the activity of the living corals, which form the seaward margin of the reef, and by their growth prevent the sea from always destroying the masses of sediment which it may have thrown up.

To the second question, "How is it that the corals are also found at great depths?" The answer is—The production of a barrier reef from a fringing reef is to be ascribed to a subsidence of the foundation on which the fringing reef rested.

Thus, if the fringing reef that surrounds an island be supposed gradually to sink beneath the level of the sea, the upward growth of the corals will neutralize the downward movement of the land—so far, at any rate, that the reef will appear to be stationary whilst it is really growing upwards. The land, as subsidence goes on, will gradually diminish in size as well as height, and a channel will be formed between it and the reef. If subsidence continue, this channel will widen and deepen, until at length the island will disappear, and a sheet of calm water surrounded by a complete ring only remain.

Had a continent, such as Australia, taken the place of the island in the case supposed, it must be evident that an atoll could not be formed, for it would be impossible to secure around our coasts an uniform winter temperature of 66° F. But the substitution would be most favourable to the pro-

duction of a barrier reef such as has been described in Chapter I.

The existence of a barrier reef is an evidence of subsidence; and, if so, the Great Barrier Reef of Australia indicates subsidence on a scale so huge that there is no land which has been so robbed of its fair proportions by the devouring sea as this land of ours.

Australia* rises from the bed of the Pacific, which has an average depth of 15,000 feet, upon several well-defined terraces. The first of these, having an average depth of 8,000 feet, is not further distant than 150 miles from the present shore line in Western Australia. At the Australian Bight it is 300 miles distant; and, drawing closer to the shore in Victoria, runs south to 55° S. lat. below Tasmania, as a gigantic promontory, 1,000 miles long. Upon attaining its greatest southing it returns, skirting Tasmania and New South Wales at a no greater distance than 60 miles from the coast. At Port Macquarie it extends in every direction as a foundation for New Zealand, Melanesia, Micronesia, the East Indian islands, and Asia.

The second terrace, averaging 3,600 feet of depth, is 80 miles from the shore in Western Australia; 200 miles in the Australian Bight; extends to 50° S. lat. below Tasmania; is 40 miles from the shore in New South Wales; supports the Great Barrier Reef, New Guinea, and New Zealand on a slender south-eastern prolongation.

The third terrace, averaging 600 feet in depth, lies within the last line and the present coast, and carries on it New Guinea, Australia, and Tasmania—three lands bound thus firmly together by the iron hand of Nature; bound also by a more than iron grasp—by the knowledge that we, Australians, form no unimportant part of the greatest and freest empire in the world.

* See Plate I.

Above the surface of the ocean the land rises rapidly along the eastern and southern coasts, except where the Murray basin reaches the sea, through a low-lying tract from Portland Bay to St. Vincent's Gulf. The western shore is below 500 feet high, and the northern rises within a few miles of the shore to 1,000 feet, except at the Gulf of Carpentaria, where from the Gregory river to Cape York an extensive area lies below the level of 500 feet.

The student will comprehend better the general surface of the land if he suppose for a moment that a general subsidence of 500 feet were to take place. This change of level would affect but little the eastern coast, the only inroad of the ocean taking place in the valley of the Fitzroy. But on the south an immense change would be effected. The southern ocean would cover the whole of the Murray valley, making of Victoria a west-trending promontory ending near Portland, and bounded on the north by the waters of an inland sea which would deprive her of her north-western province. This inland sea would extend eastward to within 400 miles of the eastern coast as far as the Darling Downs, and, pushing north along the course of the Thompson river, would make the width of the continent, between the highlands at its sources, and the greatly-increased Gulf of Carpentaria, not more than 300 miles. In the centre it would enclose Lakes Eyre, Torrens, Gairdner, and insulate the ranges on the east of South Australia. Above the surface would rise many islands, of which the Cheviot, Stanley, and Grey ranges would be the largest.

On the west the present coast would lose a strip 60 miles wide at Perth, and widening to the north to 200 miles at the mouth of the De Grey.

On the north, except for the great decrease on the south-western shore of the Gulf of Carpentaria, no great change would result.

If the subsidence were 1,000 feet, the ocean would make further encroachment in all directions, but the lessened form of the continent would be similar to that just described.

If the subsidence were 2,000 feet, nothing resembling a continent would remain. A narrow, rocky barrier would be all left of Queensland, New South Wales, and Victoria. The Macdonnell ranges and the Great Victoria Desert would represent South Australia ; and West Australia, the largest of the colonies, would dwindle down to islands formed by the Stirling, South Darling, and Ophthalmia ranges.

The present land outline has as principal prominences—On the east:—Capes York, Grenville, Weymouth, Direction, Sidmouth, Melville, Lookout, Flattery, Bedford, Tribulation, Grafton, Cooper, Tam o' Shanter, Cleveland, Bowling Green, Upstart, Gloucester, Conway, Hillsborough, Shoal Pt., Palmerston, Clinton, Manifold, Bustard Hd., Round Hill Hd., Burnett Hd., Sandy, Inskip Pt., Double Island Pt., Neusa Hd., Pt. Arkwright, Pt. Wickham, Pt. Danger, Sutherland Pt., Byron, Smoky Hd., Crescent Hd., Pt. Plomer, Indian Hd., Crowdy Hd., Hawke, Treachery Hd., Pt. Stephens, Pt. Jackson Hds., Banks, Solander, Bass, Crocodile, St. George, Upright, Green, Howe, and Wilson's Promontory.

On the south :—Capes Liptrap, Patterson, Griffith Pt., Grant, Schanck, Nepean, Gellibrand, Pt. Henry, Lonsdale, Otway, Moonlight Hd., Nelson, Bridgewater, Northumberland, Buffon, Martin, Rabelais, Dombey, Thomas, Bernouilli, Jervis, Troubridge, Spencer, Corny, Elizabeth, Riley, Jarrold, Lowly, Bolingbroke, Donnington, Catastrophe, Wiles, Whidby, Reef Pt., Sir Isaac, Longmore, Drummond, Finnis, Radstock, Westall, De Mole, Brown, Bell, Pt. Sinclair, Pt. Fowler, Adieu, Pasley, Pt. Hood, Knob, Riche, Chatham, d'Entrecasteaux, and Leeuwin.

On the west coast are Capes Naturaliste, Steep Pt., Cuvier, North-west.

On the north are Preston, Leveque, Londonderry, Dombey, Blaze, Arnhem, and Duyfhen Pt.

Inseparable from the geography of the coasts are the outlying islands.

The principal on the east coast are :—The Flinders Group, Howick Is., Lizard, Hinchinbrook, Palm Is., Magnetic, Gloucester, Hook, Whitsunday, Flat-top, Cumberland Is., Beverly Is., Northumberland Is., Percy Is., Townshend, Capricorn and Bunker Groups, Curtis, Facing, Woody, Lady Eliot, Fraser, Russell, Macleay, Peel, Green, St. Helena, Mud, Bribie, Moreton, Stradbroke, Broughton, Bird, Five Is., Montague, Gabo, Sunday, Snake, Seal, and Glennie.

On the southern coast are :—Phillip, French, Julia Percy, The Lawrence Rocks, Kangaroo, Granite, Torrens, Wardong, Sir Joseph Banks Group, Boston, Gambier, Neptune, Thistle, Four Hummocks, Whidby, Greenly, Investigator Group, Flinders, St. Francis Group, Nuyt's Archipelago, Recherche Archipelago, and Eclipse.

On the west coast are :—Rottnest, Easter Group, Dirk Hartog, Dorre, Bernier, and Barrow.

On the north-west and north are :—Rosemary, Legendre, Forestier, Turtle, Lacepede, Caffarelli Is., Cassini, Melville, Croker, Goulburn Group, Wessel Group, Woodah, Bickerton, Groote Eylandt, Sir Edward Pellew Group, Vanderlin, Wellesley Group, Mulgrave, Prince of Wales Group, and York.

CHAPTER III.

AUSTRALIA: ITS PLAINS AND TABLELANDS.

DEFINITIONS.—A **Plain** is land lying at a lower level than 500 feet. It may be an expanse of verdure and fertility, as in the case of short river valleys; but it is more usual to find great plains presenting every variety of surface from cold, bleak swamps to rough, sandy flats.

A **Tableland** or Plateau is land at a higher elevation than 500 feet, of a fairly level surface, of considerable length and breadth, bearing perhaps upon it more than one mountain chain, and forming the gathering grounds of many streams.

THE **Central Plain**, or plain of the Murray river,* begins near Portland, at the mouth of the Glenelg, and is bounded by an almost straight line to the Wimmera river; thence by a line joining the Wimmera to Albury; and at Albury by the 147th meridian to 27° S. lat. Following this latitudinal line to the west, it is intersected by the Cheviot, Grey, and Stanley ranges, which divide its northern portion into two distinct parts. To the east of these ranges it follows the course of the Thompson—an affluent of the Barcoo—almost to its source as a narrow river valley, and is bounded by 28° S. lat. in South Australia; it extends westward so as to include Lake Eyre. This plain is here bounded by the high lands between Lakes Eyre—70 feet high—and Blanche, and by the Lofty range. This great area is 500,000 square miles in extent. In the descriptions of the rivers in a later chapter some details of the lands embraced within this area will be given. All that need be here said is that, in general terms, this plain is eminently suitable for pasture, has an inadequate supply of water, is scanty in forest growth, and has an average summer temperature of 89·3° Fahrenheit.

* See Plate I.

The **Lake Gairdner Plain** is of small extent, bounded by the Turret range on the north ; the Warburton range on the west ; the Gawler range on the south ; and the Flinders range on the east. It includes a great number of lakes, of which Gairdner, 366 feet above sea level ; Salt Lake, 240 feet ; and Torrens, 200 feet, are the largest. The whole country is extremely uninteresting as regards scenery, and of no commercial value.

The **South Australian Coast Plain** extends from Cape Jervis to Port Wakefield, and varies from 2 to 3 miles on the south to 30 miles near the Gawler river. In the southern portion is the "30-mile Scrub," running down to the coast. This is succeeded by rather better country, which improves to excellent agricultural land at the back of Adelaide.

The **Indian Ocean Slope** extends from the Leeuwin to the Leopold ranges on the north. Along the Darling range it is about 20 miles wide for 200 miles, and then begins to extend inland, being widest where it partakes of the characters of river valleys.

The **Plain of Carpentaria,** beginning with the Nicholson river on the west, stretches south as far as 21° S. lat., and is bounded on the east by the great mountain system of the east coast. In the chapter on rivers something more will be said about the country lying between the streams included in this area.

The remaining plains are simply the valleys of rivers. Of these the valley of the Fitzroy, in Queensland, is the most considerable.

But if Australia has few plains, it may be said to be nearly altogether tableland.

For convenience of description the following subdivisions of the highlands may be made :—1st, The Tableland of the East Coast ; 2nd, The Tableland of Victoria ; 3rd, The Great Victoria Desert ; 4th, The Great Northern Tableland.

1st. The **Tableland of the East Coast** is the basement of the great mountain system, which will be described in the next chapter. It extends from Cape York to Wilson's Promontory, a distance equivalent to 29 degrees of latitude nearly. Beginning at Cape York with only a few miles of breadth, it quickly widens out to 150 miles at 15° S. lat. ; to 350 miles at the tropic of Capricorn ; then gradually diminishes in width to 200 at 36° S. lat. ; and terminates almost abruptly in south-eastern Victoria. Although the extent of this tableland is by no means limited, and its geological structure very varied, yet it is impossible to disassociate it from the mountain ranges which rise upon its highest levels. The student, therefore, is referred to the next chapter for further information.

2nd. The **Tableland of Victoria** extends from the Bowen Mountains to the valley of the Glenelg, has an average width of 120 miles, and is nothing more than high foundations from which rise the Great Dividing Range.

3rd. The **Victoria Desert** partakes more of the character of a true tableland. It may be said to commence on the east, in the Stuart range of South Australia, and to extend almost to the Darling range of Western Australia. It is bounded on the south by the Southern Ocean, and on the north by the Macdonnell and Ophthalmia ranges. All this immense area is over 1,000 feet above the sea level, and the Victoria Desert proper, lying between 132° and 120° E. long., s between 2,000 and 3,000 feet high. In the 500,000 square miles included within these boundaries there is not a single river ; even along the coast line, incredible as it may appear, there is not for 1,000 miles a creek to be met with. The explorers who have had the courage to venture through this lesser Sahara give a dreary and painful record of their journeys. Mr. Giles's journal of his expedition from the Youldeh Depôt to Perth in 1875 may be summed up in one depressing

paragraph :—"There is no possibility of settlement, for there is no water—for hundreds of miles not even a native well. The lakes are dry, or salter than the sea ; a dense mallee scrub, wide areas of spinifex, and patches of mulga spread over the northern portion."

The student will in the following pages often meet with the words "mallee," "spinifex," and "mulga," and a suitable opportunity of defining them now presents itself. "Mallee" is a term applied to a low-growing eucalypt—the eucalyptus dumosa. Its average height is 12 feet, and its general appearance is of innumerable close-growing twigs, with a dark-leaved foliage on the top. It is found extensively in the sandy districts of Southern Australia. "Spinifex," or "Porcupine Grass," is a tall, spiny grass—an indication of the worst country—is useless as food, and renders travelling impossible. "Mulga Scrub" is applied to a thick growth of a dwarfed acacia, which is armed with long spines. It grows in irregular bushes, very dense, and intertwined with creepers. In a young country it is as effectual a barrier to advancement as perpendicular walls of rock.

4th. The **Great Northern Tableland** extends from the Pacific Coast chain in Queensland to the Indian Ocean. For simplicity in description it may be divided into two parts by a line following the overland telegraph line of South Australia. As this line is one of great interest, an epitome of Mr. Giles's admirable account of it is here given :—

Beginning at the Elsie river, the line, after striking the Birdum Creek, follows the eastern side of the valley for 70 miles, and then, crossing it, follows the western side for 20 miles to Daly Waters station, on the Daly Creek. The land surrounding the station is open forest, splendidly grassed. At 50 miles south of the station is Frew's Pond, "a circular basin 300 yards in circumference, with a depth

of 30 feet for one-third of the circumference, where the bank slopes gradually into the water ; on the other side are perpendicular walls of conglomerate ironstone. When full, the pond is a fine one ; but when the water gets low it is almost undrinkable, in consequence of the thousands of divers and cormorants which frequent it." To the north are patches of grass land and mulga ; to the east, scrub ; and to the west and south, open plains of "Bay of Biscay" land—plains having a peculiar, rough, undulating surface, and looking like a tempestuous sea which has suddenly solidified. From Frew's Pond, through country bounded on the east for miles with forest, and open, treeless plains on the west, Newcastle Waters is reached. This watercourse rises to the eastward of the Ashburton range, and flows for 35 miles into Lake Woods. Along the whole course there is excellent water, numerous birds, and a hostile tribe of powerful natives, without beard or moustache—a peculiarity of all the tribes north of the Macdonnell ranges. The Ashburton range is of hard, white sandstone, and contains the sources of many creeks. About 60 miles to the south is Powell's Creek Station, the greater part of the way being through hilly country. South of the station, to Rennie's Springs, is also hilly ; and below the springs are spinifex, scrub, and stony rises for 40 miles, to Attack Creek. Tenant's Creek Station is 40 miles below Attack Creek ; half of the way is through spinifex country, and the remainder poorly watered. Ten miles lower down there is fine country. Then follows most wretched land, with spinifex ; but as Barrow Creek Station is neared the land improves. The line passes over a spur of the Forster range to the south of the station, and from this point a fine view is obtained. West and north are high lands, high chains, and sombre-looking mulga, "spread out like a map before the traveller's eye." The line passes Central Mt. Stuart—high and massive—and through the valley

formed by the Freeling and Boothby ranges to Mt. Boothby, a very high, black-looking, and rugged elevation. From this to Burt Creek, the point at which this dividing line terminates, is spinifex and thick mulga.

The eastern portion of the tableland is bounded on the west by the overland telegraph line ; on the north by the Gulf of Carpentaria and the plain already described ; on the east by the dividing chain ; and on the south by the Great Central Plain and the Fergusson and Macdonnell ranges. The east is described as containing 180,000 square miles available for pasture, and about 70,000 unavailable. But as this great district has been only recently taken up, it is not improbable that a great deal more well-grassed country will be met with. As a rule there is little forest. Enormous plains stretching to a vanishing point on the horizon, or undulating downs, over which—from an elevation —the eye can range 40 or 50 miles without a check, and the whole sheeted with grass or nutritious herbs. Belts of timber fringe the watercourses, and there are in places extensive scrubs, comprised mainly of short, gnarled trees, with no entangling creepers or vines, but often filled with saline shrubs or plants which are eaten greedily by the stock. The watercourses are mere channels connecting pools of greater or less magnitude. There are very few springs, and no running water. The scarcity of surface water is the main defect of the country. The air is pure, and exceedingly dry. There is seldom any dew at night, and the rainfall is scanty and irregular. Naturally, under these conditions, the temperature is variable, and apt to be in extremes. The sun's heat in the daytime is very great ; but when the sun sets, the temperature falls rapidly, and it is rarely that the bushman is inclined to dispense with his blanket even in the midst of summer.

Between the Herbert and the telegraph line there is a

great deal of unexplored country. The reports of Gregory, who traversed the northern part in 1856, led to no settlement; and the more recent explorations of Scarr, 1878, *Queenslander* expedition, 1879, and Heinecke, 1880, have been over very nearly the same district. Scarr and Heinecke made Tennant's Creek Station their destination, and report, of the country lying between 18° and 21° S. lat., the prevalence of vast areas of scrub, spinifex, and inferior land to the west of the Rankin river. North of this river two streams—the Playford and Buchanan—flow west, and unite in splendidly grassed plains. In all directions to the edge of the scrub the country is well grassed, and dotted all over with blue bush swamps. The *Queenslander* expedition, pushing northward from the Playford, passed Lakes De Burgh and Sylvester, through very poor and dry country, to Cresswell Creek—a well-defined polygonum channel, with large waterholes 10 to 20 chains wide and of considerable depth—and then turned west along the 18th parallel of S. lat., encountering stony downs and blue bush flats all the way to Powell's Creek Station.

The south-western portion of this plain, between 21° and 23° 30′ S. lat., has been explored by Barclay in 1878, and contains much good country, numerous peaks, and streams, of which the Waite and Marshall are the largest. Towards the north spinifex, sandhills, and desert extend to the horizon.

The western portion of the Northern Tableland is bounded on the east by the telegraph line; on south by the Macdonnell ranges and a line of rocky hills; on the west by the valleys of the Ashburton, Cave, Robe, Fortescue, Yule, and De Grey rivers; and on the north by 19° 30′ S. lat.

On the south-east of this great tableland is Lake Amadeus, 200 miles long; and further west is the Gibson Desert. Forrest traversed this country in 1874, and Giles in 1876.

Forrest's journal may be summed up in a few words. Entering upon the desert at the Kimberley range—the watershed of the Murchison—he proceeded at first north-east through wretched spinifex country past the Frere range and some splendid permanent waterholes to the Weld Springs, where on every side he was surrounded with spinifex. Returning south-east to the latitude at which he started, he found no permanent water during his eastward course, and only one creek—the Hughes—was met upon the track. To the north, oceans of spinifex, sandstone ridges, and occasional clusters of mallee and mulga were observed; and to the south, over undulating country, the same dreadful plagues spread as far as could be seen.

Giles, starting at the same meridian, from the sources of the Ashburton, encountered spinifex ridges and mulga rises to the Alfred and Marie ranges. Reaching, shortly after, his furthest point of 1874, he proceeded along the Petermann range, which will be described in a future chapter. To the north of his track, for 800 miles, nothing was to be seen but the Great Spinifex Desert.

To the north of this region is the Great Sandy Desert. In 1873, Colonel Warburton, starting near the Macdonnell ranges, took a north-westerly course; and, beaten back by spinifex country at 21° S. lat., made more towards the west, reaching Gregory's furthest at the Great Salt Sea, near Sturt's Creek. Thence to the Oakover river nothing but sandhills, spinifex flats, and open sandy country was met with in this wearisome and dangerous expedition.

CHAPTER IV.

AUSTRALIA—ITS OROGRAPHY.

DEFINITIONS.—A **Mountain** is a peak rising to a height of more than 2,000 feet; all beneath that height are regarded as hills or hillocks.

A **Mountain Chain**, or Mountain range, is a series of elevations, having their bases in contact, and their lines of elevation continuous over a considerable distance.

The **Slope** of mountain chain is its longer, and, therefore, its gentler declivity.

The **Counter-Slope** is its shorter, and, therefore, steeper declivity.

UNLIKE Europe, Asia, and the two Americas, which are divided by vast systems of parallel mountains, Australia has its principal ranges near its coasts, and running in directions parallel to them. This orographic (*oros*, a mountain, and *grapho*, I write) disposition suggests a resemblance between our country and Africa, which, as far as is known from the explorations of Livingstone, Speke, Burton, and Stanley, has no great central ranges, and is fringed with chains of greater or less altitude. Within these fringing chains in both continents is a plateau or tableland dotted over with numerous short ranges and isolated peaks. The comparison, as far as height is concerned is much in favour of Africa; as far as water supply and fertility, in favour of Australia.

It has been already stated that no Australian ranges attain a great height. Not a single peak reaches the limit of perpetual snow. Yet in many places the mountain scenery is imposing. Here and there are sierras, less grand, but not less perfect than those of Spain or Mexico—bald flat domes—bleak, precipitous crests—wild and intricate spurs

—in fact, every mountain feature, from the naked needle peak, on which the eagle alone takes his solitary perch, to the forbidding torrent-swept gorge, where the shy bird or the daring rôbber finds a refuge unapproachable to pursuers.

The principal mountain systems are :—1, The Pacific East Coast Range, or Great Dividing Chain ; 2, The Victorian Dividing Range ; 3, The Eastern System of South Australia ; 4, The South-West System ; 5, The Indian Ocean System ; 6, The Pacific North Coast System ; 7, The isolated systems of Queensland, New South Wales, and Victoria ; and, 8, The Central System of South Australia.

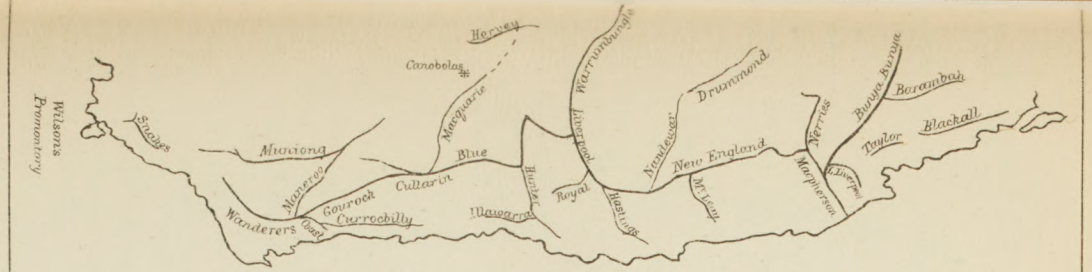
The Pacific East Coast System,* or Great Dividing Chain, is the grandest and longest continuous range of elevation in the continent. From the reports of D'Albertis it is almost certain that this chain begins in Papua. It reappears in Queensland, near Cape Melville, traverses New South Wales, Eastern Victoria, and reappears again in Tasmania. In the north it is low and disconnected, but from 28° S. lat. it assumes all the grandeur of a mountain chain. Its average height is 3,000 feet, and its length more than 2,000 miles.

In Queensland, beginning at Cape Melville, the principal subdivisions are :—

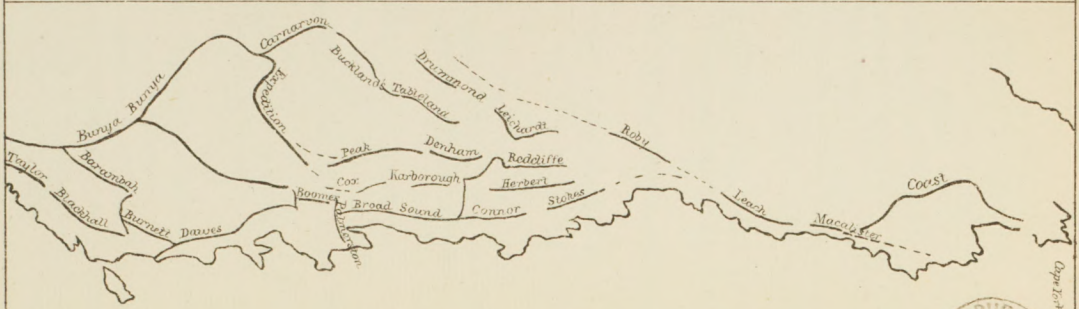
The **Coast Range**, from 14° S. lat. to 17° S. lat.—rises near Princess Charlotte Bay in Mt. Newbery, runs in an almost semicircular course to Distant Peak, 3,573 feet, where it is joined by an ill-defined range following the coast from Cooktown. The peaks of this latter range are—Cook, 1,476 feet ; Thomas, 2,318 feet ; and Peter Bottle Mt., 3,311 feet.

The **Macalister Range** continues the coast range for a short distance, and has for highest point Saddle Hill, 2,214 feet ; Red Peak, 2,032 feet ; Grey Peak, 3,357 feet ; and Conical Hill, 3,016 feet. This range terminates in the Bellenden Ker Hills, 5,158 feet and 5,433 feet respectively.

* See Plate II.



Pacific E.: Coast System from Sandy Cape to Wilson's Promontory.



Pacific E.: Coast System from Cape York to Moreton Bay.

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Plate II

The **Leach Range** extends as far as 18° 30′ S. lat. Its only peaks worthy of notice are Mt. Leach and Double Point. To the south of Double Point an ill-defined range, forming the eastern watershed of the Burdekin, stretches south to Mt. St. Michael, near which is the isolated Mt. Elliot, 4,075 feet high, to the south of which is the **Stokes Range**. Here the main range begins to depart from the coast, and to break up into short, and nearly parallel, ridges.

The **Herbert Range** begins at 19° 30′ S. lat., and rises to a considerable height in Mts. Toussiant, Macartney, Dalrymple, 4,255 feet, and Bryden.

The **Redcliffe** Mts. are east of the Herbert, and contain Mts. Martin, Leslie, and Peak.

The **Leichardt Range** is west of the Redcliffe, and trends south-east to 21° S. lat., and then south-west. Its peaks are Whitestone and Loudon.

The **Roby Range** takes up the main axis of elevation, which passes through Mt. St. Michael. Through its broad and widely-separated peaks on the south the Belyando flows in a succession of charming valleys.

The **Denham Range** is south of the Redcliffe Mts., and extends from Mt. Illalong on the north to Fletcher's Awl on the south. The intermediate points of highest elevation are Mts. Rankin and M'Laren.

The **Peak Range**, continuing the Denham southwards, is a remarkable series of high elevations, stretching to the Expedition Range.

The **Karborough** and **Coxen** Ranges lie to the east of the Denham, between the Isaacs and Furnell Creek.

The **Drummond Range** is south-west of the Denham. On the north it is a range of some importance, but towards the south it is little more than a crested highland. Its principal peaks are Black Mt., Table-top, Chantry, Leura,

Smyth, and Rainworth, near which an elevated tract, called Buckland's Tableland, rises. In Buckland's Tableland are Mts. Faraday, 2,523 feet, and Pluto, 2,420 feet.

The **Expedition Range** starts at Arthur's Bluff to the south of the tropic of Capricorn, and trends almost due south to Pyramid Height; thence west, meeting the **Carnarvon** range with Mts. Inglis, Acland, and Lindlay. The range at this point again assumes a south direction to Mt. Euramburin, where it receives the name of the **Dividing** Range, which trends south-east by east for a distance of nearly 200 miles to the sources of the Boyne river. In the centre of it are Mts. Combabula and Horrible.

The **Bunya Bunya** Mts. continue the main axis of elevation in a south-south-east direction to 27° 20′ S. lat. The coast systems find their most southern points in this range. The highest peaks are Mogatta, Hay, the Crow's Nest, and Wilson.

Returning to the north, we find a complicated system of mountains along the coast line.

The **Clarke Range** rises near Edgecombe Bay to the south of the **Stokes Range**, and follows the coast line for more than 150 miles. Its peaks are at great distances apart, and between them are narrow chains of highland. Mt. Dryander, 2,985 feet, Mt. Mia Mia and Mt. Long, 2,332 feet, are the highest points.

The **Broad Sound** Range begins at Mt. Long, in 21° 45′ S. lat., and extends nearly to the tropic of Capricorn. About 30 miles south of Mt. Mackenzie the range is intersected by the **Palmerston** Range.

The **Boomer Mts.** are the southern extension of the Broad Sound, and terminate below Rockhampton in a bifurcation. The more easterly fork, with Mts. Atherton, Buckland, and Kroombit, terminates opposite Hervey Bay as the **Dawes** Range. The western fork, trending due south

through Mt. Wiseman and Prospect Peak, joins the Dividing Range a few miles to the east of Mt. Horrible.

The **Burnett** Range extends from the Dawes to Mt. Perry, in 24° 15′ S. lat., and thence, as the **Barambah** and **Jimna** Ranges, joins the Bunya Bunya at Mt. Mowburian.

The **Blackhall** Range takes its rise in Mt. Bopple, south of the estuary of the Mary river, and runs parallel to the coast to the Brisbane river. Toolara in the centre, and Samson at the southern extremity, are its best known peaks.

The **Taylor Range** and the **Glasshouse Mts.** to the west of Brisbane, and the **Little Liverpool Range** to the west of Ipswich, also join the main range.

The average height of the Queensland portion of the great chain is 2,000 feet, though in many places peaks attain a height of 4,000 feet. The average distance of the axis of elevation is—on the north 30 miles, and on the south 100 miles from the coast. The width on the north is narrow, but at Mt. Elliot the chain widens out, the elevated country consisting of numerous chains with intervening fertile valleys. The greatest width is attained at the Buckland tableland, 200 miles from the coast. Between these wide-spreading chains are beautiful valleys, luxuriant with forest growth, and refreshed by the rivers and rivulets which ultimately find their resting-place in the Pacific. The scenery of the coast of Queensland owes its charm to the tropical aspect of its woodlands, to the rich and verdant valleys, and to the islands—some of great height—which stud the peaceful waters within the reef.

Upon entering New South Wales the chain assumes a more unique aspect, attains an average height of 3,500 feet, and presents to the traveller every phase of mountain scenery, from the wild and picturesque to the savage and forbidding.

The **Macpherson Range**, about 70 miles long, dividing Queensland from New South Wales, is of considerable height, and trends due east from Wilson's Peak to the ocean, north of Point Danger. The principal peaks are Boologáng, Merino, Mount Lindsay, 5,500 feet, Mt. Gipps, and Barney.

The **New England Range**, from 28° 15′ S. lat. to 31° 15 S. lat., is parallel with the coast. Not far from Wilson's Peak it is joined by the **Herries** Range, dividing the waters of the Barwon from those of the Condamine, and having as highest elevations Mt. Domville and Mt. Magnus, 3,120 feet. Below the junction is Capoompeta, 4,730 feet, and Ben Lomond, 5,000 feet. At Ben Lomond it throws off the M'Leay Range, with Chandler's Peak and Mt. Lofty. At its southern extremity it is crossed perpendicularly by the **Hastings Range**, containing Mt. Sea View, 6,000 feet, Mt. Kinnara, and (in a short spur) Mt. Jasper.

The **Drummond Range**, with Mt. Lindsay, 3,000 feet, and the **Hardwicke** or **Nandewar** Range, with Mt. Lowry, which form part of the watershed of the Gwydir and Namoi rivers, strike into the New England Range about 30 miles from its southern extremity.

The **Peel Range**, about 50 miles long, runs parallel to the New England Range, and joins the western extension of the Hastings Range near the sources of the Peel river.

The **Liverpool Range** runs due east and west, in 31° 48′ S. lat., and on the east throws out a long spur, the **Mt. Royal Range**, which trends due south towards the Hunter river. In it are Mts. Wollon, 3,000 feet, Royal, and, at its southern bifurcation, Mt. Patterson. Near the sources of the Erskine river on the west the Liverpool Range bifurcates; one branch, the **Warrumbungle Range**, stretches north-west to the **Arbuthnot Range**. In the Warrumbungle Range are the Pandora Pass, and Mt. Exmouth, 3,000 feet

high. The other branch trends south-west for 70 miles, and at Culgong turns south-east to meet the Hunter Range. Between Culgong and the Hunter Range are Mts. Pomany, Punker, and Kindaroon. Oxley's Peak, 5,000 feet, is the highest point of the Liverpool Range. All the spurs, as well as the main range, are difficult of access in consequence of their almost perpendicular sides ; but once these precipices are scaled, the traveller finds himself on a surface about 3 miles wide and so level that a carriage might be driven across it.

The **Hunter Range** trends east from Kindaroon, and after a few miles throws out spurs in all directions. The most northerly of these joins the Mt. Royal Range ; another terminates in a most complicated knot at a short distance from the shore ; whilst a third divides the waters of the M'Donald from those of the Colo.

The **Blue Mountains** at Kindaroon and Coorangoola heights suddenly trend west, and, after running for 25 miles in this direction, assume a meridional course to the railway station at Rydal. To the east of Rydal is the Darling Causeway, which separates the affluents of the Cox from those of the Parramatta. In this part the range separates the silurian formation of the north from the extensive coal measures of the south-east. The principal peaks are—Mts. Lambie, 4,078 feet ; Walker, 3,786 feet ; Mt. King George, 3,620 feet ; Mts. Hay, 3,400 feet ; Tomah, 3,240 feet ; and Wilson, 3,478 feet.

At 33° 45′ the Blue Mountains throw off spurs of considerable length. Of these the **Macquarie Range** is the longest on the west. The Blue Mts. in the latter portion of their course follow the coast line, and culminate in Mts. Marsden ; Beemarang, 4,500 feet ; Clarence, 4,000 feet ; and York, 3,292 feet. The chain is a single ridge, with flat summits, and throwing out spurs to the east and west. In

some places on the western slope of this range are natural caves excavated as if by the hand of man. In them have been found some very remarkable fossil remains, about which more will be said in the chapter on the geology of our country. In them also are strange markings, which cover the sides, roofs, and stalactitic pillars. These markings resemble in form the human hand, and are supposed to have been traced by the natives of the district in order to deter the shore tribes from making excursions beyond their own territory. It is certain that the blacks, dreading the presence of the evil spirit, will not camp in a hand-marked cave.

There are some very grand scenes on this range. Those most frequently visited by tourists are the Mabel, Edith, and Gemini Falls of the Woodford Creek; and the cascades to the north and south of the Blue Mountain at Lawson; on the north, are the Cecilia, Sebastian, St. Michael's, and Christabel Falls; on the south the Livingstone, Stanley, Hay, and Bass Falls. Two, the Wentworth Fall and Govett's Leap, surpass all the others in grandeur. The Wentworth Fall, called sometimes Campbell's Cataract, is on the Jamieson's Valley Creek, near the Weatherboard Hut. The creek rises about 2½ miles from the fall, and draws supplies from the lateral streamlets which issue from every mountain gap. During a period of heavy rain it is converted into a swollen and angry torrent, and, plunging over a precipice 1,000 feet high, is lost in the vast natural excavation called the Prince Regent's Glen.

The Govett Leap is one of the sights of the world. Standing on Look-out Point, near the village of Blackheath, which is 3,494 feet above the level of the sea, the spectator has before him a scene of surpassing grandeur. Within a horseshoe excavation, forming a part of the Grose Valley, he is flanked on the left by perpendicular cliffs 800 feet high;

before him stand forth countless peaks, some barren as the sea shore, some clothed to their summits with verdure. Prominent among these are the Pulpit Rock; the crested Mount King George, terminating above in a perpendicular precipice 1,000 feet high; Mount Hay, with its endless labyrinth of almost subterranean gullies. Then follows a vast perpendicular wall, 1,400 feet high, towering in the background over the intervening mountains. As the spectator turns to the right the chain assumes a flatter appearance, and his eye is caught by the sparkling waters of the cascade, 520 feet high, plunging over a narrow gorge into a chasm of tartarean blackness. Lost for a while in the gloom, the stream is again seen rushing with mad haste down the valley to the Trinity Cascade. Here it is joined by the waters of another creek, which, coming from the left, has rushed over the Left Hand Fall. At this boisterous meeting-place the depth below the spectator is 2,000 feet. Thence as a silver thread the united waters wind eastward out of view.

In early days it was supposed that this range was unapproachable from the east. We read now with a smile of expeditions, which started with the express purpose of crossing the range, giving up the undertaking in despair. Now over it runs the zig-zag railway. From the low level of the Emu Plains to the range is 37 miles, and the height to be scaled in this short distance is 3,407 feet. The rails are laid on gradients as steep as is compatible with safety; and when further advance on a gradient becomes impossible, the line bends round and ascends with the same gradient in the opposite direction. In the ascent the engine draws the train up the first deviation, pushes it up the second, draws it up the third, and so on, until the summit is reached.

The **Cullarin Range** continues the Blue Mountains to 35° 15′ S. lat.

The **Gourock Range** begins at 35° 15′ S. lat., and extends to 36° 30′ S. lat. Its culminating point is Jindulian, 4,300 feet high. The range is very rugged and forbidding. At 36° 30′ S. lat. the **Maneroo Range**, coming from the north-west, intersects it at Mt. Nimmitabel. At this point the range is called the **Wanderer's Range**, which reaches the Victorian boundary at Mt. Tennyson, and pushes south to the banks of the Snowy river.

The **Maneroo Range** joins the Gourock to the Muniong range. It starts at Mt. Murray and forms the watershed of the earlier affluents of the Murray and Murrumbidgee.

The **Muniong Range** leaves the Maneroo at about 36° S. lat., and attains an average height of 6,000 feet. Sixteen miles from the frontier of Victoria is Kosciusko—the giant mountain of Australia—7,308 feet high, and within 700 feet of the limit of perpetual snow. Although below the actual snow-line, it retains for the most of the year patches of snow on the sheltered parts. The principal spurs of the range are the **Tumut**, **Murrumbidgee**, and **Murray** ranges.

To the east and west of the main axis of elevation there are in New South Wales numerous ranges, forming the platform on which the Great Dividing Chain rises. On the west are the **Harvey** and **Coccopara** Ranges, hereafter to be described; and on the west—(1) The **North Coast Range**, between the Macpherson and M'Lean Ranges; (2) the **Illawarra Range**, between the Hunter and Parramatta rivers; (3) the **Currockbilly** Range, between the Shoal-haven and Clyde rivers; and (4) the South Coast ranges along the Tuross and Bega.

The distance of the New England Range from the Pacific is 80 miles; of the Liverpool, 200 miles; of the Blue Mts., 80 miles; of the Cullarin, 70 miles; of the Gourock, 64 miles; and the Slope of the Southern Coast Extension is not more than 50 miles.



Southern Ocean System . Victorian Division.

R.G.S.M.

Plate III

The Blue Mountains are extremely rugged and forbidding, forming a natural barrier between the coast and the interior. The Cullarin and Gourock are somewhat less formidable ; but the Muniong Range—a vast granite elevation—is the bleakest and most inhospitable chain in Australia. Unlike the Queensland part of the chain, the mountains of New South Wales give rise to short, deep rivers, which rush down their precipitous sides as torrents.

The scenery of New South Wales, taken as a whole, cannot be described as beautiful, for the great extent and sameness of the plains, where for miles and miles the same forms of vegetation present themselves to the eye, render the landscape almost wearisomely monotonous. On the sea coast, however, where small areas are blocked in by the spurs and lower terraces of the mountain system, we have a great variety of scenery—picturesque valleys teeming with almost tropical luxuriance ; miles of woodland, where climbers of giant growth and brilliant bloom give a weird aspect to the scene ; and deep ravines, in some places bounded by jutting crags, in others pouring their angry torrents through impenetrable scrubs.

SOUTHERN OCEAN SYSTEM, OR VICTORIAN DIVIDING RANGE.*

As the Great Dividing Chain passes into Victoria, the main axis leaves the continent, and is found again in the island of Tasmania. It is its Great Spur—the Muniong—which crosses the border, and turning almost due west, under various names, splits the colony into a northern and southern watershed. Just before entering Victoria the Pilot, 6,000 feet, and Forest Hill, 5,000 feet, may be said to terminate the Muniong. At Forest Hill begins the Southern Ocean System.

The whole range, extending from the east to the west of

* See Plate II.

the colony, is of considerable elevation, and, except in the Australian Alps, rarely presents the formidable aspect so characteristic of the mountains of New South Wales. The main subdivisions are—The Bowen, connected intimately with which are the Australian Alps ; the Barry, the Dividing Range proper, the Pyrenees, and the Grampian, Serra, and Black ranges.

The **Bowen Range**, beginning at Forest Hill, continues the direction of the main axis until it throws off, to the south, the **Mountain Ash** Range, with Notch Hill, 4,507 feet ; Bald Head, 4,625 feet ; Morris Peak, and Ryan's Peak. At this point the Bowen assumes a north-east by north direction to Mt. Hotham. The principal peaks are—The Cobboras, a serrated peak, 6,100 feet ; Mt. Leinster ; Mt. Tambo, 4,700 feet ; Mt. Phipps. To the south of Ænano, a south-trending spur dividing the affluents of the Snowy and Tambo rivers has for highest points Mts. Black, Stratham, and Murrindal. North of Mt. Leinster a spur of great length and intricacy runs north-east, shooting out subsidiary spurs in almost every direction. The points of greatest elevation are—Mts. Misery ; Gibbo, 5,764 feet ; and Benambra, 4,840 feet. Further south, near the "Sisters," another spur trends north ; the axis of this spur passes through the bold, escarped Mt. Wills, 5,758 feet ; Mt. Cooper, Mt. Martin, and Granite Peak. Branching off to the westward from Mt. Wills are the Bogong Mts., containing Mts. Bogong, 6,508 feet ; Towanga, 4,161 feet ; a little above which a second bifurcation takes place, the more easterly fork ending in Talgarna, 2,101 feet ; the more westerly in the flats where the Kiewa joins the Murray. Excepting the loftiest peaks, this spur is characterized by sloping timbered terraces, rocky peaks, and rounded nobs.

A third spur, forming the main watershed of the Alps, leaves the Bowen at Mt. Hotham, intersects the Bogong

Plateau, and in rocky, serrated ridges, rounded bosses, and narrow razorbacks, reaches the Murray. The highest points are—Feathertop, 6,303 feet; Mt. Cope, 6,015 feet, in the Bundarra Spur; and Mt. Stanley, 3,444 feet, in a north-west extension. The more prominent peaks of the Australian Alps are covered with snow, which, on the southern sides, does not melt for several months. The peaks above 6,000 feet are bare of all vegetation on their summits. Between the distinctly-marked ridges just described are the high plateaux of the Bogong, 6,000 feet; Snowy and Dargo, 5,000 feet; the Nunniyong, Gelantippy, and Omeo, over 3,000 feet. On these plateaux the snow falls to a depth of ten feet. From the similarity of these ranges to the Urals, Sir Roderick Murchison, in 1844, foretold a great gold-producing future for Victoria.

The **Barry Mountains** extend from Mt. Hotham to Mt. Howitt. The principal peaks are—Mt. Barnard; the Twins, 5,575 feet; Mts. Selwyn and Howitt, 5,715 feet. From Mt. Selwyn the Buffalo mountains trend due north, and culminate in Buffalo Peak, 5,645 feet, in the centre of the chain.

At Mount Howitt, and 4 miles to the north of it, two spurs of very varied character tend north-west. The longer spur culminates in Mts. Cobbler, 5,342 feet, and Typo; the shorter in Mts. Buller, 5,911 feet; Table-top; Samaria, 3,136 feet; Battery, and the Blue Range.

At Mt. Howitt the **Dividing Range** trends south for 60 miles to Mt. Selma, and thence in an almost due west direction for 200 miles. In the first 60 miles are Mts. Magdala, Clear, The Bluff, Macdonald, Skene, Shillinglaw, Singleton, Selma, and Matlock, 4,561 feet. At Selma a high tableland is enclosed by the spurs of the Dividing Range, and to the south of this enclosure the **Strzelecki** Range extends south in two ridges—the more easterly from Mt. Useful, 4,756 feet, to Mt. Look-out, near Toongabbie;

the more westerly from another Mount Look-out to the junction of the Thompson and Aberfeldy rivers.

A few miles west of Matlock a south-east trending spur culminates in Mts. Baw-Baw, Mueller, and Erica. At the latter it turns almost due west, and terminates in the **Dandenong Range**, a granitic knot of considerable extent, having for highest point Mt. Dandenong, 2,050 feet high.

Returning to the Dividing Range, we notice at Mt. Arnold a north-trending spur extending to the **Cerberean Ranges** at the Goulburn river; and beyond the river bending north-east as the **Puzzle** Range, and stretching to the impenetrable **Strathbogie** Ranges, the haunt of the Kelly desperadoes. The highest point of the Cerberean Range is Mt. Torbreck, 4,995 feet; of the Puzzle Range, Mt. Paradox; and of the Strathbogie, Mt. Barranhat.

The main axis of elevation at Mt. Arnold dips a little to the south at Robley's Spur, near Mt. Grant, and contains in the next 30 miles Mt. Strickland, the Black Spur, and Mts. Ronda and St. Leonard. Beyond the latter mountain is The Gap, to the north of which a spur in broken ridges joins the Strathbogie Ranges. Below the Goulburn the **Break o' Day Range** is the most clearly defined of the group; and to the north of the Goulburn the **Black Range**, with Mts. Cunningham, Nibo, Maxwell, and Concord, rises to an average height of 1,500 feet.

West of The Gap is the **Hume Range**, a name given to a short section of the main axis of elevation. Mt. Disappointment, 2,631 feet, in the centre, is the highest point. From Big Hill the Great Dividing Range trends north-west to Mt. William; and, forming three sides of a rectangle, within which are all the sources of the Saltwater river, it resumes its westerly direction at Mt. Macedon, 3,324 feet. Beyond this point are Blue Mount, Wilson, 2,000 feet; Pisgah, Bolton, The Cardinal, Ben Major, Ben More, Ben

Nevis, 2,675 feet; Buangor, 3,247 feet; Mt. Cole, Lar-ne-Gerin, 3,123 feet, and Mt. Ararat, 2,020. The **Pyrenees**, under which name the range is known from Mt. Cole, terminates near Kirk's Hill.

Twenty miles east of Pisgah a spur of the chain proceeds south. The northern portion is the Stieglitz Range, containing Mt. Wilson, already mentioned, and Mt. Stieglitz. The southern portion is the **Pentland Hills**, with Mt. Blackwood, 2,432 feet high.

Still further to the west a spur, leaving the main axis at Bungaree, trends south in broken ridges to the **Anakies** and **Yowang Mts.**, which approach near the coast of Hobson's Bay. Point Flinders, 1,802 feet, and Station Peak are the highest points.

Beginning near Daylesford in an uneven tableland, a well-defined spur extends north as far as Eaglehawk. It is of moderate height, highly auriferous, and has for highest peaks Mts. Alexander, Sargent, Barker, Thorpe, and Prospect.

To the west of this spur is another—the **Black Range**—which starts from the Dividing Range at the remarkable enclosure called the Amphitheatre, and in highlands joining Mt. Direction to Avoca Hill, 2,464 feet, becomes fully developed at Landsborough Hill, 1,903 feet high. As it trends north it divides into two branches, of which the western terminates abruptly in Bolangun, 1,225 feet. This range is highly auriferous.

Between the Great Dividing Range proper and the Grampians is a low-lying tract, of 8 or 9 miles in width, spreading to the north and south along the whole length of the chain, and enabling the traveller to obtain from a distance an uninterrupted view of these beautiful sierras.

The **Grampians** rise below the isolated peak of Mt. Zero, in the north, and trend south in a direction perpendicular to

the main axis of elevation. They are interrupted on the north by Rose's Gap, through which flows an affluent of the Mt. William Creek.

At Brigg's Bluff the chain divides and encloses a tableland 16 miles long and 5 miles wide. In this tableland are the sources of the Mackenzie, a tributary of the Wimmera, and a beautiful cascade 100 feet high.

At the southern point of the tableland the eastern branch is broken at Hall's Gap, below which it extends for 16 miles. The western branch continues south, and near the sources of the Wannon is called the **Serra Range** to its termination in Mt. Sturgeon. The total length, from Mt. Zero to Mt. Sturgeon, is 60 miles. A few miles south of the sources of the Wannon a spur of complicated structure is thrown off to the westward, and unites this range with the Victoria range.

The principal peaks are—Mt. Zero, Brigg's Bluff, the Ass's Ears, Mt. Difficult, 2,657 feet; Tower Hill, Castle Hill, Mt. William, 3,827 feet; Mount Abrupt, 2,724 feet; and Mt. Sturgeon, a magnificent cone lifting its barren head above the forest of trees which adorn its sides. The Serra is the watershed of the Hopkins, Glenelg, and Wimmera, and affords an admirable illustration of the effect produced on a district by a mountain chain. Upon its western slopes blow the rain-bearing winds of the continent; and the clouds, checked in their course, discharge themselves as rain upon the Victoria Valley, which is in places luxuriant with trees and grass; or cold and bleak, from the fresh water swamps which can find no escape from the mountain-locked district. On the east the land is comparatively poor, dry, and dotted over with salt lakes, those characteristic indications of sterility.

The **Victoria Range** is separated from the Grampians by the Victoria Gap on the north, through which flows the Glenelg. It trends south in an S-shaped curve to the

Wannon. Its length is 24 miles, and its leading prominences Mt. Thackeray, on the north, and Chimney Mt., where the Serra spur intersects it.

The **Black Range** is connected on the south with the Victoria Range, and on the north with the Grampians. It is divided into two almost equal portions by the Glenelg ; in the southern portion is Conical Hill, and in the northern Mts. Byron and Talbot. The whole length does not exceed 16 miles.

From the foregoing description of the Great Dividing Chain it will be seen that it resembles, as Delavaud graphically says, the "scarp of a bastion, defending, or rather shutting off, the interior from the sea." Its average distance from the coast is 70 miles. The Bowen Mts. are 70 miles from the sea ; the Barry, 100 ; Mt. Matlock, 105 from Wilson's Promontory ; the Hume Range, 26 from Hobson's Bay ; Mt. Macedon, 36 from Williamstown. At Lake Learmonth the distance from Lorne is 78 miles. Mt. Beckwith is 100 miles from the Otway ; and Kirk's Height is 85 miles from the Bay of Martyrs.

The remaining mountain chains of Victoria are few in number, and are all more or less connected with the great system just described. On the south are the **Delegete**, or **Wanderers' Range**, with Delegete, Ellery, Bowen, and Deddick, near the frontier of New South Wales. Further west is the **Fainting Range**, separating the drainage of some of the affluents of the Tambo. It is a rugged and lofty range, probably a spur of the Bowen from Ænano. Mts. Bindi, Elizabeth, and Gillun are in the range, and near it are Mts. Stewart, Tongio, and Green Hill.

In the centre of the tableland forming the heads of the Mitchell river is a knot called the **Moroka** or **Caledonia Range**, containing a number of high peaks, of which Snowy Bluff, Tamboritha, 5,381 feet ; Mt. Kent, 5,129 feet ; Castle

Hill, 4,860 feet; Mt. Wellington, 5,363 feet; Mt. Thompson, Djoandah, 2,000 feet; and Budgee Budgee are the most remarkable. To the south of the Latrobe river is the **Snakes Ridge**, 30 miles long, with an average height of 1,000 feet.

To the south-west of this range are the **Buln Buln Mts.**, of which Mt. Fatigue is 2,110 feet high. This range is continued in the direction of Wilson's Promontory by the **Hoddle Range**, beginning in Cement Height and ending at Mount Liptrap. On the Promontory are Mt. Hunter, Mt. Vereker, Mt. Latrobe, 2,590 feet; Mt. Wilson, 2,350 feet; and Mt. Boulder.

The **Otway Ranges**, north of Cape Otway, are impenetrable heights, covered in parts with a dense forest of eucalypti and beeches, and in parts barren and inaccessible cliffs.

From the Black Range, west of the Grampians, to the Murray, and for miles beyond, the country—at first hilly by Coleraine and Harrow—assumes almost a dead level, in places sandy, in places well grassed.

The scenery of Victoria is very pleasing, owing to the very general distribution of its chains and individual peaks, most of which are clothed with rich verdure and forest growth to their very summits. Here and there, above the leafy clothing, pointing to the sky or frowning upon the valleys below, peaks are seen which are draped for several months in a covering of snow.

THE EASTERN SYSTEM OF SOUTH AUSTRALIA.*

The second division of the Southern Ocean System commences at Cape Jervis, the most southern point of St. Vincent's Gulf, and trends north for a distance of 150 miles as a well-defined chain, and beyond this is little more than a series of peaks rising from a tableland of moderate elevation.

* See Plate I.

The **Lofty Range**, from Cape Jervis to the latitude of Adelaide, is the most southern subdivision, and contains in the south Mts. Observation, Compass, Magnificent, and Lofty, 2,334 feet.

Near the sources of the Gawler the range is called **Barossa**; further north the **Julia** or **Belvidere**; near Kooringa, the **Princess Royal Range**; and, 15 miles north of Kooringa, the **Razorback**. The principal peaks are Burra Mt., Cone, Hallett, 2,300 feet; and Bryan, 3,012 feet. At Ulooloo Creek the chain proper terminates.

Parallel with this range, and following closely the coast of Spencer's Gulf, are the **Hummocks**, which extend as far as Crystal Spring.

At Crystal Spring begins the **Flinders Range**, the main branch of which stretches to Lake Blanche, and the minor to Lake Eyre. The principal peaks are the Bluff, 2,300 feet; Cavern, 2,700 feet; Remarkable, 3,100 feet; Brown, 3,100 feet; Mockra Tower; Arden, 3,012 feet; Sunderland, Frome, Andre, Wallace, Searle, 3,000 feet; Rose, Clive, the Freeling Heights, Distance, and Hopeless. The minor branch stretches away to Lake Eyre through Hut Hill, Mts. Stephens, Aleck, Burns, Emily, Falkland, Samuel, Hemming, Stuart, James, Deception, Scott, Hutton, Parry, Termination, and the parallel ranges of **Willouran** and **Hermit**.

The Flinders Range, which divides the waters of the Torrens and Eyre basins from those of the Frome and Blanche basins, is in parts extremely wild and barren, whilst in other parts gum-trees of great height cover its sides with dense foliage.

West of the Hermit is the **Turret** Range, in 136° 30′ E. long.; and further westward the **Stuart** Range, the **Dennison Range**, and the **Hansom Range**, forming the western watershed of Lake Eyre.

Returning to the extremity of the chain proper, a short spur, the **Gouger Range**, trends east to Porcupine Hill; and further north, at 32° S. lat., another range, the **Warroonee**, runs north-east. A third range, to the north, containing the sources of the Siccus river, has Mt. Victor for its highest point.

The Southern Ocean System is continued along the south of the chain of lakes by the **Baxter Range** and the **Gawler Range**. The latter has a mean elevation of 2,000 feet, and extends in a latitudinal direction for 130 miles. On the east its height diminishes considerably from the average above given, while on the west it is a rugged chain of considerable pretensions. Its peaks are Mts. Separation, Reid's Look-out, Nott, Double, Fairview, Kundery, Centre, Warnoo, Friday, Pyramid, and Yarlbrinda.

The scenery of the southern part of South Australia is far from as grand as that of New South Wales, or as pleasing as that of Victoria. To the east the land is flat or broken, and often heavily timbered. It is especially good near the Murray, and terminates in splendid volcanic soil at Mt. Gambier, where the Blue Lake and wonderful Limestone Caves must ever prove novel scenes even to experienced travellers.

In the Lake district we look in vain for the charms of the Swiss, Italian, and English lakes. Here such names as Hopeless, Deception, Illusion, &c., tell plainly how Eyre and contemporary explorers felt when from these peaks they viewed the sheets of water as barren as the sea.

THE SOUTH-WESTERN SYSTEM.*

The remaining ranges, composing the last division of the Southern Ocean System, are distinctly littoral, and stretch from 128° E. long. to the Leeuwin, thus being

* See Plate I.

altogether within the territory of West Australia. The subdivisions are—The **Hampton Range,** from 128° E. long. to 126° E. long., rising from a grassy under-range to a considerable height; the **Russell Ranges,** beginning at Mt. Dean, north of Israelite Bay, and ending at Esperance Bay. The peaks in the more northerly ridge are Dean, Locke, Symmonds, Ney, Burdett, and Wittenoom; in the more southerly, Ragged, Mica, Baring, Hawes, and Merivale.

The **Eyre Range** skirts Doubtful Bay, having East Mt. Barren, Drummond, Middle Mt. Barren, Mt. Bland, and West Mt. Barren.

The **Stirling Range,** stretching latitudinally from the Pallinup to the Gordon rivers, begins at Mt. Ellen, 3,640 feet, and rises to a height of 3,000 feet on the average. The highest elevations are — Ellen, Hume's Pk., 1,800 feet; Mondurup, Rose Pk., and Hamilda.

South-west of the Stirling is the **Porongurup Range,** with Mts. Barrow and Barker.

Bennett's Range, between the Hay and Collier rivers, has Mt. Shadforth as highest point; and, 20 miles west of this, the system terminates in a small knot containing Mts. Roe, Mitchell, and Frankland.

THE INDIAN OCEAN SYSTEM.*

The Indian Ocean System may be divided into the Darling Range, the ranges lying between the Gascoyne and De Grey rivers, and the Leopold Ranges.

The **Darling Range** extends from Point D'Entrecasteaux to the Murchison. The principal subdivisions are as follow :—

The **Roe Range,** from Point D'Entrecasteaux to the Murray river, contains the highest point in the system, Mt. William, 3,000 feet high.

* See Plate I.

The **Darling Range Proper** terminates at the 31° S. lat., and has for highest point Mt. Wells.

The **Smith Range** extends from the Moore river, and is called the **Herschel Range** in its northern part, in which are Mts. Magawa, Horner, Michael, and Fanny; and in its easterly spurs—the **Murdalyou Range**, the **Budadoo Range**, and **Edamurta Range**—are Peterwandy and Murdaburia. Within the Smith range is the **Gairdner Range**, north of the Smith river, containing Mts. Green, Lesner, and Peron.

The **Victoria Range** ends the chain. Lying parallel to the coast, between the Greenough and Murchison rivers, it sends its spurs from almost every point towards the coast. The southern part has recently been called the **Waterloo Range**. In it are Mt. Fairfax, in the Moresby spur, and Lizard Hill. To the north are Mts. Gregory, Kianooka, and Victoria and Albert.

The division of the system just described is 200 miles long, and is, upon the average, distant 30 miles from the ocean. The average height is 1,500 feet, rising in gentle undulations, which are clothed with forests of jarrah, thereby depriving the range of the scenic effect generally expected from important chains.

South of the Murchison, highlands extend in a north-easterly direction as far as the **Nicholson** and **Weld Ranges**, containing numerous peaks, of which Mts. Luke and Lulworth may be noticed. Somewhat nearer to the sources are the **Glengarry**, **Kimberley**, and **Robinson Ranges**. In the latter are Mts. Gould, 2,600 feet; Seabrook, Fraser, Maitland, Padbury, and Leake. North-east of the Kimberley range is the **Frere Range**, which unites the central highlands to the ranges of South Australia.

North of the Gascoyne is the **Lyell Range**, a few miles from the coast; the **Kennedy Range**, west of the Lyons

river ; the **Lockyer Range**, between the Lyons and Gascoyne, extending in high peaks to the sources of both rivers. The highest mountains are James, Agamemnon, Phillips, Augustus, 3,580 feet ; Samuel, Egerton, and Labouchere, the height of which has been stated variously as 3,400 feet or 1,700 feet. Just below the Tropic is the **Barlee Range**, containing Mt. Palgrave ; and to the north of the same line, above the sources of the Ashburton river, is **Ophthalmia Range**. Between the Ashburton and the Cane rivers, **Remarkable Range** begins in Mt. Minnie and ends in Mt. Amy.

South of the Fortescue, and containing the sources of the Hardey and Fortescue, is the **Hammersley Range**, the highest peaks of which are Pyrton, Vigors, and Bruce, nearly 4,000 feet high.

Along the Fitzroy river are the **George**, **Grant**, **Oscar**, and **Mueller** ranges, with Mts. Krauss, George, and Barrett ; and, from the union of the Margaret and Fitzroy rivers, the whole country extending to Collier Bay is occupied by the **King Leopold Ranges**, so named by that most successful of explorers, Alexander Forrest. In his graphic account they are described as extremely rugged, baffling his most strenuous efforts to get on them at one time, and to descend from them at another. He has named Mts. Leake, Eliza, Hart, Mathew, Humbert, and Hopeless ; where, unable to reach the sea, he was forced in despair to retrace his tracks. The direction of the range is north-west, and the length 160 miles.

PACIFIC NORTH COAST SYSTEM.

The Pacific North Coast System lies between the Cambridge Gulf on the west and Limmen's Bight on the east. It consists of numerous short ranges assuming a north-eastern or northern direction.

On the east of Cambridge Gulf is a range, of which little is at present known, extending from Mt. Cockburn—a knot of considerable extent—through Bastion Height, Quion Height, and Roof House Height to Mt. Connection.

On the left bank of the Victoria* river are the **Murchison, Stokes, Newcastle, Jasper, Rudolph,** and **Fitzgerald** ranges ; and somewhat further west are the **Connaught** and **Stirling** Ranges, crossed by A. Forrest, and forming the watershed of the Humbert, a tributary of the Victoria.

On the right bank of the Victoria are the **Bynoe, Forsyth,** with Valley Height, and a long range running north-east, intersected by the valleys of the Fitzmaurice and Daly rivers, and reaching, as the **Daly Range**, as far as Palmerston. Of its numerous peaks the most notable are Sergison and Brock.

Within this range and the western coast are **Adam Range**, along Queen's Channel ; **Sugarloaf Range**, at Treachery Bay, with Mt. Providence and Table Height ; the **Barthelemy Hills**, and an unnamed range extending from the Daly to the Darwin rivers, and attaining its highest elevations in Mts. Hayward, Lichfield, Tolmer, and Alaric.

To the west of the Alligator river we arrive at a vast district, at the present unexplored, and of which we know nothing even by report. South Australia, which of late years has taken the lead of the colonies in sending forth well-equipped parties for exploration and discovery, is about to commission an experienced traveller to penetrate into this unknown country.

Along the Roper river are ranges which surpass any of the mountain systems of Australia in extreme beauty, being intersected in every direction by vales and gullies, ever verdant with rich tropical vegetation. The ranges which have received names are — The **Chambers**, between the Katharine, Chambers, and Roper rivers, containing Mts.

* See Plate IV.

Watts and Rigg ; and the **Hart** and **Fiddian** Ranges, near the northward bend of the river at the Devil's Elbow.

Along the river the following peaks have received names :—On the left bank, Rendezvous, Solitary, Caroline, Emily, Cooper, Patterson, Ingram, the Stuart Heights, James, Reid, Alligator Bluff, and St. George ; on the right bank, Giles, Ross, Sir James, Moles, Harriet, Frederick, Keys, Jessie, M'Minn, and Beckwith. On the Strangways are—On the left, Birdum and Landon ; on the right, Mais, Colton, Mueller, Gregory, and Page.

From the Roper the land rises in a well-marked tableland, with no mountains, and sends into the Gulf of Carpentaria short streams, until we reach the Gregory. Here, at a distance of 100 miles from the shore, is the **Premier Range**, parallel with the coast, and culminating in Mts. M'Kay, Moore, and Heales. Thence, in well-grassed plateaux, the country stretches to the Norman river, beyond which poor and inhospitable highlands stretch eastwards to the Great System of the Pacific.

ISOLATED RANGES OF QUEENSLAND, NEW SOUTH WALES, AND VICTORIA.

The ranges in the interior of the continent require but a short notice, for they are of such insignificant proportions as to have little or no influence upon the physical or climatic condition of the districts where they are found.

In Queensland are—The **Gregory Range**, between the Gilbert and Norman rivers. It is highly timbered, and has Bald Hill, Mt. Wildash, and Morphett's Peak.

Fletcher's Range, west of the Burdekin, in 20° S. lat., is the extremity of a long chain of impenetrable basalt, "towering," as M'Kinley says, "in range above range." The principal peaks are—Daintree's Look-out, M'Leod's Bluff, and Mt. Connell.

The **Granite Ranges**, between the Flinders and Burdekin rivers, with Mts. Emu, Sturgeon, Cracknell, Desolation, Main, Mard, Black, Davenport, Lascelles, Looloo, Beckford, Willek-Willek, Norman, Arthur, Walker.

The **Selwyn Range**, of which the **M'Kinley** Range is a spur, divides the waters of the Cloncurry and Gilliat from those of the Burke, Hamilton, and Diamentina.

The peaks are Nicholson, Ligar, Forbes, Collis, and Kerr's Table Mt.

The **Standish Range**, a southern spur of the Selwyn, divides the waters of the Burke from those of its tributary, the Wills. Its highest points are Birnie, Aplin, Murray, Bruce, and Meerlin.

The **Lanarth Range** and **Dividing Range** lie south of Cape River ; the **Main Range** and the **Belyando Range**, at the sources of the river of the same name ; the **Johnstone Range** lies between the Thompson and Cooper's Creek ; the **Goyder Range**, on the right bank of the Diamentina ; and the **Thomas Range**, near the sources of Farrar's Creek. The **Beal Range**, 200 miles long, forms a part of the water-shed of the Farrar and Cooper's Creeks. The **Cheviot Range** trends south-east for some distance, and then, as the **Grey Range**, in a generally south-west direction for 400 miles. This range separates the waters of Cooper's Creek and the Bulloo or Coorni Paroo. In Queensland the highest peaks are Heays, Childers, Shillinglaw, Intrepid, Morris, and Bygrave. In New South Wales, King, Poole, Stuart, and Brown.

Between the **Grey Range** and Cooper's Creek are the **Cannaway Range** and **Coleman Range**, running nearly parallel, and joining at Curalle Creek. Further south along the creek is the **Macgregor Range**, with Mt. Neatman, dividing the waters of the Barcoo and Wilson river.

Between the Coorni Paroo and Paroo rivers are the

Dividing and **Helen Ranges**; and between the Paroo and Warrego, the **Bald Range** on the north, and the **Berkeley Range** on the south.

The **Warrego Range** forms the watershed of the Langlo, on the north.

In New South Wales, the ranges of the interior are—The Grey Range, already mentioned; to the south of this the **Great Barrier** or **Stanley Range**, containing Mts. Robe, Lyell, and Babbage, extends as far as the **Coonbaralba Range**. East of the Stanley are the **Yencen Bolo, Cadell, Macadam, Wonominta, Cournlaundi, Coorato, Malia, Daubeney, Scrope,** and **Dolo Ranges.**

South of the Darling are **New Year's Range, Durban's Group, Dunlope Range, Rankine's Range,** with Mts. Glass, Deerina, and Margaret. The **Greenough Group** and **M'Culloch's Range,** are near Lake Poopelloe. Due south of this lake, in 33° S. lat., is the **Culparlin Range.** The **Hervey Range,** already mentioned in connection with the Great Dividing Chain, is near the sources of the Bogan; and the **Cocoparra Ranges,** between the Lachlan and Murrumbidgee, occupy a large tract of country. The western ridges contain Mt. Sugar Loaf, Cave Height, and Mt. Binya; whilst the eastern ridge, stretching southward from the river at 147° E. long., passes Wantabadgery, in a tableland of considerable elevation, divides the waters of the Tumut from those of the Murray, and joins the Muniong range. The leading peaks are Wallaroy, Barrens, Barrow, and Narriah.

The isolated peaks in New South Wales are not many; of them Mt. Canobolas, 4,600 feet, is the highest.

In Victoria there are no ranges which can be said to be wholly unconnected with the Great Dividing Range, except those forming the promontory of the Otway.* Grouped together in this little independent system are—The **Black**

* See Plate III.

Range, with Mt. Murray; the **Latrobe Range**; the **Dividing Range**, with Mts. Chapple and Sabine, 1,912 feet; and the **Otway Ranges**, which have been but partly explored.

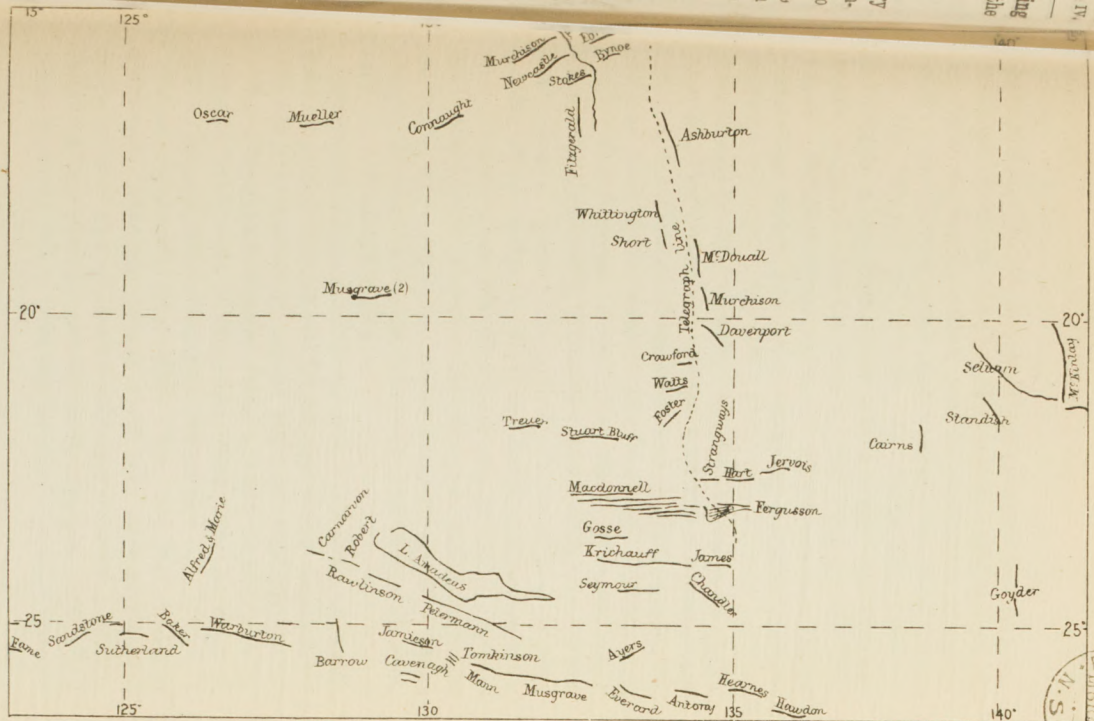
THE CENTRAL SYSTEM OF SOUTH AUSTRALIA.*

Beginning, as far as is at present known, at the boundary line of Western and South Australia, a great range of mountains runs east in a direction parallel, or nearly parallel, to the Equator. The central ridge is the **Macdonnell Range**, along the tropic of Capricorn; and to the north and south are continuous ranges of great extent. The northern range converges towards the Macdonnell at the Alice Springs station; whilst the southern ranges, separated by Lake Amadeus on the west, rise at about the same latitude as the Macdonnell, but diverge towards the south-east, and seem to be a continuation of the ranges which skirt Lake Eyre on the west.

Beginning, then, at the point where we left the Eastern System of South Australia, at the Alberga river, we find that a system of great extent separates its affluents from those of the Finke.

The ranges of this system are—The **Hawdon**, east of the Stevenson River, with Mts. Hammersley and Crisp; **Hearnes**, with Mt. Frank; **Anderson**, with Mt. Grundy; the **Antony**, forming an arc containing three quadrants of a circle; the **Ayers**, with Mts. Cavenagh, Reynolds, and Barrow; the **Everard**, at the Ferdinand river, with Mts. Everard, Carnarvon, and Ferdinand; the **Musgrave**, with Mts. Officer, Woodroffe, 2,030 feet, Morris, 1,830 feet, Caroline, and Mary; the **Mann**, with Mts. Charles, 1,565 feet, Samuel, Harvey, Davies, and Hinkley; the **Tomkinson**, beginning near the border in three parallel ridges, with Mts. Jane, Bell Rock, Maria, and Glen Osborne; the **Blyth**,

* See Plate IV.


15°
125°
Murchison
Newcastle
Stokes
Byrne
Oscar
Mueller
Connaught
Fitzgerald
Ashburton
Whittington
Short
Telegraph Line
McDonall
Murchison
Musgrave (2)
20°
Davenport
Crawford
Watts
Foster
Treuer
Stuart Bluff
Strangways
Hart
Jervois
Macdonnell
Fergusson
Gosse
Krichauff
James
Seymour
Chandler
Alfred & Marie
Carnarvon
Robert
L. Amadeus
Rawlinson
Peermann
Jamieson
Tomkinson
Ayers
Hearnes
Hawdon
Everard
Musgrave
Mann
Cavenagh
Barrow
Sutherland
Sandstone
Baker
Warburton
Fame
25°
125°
130
135
140°
Seldom
Standish
Cairns
Goyder
Plate IV
Macdonnell and other interior ranges.

south of Mt. Jane and bisected by the border line ; the **Cavenagh**, with Mts. Mueller, Morphett, Conigrave, Cooper, and Borrows ; the **Jamieson**, north of Conigrave, with Mt. Fanny ; the **Barrow**, with Mt. Squires ; the **Warburton**, with Mts. Waugh and Whitby ; the **Townsend**, south of Mt. Whitby ; the **Todd**, with Mts. Harvest and Charles, to the north of the Warburton ; the **Baker**, with Mt. Samuel ; the **Sutherland**, with Mt. Allott ; and the **Fame**, **Parker**, and **Frere**, the latter extending far into Western Australia.

Returning to Mt. Morris, in the direction of Lake Amadeus, the **Petermann Range** stretches in a north-west direction into the great spinifex desert, which forms the southern base of the Great Sandy Desert of Western Australia. The principal elevations of the Petermann are—Stevenson, 1,480 feet ; M'Culloch ; Phillips ; Curdie, in the Curdie Range ; Skene ; Sargood ; and Russell. The western portion of the range is called the **Rawlinson**, running in three parallel ridges, with Mts. Buttfield, M'Kellar, Forrest, and Christopher. Beyond this point, as far as the eye can reach, are ranges in almost every direction. These heavily timbered elevations received from Mr. Giles the name of **Alfred and Marie.**

Between this system and Lake Amadeus are the **Nicholls**, **Rowley**, **Blood**, **Robert**, and **Carnarvon** ranges, terminating with the characteristically named peak, Mt. Destruction.

The **Macdonnell Ranges** form a great system, closely following the Tropic of Capricorn, from 129° E. long. to 135° E. long., a distance equal to 300 miles.

Starting eastward from Mts. Udor, 900 feet, Palmer, 1,800 feet, Crawford, Liebig, 2,050 feet, and Haast—the range, at first narrow, greatly increases in width. At Mt. Palmer a second ridge, parallel to the one just mentioned, takes its rise ; and, a little to the south, a third parallel

ridge begins at Mt. Solitary, and sends S.E. a spur known as Gardiner's Range.

The most northerly range ends at Mt. Liel. The third ridge continues its easterly course to the end of the system. In it are Mt. Sonder, where the Finke rises, and Mt. Giles, near which are the sources of the Hugh. To the east of the Hugh the range is tripled for a short distance, and then extends to Alice Springs station in ten distinctly marked ridges. In this portion of the chain, which resembles a gridiron, are Mts. Solitaire, Brinkley, Conway, Forster, Everard, and Sir Charles. Beyond Alice Springs station, and separated from it by a vale flanked on both sides by precipitous ridges, are the **Fergusson Ranges.**

Returning to the west, the **Gardiner's Range,** already mentioned, terminates at 24° S. lat. ; and immediately to the south are the **George Gill Ranges**—two parallel ridges running east and west. The **Krichauff** and **Bacon Ranges** form the watershed of the Finke and its tributary, the Palmer, on the north. The Krichauff ends at the Glen of Palms, and the range, continuing east, receives the name of the **James** from the left bank of the Finke to the Hugh. Between the Finke and the Hugh the **Chandler's Range,** with Christopher's Pinnacle, acts as a dividing chain.

To the north of the Tropic, intimately connected with the Macdonnell, are **Strangways Range,** in 134° E. long. ; the **Hart Ranges,** terminating in Mt. Powell, 2,500 feet ; and the **Jervois Range,** with Mts. Sainhill, Baldwin, Leighton, and Playford. To the east of this point ridges are seen extending north and south, and forming probably the watersheds of many of the tributaries of the Herbert.

Beyond these ranges is the **Cairns Range,** a line of broken hills forming the western watershed of the Manners Creek.

To the west of the district, the mountains of which have been just now described, is the **Treuer Range,** an extensive

granite ridge, containing Mts. Stanley, Davenport, Hardy, Rock, and Eclipse, so named by Colonel Warburton, who, much to his annoyance, was surprised at this point of his route by a total eclipse of the moon.

The **Stuart's Bluff Range** is nearly south of the Treuer. To the west of this range is Mt. Wedge, 1,650 feet, the eastern point being a perpendicular scarp 615 feet above the slope of the mountain; while on both sides of the central height a low chain extends in a series of perpendicular walls of rock. Eastward of the Stuart's Bluff Range is the **Reynolds Range**, with Mt. Freeling; and **Hann's Range**, with Mt. Ewart.

Along the telegraph line to Port Darwin are the **Forster, Watts, Crawford, Osborne, Davenport, Murchison,** and **Ashburton** Ranges.

Returning to the Macdonnell Ranges, the following extracts from Mr. Giles's journal will not be uninteresting: —"The most northern range—4,000 feet high—is the highest; and the other two lines of hills may be called only foot-hills to the higher chain. The most southern and lowest is formed of sandstone; the middle tier is of basalt, and I believe the main chain is of basalt also. After leaving the camp, I climbed for several hours over masses of hills, but always found one just a little further on that shut out the view. At length I reached the summit of a high round mountain, in the middle tier, and a most varied and splendid panorama was spread out before me. To the north was the main chain, composed for the most part of individual high mounts with lower ridges between them. The view to the west was gratifying, for the ranges seemed to run on in undiminished height in that direction. The middle range of hills is the most strange looking. It recedes in the distance eastwards in almost regular steps or notches—each step or notch being a bluff itself, and all

overlooking a valley. The bluffs all have a circular curve, are all coloured red, and, looking at them in perspective, appear like a gigantic flat stairway, only they have an oblique tendency to the southward, caused, I presume, by the ocean currents that at perhaps no greatly distant geological period must have swept over them."

The northern range presented to Stuart the appearance of a gigantic wall, unscalable even by the nimble rock wallaby, which seeks refuge in the mountain fastnesses from the ever watchful eye of the black man.

Speaking of the Glen of Palms, Mr. Giles says—"I was literally surrounded by fair flowers of many a changing hue. Such a variety of lovely flowers of every colour and perfume I have never met with previously. They alone would have induced me to name this Glen Flora : but having found in it also so many of the stately palm trees, I have called it the Glen of Palms."

In the Chambers Range, the Chambers Pillar was visited and described by the same explorer :—"It is not likely that any future explorer (speaking of Stuart) will ever discover so singular a monument wherewith to immortalize himself or his patron. Upon reaching it I found it to be a columnar structure, standing on a pedestal which is perhaps 80 feet high, and composed of loose white sandstone, having vast numbers of large blocks loose and lying about in all directions. From the centre of the pedestal rises the pillar, composed also of the same kind of stone, though at its top, and for about 20 or 30 feet from its summit, the stone is red. The column must be itself about 150 feet above the pedestal. There it stands, a vast monument of the geological periods that must have elapsed since the mountain ridge, of which it was formerly a part, was washed by the action of the ocean waves into mere sandhills at its feet."

Future discoveries will add to the list of ranges noticed

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in this chapter, and will demand considerably more detail in the description of even our best known mountain chains; they, therefore, must detract from the completeness of this account, but they ever afford the geographer that intense pleasure which the scientific inquirer experiences when he hears of, reads of, or finds out something new.

CHAPTER V.

AUSTRALIA—ITS SEAS, ETC.

AUSTRALIA is bounded on the east and north by the Pacific Ocean, which is 50,000,000 square miles in extent—of great width compared with its length; shallow; peaceful; studded with islands; with sluggish currents; and intermediate in temperature between the warm Indian Ocean and the cold Atlantic. Its depth on the coast of Queensland varies from 2,000 to 5,000 feet outside the Barrier Reef; but upon reaching Moreton Bay the bed is suddenly depressed to 15,800 feet for a distance of 100 miles. Rising again to 7,000 feet near the frontier of New South Wales, it sinks opposite Newcastle to 15,000 feet, and maintains this uniform depth to the Antarctic Ocean. On the east Australian coast it has no indentations sufficiently large to be called branches; but on the north there are the Gulf of Carpentaria and Timor Sea. The latter, which, except in a narrow depression near Timor, nowhere attains a greater depth than 1,200 feet, has numerous sounds and inlets on the coast, between C. Bougainville and Melville Island. The principal are—**Vansittart Bay, Cambridge Gulf, Queen's Channel, Treachery Bay, Port Keats, Anson Bay,**

Port Patterson, Port Darwin, Shoal Bay, Adam Bay, and **Clarence Strait.**

Between Melville Island and Coburg Peninsula is **Van Diemen Gulf.** Then follow in order—**Mountmorris Bay, Malay Bay, Junction Bay, Rolling Bay, Castlereagh Bay, Buckingham Bay, Arnhem Bay,** and **Melville Bay.**

The **Gulf of Carpentaria** lies within Cape Arnhem and Cape York. It is 430 miles wide between the mouths of the Roper and Mitchell rivers, and 440 miles long from the mouth of the Flinders to Cape York. It is bounded on the east and west by mountain chains which have the counter-slopes to the east and slopes to the west, and in consequence the land falls gradually on the east side, and presents a bold and precipitous margin on the west. Between, the coast is a low alluvial plain, covered with mangrove swamps, and fringed with small rivers which rise on the sandstone tableland at no great distance from the gulf. Its depth is nowhere greater than 1,200 feet. Its inlets are **Caledon Bay, Blue Mud Bay,** and **Zimmen's Bight.**

Along the east coast are **Newcastle Bay, Oxford Bay, Hanibal Bay, Shelborne Bay, Temple Bay, Weymouth Bay, Lloyd's Bay, Princess Charlotte Bay, Bathurst Bay, Weary Bay, Trinity Bay, Rockingham Bay, Halifax Bay, Bowling Green Bay, Upstart Bay, Abbott Bay, Repulse Bay, Broad Sound, Shoal Water Bay, Keppel Bay, Port Curtis, Bustard Bay, Hervey Bay, Laguna Bay, Moreton Bay, Trial Bay, Camden Haven, Port Stephens, Morna Bay, Broken Bay, Port Jackson, Botany Bay, Jervis Bay, Sussex Haven, Bateman's Bay, Twofold Bay, Mallacoota Inlet, Sydenham Inlet, Shallow Inlet, Port Albert, Corner Inlet,** and **Waterloo Bay.**

Of these Port Jackson is specially worthy of notice. It is a magnificent expanse of water, with a narrow entrance from the ocean. The cliffs which form the general entrance to the

harbour are 250 feet high, and the depth is sufficient to permit the largest men-of-war to approach within a few yards of the shore. From the Heads to Sydney is 4 miles, and branching out in every direction the eye of the traveller is charmed with a succession of beautiful landscapes. Within the Heads the port is divided into three principal ports—The North Harbour, Middle Harbour, and Port Jackson. The North Harbour is entered through Inner North Head and Grotto Point, and its indentations are Manly Cove and Little Manly Cove. The entrance to Middle Harbour is through the Grotto Point and Inner Middle Head; within the points are Long Bay, Shell Cove, and Hunter's Bay. Port Jackson lies within Middle Head and Inner South Head. The scenery on the north is truly grand, numerous headlands being formed by the intricate spurs of the coast range and the intervening bays running far into the narrow valleys. The bays in order are—Obelisk B. and Chowder B., separated by George's Head; Taylor's B.; Whiting Beach, Little Sirius Cove, Great Sirius Cove, and Mossman's B., between Bradley's Head and Careening Point; Shell Cove, Neutral Harbour, and Careening Cove, between Careening Point and Kirribilli Point; Lavender B., between Milson's Point and Blue's Point; then follow Barry's B., Balls Head B., and Woodford B., at the estuary of Lane Cove river. On the south shore are Lady B., Camp Cove, Watson's B., and Vaucluse B., between Inner South Head and Shark Point; Rose B., between Shark Point and Point Piper; Double B., between Points Piper and Darling; Ruscutter's B. and Elizabeth B., between Points Darling and Potts; Wooloomooloo B. and Farm Cove, between Points Potts and Macquarie; Sydney Cove, between Points Macquarie and Dawes; Darling Harbour, Johnson B., and White B., between Miller's Point and Goat Island; and to the west of this island are Waterview B., Snails B., Long Cove, and the

estuary of the Parramatta river. Port Jackson can boast of several very picturesque islands; these are—Shark I., Clarke I., Garden I., Goat I., Cockatoo I., Spectacle I., and Snapper I.

The Southern Ocean bounds Australia on the south. It is 10,000,000 square miles at least in area; cold; with few islands; 15,000 feet deep, and intermediate in roughness between the peaceful Pacific and the stormy Atlantic. Its indentations are—**Waratah Bay, Venus Bay, Western Port, Port Phillip, Loutitt Bay, Warrnambool Bay, Port Fairy, Portland Bay, Bridgewater Bay, Discovery Bay, Macdonnell Bay, Umpherstone Bay, Rivoli Bay, Guichen Bay, Lacepede Bay, Encounter Bay,** the **Australian Bight, Rossiter Bay, Esperance Bay, Stokes Inlet, Gilham Inlet, Fitzgerald Inlet, Doubtful Island Bay, Premier Bay, Dillon Bay, Beaufort Inlet, Cheyne Inlet, Port Two People, Port Valiant, King George's Sound, Torbay, Radcliffe Bay, Port Hillier, Irwin's Inlet, Nornalup Inlet,** and **Flinders Bay.**

Port Phillip is entered by a narrow passage between Pt. Lonsdale and Pt. Nepean. From Pt. Nepean to Sandridge is 37 miles, and from Frankston to Geelong is 42 miles. Its bays are—**Dromana, Balcombe, Hobson's, Geelong Harbour, Corio,** and **Swan.**

The Great Australian Bight is 800 miles wide from Cape Willoughby, in Kangaroo Island, to Cape Pasley. In Kangaroo Island are—**D'Estree Bay, Vivonne Bay, Hanson's Bay, West Bay, Emu Bay, Bay of Shoals,** and **Nepean Bay.** Along the coast are—**Rapid Bay, Aldinga Bay; St. Vincent's Gulf,** including **Port Adelaide, Oyster Bay, Sturt Bay, Foul Bay,** and **Marion Bay; Spencer's Gulf,** including **Hardwicke Bay, Wallaroo Bay, Tickera Bay, False Bay, Franklyn Harbour, Dutton Bay, Tumby Bay, Louth Bay,** and **Boston Bay.** West of Cape Catastrophe

are—Sleaford Bay, Avoid Bay, Coffin's Bay, Hall's Bay, Anxious Bay, Baird's Bay, Sceales Bay, Covisart Bay, Streaky Bay, Smoky Bay, Denial Bay, Fowler Bay, Scott's Bay, Head of Bight, Israelite Bay, and Sandy Bight.

The Indian Ocean bounds Australia on the west. It is 17,000,000 square miles in area; warm; with numerous islands; calm, but frequently visited by the terrible cyclone; having many branches, and varying in depth from 12,000 to 20,000 feet.

Its Australian indentations are—Geographe Bay; Koombana Bay; Leschenault Inlet; Peel Inlet; Warnbro' Sound; Breton Bay; Jurien Bay; Champion Bay; Geelvink Channel; Gantheaume Bay; Sharks' Bay; Geographe Channel; Exmouth Gulf, and Bay of Rest; Nickol Bay; Port Walcott; Port Heedland; Geoffroy Bay; Lagrange Bay; Roebuck Bay; Carnot Bay; Beagle Bay; King's Sound, including Goodenough Bay, Disaster Bay, Stokes' Bay, and Cone Bay; Collier Bay; Doubtful Bay; Camden Harbour; Brunswick Bay; Port Nelson; York Sound; Montagu Sound; and Admiralty Gulf, with Walmesby Bay and Port Warran-der.

AUSTRALIA—ITS TIDES.

The tides are caused by the attracting power of the moon and sun upon the oceans. The moon has the greater power, and draws after her, in her circuit, as meridian after meridian passes daily under her, a great wave, travelling with a velocity of 1,000 miles an hour in open ocean. The sun acts with less force, but modifies the form of the wave very perceptibly. If the sun and moon are in the same meridian, or at a distance of 180° apart, they raise the crest of this wave to its highest point and form a Spring Tide. This happens at new and full moon. But if the two bodies be 90° apart, the

attraction of the sun neutralizes the attraction of the moon to some extent; the crest of the wave is lowest, and is called a Neap Tide. This happens in the first and third quarters of the moon.

A secondary wave is formed simultaneously in the hemisphere opposite to the attracting forces by a displacement of the earth.

A **Co-tidal Line** is one drawn on a chart through all adjacent places which have high water at the same time. These are drawn at intervals of an hour, and are very irregular in shape in consequence of the depth of the sea-bed, the interposition of land, and the presence of estuaries.

The tidal wave receives its primary impulse in the Antarctic Ocean, between Cape Horn and New Zealand. Moving towards the west, it encounters the most easterly points of Australia and Tasmania at the same time, and, being divided by the continent, it reaches the Indian Ocean in two sections—one passing slowly through Torres Strait, and the other with a greater velocity through the Southern Ocean.

* If we take the tidal wave that rises in the Antarctic Ocean at 12 o'clock, and mark its westward progress by the co-tidal lines, we shall understand the subject more clearly. The co-tidal of 6 reaches New Zealand; of 10 almost touches the coast of New South Wales at the mouth of the Clarence; of 11 passes Cloudy Bay in New Guinea, Point Danger, and South-east Cape in Tasmania; of 12, Port Moresby, estuary of the Fitzroy, and Port Davey; of 1, Yule Island, Cape Palmerston, and Cape Grim; of 2, mouth of the Fly River, Cape Melville, and Cape Northumberland, in South Australia; of 3, Thursday Island, Cape York, and Spencer Gulf; of 4, Frederick Henry Island, estuary of the Flinders, and head of the Bight; of 5, east of Cape Steeinboom, estuary of the Albert, and the Leeuwin; of 8, Cape

* See Keith Johnston's Physical Atlas—Plate XI.

Steeinboom and Cape Arnhem ; of 12, M'Cluer Island and Port Darwin. In the Indian Ocean it is lost, being probably driven back by the southern branch, which passes the Leeuwin nearly 12 hours later.

The height of the tidal wave is not great along the east, south, and west coasts ; but, owing to the cause already mentioned—namely, the swifter wave of the Indian Ocean—as well as to the opposing north-west summer winds and the narrowness of the seas on the north, the wave greatly increases in height along the Gulf of Carpentaria and the north-west coast. On the east coast the wave attains at spring tide a height of from 9 feet at Port Jackson to 7 feet at Twofold Bay, and increases to 10 feet at French Island. On the southern coast the spring tide enters Port Phillip Heads with a height of 7 feet, but falls to 2 feet 8 inches at the Queen's Wharf on the Yarra at Melbourne. From Point Lonsdale, where it is 7 feet, it gradually decreases to the Murray mouth, where it is $3\frac{1}{2}$ feet, and thence maintains a uniform height of 6 feet to Fowler Bay, except at Spencer's Gulf, in which, owing to the form of the shores, it increases to 12 feet at Port Augusta. From Fowler Bay to the Leeuwin it falls gradually, and passes the latter point with an imperceptible rise of from 2 to 3 feet.

Along the west coast the wave from the south advances with considerable velocity and force, but with decreasing height, until it reaches the mouth of Swan river, where it is scarcely 12 inches high. At this point, or perhaps at Champion Bay, it leaves the coast ; and along the north-western shores the tidal wave of the north coast makes itself felt.

The tidal wave of the north coast enters Torres Strait with a height of 9 feet, and flows west with an ever increasing ridge, except where the formation of the land at river estuaries modifies the height. At the mouth of the

Flinders it is 12 feet; at the Albert, 17 feet; at the head of the gulf, 12 feet; at Port Essington, 13 feet; at the mouth of the East Alligator river, 15 feet; at Adam Bay, 18 feet; at Port Cockburn, 24 feet; at Port Darwin, 24 feet; in the Queen's Channel, 27 feet; at Hanover Bay, 34 feet; and culminates in Camden Harbour at a height of 40 feet. Thence it gradually decreases. At Collier Bay it is 36 feet; at Stokes Bay, 34 feet; at King's Sound, 33 feet; at the Fitzroy, 18 feet; at Carnot Bay, 14 feet; at Turtle Bay, 6 feet; and at Port Gregory, 3 feet.

A very remarkable thing in connection with the tidal wave of the north and north-west coast is that, except in a few places, there is only one rise in the day.

AUSTRALIA—ITS CURRENTS.

DEFINITION.—An oceanic current is a river in the ocean having its bed and banks composed of water of a different temperature from that of the stream itself. Oceanic currents are permanent, periodical, or variable.

A **permanent** current always flows in the same direction; a **periodical** current flows during one-half of the year in one direction, and during the other half in the opposite direction. A **variable** current owes its direction to the prevailing wind; a periodical current to a moonsoon; and a permanent current to the diversion of water from the land down the deep sea slopes, which, by giving a motion to the ocean, force the lighter waters to the surface in narrow streams. The currents of our oceans are either permanent or variable.

Assuming that the student is already acquainted with the oceanic currents or ocean rivers, those alone will be here mentioned which have a direct bearing on our own seas.

The Antarctic drift,* starting in the Antarctic Ocean,

* See Plate I.

between New Zealand and America, flows in an easterly direction towards the latter continent. Here one branch of it is deflected, and, washing the shores of Chili, Bolivia, and Peru, assumes a westerly direction at the tropic of Capricorn. With a velocity of about 11 miles a day, it moves slowly towards Australia and Asia; and, upon encountering the former, the stream is divided into two branches, one of which, retaining its name of the **Equatorial current**, flows past Australia on the north into the Indian Ocean; the other branch—the **East Australian current**—carries its warm waters along the east coast, and, meeting a branch of the Antarctic drift at Bass's Straits, forms the counter current of the Southern Ocean. Its velocity is 2 miles an hour.

Returning to the Antarctic drift at Cape Horn, it will be seen, upon reference to Keith Johnston's Physical Atlas, * that a branch of this current, sweeping past the South Atlantic and Indian Oceans, encounters the Leeuwin, and bifurcates. The upper branch flows as a cold current along the shores of Western Australia as the **West Australian current**. On the north-west coast of the continent the West Australian current meets the Equatorial current, which has passed Australia on the north, and is deflected towards Africa. Recoiling upon collision with Madagascar, it returns; and its now heated waters not unfrequently influence the climate of Western Australia. The lower branch sweeps past the Australian Bight into Bass's Straits, where it encounters the East Australian currents, forming the counter current already mentioned. Another portion of the Antarctic drift passes Tasmania on the east, and enters the Pacific between the East Australian current and New Zealand. Such is the superior strength of this branch of the Antarctic drift that it forces the outer waters of the East Australian current to return as a counter current into the Pacific.

* Plate XI.

In addition to these permanent ocean streams there are varying currents, depending on the wind and local causes; but these do not come within the scope of this work.

The effects of the permanent currents upon the climate are very noticeable. Along the shores of Queensland and New South Wales the warm East Australian current renders the summer-heat moist and disagreeable, and modifies the winter chills by its genial influence.

The Antarctic drift has the effect of lessening the temperature along the southern shores. To this Victoria and South Australia owe the refreshing coolness of the south wind, which succeeds the scorching north wind of the summer months. In West Australia the great heat from the sandy plains which bound the settled portion on the east, and that from the Indian Ocean on the west, is greatly modified by the cool West Australian stream.

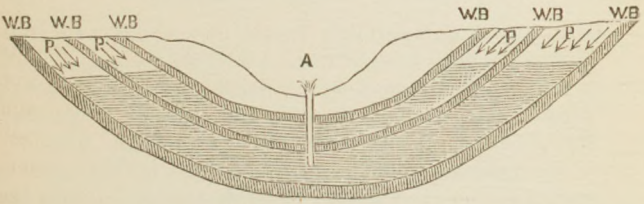
SPRINGS AND WELLS.

The water that falls as rain on the surface of the land is either drawn back into the atmosphere by evaporation; or carried to the ocean by river channels; or percolates through the porous soil until it reaches a stratum which is impervious to water. Having reached an impervious, or water-bearing stratum, it may accumulate, and eventually as springs reach the surface again; or it may flow slowly as subterranean water to the ocean.

The springs of our country are very few. Our rivers are fed by rain showers, not by the ever-flowing crystal waters of springs. The black man does not camp near a spring, but beside a well of his own making. Yet there are some springs; they are mostly saline, but occasionally contain valuable mineral substances in solution.

The absence of springs, while it is an evidence of a stinted rainfall, indicates also a deep porous surface, through

which the water sinks until it reaches an argillaceous or limestone stratum. In the chapter on geology we shall see good grounds for believing that a gigantic limestone water-bearing stratum underlies the more recently formed soils. If wells be sunk to reach the limestone, water will rise and flow over the surface. The only well suitable for us is the Artesian well, which received its name from the province of Artois in France. The best, but not the absolutely necessary, form of land for an Artesian well is one with a quaqua-versal dip—that is, where the strata are bent like the inside of a basin. If a series of beds of this form be alternately porous and water-bearing, the rain trickling through the porous will be accumulated at the lowest part of the water-bearing beds. If at the lowest point a rock-borer be driven, water will rise to very nearly the same level as that of the subterraneous imprisoned fluid.



In the diagram the strata marked P are porous, and are represented as saturated with water up to the highest lines of shading. The strata marked WB are water-bearing. The arrow-heads show the course of the surface water as it percolates through the porous strata. A is the Artesian well. The bore at A will be filled with water, which will rise, in consequence of friction, somewhat lower than the highest line of shading. Should the supply fail, a further boring will secure water at a lower level. Some of these wells have been sunk to a depth of 2,000 feet in America, with such

success that in an absolutely rainless district vineyards of great size flourish in the midst of the sand.

In consequence of the very level surface of Australia it is not often possible to secure the most favourable conformation of land for the sinking of Artesian wells; but, as the dweller on the hill side, though he cannot catch all the water from the rills around, yet can always secure as much as he wants, so the settler on the gradual south-westerly sloping lands of Queensland and New South Wales will find that by boring he will obtain enough, and more than enough, for all his requirements.

CHAPTER VI.

AUSTRALIA—ITS RIVER SYSTEMS.

DEFINITIONS.—A **Streamlet** is formed by a flow of water from a spring, or from a fall of rain, or from the melting of snow.

A **Stream** is formed by the union of several streamlets. Streams are permanent if rising from springs, intermittent if dependent on the melting of snow or the fall of rain.

An **Affluent** or **Tributary**, is formed by the union of several streams, and discharges its accumulated waters into a still larger watercourse.

A **River** is the largest form of running water.

A **Creek** is a **Watercourse** found in districts of infrequent rain, and is dry, altogether or in part, during a portion of the year.

A **Basin** is the whole extent of country drained by a river and its tributaries.

A **Watershed** is the line, or ridge, or mountain system which divides one basin from another.

A **River System** is the sum of all the basins which discharge their rivers into a particular ocean.

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A **Delta** is a river-mouth formed by several streams.

The right bank of a river is on the right hand of a person descending with the current, and the left bank is on his left.

In consequence of the fitful and insufficient rainfall (which will be treated of in more detail in the chapter on Climatology)—of percolation—of the moderate height of the mountain chains, and their littoral situation—and of the comparative scarcity of forest growth, Australia is more deficient in rivers than any other continent. In fact, there are very few rivers which possess a large and constant volume of water. The typical Australian river may contain, during the rainy season—which in the extra tropical region is in winter—a large quantity of water, but the same river will be a parched channel, a mere succession of pools and waterholes, or, at best, a scanty, though regular, stream during the long summer and autumn droughts.

Of the Pacific, Southern, and Indian Ocean basins the watersheds are the chains already described, and their proximity to the coasts precludes the possibility of rivers of any great length existing between them and the coast line. In the great interior only can a large river be expected ; and here is found the Murray, by far the greatest stream of the continent. If we take into consideration the size and number of its tributaries, we should be inclined to rank it among the giant rivers of the world—a smaller Amazon on the map—yet it is navigable by flat-bottomed vessels only ; and these, when laden, often lie helpless on the mud banks in the channel way.

The River Systems are five :—1. The East Pacific System ; 2. The Southern Ocean System ; 3. The Indian Ocean ; 4. The North Pacific Ocean System ; and, 5. The basins of Continental Streams.

1. The East Pacific System

Is bounded on the west by the Great Dividing Chain, and may, for convenience of description, be divided into three parts, a northern, a central, and a southern.

The northern part includes all the east-flowing rivers of Queensland. In general appearance these rivers are unlike any found in other parts of the world. Lying between ranges running in parallel lines, north and south, we find the eastern course of the river short; while long tributaries, flowing from opposite points of the compass, either form the main stream in the same valley, or unite with it in valleys separated by narrow ridges only.

The first river on the north is the **Kennedy**, 200 miles long, with a basin of 10,000 square miles, having as affluents the Laura, Normanby, Coleman, and King.

The **Endeavour**; the **Barron**, 120 miles long; the **Ross**; and the **Houghton** follow in order.

Below the Houghton is the **Burdekin**, which rises in Mt. Lang, and, flowing south, receives the Clarke and Basalt. Further south it is joined by the Belyando. The **Belyando** rises in the south, in a range of the same name, and has as affluents the Suttor and Cape. After its union with the Belyando, the Burdekin flows towards the ocean. It is joined in its easterly course by the Bowen and Bogie, and falls into Upstart Bay. Its length is 350 miles, and its basin probably 25,000 square miles.

The **Pioneer** runs east into the ocean at Cape Palmerston.

The **Fitzroy**, like the Burdekin, has a northern and a southern branch. The northern—the **Mackenzie**—is formed by the union of the **Nogoa**, rising near Mt. Hutton; the **Teresa**, rising in the Drummond Range; the **Isaacs**, from the Denham Range; and the **Comet**, or Brown, which has its sources in the Carnarvon Range. From the south the

Dawson, rising in southern part of the Expedition Range, joins the Mackenzie north of Mt. Spencer. Upon their union, the combined streams, under the name of the Fitzroy, approach the sea in a somewhat circuitous route, and fall into Keppel Bay. The length is 450 miles, and the basin between 30,000 and 40,000 square miles.

South of the Fitzroy are the **Boyne** and **Kolan.**

The **Burnett**, a winding, irregular stream, rises in the Dividing Chain at Prospect Peak, and at first flows south ; but upon its junction with its principal affluent—the **Auburn** —it turns, and in a north-easterly course reaches the ocean at Burnett Head, in Hervey Bay. Its length is 280 miles, and its basin 18,000. The affluents of the Auburn are the **Boyne** and **Stuart.**

The **Mary** rises in the Blackhall Range, and flows due north to about 30 miles from its mouth. At this point it bends east, and falls, after a course of 120 miles, into Wide Bay.

The **Brisbane** is the most southern of the important rivers of Queensland. It rises in the northern extremity of the highland lying between the Blackhall and Bunya Bunya Ranges, and, after a serpentine course of 200 miles, falls into Moreton Bay. The **Stanley** from the north, and the **Bremer** from the south, are its principal tributaries. The city of the same name is built on the Brisbane at 25 miles distance from its mouth. To it steamers of heavy tonnage can proceed ; and 23 miles to the west, on its tributary, the Bremer, is Ipswich, which is easily reached by steamer from Brisbane.

To the north of the Macpherson Range the **Logan, Albert, Coomera,** and Narang reach the Pacific opposite Stradbroke Island.

The central part of the East Pacific System includes a large number of rivers, all rising within the great barrier

of the Dividing Chain, and flowing in short, rapid, deep courses, through mouths difficult of navigation, into the ocean. They are subject to tremendous floods, by which they are raised as foaming torrents 30, 40, or even 50 feet above their ordinary levels.

The first river is the **Tweed**, which rises in the Macpherson Range, and falls into a well-sheltered bay a little to the north of Point Danger. The district between it and the Richmond is the centre of the cedar trade.

The **Richmond** has its sources in the Macpherson Range, near Mt. Lindsay, whence, after a south-easterly course of 110 miles, it falls into the ocean at Lennox Head. It is navigable for 40 miles.

The **Clarence** also rises in the Macpherson Range. Its course is southerly to its junction with the **Nymboi**, which has as affluent the **Mitchell**, a stream formed by the union of the **Guy Fawkes** from the M'Leay Range and the **Yarrow** from the New England Range. A natural canal—the Boyd—joins the Nymboi to the Guy Fawkes. Upon its junction with the Mitchell, the Clarence in an almost semicircular course reaches the ocean at Shoal Bay. An effluent—the **Orara**—leaves the Clarence 12 miles to the west of Grafton, and falls into the ocean at Red Rock. The Clarence is 240 miles long, and drains an area of 17,000 square miles. It is navigable for 60 miles by ocean steamers.

The **M'Leay** river is formed by the union of the **Gyra** and **Apsley** from the New England Range. In a small affluent of the Gyra are Dangar's Falls, 600 feet high. The M'Leay is 200 miles long, and drains the small area bounded by the M'Leay, New England, and Hastings Ranges.

The **Hastings** rises near Mt. Sea View, and runs due east to Port Macquarie. Its principal tributary is the **Wilson.**

The **Manning** rises in the Hunter Range, and at about 25 miles from its source receives the **Barnard**, which rises at the most easterly angle of the Liverpool Range. After its union with the **Avon**, from the south, it flows into the ocean by two mouths, between which is Mitchell Island. The northern channel is called the Harrington Inlet, and the southern Farquhar's Inlet. The length of the Manning is 100 miles, and the basin 2,500 square miles.

The **Hunter** rises in the Liverpool Range, and is joined by the **Isis**, coming from the junction of the Peel and Liverpool ranges, before it has traversed 30 miles. Its course from its source for 50 miles is south-west until it receives the **Goulburn**, which rises in the Liverpool Range, near Gulgong. After the inflow of the Goulburn, the Hunter runs nearly due east, receiving the **Patterson** and **Williams** from the north, and reaches the Pacific at Port Hunter. Its length from the sources of the Goulburn is 300 miles, and its basin 9,000 square miles. It is navigable as far as Morpeth, flowing through valuable alluvial country in the middle part of its course ; but, on nearing the ocean, the land is low, swampy, and covered with giant eucalypts, which have not felt the axe of the woodman.

The Patterson is navigable above the town of the same name. It flows through a great wheat and tobacco growing country enjoying an admirable climate.

The physical character of the Williams is similar.

The **Hawkesbury** is the longest river in the second division of the East Pacific basin, and surpasses the Rhine in scenic beauty. It is formed by the union of the Cox and Wollondilly. The **Cox** rises in the Blue Mountains, and, after receiving the Cowmung, flows east as the **Warramba**. The **Wollondilly** rises in the Cullarin chain, 100 miles below the Cox. It is joined by the Mulwaree, Cockbundoon, Wingecarribee, and Nattai. The union of the Cox and Wollondilly

takes place about 80 miles from the ocean. In these 80 miles the Hawkesbury receives—from the south, the **Nepean**; from the west, the **Grose**, and the **Colo** (formed by the junction of the Capertree, Wolgan, and Wollemi); and from the Hunter Range, the **Macdonald**. It falls into Broken Bay amidst lofty hills clothed with the richest verdure.

Trollope says—"There can, I think, be no doubt that among rivers the Rhine has the highest character for sustained beauty. There may be special points on some streams which have endeared themselves to the world—such, especially, as the Falls of Niagara—such as the Inn at Innspruck, or the Rhone at Geneva, or the Upper Lake at Killarney, which is, in truth, a river. But for continued beauty the Rhine stands first. There is a river, or, rather, a portion of a river, which beats the Rhine. This is the Upper Mississippi, for about 150 miles below St. Paul's. It is not my business here to describe the Mississippi, but I mention it with the object of saying that the Hawkesbury beats the Mississippi. At all of them the beauty consists in the breaking of the land on the very margin of the river, and is not carried far back to the interior. At all of them the banks rise suddenly, sometimes covered with timber, and sometimes bald; sometimes sloping, and sometimes precipitous; but at all of them the banks are broken here and there into lateral valleys, which give to the imagination the idea that the beauty is far-spread, and would repay pursuit. On the Rhine, on the Mississippi, on the Hawkesbury alike, there is created an idea that if the traveller would only leave the boat and wander inland, he would be repaid by the revelation of marvellous beauties of nature—beauties which have, perhaps, never yet met the eyes of man."

The **Nepean**, a splendid stream, is formed by the junction of the Cowpasture with several smaller streams; and, skirt-

ing the ranges for many miles, reaches the rich Emu plains, where it is 200 yards wide, and of great depth.

The **Grose**, starting in a remarkable cleft of the Blue Mountains, near Mt. Victoria, 3,422 feet high, is separated from the Hawkesbury by a precipitous spur terminating in Mount York. Near its source, in Mount Victoria, it is joined by the streams from the Blackheath village, where the falls already described—Govett's Leap, the Left-hand Falls, and the Trinity Cascade—form the most remarkable item in Australian scenery.

The Hawkesbury is subject to floods, which surpass in magnitude the inundations of the older worlds. In 1806 it rose 93 feet above its ordinary level; in 1809 it rose 50 feet at Richmond; in 1867 it surpassed this by rising 63 feet at Richmond. The awfulness of such catastrophes can scarcely be estimated by those who have been fortunate enough not to have witnessed them.

The **Paramatta** is a short river—in reality only an extension of Port Jackson, but deriving importance from the fact that Sydney is in its immediate vicinity. Its length is about 15 miles.

The **Shoalhaven** rises in the Gourock Range in 36° S. lat., and flows through rich alluvial land for a long distance north by east, receiving numerous creeks. At 34° 43′ it deflects to the east, and enters the ocean at Shoalhaven Bight. Its length is 250 miles, and its basin 4,000 square miles.

The **Clyde** is a very short river, taking its rise near the coast in 35° 20′ S. lat., and, flowing parallel to the coast line through country hopelessly barren for 30 miles; it falls into Bateman's Bay—a fine estuary, safe, deep, and sheltered. Then in order follow the **Moruya**, with its affluent, the **Dena** river. The **Tuross**, the **Bega** or **Brogo**, and the **Towamba**, rising near Coolaneubra, in the Maneroo or

Wanderers Range—all these rivers are subject to heavy floods, which bring down a rich alluvial soil so dear to farmers.

The southern portion of the Pacific System includes but few rivers—all, except the Genoa and Snowy river, in Victoria. The **Genoa** rises in the Maneroo Range, half-way between Coolaneubra and Tennyson, receives near its mouth the Wallagaraugh, and falls into Mallacoota Inlet.

The **Snowy River** has its sources in the Muniong Range, near Kosciusko. About 8 miles from its source it receives the Gungarlan Creek, and, five miles further, the **Eucambene.** The latter rises in the fork formed by the intersection of the Maneroo and Muniong Ranges. After the union of the Wullwye and Boundarua creeks, the Snowy river is joined by the M'Laughlin from Nimmitabel, and by a stream formed by affluents coming from the Maneroo and Wanderers Ranges. Those from the Maneroo are the Cambatong, Bombala, Coolumbooka, and Maharatta creeks; and those from the Wanderers Range are the Queensboro' and Delegete rivers. At the point of junction with this stream the Snowy river deflects to the west, and crosses the border near Mount Trooper, after receiving the Crackenbae, Towamba, Tongara, and Moyangul rivers from the Muniong. Upon entering Victoria, it flows in a general southerly course, and reaches the ocean through Lake Corringle. The Victorian tributaries are—on the left bank, the Jingalla, from the Wanderers Range, and the Brodribb, from Mount Ellery; on the right, the Toonginbooka, from Forest Hill, and the Buchan.

The length of the river is 400 miles, and the basin in New South Wales, enclosed by the Muniong and Maneroo Ranges, is 3,000 square miles. The Victorian basin is inconsiderable.

The **Tambo** rises in Mount Leinster, flows in a broken

course between the Fainting and Bowen Ranges, and falls into Lake King.

The **Mitchell** is formed by the union of the **Dargo** and **Wonangatta.**

The Dargo rises near Mount Hotham, and flows south. The Wonangatta rises near Mount Howitt, and flows south-east. The rivers unite to the south of Mount Thompson as the Mitchell, which falls into Lake King. The tributaries are the **Wentworth,** on the left, from Mount Phipps ; and the Cobbanah, on the right, from Budgee Budgee. The length of the river is 90 miles.

The **Latrobe** rises between Mounts Baw Baw and Erica as the Moondarra, which flows south. Upon receiving the name of Latrobe, it flows due east into Lake Wellington. Falling into it on the left are the Thompson, with its affluent, the Aberfeldy, from Mount Selma ; and the Macalister, with its tributaries, the Barkly and Hamilton, from Mounts Clear and Macdonald. The Thompson and Macalister unite 5 miles south from Maffra, whence the united streams flow south to the Latrobe at Longford. On the right bank the **Morwell** reaches the main stream at the township of the same name. The length of the Latrobe is 80 miles, and its basin 2,650 square miles.

The **Tarra, Albert,** and **Franklin** rivers fall into the ocean, after short, deep, clear courses, at Shallow Inlet, Lewis' Channel, and Corner Inlet respectively.

2. The Southern Ocean System.

This system, extending from Wilson's Promontory on the east to the Leeuwin on the west, is readily subdivided, from its physical characters, into three parts—the first, from Wilson's Promontory to the mouth of the Murray ; the second, containing the rivers falling into St. Vincent's and

Spencer's Gulfs; and the third, from Cape Pasley to the Leeuwin.

In the first subdivision are all the rivers of Victoria. In winter these are angry torrents, swollen with flood waters; and in the dry summer they dwindle down into shallow and often broken streams.

The **Yarra Yarra** drains all the area lying between the Great Dividing Range, Baw Baw Mountains, and Dandenong Range. It is fed by a large number of streams of a permanent character. Its sources are in the Baw Baw Mountains, whence it flows in an almost due west course to Melbourne. From the Great Dividing Range it receives the Doctor's, Meola, and Cement Creeks; the Ligar river from Mount Strickland, the **Watts** from the Black Spur, the **Plenty** from Mount Disappointment, and the Merri Creek and the **Saltwater** river, rising in numerous creeks between Mounts William and Macedon. From its southern watershed its affluents are the M'Mahon, Starvation, Crooked, and Big Pat's Creeks, the Yarra rivulet, Hoddle's, M'Crae's, and Dandenong Creeks. The Yarra is the Thames of the London of the Southern Hemisphere. It is navigable for steamers of 1,000 tons as far as Melbourne; and, under the able superintendence of its Harbour Trust, such improvements are now being carried out, that almost from week to week one can see an increase in its already enormous shipping business. Along its banks are extensive manufactories, which import, in fleets of their own, the raw material necessary for their industries; and docks into which the largest ships in the world can be taken for repairs.

The total length of the river, from its sources in the Baw Baw Mountains to its mouth at Williamstown, is 90 miles; and the basin, if the Saltwater river be included, nearly 4,000 square miles.

The **Saltwater** river rises near Mount William, flows due

south, and falls into the Yarra Yarra about half a mile from its entrance to Hobson's Bay. Its principal affluents are on the right bank. Among them, the Emu Creek, from Alexander's Crown, with its tributary, Jackson's Creek, from the westward, is the only one deserving of notice.

The **Werribee** rises in the Dividing Range, between the Blue Mountains and Mount Blackwood. Its principal tributaries are—on the left, the Lerderderg ; on the right, the Parwan Creek. After a course of 56 miles, the Werribee reaches Hobson's Bay near Point Cook.

Little River rises in the Stieglitz spur of the Dividing Range, and at Kirk's Point falls into Hobson's Bay.

The **Barwon** has its heads in the highlands north-east of Mount Sabine, about 25 miles distant from Cape Otway. It flows north-east to its union with the Yarrowee, which comes from the Dividing Range north of Ballarat. From the junction it takes an easterly direction till it receives the Moorabool.

The **Moorabool** rises in the Dividing Range, near Mount Stieglitz, and at about 20 miles from its source is joined by the Western Moorabool, with its affluent, the Lal Lal, from the Creswick Ranges. It flows due south, without receiving any other tributaries, to the picturesque spot where it joins the Barwon. The Lal Lal Falls, on the Lal Lal river, are very beautiful ; and in many places scenes of peaceful beauty meet the eye of the traveller along the banks of the Moorabool. The rivers join 3 miles north of Geelong, and the united waters reach the sea at Lake Connewarre. The length of the Barwon is 75 miles ; of the Moorabool, 56 miles ; and the basin about 2,000 square miles.

The **Curdie** starts in the Stony Rises, near the singular Lake Purrumbete, and, after a south-westerly course of 40 miles, falls into the ocean at Curdie's Inlet.

The **Hopkins** rises in the Pyrenees, 4 or 5 miles north of

Mount Ararat, and near Mount Warrnambool receives the Emu Creek from a more easterly point of the Pyrenees. The Hopkins, after a course of 130 miles, reaches the sea at Warrnambool Bay. Its basin is not easy to estimate, for the right bank has a watershed of only a few miles width, whilst the Emu Creek flows through a country studded with small salt lakes, which form a number of inland basins. The largest of these is Lake Bolac, the recipient of the Fiery Creek.

Between the Hopkins and the Glenelg are the **Merri, Moyne, Shaw, Eumerella, Fitzroy** (with its beautiful affluent, Darlot's Creek), and the **Surrey** rivers.

The **Glenelg** rises between the Serra and Victoria Ranges, and flows north-west through the "gap" till it reaches the highland lying between the Grampians and Black Mountains. Here it turns south-west, and, in a sinuous westerly course, passes the pretty town of Harrow, where it is a large and deep stream. About 100 miles from its source it suddenly bends south, and, preserving its character for sinuosity, flows past Casterton and several small townships to 38° S. lat. A few miles south of this point it suddenly bends west for 20 miles, and in an S-shaped curve reaches the ocean at Discovery Bay. Its principal tributaries are Mather's Creek, and the **Chetwynd, Wando, Koroite, Wannon,** and **Crawford** rivers.

Of these, the **Wannon** deserves special notice. It draws its sources from the eastern slope of the Serra Range, and upon passing between Mounts Abrupt and Sturgeon, at the extreme south of the chain, it describes a semicircular course until it receives the waters of the Grangeburn. About 11 miles before the junction it passes over the Cascades of Nigretta, which are surpassed in beauty by the Wannon Falls, 6 miles lower down. Here, in one bound of 105 feet, the river falls into a seething cauldron of great depth, and

then winds away among the hills in a series of charming bends. In the winter, when the river is high, the scenery of Redruth is unequalled in the colony.

The Wannon is 95 miles long; the Glenelg is 230; and the joint basin drains an area of 4,500 square miles.

The **Murray** rises in the Australian Alps at Forest Hill, and for many hundred miles forms the boundary between New South Wales and Victoria. For 60 miles it flows meridionally in a clear, cold, limpid stream, between precipitous banks of rock, as far as the 36th parallel of latitude. As the infant stream passes through the "Murray gates" it is flanked on both sides by walls of rock, 3,000 feet high. At 36° S. lat. it flows north-east to the western frontier of Victoria as a great river, and yet possessing all the characteristics of Australian streams—it is sluggish, sinuous, dark watered, fringed with trees, and depending for its supplies on the fall of rain. In 139° 40′ E. long., encountering the highlands east of the Eastern Mountain System of South Australia, the river suddenly alters its course, and flows due south to Chucka Bend, and thence into Lake Alexandrina. The length of the Murray from Forest Hill to Lake Alexandrina is variously stated. It is about 870 miles, if estimated in straight lines drawn between its chief points of flexure; but along the river bank it measures from source to mouth 1,400 miles. It is navigable for steamers of light draught for 500 miles, and is joined by many tributaries, which are also navigable. It will be necessary to give detailed accounts of these in the following pages, in the study of which the reader will become acquainted with a great number of interesting facts regarding the great interior.

The list of the right-bank tributaries begins with a number of creeks, rising in the Great Dividing Chain. Of these the principal are the Murray, Kancobin, Swampy Plain, Spring Flats Creeks, and the Tooma river, in the first 60

miles. The Gingellee, Bowna, and Major's Creeks join it in the north-easterly portion of its course to Tocumwall.

The **Wakool**, probably an ana-branch of the Murray, is formed at Deniliquin by the junction of several creeks rising close to the right bank of the Murray. It flows north-east, and receives the Merrang, an affluent of the Murray, from the south ; and the Neimur, with its affluents, the Cochrane, and Bigyare creeks, from the north. About 12 miles before falling into the Murray it forms a junction with the Edward.

The **Edward** also rises at Deniliquin, and is immediately connected with the Wakool by the Cochrane and Bigyare. On its right bank its affluents are the Billabong and Box Creeks.

The **Billabong** rises in two branches, one from Kyambra, and the other from Mount Pleasant, both in the county of Goulburn. It receives from the Murrumbidgee an affluent, which divides into the Colombo and Yanco Creeks. Upon the union of the Yanco at Conargo, the Billabong is often called the **Moulamein** Creek.

The **Box** Creek, after receiving the Euleurie Creek from the Old Man Plain, joins the Edward 12 miles lower down than the Moulamein. All the country situated to the south of the Edward and its affluents is low, level, and destitute of permanent water. In winter and spring the grass on the eastern and central parts is abundant, but during the summer it is all parched up by the long-continued solar heat. Between the Edward and Murrumbidgee the country is of the same character ; the Old Man Plain, lying between the Yanco and Euleurie Creeks, being entirely destitute of water storage.

The **Murrumbidgee** rises at Mt. Murray, and, flowing south, receives numerous short rapid streams from the Maneroo and Gourock chains ; of these we may mention the

Wambrook, Stacks, Cooma, Kybeyan, Umaralla, Naas Valley, and Cudgenby creeks. Near its junction with the Umaralla it turns, and going due north, emerges from the high ground upon receiving the waters of the **Cotter**, from the eastern slope of Mt. Murray. It continues its northerly direction to its meeting with the Yass, whence, in a direction generally west, it flows into the Murray at the township of Weimby. Its principal affluents on the left are—the **Goodraligbee**, from the northern slope of the watershed in which the main stream rises ; the **Tumut**, from the Muniong chain ; and the Adelong, Tarcutta, Kyambra, and Pulletop creeks.

The country along the Murrumbidgee—or "Beautiful River," as the native word implies—is picturesque, and of fair quality ; but the Tumut traverses finer land, suitable for agriculture as well as pasture. Its waters flow into the Murrumbidgee almost as cold as when they left their mountain-fastnesses. From the Tumut to the meridian of Conargo there is excellent pasture land, and not a few patches adapted to farming, especially along the Billabong.

The Murrumbidgee is 1,350 miles long, and is navigable as far as Gundagai. The tributaries on the right bank are the Yass, Cunningham's Creek, and the Lachlan.

The **Yass** rises west of Lake George, 2,129 feet above the level of the sea, and suddenly falls 800 feet into the Yass Plains, a mineral-producing area with few fertile spots.

The **Cunningham**, or **Jugiong Creek**, issues from a range forming the southern watershed of the Bland, and discharges its waters into the Murrumbidgee at a township of the same name.

The **Lachlan** rises 15 miles to the north of Lake George, and flows parallel with the Cullarin Range to its junction with the Abercrombie, from the Blue Mountains. On the left it receives the Boorowa, Crowther, Bland or Yeo Yeo, and Yuglo.

The **Boorowa** runs through a mineral district, the Crowther through an agricultural district. Between it and the Yeo Yeo, which flows through Lake Cowal, is a gold district, which, from the recent discoveries at Temora, seems to be rich in the precious metal. West of the Yeo Yeo, to the 147° E. long., is good land; and, further west, poor, level, sandy country, intersected by the Cocoparra Ranges, and destitute of water. The right bank affluents are the Abercrombie, Belubula, and Goobang.

The **Abercrombie** rises in the Blue Mountains, and flows due west; the **Belubula** issues from the northern part of the Macquarie Range, and, flowing through country of a varied character, reaches the Lachlan near Canowinda.

The **Goobang** takes its rise in the southern point of the Hervey Range, and, flowing almost parallel to the river, joins it at Condooblin, through a narrow strip of good pasture land, which continues as far as the Willandra. The Willandra flows towards the swampy country south of the Culparlin Range, as an affluent of the Lachlan, from 146° E. long., and finds an outlet in the Carnpung Swamp. Between it and the Lachlan, Murrumbidgee, and Murray, there is much pastoral land along its banks, stretching out towards the south-west into plains covered with box.

The **Darling** or **Barwan**, the longest affluent of the Murray, has its sources in the New England Range, a little to the north of 30 S. lat., as the **Macintyre**. It is joined by the Severn near its rise; and, flowing nearly due north, receives the name of Barwan or Darling upon its union with the **Dumeresq**. The Dumeresq is formed by the union of the Mole and Severn—both coming from the New England Range—and 50 miles below Inglewood receives the united waters of Brachers, Treverton, Macintyre, and Mosquito creeks. Upon its junction with the Dumeresq the river flows south-west to the point where it meets the

Namoi—thence due west to Bourke—thence south-west to Menindie ; from this township it runs almost due south into the Murray at Wentworth. The length is 1,160 miles, and it is navigable as far as Bourke. Near Bogabilla the Whalan leaves the main stream, and, uniting with the **Gilgil,** rejoins the river 148° 45′ E. long.

Its affluents from the left are the Gwydir, Namoi, Castlereagh, Macquarie ; and Bogan.

The **Gwydir** rises near Uralla, in the New England Range; and, in its course of 445 miles, receives the Macintyre creek and Horton river from the Hardwicke Range ; and the Weah Waa and Coorallie from the Drummond Range. Its whole course is through the northern coal measures.

The **Namoi** rises, as the Peel river, in the valley between the Peel and Liverpool Ranges, and, flowing nearly north, drains by its left affluent—the Conadilly—the rich Liverpool plains. A little nearer to its source it is joined by the **Muluerindie,** which rises in the Moonbi Spur of the New England Range, and flows north to the Hardwicke. Deflected by this range it bends west, takes up the Manilla from the rich lands about Nundewar, and, flowing south, reaches the Namoi. The remaining affluents of the Namoi are the Turrabeile, Brigalow, and Baradine creeks, which flow through fairly-grassed champaign country. The length is 600 miles.

The **Castlereagh,** 365 miles long, rises north of Mt. Exmouth, 3,000 feet high, in the north-west spur of the Liverpool Range, and receives—on the left, the Oakey, Merrygowen, and Moolma creeks ; on the right—the Bandalla, Wallamburrabong, Baronne (from the Baronne plains), Coonamble, and Maraba. The country from Breelong, where the northerly stretch of the river begins, is of admirable character as regards both soil and water.

The **Macquarie,** a very fine stream, issues from the

Macquarie Range, about 50 miles south of Bathurst, and before arriving at this prominent town receives the Fish river at Meadow Lea. Debouching into the Bathurst table-land—2,200 feet above the sea level—it is a noble river, occasionally fringed with swamp oaks, and winding in graceful curves through a district bounded by densely wooded hills standing out clear in a generally cloudless horizon. From the right it receives the Turon, Cudgegong, and Trabalgar or Erskine, from the Liverpool Range, and, after falling over the Macquarie Cataract into the low-lying country, the joint waters of the Merri-Merri and Martaguy creeks. On the left are no streams during the early part of its course, but upon approaching the Darling, an affluent—the Mara—draws a large bulk of its waters into a more westerly point on the main stream. Some are inclined to think that the Macquarie is changing its course into this affluent. The land in this neighbourhood is patchy—in parts, good enough for agriculture ; in parts, lightly timbered and grassed ; and, near the Mara outlet, swampy.

The **Turon** rises in a number of creeks rushing down from chasms in perpendicular cliffs, and is 130 miles long, and in consequence of its width is quite deserving of the title of "river." The Cudgegong is most interesting in consequence of its passing through the centre of the Mudgee tableland, a perfect circle, with a circumference of ranges 1,500 feet high and 20 miles round.

The Trabalgar, or Erskine, takes its rise in the Liverpool Range, by which its waters are separated from those of the Goulburn. It is joined by the Coolaburragundy at Danedoo, and thence, through a coal country, reaches the Macquarie at Dubbo.

The **Bogan** rises in 33° S. lat. in the Hervey Range, and flows through country suitable for pasture only ; indeed, in some parts its course is through a red sand without grass or

other water. It flows for 450 miles in a northerly course to meet the Darling in Oxley's tableland—30° S. lat. Its affluents are—on the right, the Tomingley, Gunningbo, and Duck Creeks; and on the left, the Tongodo and Bullock Creeks.

The northern tributaries of the Darling are—The Dumeresq, Weir, Moonie, Bochara, Culgoa, and Warrego.

The Dumeresq has been already described. The **Weir** issues from the Great Dividing Chain near Mount Domville on the north, and is joined by the Cormoran Creek from the south of the same peak. The **Moonie** rises a little to the north of the Weir in the same range, and is separated from it during its whole length by a low watershed. Both rivers fall into the Macintyre near the northern boundary of New South Wales.

The **Bokhara** leaves the Culgoa at the township of St. George, and falls into the Darling at Mt. Druitt. Two effluents leave it about 15 miles from St. George; the left effluent—the Narran—is lost in the Narran Swamp; the right effluent—the Ballandoon—joins the Culgoa under the name of the Birie river.

The **Culgoa** is formed by the union of the Balonne and Maranoa.

The **Balonne** rises as the **Condamine** in the Macpherson Range near Mt. Wilson, and flows north-west, receiving from the left the Thames and Canal creeks; and from the right, the Dalrymple, Clifton, Hodgson, King's, Oakey, Myall, Middle, Jimbond, Gooranga, Chindulla, and Charley's Creeks from the Bunya Bunya. On receiving the last named affluent it is deflected west by the Dividing Chain proper, and upon reaching 150° E. long. is called the Balonne. From this point to its junction with the Maranoa it receives the Undulla and Murilla—two short watercourses on the left; and on the right is joined by the Dogwood, Uleba, Wallumbilla, Bungil, Yalebone, and Coogoon.

The **Maranoa** rises at Mt. Ogilby, not far from the sources of the Warrego, and about 100 miles from its source is joined by the **Merivale** from the Carnarvon Range. Both rivers are exceedingly sinuous, and are supplied by numerous small creeks on either bank. The junction is effected north of Mt. Kennedy, and thence the Maranoa flows south, taking up the Amby Creek, to meet the Balonne.

Upon the union the stream is called Culgoa. Its anabranches are the Bokhara and Ballandoon or Birie. It joins the Darling in the low-lying level land north of Oxley's tableland.

The length of the Colgoa is 600 miles. In the northern bend of the Condamine are the Darling Downs, and between the Balonne and Culgoa are the Fitzroy Downs. The **Darling Downs** are described by the Melbourne Exhibition (1880) Commissioners in the following terms:—"Although on the western side of the watershed of the Main Dividing Range, the Darling Downs enjoys many of the advantages of the coast districts. The atmosphere is fairly charged with moisture, and the rainfall frequent; running streams are numerous, and the high average fertility of the soil has gained for it the name of the 'Garden of Queensland.' Agricultural settlement has made considerable progress in this district, especially in the western portion of it, and several large and important towns, as Toowoomba, Warwick, and Dalby, have grown up as centres for the pastoral and agricultural population."

The graziers find the Darling Downs equally suitable for sheep or cattle, and the climate and natural pasturage are of the kind that suits either the merino, or larger framed, coarser sheep. The sharp winter frosts, however, debar the agriculturist from attempting the cultivation of tropical plants or trees; but, on the other hand, they enable him to cultivate with marked success all the products of the tem-

perate zone. There is reason to hope that this will become a great wheat district.

The **Fitzroy Downs** supplies excellent food for sheep and cattle, but is neither sufficiently rich nor well watered for agricultural pursuits.

The **Warrego**, the last tributary of any importance, issues from the Buckland tableland in two streams, the Channin and Dooloogarah, and before its junction with the Nive is increased from the left by the waters of the Hogonthulla, Augethella, and Yo Yo. The **Nive**, rising near Mt. Hutton, reaches the Warrego a few miles south of the Yo Yo ; and the united waters of the **Ward** and **Yanglo**, from the Warrego Ranges, enter it at Charleville. Below this township it is met by the Angellala from the Brunell Ranges. The Warrego enters the Darling south-west of the prosperous town of Bourke, which steamers of light draught can reach without difficulty. The Warrego is 500 miles long.

Between the Maranoa, Culgoa, and Warrego are the Wild Horse Plains, forming a small inland basin supplied with two creeks, the Mungallala and Wallam. Of this district the authorities already quoted say :—"As a rule it is all open ; there is very little of what is known as 'forest.' Enormous plains stretching to a vanishing point on the horizon, or undulating downs, over which—from an elevation —the eye can range 40 or 50 miles without a check, and the whole sheeted with grass or nutritious herbs."

The **South Rhine** enters the Murray from the east of South Australia, about 45 miles below the North-West Bend.

Returning once more to the great river itself, we have on its left bank the Mitta Mitta, Kiewa, Ovens, Goulburn, Campaspe, and Loddon.

The **Mitta Mitta** rises in the Bowen Mountains, and flows due north through the wild and charming scenery of the intricate ranges. It receives the Snowy and Tallangatta

creeks, and, after a course of 100 miles, reaches the Murray 8 miles east of Albury.

The **Kiewa** rises in the Diamentina Spring, near Mt. Hotham, flows past Towanga Peak, and after a northerly course of 100 miles reaches the Murray at Wodonga.

The **Ovens** rises in the Barry Mountains, and has a north-westerly course of 100 miles. It is joined by the Buffalo river, rising in Mt. Cobbler, in the Buffalo Range, about 7 miles north of the Buffalo Peak; and from near Mt. Howitt by the King, which falls over a precipice of 200 feet in its descent from its rocky cradle. It joins the Ovens at Wangaratta.

The **Goulburn** rises in the Great Dividing Range at Woods Point, and flows north-west into the Murray about 6 miles from Moama. For nearly half its length it is a fine stream, running through excellent agricultural country, with grassy banks, and a bed so deep that it is easily navigated; and thereby supplies the western goldfields of Victoria with excellent water carriage. Its principal affluents are—The **Black River**, which forces its narrow and gold-bearing course through almost impenetrable country; the **Howqua**, which rises also near Mt. Howitt, and, after a course of 20 miles, joins the Goulburn 9 miles from Jamieson; the **Delatite**, which issues from the Dividing Range at Mt. Buller, and joins the Goulburn on the border of Anglesey; the **Broken River**—120 miles long—which rises near Wombat Hill, at no great distance from its affluent, the Holland, and reaches the Goulburn 2 miles below Shepparton. From the Dividing Range, north of the Black Spur, it receives the **Acheron**; from the Hume Range, the King Parrot Creek; and from Mt. William, the Kur-Kuruc and Mollison Creeks. The Goulburn is 250 miles long, and drains an area of 6,500 miles.

The **Campaspe** issues from the Great Dividing Range,

between Macedon and Trentham, and flows almost due north into the Murray at Echuca. Though it receives numerous small creeks and watercourses, it has two important affluents only—on the right, the **M'Ivor Creek**, with its tributaries, the Mt. Ida and Wild-duck Creeks ; and on the left, the **Coliban** River, from the Great Dividing Chain, at Jeffries Forest, near Newburn. The Coliban joins the Campaspe about 60 miles south of Echuca. The length of the Campaspe is 120 miles, and the basin 3,000 square miles.

The Loddon, last on the list of the great affluents of the Murray, rises in a low watershed, forming the dividing range between it and the Coliban. It flows in a north-north-west direction for 250 miles, and receives numerous small affluents, of which the Deep Creek, 65 miles long, is the longest. Its basin is 4,800 square miles.

With the Loddon ends the long list of the tributaries of the Murray. By estimating its length from the source of its remotest tributary—the Macintyre—we reach the large figure of 1,510 miles, with a drainage basin which may be estimated at 500,000 square miles. These noble proportions are in themselves sufficient to claim for it a place among the giant streams of the world ; and as we look on the map portraying its numerous ramifications, we are at once struck with its likeness to the Amazon. But the comparison can be carried no further ; for as the giant Andes surpass in grandeur, elevation, and extent our Pacific system, so the mighty river which rolls its rushing waters from its cañons into the virgin forests of the Selvas dwarfs, in our estimation, the stream which forms, notwithstanding, the most striking feature of Australian geography.

What the future of this river may be it is difficult to foretell. Its insignificant entrance to the sea, its lack of depth, its ill-regulated supply of water, and its interminable windings seem to dispose of its claims to commercial importance,

and to doom it to become little more than a waterway for the townships on its banks. But for many years it has been pointed out that, in the hands of capable men, it can be converted into a great medium for irrigation.

The Murray and its great tributaries are admirably suited for an extensive scheme, which, though it must cost millions, would be effected at small expense when compared with the enormous advantages to be gained. If the Murray can never be a Thames, bearing on its bosom the fleets of the world; nor yet an Amazon, baffling human skill in curbing its fertility, may it not be a Nile, pouring its beneficent waters over our rich lands, tempering the heat of our summer months, and inviting to our shores the weary toilers of Europe, who may happen to hear of the new Land of Promise.

The remaining rivers of the Southern Ocean System are—the **Torrens, Gawler, Light,** and **Wakefield,** flowing, with short courses, into St. Vincent's Gulf; the **Broughton,** flowing into Spencer's Gulf; the **Pallinup,** into Beaufort Inlet; the **Kalgan,** into King George's Sound; the **Hay,** into Radcliffe Bay; the **Franklin,** with its affluent, the Gordon, into a small lake on the coast; and the **Blackwood.** The latter rises in the Norcott Plains as the Arthur, which is joined by the Hilman from the west, and the Beaufort and Balgarup from the east. As the Blackwood it flows west-south-west into Flinders Bay.

3. The Indian Ocean System

Includes all the rivers which flow down the western counterslope. Most of these rivers rise to the east of the coast range, and surpass in length the rivers of the eastern and southern counterslopes; but they are broken, ill supplied with water, and very brackish. The principal are—the

Murray, Serpentine, Swan, Moore, Smith, Hill, Irwin, Greenough, Murchison, Gascoyne, Ashburton, Cane, Robe, Fortescue, Yule, Maitland, Sherlock, De Grey, and Fitzroy.

The **Murray** is formed by the junction of the Hotham and Williams, which rise in the Carnarvon Hills, and after a course of 140 miles falls into Peel's Inlet.

The **Serpentine**, from the Dividing Range, flows into the same inlet.

The **Swan**, formed by the united waters of the Dale and Avon, flows north-west, receiving the Mortlock from Cubbine Hill, until it reaches Newcastle, where, bending south-west, it flows for some distance and enters the ocean by a large estuary. The only tributary during the latter part of its course is the Helen. Its length is 150 miles, its depth from 2 to 3 fathoms, and its width in the first and second reaches about 100 yards.

The **Moore** rises in the Wongan Hills, on the western extremity of the Victoria Plain, and enters the ocean south of Cape Leschenault.

The **Smith** and **Hill** rise in the Smith Range.

The **Irwin** rises in the Murdalyou Range, receives the Lockier on the left, and enters the ocean at Dongara.

The **Greenough** rises in the Wallala country, and, after a south-westerly course of 160 miles, reaches the ocean at Champion Bay.

The **Murchison**, issuing from the highlands north of Mt. Seabrook in the Glengarry Range, falls into Gantheaume Bay. During its course of 400 miles it receives the Impey from the Weld Ranges, and the Sandford from the Nicholson Range.

The **Gascoyne** has its sources north of the Robinson Range, and flows due west to the Adam Plains. Here it describes a deep northward curve towards the Lockyer Range, and, flowing between the Kennedy and Lockyer Ranges, resumes

its former direction, takes up the Lyons from Mt. Labouchere, and, after a course of 400 miles, falls into Geographe Bay.

The **Ashburton**, 550 miles long, rises in a very broken stream at the edge of the Desert, and, flowing nearly northwest enters the ocean above Exmouth Gulf.

The **Fortescue** collects its source waters from a number of bold rocky heights, 4,000 feet high, near Mt. Samson, and reaches the ocean at Point James. Its length is 240 miles.

The **Yule** rises in the Strelley Range, and flows nearly due north into the ocean at Cape Thonin. It is supplied with permanent water.

The **De Grey** starts from the Rippon Hills, and flows north to meet the **Oakover**. From this point it flows due west into the ocean, into which it discharges its waters by two mouths, forming the Rippon Delta, a marshy, unwholesome island. Its length, estimated from the sources of the Oakover in a range of granite hills, is 200 miles, and its only affluent is the Shaw watercourse.

The **Fitzroy** rises in the **Leopold Ranges** at Mount Leake, and after a short southerly course receives the **Margaret** from the Mueller Range. The rivers unite in the Oscar Range, and flow thence to the ocean in a strong clear stream. A. Forrest, who traced this stream in 1879, estimates its length as 240 miles, and states that "The country on each side of the Fitzroy, from its mouth to 17° 42′ S. lat., running from 10 to 30 miles back from the river, is well grassed and suitable for sheep, cattle, and horses. It is, however, very liable to floods, the whole of these magnificent plains being frequently under water during the rainy season, which lasts from December to March." In his geological report he states that the banks are for the most part well-wooded slopes, readily accessible for watering cattle,

although in some places the river forces its way through almost perpendicular cliffs. The mouth is 200 yards wide; and Mr. Forrest continues his very interesting narrative by saying that—"Assuming that the entrance of the river presents no obstacle, the Fitzroy would, I believe, be found navigable for small steamers for at least 100 miles upwards from its mouth." Captain Wickham made a boat excursion up this river in 1837. His companion, Captain Stokes, describes the mouth as very wide, and closed by a sandbar, which at high water becomes a series of mangrove islands. At a short distance beyond the river contracts to the width of a mile, and is studded with low grassy islets which leave narrow channels, only passable for boats. Further inland the stream widens out to a breadth of 500 yards, and, though daily visited by the tide, is fresh water. From the report of Captain Stokes, the Rev. J. E. Tenison Woods, a geologist to whom Australia owes much, concluded in 1864 that about 200 miles from the mouth there would be found a high basaltic range or tableland, with fertile intervening country, fit for settlement. The discoveries of Forrest have proved the soundness of the geologist's speculation.

4. The Pacific North Coast System

Includes all the rivers flowing into the Arafura Sea and Gulf of Carpentaria. They are long, broad at the mouth, plentifully supplied with permanent waters, and most of them navigable for many miles. Some of them are not yet explored—of some nothing but the estuaries are known; the geographer, therefore, has an unsatisfactory task before him in attempting to describe them.

Their names are—The Victoria, Fitzmaurice, Daly, Adelaide, Margaret, West Alligator, South Alligator, East Alligator, Liverpool, Roper, Limmens Bight, Gregory,

Leichardt, Albert, Flinders, Norman, Van Diemen, Staaten, Mitchell, Archur, Cowen, Batavia, and Jardine.

The **Victoria** rises in 18° S. latitude, and is broken in the early part of its course, until it receives from the left the united streams of the **Wickham** and **Humbert**—the latter probably from the Connaught Ranges. At the point where Forrest crossed the Wickham it is 600 feet wide. From the source of the Victoria to the bend, caused by Bynoe Range running at right angles to its northerly course, it is 140 miles long. After its westerly deflection it receives from the left the Shaw or Bain, which drains the area between the Murchison and Newcastle Ranges; and from the right, the Shaw or Bitter Creek. It falls into the ocean at Queen's Channel in a broad and beautiful estuary, 13 miles wide, and from 6 to 9 fathoms deep. The estuary of the river is frequently visited by a Bore—a high wave formed by the tide—which ascends the stream with suddenness and velocity, and renders navigation very difficult. The total length is 350 miles.

The **Daly** rises in a low, thickly-wooded ridge, about 16° 30′ S. lat., and, after a course generally north-west, discharges itself into Anson Bay. Not far from its source it receives the **King**, rising near the Roper watershed, in country permanently watered, with fine lagoons and good grass. Not far from its junction with the King it takes up the Flora from the east, and, 40 miles further north, the **Katherine**, rising probably in the unexplored country north of the Chambers Range. The crossing of the Katherine is stated by Giles to be 500 yards wide from cliff to cliff, and 90 to 100 feet deep at floodwater, and at the driest season not less than 150 feet wide. The land on either side is a magnificent chocolate clay, with occasionally lighter soils, luxuriantly grassed.

Within the watershed of the Daly and Adelaide is the

little river of the **Darwin**, which rises in the Daly Range, and at Southport is 200 feet wide ; its low banks are clothed down to the water's edge with trees, and as each jutting headland is passed the reaches widen more and more into a very beautiful estuary.

The **Adelaide** rises in the broken highland north of the Daly, and debouches into Adam Bay. Its banks for the last 50 miles are low, fringed to the water's edge with mangroves and giant bamboos 80 feet high. As the source is approached the banks rise often to a height of 25 feet, and are destitute of vegetation. At Adam Bay the Adelaide widens out to a mile in breadth, and is many fathoms deep. It is easily navigated by vessels of 500 tons for over 40 miles. Its principal tributaries are the Howley and the Margaret.

The **West, South,** and **East Alligator** rivers have only been explored from the sea. They receive their names from the enormous number of alligators—or, more properly, glavials —which infest them. Near the sea it is impossible to effect a landing, in consequence of the forests of mangroves which line the banks. The entrance to the South Alligator is 4 miles wide, and at 36 miles from the source there are 6 fathoms of water. The breadth of the East Alligator, at 8 miles from the mouth, is 200 yards. The immediately adjoining country is flat, but numerous hills may be seen along its course.

The **Liverpool** rises in unexplored country, and has been traced for its last 40 miles only. At 18 miles from the mouth the water is fresh and deep. Mangrove forests fringe its banks. At its mouth is Entrance Island, a low mud bank, covered with the ever-prevailing vegetation.

The **Roper** has its source waters in the Chambers Range, 3 miles from those of the King, and flows due east into Limmens Bight. On its right bank are the **Birdum** Creek and **Strangways** river ; and on its left, the **Chambers**. The

Birdum is a broad shallow valley from Stuart's Swamp, and runs north 100 miles to join the **Elsie**, which, as a stream with a strong wide current, flows through vast paper bark swamps. In the rainy season the valley of the Birdum is inundated with flood waters for a width of 4 miles, and an alluvial mud is deposited, in which grows a native rice, somewhat smaller than the common grain, and with a black husk. Near Daly Waters the land is splendidly grassed. About 30 miles from the sources of the Roper is the Bitter Spring—an immense volume of water issuing from under a ledge of limestone rock on the right bank. The channel of the spring is 3 feet wide, and of great depth, overhung by a thick growth of corkscrew palms, which give to the scene an extraordinary beauty. The Roper is at least 200 miles long, and is navigable to Todd's Bend.

The **Chambers** rises probably in the same watershed as the Alligator rivers, and runs, as far as is known, through open country until it approaches the Roper. Here it is very tortuous, and hidden from view by deep fringes of palms and canes.

The **Gregory** rises to the north of the Barkly tableland on the Queensland frontier, and receives from the west the Nicholson, and from the south the O'Shanassy. The **Nicholson** equals the main stream in breadth, depth, and volume of water. The O'Shanassy rises near the Manning Plain, and flows north-east in a succession of fine reaches.

The **Albert** is a short river, separated from the Gregory by a narrow strip of highland. It flows through the Plains of Promise. These plains have been described by the early explorers as of fabulous richness, though of limited extent. At 25 miles from the mouth the water is fresh, the country well grassed, palms abundant, and the banks bear traces of frequent inundations. At 5 miles from the mouth the land is low ; numerous creeks flow into and out of the main stream.

The entrance is barred by a sandbank, which may be crossed at high water. Within the bar the river is 350 yards wide and 30 feet deep.

The **Leichardt**, next in importance to the Flinders, runs, after a due north course of 200 miles, into the Gulf, 10 miles east of the Flinders. It is deep, broad, and rapid during the latter part of its course, and about 30 miles from the mouth is a fine fall, 40 feet high, over which the water rolls in great volume into a vast basin.

The **Flinders** has its sources in a group of hills extending from Mt. Emu on the north to Walker's Table Mountain—a vast basaltic plateau—on the south. It has a northerly course of 400 miles, during which it is joined from the east by the Dalton, Stawell, and Saxby.

A southern affluent, the **Cloncurry**, rises in the Selwyn Range, in some splendid water-holes, 1,050 feet high, at Mt. Forbes. It is joined by the Gilliat from the M'Kinley Range, through flooded country, fairly timbered and well grassed. An ana-branch, the Dugald, leaves the Cloncurry 60 miles north of the copper mines, and rejoins it after a course of 60 miles.

The Flinders, along the Hervey Downs, has a flat sandy bed, clear fresh running water, and fertile banks seldom relieved by timber. In parts the scenery is very beautiful, especially at the basaltic hills near its source, where the river is 120 yards wide. At 50 miles from its mouth the **Bynoe** leaves it, forming a low delta, often flooded. It was here that Burke and Wills, after floundering through the flooded flats in the vain attempt to reach the mouth, were forced to turn their faces south and begin their disastrous return.

The **Norman** rises in some fine springs a few miles south of Morphett's Peak, and is separated from the basin of the Flinders by high ranges. The country is dismal, sandy, and

occasionally flooded. At Normanton it is joined by the Green Creek, from poor, scrubby country, and thence flows to the sea in a wide, deep, tortuous channel. Its length is 300 miles.

The **Van Diemen** is formed by the union of the Gilbert and the Einasleigh.

The **Gilbert** rises in high, impracticable ranges, "towering in successive ridges of awful grandeur," and is very picturesque to the south-east of Gilberton. It receives from Mt. Bonsey two streams, the one joining it at Mt. Three Peaks, and the other, the Etheridge, at the Gilbert river station.

The **Einasleigh** rises near the Carpentaria Downs station in several creeks; and, before its junction with the Galao Creek, has a magnificent reach 700 yards wide.

Upon the union of these two rivers the Van Diemen flows nearly due west, takes up the Byerley Creek, and falls into the Gulf in a wide estuary.

The **Staaten**, 130 miles long, is a broad stream, subject to heavy floods, and flowing through barren country. It has a large delta, at the point of which the width is 500 yards.

The **Mitchell** rises near Distant Peak, in the East Pacific Coast Range, and flows during its earlier course due west. Upon its junction with the united streams of the Tate and Walsh, from 18° S. lat., it assumes a direction generally north-west. From the right it receives the **Palmer**, rising in the coast range, and flowing through highly auriferous country; and thence, through excellent grazing country, it reaches the Gulf in 15° 14′ S. lat.

The ocean basin ends with the **Archur, Cowen, Batavia,** and **Jardine.**

The rivers flowing into the Gulf are for the most part short, and rise on the edge of the great sandstone tableland which skirts the shore line, and extends for over 1,000

miles from east to west. The rivers described in the foregoing paragraphs are those which rise where the tableland recedes from the Gulf and is intruded into by extensive igneous rocks. Sandstone ridges, with low broad spurs of down-country, form the watersheds on the right and left; these downs slope off towards the rivers' banks in successions of plains, which vary in character from rich patches, such as the Plains of Promise, to very desolate and scrubby country. Upon approaching the sea the ridges disappear; their places are taken by low alluvial flats, subject to inundations, and by mangrove swamps, which become so dense at the mouths as to hide the rivers altogether from the view of even experienced marine explorers.

5. The Basins of Continental Streams.

There are many known inland systems which are wholly cut off from communication with the oceans; and it is highly probable that there are some yet undiscovered basins in the north-western districts.

The rivers of these systems either fall into lakes; or, spreading themselves out over flats, are partly absorbed by the sandy soil and partly carried away by excessive evaporation. They are all, without exception, broken, tortuous streams; falling off as they reach their destinations; lined by tall gums, which are specially luxuriant in the broad reaches; and subject to such heavy floods that they rush over their natural watersheds and unite themselves to adjoining watercourses. The most considerable of these continental basins is Lake Eyre, into which flow streams from Queensland, New South Wales, and South Australia.

The **Barcoo**, or **Cooper's Creek**, rises in 24° S. lat. and 147° E. long. in the highlands from which rise also the

Belyando, Nogoa, and Warrego. From the Warrego Ranges it receives numerous creeks—the Ravensburne, Gowan or Thornleigh, Bullock, and Pemberly. It is a stream of considerable size when it is met by the **Alice** in extensive open plains. At the junction the river takes a south-west course, and at the Cheviot Range is joined by the **Thompson.** The latter has its head waters in the Prairie, Tower Hill (with a beautiful fall 50 feet high), and Lansborough creeks—which rise not far from the sources of the Flinders, in 21° S. lat.—and on the left is joined by 10 distinctly marked watercourses, of which the Aramac is the most considerable; while, on the right it is joined by the Darr, with its tributary the Maneroo, the Catharine, Acheron, and Vergemont. The country on both sides of the Thompson is fine open rolling downs, admirably suited for pasture, and is very beautiful at Bowen Downs Station. Seventy miles further on the Barcoo meets on the right the Whitula Creek from the Beale Range, and thence flows due south to the Macleay Plains. On the left, during this part of its course, an effluent—the Kyabra, leaves the main stream, and carries eastward much of its flood water. At the bend opposite Lake Mackillop the river is broken into several channels—The Tanbar Billabong, Wambundery Channel, Goonagoheengy Billabong, and the main course. At the Macleay Plains the river takes a westward course to near Lake Moolionburrinna, passing on the way Fort Wills and Innaminka, where Burke died. At Innaminka an effluent—the **Strzelecki Creek**—flows to Lake Blanche. From Lake Moolionburrinna to the Moravian Mission Station the course is south-west, and thence due west into Lake Eyre.

The length of Cooper's Creek is 850 miles.

The **Warburton** rises in Sturt's Stony Desert, and, flowing through sand-hill country, enters Lake Eyre at the estuary of the Macumba.

The **Macumba** is formed by the united waters of the Stephenson and Alberga. The **Stephenson** rises in the Anderson Range, and is met by the Hamilton from the Antony Ranges on the west. The united streams flow south, as the Stephenson, to Mt. Alexander.

The **Alberga** has its head waters near Mt. Everard, in numerous creeks, of which the Agnes and Margaret are the most important. It joins the Stephenson at Mt. Alexander, and thence, as the Macumba, the two streams enter Lake Eyre through an estuary 4 miles wide.

The **Neales** rises west of the Hanson Range, in the highlands south of the Macumba, assumes a course generally south-east, and, receiving the Peake, Blyth, and Primrose, enters Lake Eyre at the north-west corner.

The **Davenport** and **Douglass**, from the Denison Range, fall into Lake Eyre on the west. The **Chambers**, from the Turret Range ; the **Frances** and **Colanna**, from the watershed of the Willouran and Hermit Ranges, discharge their waters into Lake Eyre South ; and the Frome, from Mt. Searle, empties its briny waters into the southern extremity of Lake Eyre.

The Diamentina system finds no lake into which its accumulated waters may flow, and, in consequence, spreads them over low-lying tracts dotted here and there with sandhills.

The **Diamentina**, or **Mueller River**, rises in the M'Kinlay Ranges, not far from the sources of the Gilliat, and, flowing east, encircles Kerr's Tableland, from which it receives the Crescent, Ada, and Saville Creeks. From the high open downs country west of Mt. Munroe it is joined by the Wockingham Creek, and the Western river, which rises in the Mills, Jassamine, and Oondaroo Creeks. The course of the Diamentina, or Mueller, is south-west from Kerr's Table Mt. to the frontier of South Australia, where it is lost in the

flats. Beside the affluents already mentioned are the Mayne, on the left; and the Muckunda, Spring, and Nyama Creeks, on the right. The length is 500 miles.

On the left of the Diamentina, or Mueller, and connected with the same basin, is **Farrar's Creek**, which rises in the Slattery, Boolooroo, and Portia creeks. After passing the Thomas Range the Farrar widens out into a broad shallow stream, and maintains this width till it unites in floodtime with the Congabulla.

On the right of the Diamentina is the **Herbert**, from the highlands south of the O'Shanassy. The affluents are—on the left, the **Burke**, formed by the union of numerous creeks from the Selwyn and Standish Ranges; and the **Hamilton**, from the M'Kinlay Range; and, on the right, the James, **Rankin**; and **Manners**, formed along the South Australian frontier by the union of many creeks. Sixty miles from its termination, the Herbert joins the **Eyre** or **Mulligan**, coming from the north, and the joint waters are lost in the Diamentina basin. The Herbert is 560 miles long. The whole of the country in the neighbourhood of the Herbert consists of well-grassed downs, stony in parts, and slightly timbered. In many places the country assumes a richer aspect, consisting of rich alluvial plains magnificently grassed. There is a plentiful supply of water in the rivers and creeks; and many large and permanent waterholes, deserving of the name of lakes, are dotted over the landscape.

Between the Herbert and Diamentina the country on the north is open, high, and well grassed, with here and there patches of the odious spinifex. On the south it is dry, sandy, and subject to floods; and, where the waters of the rivers unite, are sandhills, with box flats between, and flooded polygonum low-lying lands.

Between the Diamentina and Thompson high open downs prevail, well grassed, with a fair supply of water in the

creeks. But towards the south Farrar's Creek divides the country into two distinctly marked areas. The area between the Diamentina and Farrar is splendidly grassed, with fine timber; whereas the area between the Farrar and Thompson is sandy, and subject to heavy floods.

Between the Alice and Cooper's Creek, or Barcoo, the land is of excellent quality; well-grassed open plains, with occasionally highly timbered tracts and open rolling downs. Between the Belyando and the Thompson is a well-defined watershed, on the sandstone peaks of which a poisonous plant abounds. Downs country prevails between the Barcoo and the Thompson; and, below their junction, flooded lands with sandhills. From the final bend of the river to Lake Eyre the land is very poor; low, barren flats alternating with cane-bush-covered sandhills and flooded country.

Between the Grey and Macgregor Ranges is the little system of the **Wilson**, which in heavy floods receives from the Barcoo, or Cooper's Creek, a large supply of water through the natural canal of the Kyabra. It receives from the Macgregor Range the Cinnapapa, Nundramundoo, and Kayee Creeks; and in Roan's Plains spreads out over the flats.

East of the Wilson, and parallel with it, the **Bulloo** or **Coorni Paroo** rises east of the Cheviot Range, and receives—on the left, the Gumbardo, Blackwater, Wombadulla, and Beengalla; on the right, the Mobile. After a course of 300 miles it disappears in the extensive overflowings of the Bulloo Lake and Coryapundi Swamp.

Fifty miles west of the **Bulloo** is the **Paroo**, which rises in 26° S. lat., near the Warrego. It flows south-south-west, taking up in its course the Queelberry and Mirra Paroo, on the left; and the Bechel, Yowya, and Boorara, on the right. It is lost in overflowings to the east of the Cadell Range. The length is 350 miles.

The **Frome** basin in South Australia receives a great number of streams, the largest of which is the **Siccus**, rising in the south, and receiving the Passmore from Pt. Bonney.

The **Blanche** and **Gregory** basin is north of the Frome, and receives the Strzelecki Creek, already noticed, the George, and numerous others.

The basin of the Finke includes the **Finke** river and its affluents. The Finke rises in the high plateau of the Macdonnell Ranges near Mt. Giles, and at a few miles from its source it is met by the Rudall Creek. Its course is due south through the charming Glen of Palms. Issuing from the glen, it flows south-east in a very sinuous course, and at Briscoe's Pass is joined by the Palmer. The **Palmer** rises in the Krichauff Range, and drains the narrow area between the Bacon and Seymour Ranges. Seventy miles below its junction with the Palmer the Finke receives the **Hugh** from Paisley's Bluff. This stream flows due south through country thickly timbered with splendid gums, growing perfectly straight to a great height. Between the Hugh and the Finke the land is sandy in parts, and in parts well grassed. The Finke at the junction is a mile wide, and has a bed of clear, fine, white sand. During the latter portion of its course it receives on the right the Sullivan, Lella, Goyder, and the united waters of the Driffield, Coglin, and Wall. Upon passing Charlotte Waters Station it flows east, and is lost in the flats north of the Hawdon Range. The Finke is 400 miles long.

It is highly probable, from the contour of the country, that the Todd, which rises near Mt. Sir Charles, north of the Macdonnell Ranges, after passing Alice Springs Station, falls into the Finke basin.

In Victoria there are, in the low-lying north-western district, four small inland basins :—The Bael Bael, Tyrrell, Buloke, and Hindmarsh.

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The **Bael Bael**, situated near the Murray, has only one stream, the **Avoca**. This river rises in the Great Dividing Range, at the Amphitheatre, and flows due north for 130 miles.

The **Tyrrell** receives the Tyrrell Creek, an effluent of the Avoca.

The **Buloke** receives the **Avon** from the Navarre Hills. The Richardson, also from the Navarre Hills, joins the Avon about 20 miles south of its entrance into Lake Buloke.

Into Lake **Hindmarsh** falls the **Wimmera**, which rises in the Pyrenees, flows north-west past Horsham, and thence in a due north course to the lakes. It receives the Mt. William Creek, flowing through Lake Lonsdale, the Mackenzie River from the Grampians, the Norton Creek from the Black Range, and sends forth two effluents—the Dunmungle, from Glenorchy to the Mallee; the Yarriambiack, from a few miles east of Horsham to Lake Coorong; and Outlet Creek, flowing through Albacutya to Mt. Jenkins.

CHAPTER VII.

LAKES.

LAKES are divided into four classes :—

(1.) Those which neither receive nor emit streams.
(2.) Those which emit, but do not receive streams.
(3.) Those which receive, but do not emit streams.
(4.) Those which receive and emit streams.

Nearly all the Australian lakes are included within the third group—those which receive, but do not emit streams—and exhibit all the characteristics peculiar to this group in other parts of the world. They lie, for the most part, in

open plains, and present a bleak and desolate appearance. In winter they overflow their banks and deluge the adjoining lands, while in summer they are dried up, partially or altogether, and are covered on their margins with deposits of glistening salt. Contrary to the general idea, that a lake is a sheet of water entirely surrounded by land, it has been customary to swell the list of Australian lakes by the addition of a number of small bays connected with the ocean by narrow entrances.

Lakes may be subdivided into those at or near the coast, and those in the interior.

Along the Pacific Coast are **Innis, Queen's, Myall, Macquarie, Tuggarah, Illawarra, Furnell, Corringle, King, Victoria,** and **Wellington.** Along the Southern Ocean are **Reeve, Connewarra, Koroit, Bonney, George, St. Clair, Eliza, Hawdon, Albert, Alexandrina, Greenby, Macdonnell**; and along the Indian Ocean, **Clifton, Preston, Herdman's, Joondalup, Nowergup,** and **Pinjar.**

In the interior are—**Mackillop,** near Cooper's Creek; **Short,** near the union of Herbert and Everard; and along the frontier line of Queensland and New South Wales, **Numalla, Wyara, Pindegolly,** and **Bulloo.** Between the Murrumbidgee and Murray are **Urana, Talla, Yonga**; between the Murrumbidgee and Lachlan, **Cowal**; between the Lachlan and Darling, **Poopelloe, Gunyulka, Pollioillaluke, Teryaweynya, Plapacungie,** and **Dry Lake.** To the west of the Darling, **Victoria, Tandou, Cawndilla, Weytchugga**; and between the Stanley Range and Lake Frome, 13 small sheets of water. In the Blue Mountains, **Bathurst** and **Lake George.** The latter is 25 miles long and 8 miles wide, and 2,129 feet above the level of the sea. It has a well-defined basin and no outlet, so that it may be regarded from a meteorological point of view as a regular rain-gauge. Mr. H. C. Russell, Government Astronomer of New

South Wales, writes thus :—"I have been at considerable trouble to learn its history. In the latter part of 1820 it was discovered, and was then a magnificent sheet of water ; but, fine as it appeared, the blacks declared they had seen it dry, and even covered by a forest—tales that looked at the time very improbable. The heavy rains of 1821-1822 filled it up considerably above what had been its level for many years, for it killed a great number of gum trees round its margin, many of which were 2 feet in diameter. In 1824 it was 20 miles long and 8 miles wide. In 1826 the water gradually dried up. In 1828 it was 15 miles long. In 1832 it was possible to ride over it. In 1836 it was visited by Sir Thomas Mitchell, and by him described as a grassy meadow with dead timber on it. From this time it became a cattle and sheep run, at times having water in it, which soon dried up. In 1842-1843 water accumulated in it, but in 1846-1847 it again got dry, and it was not until the floods of 1852 that any large quantity of water stayed in it. In 1866-1867 the water nearly all disappeared, but from 1870 it steadily increased, and in 1874 it was higher than ever known before." Since this the water has been gradually decreasing. In the chapter on Climatology it will be necessary to refer the student to these interesting facts.

South of the Murray are **Omeo, Tyers, Cooper, Boga, Bael-Bael, Buloke, Tyrrell,** 66 square miles ; **Hindmarsh,** 45 square miles ; and **Albacutya,** 21 square miles. Between 37° and 38° S. latitude are **Learmonth, Burrumbeet,** 12 square miles ; **Goldsmith, Bolac, Lonsdale, Linlithgow, Wallan,** and **Mundy.** And south of 38° S. latitude, in the lake district of Victoria, are **Murdeduke, Calvert, Korangamite,** 70 square miles : the beautiful **Colac,** 12 square miles ; **Gnarpurt,** 16 square miles ; **Purrumbete,** a most interesting crater-cavity ; **Colangulac,** and **Condah.**

In the western part of the great central plain is the "lake country" of Australia. But though the sheets of water are numerous and of great extent, they are far from picturesque, of intense saltness, liable to be dried up, and in the centre of wretched country. The principal lakes are—**Frome, Torrens, Pernatty, Blyth, Dutton, Macfarlane, Island Lagoon, Gillies, Gairdner, Gregory, Blanche, South Eyre, North Eyre, Ellen,** and **Florence.**

In this area of depression, though far to the east of the lakes just named, is the most beautiful lake in Australia—the Blue Lake of Mount Gambier. Immediately surrounded by rich agricultural plains of volcanic soil, and girt round with country, below the surface of which are the weird caves with their stalactitic pillars, surpassing in grandeur the Gothic structures of Europe, Mt. Gambier—a solitary volcanic peak—rises to the height of 600 feet. Its well-marked crater is now a lake, unfathomable at 250 feet, of the deepest blue, and encircled by steep sides, inaccessible in places, and clothed to their ridges with the myrtle-green foliage so characteristic of Australian vegetation.

To the west of the continent the lakes are very numerous; but they are for the most part mere empty depressions filled in flood-times. The principal are **Hall, Austin, Barlee, Monger, Moore, Yarra-Yarra, Cow Cowing, Macdermott, Deborah, Seabrooke, Lefroy, Cowan,** and numerous water-patches at present unnamed.

To the south-east of the Great Sandy Desert is the great Lake Amadeus, draining an extensive watershed. On the north are hills 1,000 feet high, enveloped in scrub, and on the south is the Petermann Range. The east and west trend of these ranges gives to the lake its elongated form, which is 200 miles, with a varying breadth of from 7 to 20 miles.

CHAPTER VIII.

AUSTRALIA—ITS WINDS.

DEFINITIONS.—**Wind** is air in motion; the motion is caused by the unequal temperatures of adjacent districts.

Permanent winds are those which blow always in the same direction.

Periodical winds are those which blow in one direction in summer, and in the opposite direction in winter.

A **Cyclone** is when incoming currents blow towards the same point from surrounding places. A cyclone is always **an area of low pressure**, that is, an area in which the readings of the barometer are low.

An **Anticyclone** is when out-flowing currents blow from the same point towards surrounding places. An anti-cyclone is always **an area of high pressure**, that is, one in which the readings of the barometer are high.

Isobars are inaginary lines drawn through all places which, at a given hour, have the same atmospheric pressure.

THE varying velocities of wind give rise to the following names: We call wind travelling 7 miles an hour, **a gentle air**; 14 miles an hour, **a light breeze**; 18 miles an hour, **a gentle breeze**; 23 miles an hour, **a moderate breeze**; 28 miles an hour, **a fresh breeze**; 34 miles an hour, **a strong breeze**; 40 miles an hour, **a moderate gale**; 48 miles an hour, **a fresh gale**; 56 miles an hour, **a strong gale**; 65 miles an hour, **a whole gale**; 75 miles an hour, **a storm**; 82 miles an hour, **a tempest**; and 92 miles an hour, **a hurricane.** Occasionally a greater velocity than that of the hurricane has been attained. The greatest velocity and force ever recorded took place at Sydney on the 10th of September, 1876, when the anemometer registered 153 miles, and 117 lbs. on the square inch.

The standard weight of air at the sea level is $14\frac{3}{4}$ lbs. to

the square inch ; but air varies in weight according to the temperature. Warm air is always light, and cold air heavy ; and, in consequence, warm airs are being constantly forced into the upper air regions, and their places taken by cool, heavy airs. These do not blow to fill the vacancy caused by up-rising air in straight lines, but circle round in an ever-narrowing spiral, parallel to the isobaric lines, giving rise to the term cyclone (*kuklos*), having the highest pressure on the left and the lowest on the right. The direction of this circling movement is, in the southern hemisphere, from west to east through north ; or, in more familiar language, in the direction assumed by the hands of a watch.

From these preliminary remarks the student will be in a position to understand the explanation of the causes of the winds which prevail in this country.

In the oceans which surround us the winds are permanent. Within the tropic the south-east trade is ever flowing, and below the tropic the north-west wind. The south-east trade is warm, and gives rise to a low-pressure area along the Equator ; the north-west wind is cool, and gives rise to a high-pressure area, beginning about 24° S. lat. If, now, isobars be drawn to represent these wind-conditions, we shall find that, at the Equator, and nearly parallel to it, is a low isobar ; to the south of this, and preserving the parallelism, a higher isobar ; and so on until, upon passing the Tropic of Capricorn, a high isobar is present. All isobaric lines to the south of this are high until the southern point of New Zealand is reached.

This is the normal state of the atmosphere over the oceans, but the presence of an immense area of land such as Australia disturbs this simple arrangement, and converts the permanent winds of the ocean into periodical winds. Australia is the disturbing element, and its vast, level, and almost treeless centre is the motor force.

As soon as our vernal equinox, which takes place in September, is past, the sun, now in the southern hemisphere, begins to make its influence felt in a marked way. The interior of our country, owing to its conformation, becomes heated with even more than tropical heat; the air becomes hot, and an up-rush ensues. In accordance with the invariable natural law already stated, a great surface in-rush takes place on all sides. The up-rush of hot light air is so rapid and powerful that the south-east trade wind is turned back and literally sucked in by the cyclonic movement. The whole of Northern Australia is thus deprived of its "trade." When this happens, the north-east trade wind of the northern hemisphere, upon reaching the Equator, meets with no opposing air current, and, being deflected, blows towards Australia. On the north-west coast it becomes the north-west monsoon; on the north coast, a north wind; and on the north-east coast, a north-east wind. Among the in-rushing winds are also winds from the Pacific, Southern, and Indian Oceans. Those from the Pacific will be east and south-east; those from the Southern Ocean, south and south-west; and those from the Indian Ocean, south-west and west.

The **Summer** winds of Northern Queensland will be north; of the coast districts, north-east and east; of New South Wales, east and south-east; of Victoria, south-east and south; of South Australia, south and south-south-west; of Western Australia, south-west, west, and north-west; and of Northern Territory, north-west and north.

As these in-rushing winds blow over the land and approach the central area, they in their turn become heated, and ascend into the higher air-regions; but so extremely rarified is the atmosphere over Australia that the height of ascent seldom reaches 5,000 feet. In consequence of the superior force and velocity of the north-west monsoon, and of the

direction of the **upper return trade** wind, which blows north-west, these ascended airs assume a south-easterly direction, that is, blow from the north-west, and envelop the whole of extra-tropical Australia with a hot stratum of air 2,000 or 3,000 feet thick, and about 3,000 feet above the level of the ocean.

A **summer** weather-chart of the continent shows an area of low pressure in the interior, bounded by a low isobar very similar in shape to the continent, and surrounded by isobaric lines of gradually increasing pressure ; the maximum isobars being over the oceans.

When the sun crosses the Equator at our autumnal equinox in March, central Australia becomes cool, and an area of high pressure ; the south-east trade resumes its course, and blows over a large portion of intra-tropical Australia ; the north-west winds reappear over the oceans, and an anti-cyclonic movement takes place over the extra-tropical regions. In this anti-cyclonic movement, the interior—the Eolian prison-house of the winds—sends forth its airs in every direction, supplying to Queensland winds from the south-west ; to New South Wales, from the west and north-west ; to Victoria, from the north-west and north ; to South Australia, from the north and north-east ; and to Western Australia, from the north-east and east.

A **winter** weather-chart of the continent shows an area of low pressure near the Equator, bounded by an isobar almost parallel to the Equator, but dipping south on the north-east and north-west. This isobar is followed by others gradually rising in pressure until near the tropic, where a band of high pressure stretches almost across the continent.

The level of the land is so uniform that the continuity of these winds is rarely interfered with by irregularities of surface. There is one notable exception. It has been said

that the summer winds of New South Wales are east and south-east. The latter, blowing over the coast district, encounters the Liverpool Mountains, is deflected, and becomes over neighbouring districts a summer north-east wind.

But, though the surface of the land rarely disturbs the continuity, our daily records show that it is seriously interfered with by the cyclonic area of the Indian Ocean. An area of low pressure appears constantly in the great cradle of the cyclone, and moves west, striking Australian waters generally to the south of the Leeuwin, and passing thence at least as far as New Zealand. Before its approach the high-pressure area retires to the east, the surface winds fall off, and the upper winds descend. If the season be summer, the winds which die away are from the south, and the upper wind which descends is the north-west. Scorching hot it comes from the interior, and, drawn down by the appearance to the south of an area of low pressure, it blows as the **hot north wind**, laden with dust, enervating to man, and destructive to vegetation. Although the summer "north wind" and the "hot wind" are almost synonymous among the residents of the southern parts, its direction differs in different localities. In Queensland and New South Wales it is west, north-west, and north-north-west; in Victoria, at first north-north-west and afterwards north; in South Australia, north and north-east. The "hot" wind blows with a temperature of nearly 100° Fahr. over an enormous extent of country, and occurs very often during the summer in South Australia and Victoria; but, thanks to the height of the Great Dividing Chain, the average visits of this unwelcome intruder are only 7 on coast line of New South Wales. It is upon this well-ascertained fact that the conclusion has been drawn that the stratum of hot air does not ascend to a greater height than 5,000 feet. This theory is

not entertained by all meteorologists. Some consider that the heated air is cooled in its southerly course.

If the season be **winter**, the winds which die away are northerly, and the inrush takes places from the west and south, bringing with it violent storms and cold weather.

These areas of low pressure, which so often appear to the west, are no doubt regulated by a physical law; but a lengthened period of observation will be necessary before their frequency, force, and general direction can be thoroughly understood. All we know at present is, that in April and May, in August and September, we enjoy an almost complete exemption from these batterings on our coast. The cause of this half-yearly cessation is at present unexplained, but I am disposed to attribute it to the fact that, in April and August, the breaking up of the normal atmospheric conditions takes place in the Indian Ocean. The S.E. trade (or N.W. monsoon, according to the season) is making the final effort to maintain its supremacy against a more powerful invading antagonist. Bringing all its forces to the struggle, it lets go its hold on the extra-tropical winds, which, now free and unguided by a regulating power, lose their westerly direction, and blow in wild confusion over the centre of the Indian Ocean. The discontinuance of the cyclonic visits renders April and September our most agreeable months. The climatic conditions are then moderate; cool and bracing breezes, refreshing showers, and bright sunshine fairly share these periods, which claim an additional charm from the gorgeous bloom of Australian winter-flowering trees or of the hardy exotics from Europe.

RAIN—SNOW—HAIL.

Intimately connected with the winds are the rain, hail, and snow.

Rain is condensed vapour, falling as water ; hail is rain frozen in the act of falling ; and snow is frozen vapour.

In the present state of our knowledge of the appearance of these atmospheric phenomena in Australia, it is impossible to lay down a generalization which will be scientific and in accordance with facts. All that can be done is to state the facts which have come under observation, and to rest satisfied with the assurance that Messrs. Ellery, Russell, and Todd are giving this subject their special attention.

In northern Australia the rains are tropical in character, but scanty, except along the north and north-east coasts.

In extra-tropical Australia there are summer and winter rains ; but these differ immensely from each other in their modes of precipitation, though the cause of precipitation is the same in each.

In summer the rain comes in sudden violent squalls of short duration, except in extensive cyclonic intrusions from the south-west, and is usually accompanied by thunder and lightning. In winter, though unperiodical, the rain is more frequent, rarely attended by electrical phenomena, except in large cyclonic disturbances, and generally preceded by shifting winds and cold weather.

The student will remember that it has been already stated that the presence of a cyclonic area of low pressure to the west of Australia brings in summer the hot wind, and, in winter, storms from the south-west and south.

These cyclones also bring the rain. If a hot wind be blowing at any particular point of observation, it will continue to blow until just before the cyclone has reached the meridian of the selected place. If the axis of the cyclone pass over the place, the north wind dies out suddenly, dark clouds charged with electricity come up, and southerly winds are ushered in by a heavy shower,

accompanied with thunder and lightning. In less than an hour the sun will be shining again, and the rain gauge will probably record a fall barely sufficient to refresh the burning surface of the ground. This is the way in which rain precipitates itself in summer.

But if the cyclone pass to the south of the point of observation, the change in the wind is gradual. It veers in New South Wales from north-west through south to south-east, and in Victoria and South Australia from north-east to north, and west to south, bringing in cold squally weather with rain showers, which continue for several days. This is the way rain precipitates itself in winter.

In the case of the cyclone striking the western coast higher than the Leeuwin, and then forcing itself across the continent, we must expect extremely severe weather, accompanied with a low temperature.

In New South Wales the south-east wind brings the rain; in Victoria, the south and south-west winds; in South Australia, the west and north-west winds. In the interior the north-west and west winds are most rain-bearing. It is premature to state the rain measurements for the continent, for, although numerous and regular observations are now taken over a very extensive area, yet the period during which they have been taken is too short for the purposes of generalization. Careful notes of the rainfall have been taken along the coast lines for many years, and the results obtained give the maximum annual fall of rain to Queensland, 50 inches; next follows New South Wales, 40 inches; then Victoria, 25.6 inches; and South Australia, 21 inches. This decreasing order of magnitude following the coast lines from Queensland to the Leeuwin, if taken in connection with the sameness of origin—viz., the presence of low pressure areas to the west and moving to the east—will probably lead to important deductions in the future.

In Western Australia the average rainfall is 30 inches ; in Northern Queensland, 90 inches on the coast, and in the interior 10 inches ; along the west side of the Pacific System, 30 inches ; along the Darling, 18 inches ; along Cooper's Creek, 16 inches ; in the Murray district, 24 inches ; and in the northern territory of South Australia, 60 inches.

In New South Wales the average number of rainy days in the year is 102, and in the interior 70 ; in Victoria, 137 ; and in South Australia, 110.

In giving these annual averages, the student must not form the erroneous idea that the rainfall in any particular year will reach, or not exceed, the average. In fact, Australia is the land of droughts and floods. In the very lands from which settlers have fled as ruined men, other settlers have within a few years made great fortunes. It has been a favourite speculation to endeavour to draw from statistics a theory of periodicity ; but nearly all the theories of periodicity which have been started have been given up as contrary to a more extended experience. If there be such a thing as a drought period at all, it must be one of great length—probably one of between 50 and 60 years. In describing Lake George, in the chapter on the Lakes, the following dates are of special importance :—In 1824 it was full ; in 1836 it was empty, and remained so till 1849 ; in 1852 there was a large quantity of water in it ; in 1866 it dried to one-third its size ; and in 1876 was as full as in 1824, but showing signs of decrease. The years 1820 and 1821 were dry ; 1822 was very wet ; 1823 and 1824 dry ; it is, therefore, probable that the lake attained its maximum height in 1822, and again in 1876, giving an interval of 54 years. It was perfectly dry in 1849 (year of minimum rainfall at Sydney), and this is half-way between the two maximum dates. Again, we find that the blacks, in 1820, reported the lake dry within their own experience, and the Sydney records show 1789 to 1799 very

dry. It is not improbable that, about the middle of this period, the lake was empty. If to these established facts we add a still further drought about 1740—a drought the equal of which has not been known since the period of Australian colonization, the awful recollection of which is still kept by the blacks and recorded by the death of an ancient forest and the birth of a new—we must arrive at the conclusion that the periods of great droughts are too distant from each other to be as yet formulated as a theory.

Between these great drought periods, ones of less intensity occur ; and, judging from the fall of rain, as well as actual experience, it will not be far out to say that these divide the larger periods into three equal parts.

There is a very remarkable circumstance, worthy of notice in connection with the annual rainfalls of South Australia, Victoria, and New South Wales. During the last forty years it has been noticed that a high annual rainfall in Adelaide was contemporaneous with a low annual rainfall in New South Wales, and *vice versâ ;* and that the annual rainfall for Victoria was intermediate, partaking, however, more of the characteristics of South Australia than of New South Wales.

Hail, which always falls during the day, is often seen in Australia, and is more severe near the tropic. In the west and south it is scarcely ever so violent as to do serious damage ; but in New South Wales and Queensland there have been, since 1840, some of the most appalling hailstorms ever recorded. Hailstones, 7 inches in circumference, fell at Bathurst in 1850 ; and, in the same year, some angular pieces of ice at Moreton Bay weighed 1½ lbs. In 1856 a hailstorm caused serious loss of life over a very wide area. In 1871 another at Illawarra killed cattle and fowl which were not under shelter, and in 1872 a piece of ice picked up on the Williams river was 7 inches long and 2 inches thick.

Snow is rarely seen, except on the ranges of considerable altitude. On the southern sea coast it has fallen not more than once or twice in twenty years; on the east and west coasts even less frequently; but, in the south-east corner of the continent, from the northern point of the Muniong Range to the Barry Mountains, there is snow to be seen during most of the year. It falls for the most part in sudden and tremendous storms, and is perpetual on the shaded sides of many of the mountains over 6,000 feet high. On the night of the 21st of December, 1851, the Rev. W. B. Clarke slept under the summit of Kosciusko on 40 feet of hard, dry, crystallized snow, and, from his elevated point of observation, saw Mt. Buller to the south well covered. On this point the same writer remarks—"It seems strange that perpetual snow of any kind, even in similar proportion to that which is found in the hollows of Ben Nevis, in Scotland, should be met with so near the Equator at an elevation of only 6,000 feet; whereas, at Mt. Blanc, in latitude 45° north, the snow line is 8,500 feet above the sea. But it must be borne in mind that the Southern Hemisphere is peculiar in its relations to temperature; and, in fact, there is a case in South America which very much resembles that of the Muniong, viz., that of Antuco, in the southern part of Chili, in latitude 37° 40′, on which snow lies at the height of 7,600 feet; yet, even this is far higher in proportion than the snow of Kosciusko."

This brief sketch of the climatology of Australia may be fittingly closed by an extract from Mr. J. A. G. Little's report of the climate of the Northern Territory:—"The year has two climatic divisions, consisting of the wet season, from October to April; and the dry period, from May to September. The different changes of these seasons are so uniform and regular that they may be predicted almost to

a day. Signs of the approach of the wet season appear almost immediately after the sun has crossed the Equator during the spring equinox, in September, when the strong E.S.E. monsoon ceases, and is succeeded by calms and light variable winds ; the weather becomes intensely hot, and small thunder clouds gather over the land, increasing in size and density day by day, until they burst in terrific thunder storms, accompanied by hurricane squalls of wind and rain. These storms at first take place every four or five days, gradually increasing in number until the end of November, when they occur almost daily. They come up in a dense black bank, and travel so very rapidly that they are generally out of sight on the western horizon within 40 minutes. About an inch, or sometimes more, of heavy, driving rain accompanies each storm ; but, in the year 1871, the writer saw $2\frac{3}{4}$ inches gauged within 10 minutes during one of these squalls. During December the N.W. monsoon gradually gains the ascendancy, and blows steadily, with an occasional break of calm weather ; the thunder storms disappear, the sky becomes overcast and clouded, and the atmosphere gets thoroughly saturated with moisture, so much so that leather-work becomes green with mildew, if not constantly attended to ; the binding of books becomes soft ; and sugar or salt, if exposed in an open vessel, will soon liquefy. The N.W. monsoon is accompanied by rain almost daily, and increases in force until the latter end of January or beginning of February, when it is blowing in full heart, and penetrates with its copious and fertilizing showers into the very centre of Australia. During this period thick damp weather prevails, the clouds being very low, and scud and banks of nimbus pass over almost constantly from the N.W. to the S.E. with great rapidity. The maximum temperature in the shade during the day is 96°, and the minimum during the night is 65°. On the approach of the autumn

equinox the N.W. monsoon gradually dies away, and is succeeded again by calms, variable winds, thunder storms, and oppressive weather, until about the end of April, when cooler weather is felt; the S.E. monsoon sets in, and the dry weather may be said to have fairly commenced. This wind is characterized by a clear sky, enjoyable weather, heavy dews, and cold mornings and nights; so much so that blankets can be used when sleeping. It blows off the coast without intermission, and with great force, almost throughout the whole season, being in full heart during June and July. The maximum temperature during the day is 89°, and the minimum during the night is 56°."

CHAPTER IX.

AUSTRALIA—ITS FLORA.

A MANUAL of Physical Geography must be considered incomplete without, at least, a brief notice of the Flora and Fauna. The outline presented to the student in this chapter will, it is hoped, induce him to consult the magnificent works of the Baron von Mueller, the essay of Sir Joseph Hooker, and the many excellent treatises of botany and zoology by which eminent scientific men have enriched our literature.

The principal conditions affecting the distribution and growth of plants are heat, light, and moisture.

Heat, the most important of the three, must be considered in its latitudinal and altitudinal aspects.

The latitudinal aspect assumes that all places are on the sea level, and then takes into consideration the distance from the Equator. The further a place is from the Equator, the more obliquely do the rays of the sun strike it, and in consequence the heat is less. But, as little land can be

considered as on the sea level, it will be evident that parallel lines of latitude cannot represent faithfully the lines of equal temperature. Humboldt, by drawing imaginary lines through places north or south of the Equator, which have the same mean annual temperature, established a number of **isothermals**, which have proved of great value to botanists and zoologists. But though the mean annual temperature of two places may be the same, it does not follow that the same climate prevails—for instance, Hobart and Toronto are on the isotherm of 54°, yet the former has a charming mild and equable climate, while the latter is intensely hot in summer, and snow many feet thick covers the ground during the winter months. It is necessary, in consequence of this diversity of climate in places on the same isothermal, to subdivide regions by isotheral and isocheimonal lines. **isotheral** lines (*isos*, equal ; and *theros*, heat) are imaginary lines drawn through places north or south of the Equator, which have the same mean summer temperature ; and **isocheimonal** lines are imaginary lines drawn through places north or south of the Equator, which have the same mean winter temperature.

With the aid given by these lines, Meyan divided the surface of the globe into 8 latitudinal zones—the **Equatorial**, bounded by the northern and southern isotherms of 79° Fahr. ; the **tropical**, between the isotherms of 79° and 73½° ; the **sub-tropical**, between the isotherms of 73½° and 63° ; the **warmer-temperate**, between the isotherms of 63° and 53½° ; the **colder-temperate**, between those of 53½° and 42½° ; the **sub-Arctic**, between those of 42½° and 39° ; the **Arctic**, between those of 39° and 32° and the polar.

Our continent lies under the equatorial, south tropical, south sub-tropical, and south warmer-temperate zones. The equatorial zone is characterized by luxuriant growth of succulent stems, large showy flowers, gigantic parasites, orchids,

arborescent grasses, palms, and bananas ; the tropical by palms, bananas, tree-ferns, pine-apple, coffee, cotton, tobacco, sugar, and nearly corresponds to a latitudinal division of 15° to 23° ; the sub-tropical by mesembriaceæ, proteaceæ, myrtaceæ, epacridaceæ, compositæ, and cactaceæ, and corresponds to a latitudinal division of 23° to 34° ; and the warmer-temperate is the region of great evergreen trees and shrubs—mimosa, magnolia, figs, oranges, olives, vines, araucariæ, and shrubby ferns. It extends south to about 45° lat.

In its altitudinal aspect we regard heat as it decreases from the sea level to the higher regions of the atmosphere. For a vertical elevation of about 300 feet it has been roughly estimated that there is a fall of 1° Fahr. in the temperature of the air. There is also a diminution of pressure, so that for every 543 feet of ascent water requires a temperature of 1° Fahr. less to bring it to boiling point. At these rates of decrease, if we take the mean temperature at sea level at Kosciusko to be 60° Fahr., we shall have on the summit a mean temperature of 36° Fahr. ; and if water boil, with a barometer standing at 30 inches, at 212° Fahr., it will boil on the summit at 198½° Fahr.

This decrease of temperature and pressure as land rises above the sea has even a more marked effect upon vegetation than has distance from the Equator ; and well-marked hypsometrical zones divide the atmosphere into the climates of palms, tree-ferns, vine, forest trees, Peruvian bark, shrubs, grasses, and lichens. All these zones are represented in the Australian Alps, but their boundaries are ill defined.

Light is an agent of great power in the production of vegetation, and is demanded by all our known plants ; yet in consequence of the heat rays of the sun we are obliged in our houses and gardens to shelter the tree-ferns, fuchsias, &c., from the northern glare.

The want of moisture, absolutely and relatively considered, deprives us of many beautiful and luxuriant forms, and confers upon us the superabundant proteaceæ, banksias, hakeas, and acacias, which prevail where neither water nor soil can be seen for hundreds of miles.

Besides heat, light, and moisture, there are several minor conditions which affect plants. Of these the principal are—geological formation, relative position, prevailing winds, and the slope of the land.

Turning from these general remarks to our vegetation, the most striking characteristics are—the sombre hue of the leaves and stems of all plants ; the great extent over which the same forms spread ; the wide difference between the woodland vegetation and the vast scrubs which cover the plains and plateaux ; the enormous variety of plants, which, contrary to the experience of other lands, is due to the temperate rather than the tropical districts ; the extreme peculiarity of the vegetation, which is not the result of difference of origin, but of great isolation ; and the marked distinction between the prevailing forms of the eastern and western regions.

The three first of these require no comment. The fourth is of much interest. To the Australian who has visited Europe, and seen the varied foliage of the trees and the striking contrasts in the shrubs, it will appear strange that in his own smaller continent, with its sameness of aspect, there are more flowering plants—plants not composed largely of a teeming tropical vegetation, but of the hardy inhabitants of the eastern, southern, and western coasts. The fifth characteristic states the allied character of the old world flora to our own. All the widely distributed orders are present in both, and there is no Australian order, with two small exceptions, which is not found in other parts of the world. And the last characteristic is perhaps the most

remarkable, viz., the contrast between the eastern and western flora. The west is of very much poorer soil, is less supplied with water, has fewer and less imposing mountain chains than the east, yet it contains 600 species more than the east; and of the 6,600 species in both, 300 only are common—not a species of eucalypt, acacia, or melaleuca is common to the two.

A brief description of the most remarkable flora will be of interest.

THE MYRTACEÆ.

Although represented in Europe by the solitary myrtle, there are in our land about 700 species of all sizes, from giant trees to low scrubs. Of these, the eucalypts—called by an unfortunate misnomer gum trees—are the most remarkable. They extend all over the continent, and are found at a height of 5,000 feet above the level of the sea. The eucalyptus amygdalina, or almond-leaved eucalypt—and often called white gum or messmate—is an inhabitant of the south-east, and is the tallest tree in the world. One colossal specimen, felled on the Black Spur, in Victoria, measured 480 feet in length, 81 feet in girth, and at a height of 300 feet from the ground had a diameter of 6 feet. This magnificent eucalypt surpasses in height the "Monarch of the Forest," in the Mammoth Pine Grove of California. The white gum of Western Australia—eucalyptus viminalis—is also a grand forest tree, and covers 10,000 square miles of the colony.

The eucalyptus globulus—or blue gum—is a very tall tree, of rapid growth, found in Victoria and South Australia. It is valuable for its antiseptic exhalations and for the powerful medicinal oil which is procured from it. It has been recently planted largely in the Campagna, and has reduced the malaria of that unwholesome district of Italy.

The eucalyptus saligna of New South Wales and Queensland —also called a blue gum—is a fine tree, and is extensively used in shipbuilding.

The eucalyptus rostrata, or red gum, ranks with the jarrah as the most valuable of our timbers. It seeks the neighbourhood of the watercourses, and is found all over the continent.

The eucalyptus colossea of Western Australia rises in the glens of the Warren river to a height of 400 feet. In the same colony is the eucalyptus diversicolor, or karri, a colossal tree of splendid timber, occupying 2,300 square miles.

Eucalyptus obliqua, or stringy bark; eucalyptus fissilus, the true messmate; and eucalyptus dives are inhabitants of New South Wales and Victoria. They constitute a large part of the forest of the less fertile ranges, and are of little use except for fencing and shingles.

Eucalyptus marginata, or jarrah, is the most durable of hardwood timbers, and, being impervious to the borings of the teredo, termite, and chelura, is largely used in piers and docks. It is an inhabitant of Western Australia, and covers 14,000 square miles.

Eucalyptus melliodora, of the east; and eucalyptus odorata, of the west—the box tree—spreads all over the continent, and is the tree most commonly met with along the watercourses of the interior.

Eucalyptus viminalis, or manna eucalypt, is found in New South Wales, Victoria, and Tasmania, and receives its name from a sugary substance formed on its leaves by cicadæ.

The melaleucas belong to the order of the myrtaceæ, and are remarkable for possessing a very liquid pungent oil; they, in conjunction with leptospermum, kunzea, and callistemon, constitute the tea-tree scrubs of our coasts.

The eucalyptus ficifolia, or scarlet-flowering gum—a native of Broken Inlet, Western Australia—is a low tree, but compensates for its diminutive size by the extreme beauty of its tufted heads of bright scarlet bloom.

The eucalyptus dumosa and eucalyptus incrassata are low scrubby species, rising in very closely packed stems to the height of 8 to 12 feet, and inhabit the level sandy plains to the exclusion of every other form of vegetation. They have been called "mallee,"—one of the pests of which explorers complain so bitterly.

LEGUMINOSÆ.

This order has many representatives, but pre-eminent are the acacias and cassias. The acacias are not peculiar to our country, but are far more abundant in it than in any other botanical province. There are no less than 300 species. These are spread over every part of the continent, and flourish where no other plant can endure existence. They yield the true gum, and some species are rich in tannin.

Acacia mollissima, the black wattle, extends its geographical range from the east districts of South Australia, through Victoria and New South Wales, to the Darling Downs. It stands cold well, and is found at a height of 5,000 feet above the level of the sea. Its bark is of high commercial value.

Acacia pycnantha, the golden wattle, is the most beautiful of the acacias, when seen loaded in spring with its bright yellow blossoms. It grows rapidly, has a large supply of gum, and is rich in tannin. Its geographical area is more contracted towards the north than that of the black wattle.

Acacia melanoxylon, the blackwood, is one of our most valuable trees. It is of unusual beauty and hardness of

texture; and is, in consequence, used much in the manufacture of furniture. It is a very handsome tree, of low growth and luxuriant foliage, requiring water and good soil. In the districts where it abounds, and from which other trees have been removed, it gives to the landscape that park-like aspect which the oak gives to English demesnes.

Belonging to this order is the dreaded mulga, a prickly acacia, which has been already described in the chapter on the interior.

The cassias are a numerous tribe of trees and shrubs, widely distributed over the low-lying lands, especially in the north-western deserts. The Queensland cigar cassia is the most singular species.

The papilionaceæ—the pea-flowering tribe—are found all over the continent, and are well represented by the magnificent Kennedyas, Indigoferas, Pultenæas, Dillwynias, and the native liquorice tree of the Murray.

The myall and yarran are scented acacias found largely in the interior, and now principally used for fancy and ornamental work.

THE CASUARINEÆ

Are better known by the name of sheoaks; and, though found in Madagascar and India, must be regarded as thoroughly Australian. They are small-sized trees and shrubs of gloomy aspect, with branches apparently leafless.

Casuarina quadrivalvis is a useful tree in dry country, where other trees are scarce. Its wood is excellent fuel; and, when food is scarce, the sheep will eat the felled boughs, and support life until rain enables the grass to make a fresh start.

Casuarina suberosa is an eastern and south-eastern species. Casuarina glauca extends from east to west of extra-tropical

Australia, and casuarina distyla is a very common shrub of South Australia.

Closely allied to the casuarineæ are our native beeches, Fagus Cunninghami and Fagus Moorei. The former is a native of Victoria, and extends from Gippsland to the Otway Ranges, where it is said to be present in large numbers ; but the track through the forest is of such a nature as to endanger the lives of those who seek to unearth its treasures. The Fagus Moorei belongs to New South Wales. It comprises large forests of dense foliage on high mountain slopes.

THE CONIFERÆ

Are represented by few species, although the climatic conditions favourable to their growth are present.

The ancient vegetation of Europe is associated with the present one of Australia by the giant araucarias.

Araucaria Bidwellii, the bunya-bunya, has at base a diameter of from 30 to 58 inches, and a height varying from 100 to 200 feet. It covers large tracts from the Fitzroy to the Burnett rivers, is a magnificent tree, and supplies a wood of strong and handsome texture. The cones, which are about 2 inches long, are greedily eaten by the blacks. There is a yearly crop, but the triennial harvests are the most abundant. At these periods the natives assemble from all quarters to feast on the roasted fruit.

The araucaria Cunninghami is the largest, most useful, and most ornamental tree of Queensland. It is a beautiful regular pyramid of dark green foliage, and literally covers the colony.

The Dammara robusta, or kauri pine, in consequence of its being limited to a very small portion of Queensland, would be unworthy of notice in a physical geography, were

it not that its timber is of the highest value for building purposes.

The frenellas are cypress pines, having a more extended area than the Dammara, stretching from the Darling Downs to the south of the continent. The most singular frenella is the Murray pine—callitris verrucosa—inhabiting desert districts, attaining a height of 90 feet, and rich in sandarac.

Exocarpus cupressiformis, the native cherry, is truly Australian. It is a short cypress-looking tree, bearing a peculiar fruit, raised on a brilliant red stalklet, and protected by a hardened calyx. It ranges geographically from South Australia to Queensland, and is not found in clumps or forests, but chooses the neighbourhood of taller trees, under the shade of which it may luxuriate.

THE PROTEACEAE.

Of the large orders of plants there is none more curious than the proteaceæ, so called from the protean shapes which it assumes. It includes the banksias, grevilleas, hakeas, native pear, native tulip, and many other species. Though so varied in appearance, they are all readily distinguished by the woody texture of the leaves.

The banksias attain their maximum growth in the southern parts of Western Australia, where they are of great size, abundant foliage, and magnificent brilliancy. They are absent in the interior, and reappear in northern Australia. They are represented in the east and south-east by only a few species; the best known are the banksia marginata, or common honeysuckle, and the banksia integrifolia, or sea-coast honeysuckle. The common honeysuckle is a small tree, growing on poor ground. Its fruit consists of a number of hard fruitlets arranged on a woody axis, containing two seeds, and surrounded by fibrous-looking remnants of flowers.

The grevilleas are, with two excepted species, all natives of our country. There are 150 species exclusively found in the eastern half of the continent. They are for the most part beautiful shrubs, cultivated for their flowers. A few species are of considerable size—as, for instance, grevillea robusta, the beautiful silk oak of Queensland, which chooses the scrubby areas along the coasts, where it attains a height of 100 feet. The wood of the silk oak is in high esteem among cabinetmakers.

The hakeas are widely spread over the continent, and especially plentiful in Western Australia. In all there are 100 species, and most of them are handsome garden shrubs.

THE EPACRIDEÆ

Form the great genus of Australian heaths. They differ from the true heath—the erica—in the number and position of the stamens. The epacrideæ are truly Australian. There are 300 known species, nearly all of which are greatly prized by collectors. The most beautiful species are epacris, sprengelia, styphelia, richea, lissanthe, and the native currant, leucopogon. The epacrideæ are entirely absent from the vegetation of the west.

THE STERCULIACEÆ

Have in our country three very remarkable species—the gouty stem tree, the bottle tree, and the flame tree. The gouty stem tree—Adansonia Gregorii—is by far the most remarkable form of vegetation in the north-west. It has precisely the same shape as the baobab tree of tropical Africa. It is low, when compared with its enormous circumference, which is said to commonly reach 85 feet. The bottle tree—sterculia rumpestris—is curiously like an inverted bottle. It is

of no great dimensions at the base, but bulges out in the middle of the trunk to double its size below. The wood is very soft and loose, containing a jelly-like, nutritious substance. Sterculia acerifolia, or flame tree, is one of the most magnificent trees in the world. Its leaves are large, of a bright green, and numerous ; and its flowers are racemes of scarlet, and so many are they that the tree deserves its familiar appellation. It is an inhabitant of central and northern New South Wales and of South Queensland.

The flowering plants of our country include some magnificent climbers, which scale the summits of the tallest trees, and, throwing out their branches in every direction over the neighbouring trees, draw a gloom over the forest by their dense foliage. Among the most noteworthy are—the lyonsias, which, like gigantic cables, join tree to tree, and, sending down their branches to the ground, strike again as new plants—the trichosanthes pentaphylla and lufa Egyptica, two gourds of coarse habit, which render parts of the Queensland river banks almost inaccessible—the entada and mucuna, two peas of colossal proportions, and having pods. The pod of the entada is 4 feet long, with seeds 2 inches in diameter ; and that of the mucuna is enveloped in stiff brown hairs, which sting most severely. The loranths, of the mistletoe group, are almost protean. If they grow on an eucalypt, their leaves are narrow ; if on banksias, broad ; if on sheoaks, they are string-like. The most ornamental species are the loranthus exocarpi and loranthus linophyllus, which are found as parasites of the melaleucas, acacias, and native cherry trees.

One member of the order is not a parasite. It is covered, when in flower, with such magnificent orange blossoms that in Western Australia it is called the "fire-tree."

LILIACEÆ.

With a few words upon this order this brief sketch of the leading phanerograms will end. Foremost among the species are the xanthorrhœas, or grass trees. From a rugged stem, varying from 2 to 12 feet, rises a tuft of drooping wiry foliage, which increases in beauty when its winter star-like flowers appear upon its upright bulrush-looking spike. The grass trees extend over large portions of our continent, but not beyond it.

The nymphœa gigantea of Queensland has leaves 18 inches in diameter, which float upon the water.

The giant doryanthes sends up a flower stalk 30 feet high, on which flowers several feet in circumference are supported.

THE CRYPTOGAMS.

The cryptogamous, or non-flowering, trees of our country form one of its special scenic charms. Our beautiful ferns come first in importance and gracefulness. They present themselves in almost every form of stem from the minute hymenophyllum to the giant climbers and arborescent varieties. The Alsophila Australis has a slender stem which attains a height of 60 feet ; the Dicksonia antarctica is nearly as tall, and has a stouter stem ; the Cyathea medullaris of the Cape Otway Ranges is 50 feet high ; and the Dicksonia squarrosa, a slender tree of moderate height, is a native of the Dandenong Ranges.

The three first are found in Queensland, New South Wales, and Victoria, and the Dicksonia very sparingly in South Australia. For magnificence, gracefulness, and scenic richness the tree-ferns are unequalled in our country.

For the remaining flora, full of interest though they be, and occupying volumes when dealt with by Bentham and Mueller, the student must consult special treatises. There he will

read of the sensitive insect-eating sundews ; of a tree among the composites ; of the wonderful method of propagation among the valisneria; of the West Australian cephalotus, with its pitcher blossom, the lid of which opens and shuts when irritated ; and indeed of hundreds of plants which are qualified by their giant size or strange aspect to fill in the background of a fairy scene.

THE TROPICAL FLORA.

The tropical flora number about 2,000 species, and of these at least 500 species are Indian or Malayan. Intermingled with these are the extra-tropical Australian types. The palms are represented by the cabbage palm, bangalow palm, and black palm.

The cabbage palm—Livistona Australis—which, strange to say, is found in a little tract in Gippsland, is abundant in the river valleys of tropical Australia. It rises to a height of 120 feet, has large fan-like leaves, and bears a fruit, "Konda," which the natives eat with avidity.

The bangalow palms—Seaforthia—vary from 100 to 150 feet in height, and have beautiful feathery fronds. Seaforthia robusta is found as low down as Illawarra, that "garden of Australia."

The black palm is of more moderate growth.

The mangrove—Rhizophora—is abundant in the low-lying marshy lands within the tropic. It is from 40 to 50 feet high, and is a characteristic type of the aerial-root plants. It is a strange object in the landscape, as it stands out of the water on an irregular group of piles.

The pandanus, or screw pine, is also aerial, and partial to the sea coasts. The name is obtained from the peculiar spiral arrangement of the leaves in three rows. The natives eat the bracts.

The cedar tree is found in scrubs along the coast of Queensland. It is 150 feet high, deciduous, of very high commercial value.

Bamboos are rare, but a number of small trees and shrubs are found inland. On the whole the great Australian trees and shrubs, penetrating to the very north amidst the tropical forms, give to this part of Australia an appearance of a mixed character, very disappointing to the traveller who has seen the glories of Ceylon.

CHAPTER X.

AUSTRALIA—ITS FAUNA.

THE Fauna, peculiar and indigenous to our country, are as thoroughly characteristic as the Flora. There are in it none of the monsters of Asia, Africa, and America ; none of the terrible carnivora whose favourite diet is man ; none of the useful creatures which form our main staple of food ; none even of those domestic animals which in other countries are our friends and companions.

Among the mammals the types are the oldest in existence—the remnant of a by-gone epoch—which owe their occupation of this corner of the world to isolation. The birds are not so very singular, but there are some very beautiful and interesting forms ; and among the reptiles and fish the types still more closely resemble the well-known old-world forms.

THE MONOTREMATA

Are purely Australian, and form the smallest order of animals, being represented by two genera only—the ornithorhynchus and echidna.

The ornithorhynchus, the lowest of all mammals, has created more interest and curiosity among zoologists than any animal of the old or new world.

The O. paradoxus, which is the solitary species, has four horny plates which act as teeth. The females possess no pouch, but the marsupial bones are present. The feet have five toes, and the males carry on the hind feet a curved perforated spur leading to a gland. The feet are broad and webbed, the webs of the fore feet extending beyond the claws, which are so powerful that it can burrow through 2 feet of hard gravel in the short space of 10 minutes. This curious little animal has received several names from us. We call it generally the duck mole and the duck-billed platypus. These arise from the remarkable arrangement of its jaws, which terminate in a bill, which is somewhat broader and flatter than that of the duck; as well as from the mole-like habit which it possesses. It is aquatic and a burrower. Its burrow, situated on the bank of a stream, is 40 feet long, declining at first from the surface, and afterwards inclining towards it. In constructing this extensive edifice it is assisted by having a very loose fitting skin, as well as by the powerful structure of its ribs. The appearance of the stuffed animal conveys but a small idea of its beauty; for during health the soft brown skin on its back is resplendent with gloss, and its fawn-coloured abdomen is equal in beauty to that of our brightest birds. Its food consists of land and water insects, which it stows away in its jaw pouches until it has obtained enough for a meal, of which it then partakes with complacent ease. Its habits are nocturnal. Its geographic area is very limited, extending from Queensland to the east of South Australia. The animal is rare.

The echidna, the second and last genus of the monotremes, is popularly known as the porcupine anteater, from the long spines which cover the whole body, leaving the head

only bare. It is furnished with an extensile tongue, which issues from a long, fine snout, like in general resemblance to the great American anteater. It has two integumentary pouches, no teeth, and five-toed feet without webs. It measures from 15 to 18 inches, lives on insects, and its burrows may be found over all the sandy districts of our country, except the north.

THE MARSUPIALIA.

This order, with the monotremes, forms the division of non-placental animals. All of them possess the marsupial bones attached to the brim of the pelvis. The young are born in a very imperfect condition, of very small size, and at a time when their development has proceeded to a very limited degree. Special arrangements are provided for their preservation. When born, they are, in most cases, transferred by the mother to a pouch (*marsupium*) formed by the folding of the skin of the abdomen. Within this are the nipples, which are of great length. The extremely feeble young attach themselves to these intuitively, and are fed involuntarily, until, gaining strength, they are able to leave the pouch, to which they return on the approach of danger. We are all familiar with their contented and inquisitive look as from their comfortable hiding-place they survey the world. The marsupial bones are present in both male and female, and Professor Owen is disposed to think that they are used not only for the support of the pouch, but also for compressing the milk glands for the involuntary supply of food to the undeveloped progeny.

The marsupials are divided by Professor Owen into the rhizophaga, poephaga, carpophaga, entomophaga, and sarcophaga.

(*a.*) The rhizophaga, or root-eaters, are best represented by

the wombat—phascolomys fossor—an extremely clumsy, grey creature, attaining a length of 3 feet, and differing widely from the other marsupials. Its very stout fore legs are furnished with strong, curved, digging claws, with which it burrows into sandy soils. Its tail is rudimentary. It rolls along rather than walks on four legs, and but for its pouch might be classed among the herbivorous rodents. It displays on capture the utmost indifference, receiving the contents of several gun-barrels with the same phlegmatic demeanour as it would a caress from a lady's hand.

(*b.*) The poephaga, or grass-eaters, include the kangaroos and kindred species. In these the fore legs are short, and the hind legs, which alone are used in rapid flight, are disproportionately lengthened, and armed with four toes, of which the third is large and powerful, and used by the male with terrific effect when he is brought to bay. The tail is very long and heavy, but not used in locomotion.

The macropus giganteus attains a length of 7 feet 6 inches, and weighs 160 lbs. The female is smaller and much more timid than the male.

The macropus laniger, or woolly kangaroo, is still larger, turning the scale at 200 lbs. It is a native of South Australia, and there are said to be 80 distinct species of it.

The kangaroos differ greatly in size from the wallabies; but also in this—the muzzle of the kangaroo is hairy; of the wallaby, naked.

Of the wallabies, the petrogale, or rock kangaroo, is the most remarkable. It frequents the mountain chains of the continent, scaling with ease the precipices which neither the active native nor the crafty dingo can attempt. It is of a brownish-grey colour; and, inclusive of tail, is 4 feet long.

The brush-tailed bettong, or Jerboa kangaroo, belongs to a family differing from the macropus in having a short, broad head. It is brownish, pencilled with white; the abdomen

whitish, and the brush black. It is an inhabitant of the prairie country. It builds its nest in rather an artistic manner. Dr. Bennett describes how it seeks a little hollow in the plain, where the grass is high, and carries to the chosen spot, in its tail, a bundle of dried grass. These it arranges so cleverly that it requires the practised eye of the black man to discover its hiding-place.

The kangaroo rat—hypsiprimnus—is of smaller size; equally lively by day and night; and possesses well-developed upper canines, which are absent in the kangaroos. They are brown, with white abdomen. The tail is scaly, with protruding, stiff, black hairs.

The kangaroo hare—lagorchestes leporoides—is 2 feet from snout to tip of tail; of a colour not unlike the European hare—which it still further resembles in squatting in a form, and in doubling when closely pressed by dogs. It inhabits every part of central Australia.

(c.) The carpophaga, or fruit-eaters, are a very numerous and interesting group. At the head is the native bear—koala—the link between the kangaroos and phalangers. Owing to the peculiar formation of its feet, which are furnished with long curved claws, it is almost unable to walk. It is grey, 2 feet long, and tailless.

The phalangers derive their name from the strange junction through the whole length of the second and third digits of the hind feet. The habits of the whole sub-family are arboreal and nocturnal. There are three subdivisions of the phalangers :—

(1.) The petaurists, having the skin of the flanks developed into a parachute-like expansion affixed to the fore arm and hind leg on either side; the hind feet five-clawed, with the thumb opposable, and without a claw; and the tail hairy, very long, and not prehensile.

(2.) The phalangists, having no parachute, but furnished

with a prehensile tail covered with hair, except at the tip, and with a naked stripe along the under side of the extremity.

(3.) The koalas, or native bears, with neither parachute nor tail.

The petaurists use their parachute for passing from bough to bough when in search of food, or in the effort to escape from some more powerful enemy. Having stretched their limbs to the utmost, they launch themselves in this attitude, and not only pass over considerable distances, but even divert their course at will.

The principal genera are the acrobates, petaurus, and petaurista.

The acrobates are well typified in the opossum mouse—A. pygmaeus—having stiff hairs on the tail, set in a double row, like the barbs of a feather. Its back is mouse-coloured, and its abdomen a beautiful white. It is 6 inches long, half of which is tail, and is plentiful at Port Jackson.

The petauri are well represented in the hepoona roo, petaurus Australis; the flying squirrel, P. sciureus; and the beautiful ariel petaurus.

The hepoona roo, or flying phalanger, is a native of New South Wales. It is brown, with a very dark brown stripe extending along the spine. Its head is darker than its body, its abdomen yellowish, tail bushy, and ears long. The body and tail are of equal length, about 18 inches each.

The flying squirrel is known over almost all the continent. The grey bushy tail, with a white stripe underneath, is 8 inches long; the parachute is a light grey, with a dark stripe; and the back is a beautiful brown.

The ariel petaurus, called after the airy spirit of the "Tempest," is of extreme grace and beauty. On the back it is light grey, deepening into a dark brown on the parachute. The abdomen and fringe of the parachute is a

perfect soft white. Dr. Bennett mentions that it is able to fly across a river 40 feet wide from an elevation of 30 feet only. It is widely distributed.

The petaurista are represented by one species, the taguan, P. taguanoides. It is the largest of the petaurists, and is found in the eastern and south-eastern ranges. The general hue of the back is a blackish brown, muzzle and feet black, and abdomen white. It fights fiercely with both teeth and claws when defending itself from capture.

The phalangists have already been described as without a parachute, but provided with a powerful prehensile tail.

The vulpine phalangist, or common opossum, is the species best adapted for description. This animal must not be confounded with the American opossum, which belongs to the entomophaga. Though generally satisfied with a vegetable diet, it will eat eggs, and even birds and insects when hungry. It is as large as a cat, of a greyish-brown colour, and 2 feet 6 inches from snout to tip of tail. There are many other opossums, with most of which we are familiar.

(*d.*) The entomophaga, though they eat herbs and roots, prey for the most part on weaker forms of invertebrate life.

The bandicoot is the most interesting. It is a small animal capable of quick motion, but of a singular character, for though its hind legs are longer than its fore legs, it bends its back into an arch so as to bring its fore feet to the ground, and runs on all-fours. It has five toes on the fore feet—two rudimentary, and three strong and well suited for burrowing. The pouch opens backwards.

The banded anteater is another very interesting species. It is often called the long-nosed bandicoot—myrmecobius. It is a small and extremely elegant little animal, inhabiting South and Western Australia. Its tail is very bushy, and its back has seven white stripes on a brownish-yellow ground ; the abdomen is a yellowish white ; the head is a bright fawn,

and its ears are long. It has no less than fifty-two teeth, outnumbering the teeth of every other animal except the whale and the armadillo. The body is 10 inches long, and the tail 7 inches—this it carries, squirrel-like, over its head.

(*e.*) The sarcophaga—or flesh-eaters—are predacious, and extremely rapacious. Their teeth are very formidable, and give them almost the appearance of the great old-world carnivora.

The dasyures and phascogales are the principal genera in Australia; but in Tasmania two much more dangerous members of this section—the Tasmanian devil and native hyæna—are present.

There are four or five known species of dasyures, all widely distributed over our country, finding a home in the decayed stumps of trees. They flourish best along the sea shore, where they love to roam in search of molluscs and even daintier food. Their general colour is from a very dark to a light brown, on which are a number of white spots somewhat less in size than a three-penny piece. The tail is of moderate length, sometimes spotted, but not prehensile.

The phascogale is not larger than a rat, which it resembles at a distance. Upon examination, however, it is seen that the tail is, near the tip, covered with a mass of jet black hair. It is a most destructive and audacious little pest, penetrating into houses, depredating the larder and hen-house, and defending itself when captured with a savagery not to be expected from its harmless appearance.

THE DINGO.

Although not an Australian native, the dingo, or warragal, deserves a passing notice. It is a true wild dog, of a reddish-brown colour, sometimes approaching to black-and-tan. It has a sharply pointed nose, short erect ears, small, cun-

ning, obliquely set eyes ; powerful legs, and a long bushy tail. After the manner of wolves, they hunt in packs, but are not so formidable as their American *confrères*, slinking away on the approach of man, and fighting only when hard pressed. But they are superior to the wolf in cunning and intelligence. They belong to the few genera which defy the efforts of man to tame them. Even when taken young, and regularly fed, their savage nature exhibits itself in treacherous assaults on the unsuspecting animals which come within reach. They are said to have some curious customs. Each pack has its own hunting ground, beyond which it never travels, and into which it does not permit a neighbouring pack to intrude. They are not cannibals as a rule, though it has been lately stated that the black-and-tan dingo will help himself to the dead flesh of the ordinary species. It is impossible to even guess at the period of the introduction of this pest ; but it must have been at a very remote time, for the genus must now be regarded as Australian.

THE BIRDS.

In consequence of their superior powers of locomotion, the birds do not vary so much from the old-world forms as do the mammals. Yet among the birds, too, our country has some forms entirely its own. All the orders—the cursores, natatores, grallatores, rasores, scansores, incessores, and raptores—are represented.

(*a.*) The cursores, or runners, have rudimentary wings, quite useless for flight, but are furnished with compensating length and strength of leg. They have no breast-bone. The toes are three in number, and are provided with strong blunt claws. The plumage, owing to the fact that the barbs of the feathers are remote and disconnected, presents some resemblance to very coarse hairs. Our representative is the emu.

It is nearly as tall as the African ostrich, and is much taller than its American congener—the rhea. It attains the height of 7 feet. The head is feathered, the throat bare, and the plumage hangs down from a central parting along the back. There are two varieties, and in both the female is smaller than the male. It inhabits the plains and open forest lands of the continent, and feeds on grasses and fruits. The female lays her eggs—13 in number—in a shallow hole and hatches them. When hunted, the emu runs with great speed, and in defence kicks backwards and sideways like the cow, whereas the ostrich kicks forwards. In walking, it makes a booming noise from the throat.

(*b.*) The natatores, or swimmers, are very abundant in species and individuals. Our most representative bird of the order is the black swan. Its head is jet black, its body brownish black, and its wings, with the exception of the six outer quills, are also brownish. In size it is less than the white swan, but possesses far higher powers of flight. It is a fine sight to see these strong-pinioned birds migrating in flocks, in the form of a V, far above the reach of gun-shot. But it is on the water that they are seen to greatest advantage. The neck, in the act of swimming, is inclined slightly back, and is straight almost up to the head, where it bends in a sharp, graceful curve of greater beauty than the S-shaped curve of the white swan. It is easily domesticated, and is very prolific.

(*c.*) Grallatores, or waders, frequent the banks of rivers, marshes, lagoons, and shallow pools. They have legs of great length, and feet elongated, straight, and not quite palmate. The body is generally slender, and the neck and beak long.

The jabiru—Mycteria—is the grandest representative of the order in the world, and is, in fact, the most stately of all birds. It stands 4 feet high, is furnished with a powerful

beak, and feeds for the most part on fish. It is very rare, very wary, choosing the open plains, where it cannot be easily approached. The head and neck are green, the breast, shoulder, and abdomen white, and the lower part of the back and wing is a purplish brown.

The native companion—grus Australis—is another stately and graceful bird. It is found in large flocks in almost every part of the continent. It lays its eggs near the water, and lives on fish, reptiles, and roots. It is of a bright greyish colour, and varies from 2 to 4 feet in height. It is a very treacherous pet, as even the eyes of children are not safe from its dangerous beak.

The straw-coloured ibis, so called from the peculiar straw-like feathers on its neck, is a splendid bird. Its back is green, its abdomen white, and its head a sooty black. Like all the birds of this order, it is gregarious, and assumes the V shape in flight. It is probably a native of the interior, but in seasons of severe drought presents itself at the mouths of our rivers in innumerable hosts.

(*d.*) The rasores, or scratchers, are not largely represented, but there are few birds whose habits are more extraordinary than those of the turkey. The order has strong robust legs ; four toes, three in front, and one behind and on a higher level. The rasores build nests, and the young are precocious, running about and providing themselves with food when they quit the egg-shell. We see their habits well in our yard fowls.

The turkey—tallegalla lathami—the leipoa or native pheasant, and the jungle fowl—Megapodius—exhibit the characteristics of the order in a most marked way. Their feet and legs are immensely powerful ; the young are extra-ordinarily precocious ; and their nests are not simple structures as those of the magpie or swallow, but edifices of huge dimensions. They build on the ground a large tumulus

or mound, as high sometimes as 15 feet, and 60 feet in circumference. In these they place their eggs, and leave them to be hatched by the heat of the sun and of the decaying matter of the mound. Mr. Gould says :—"The mode in which the materials composing this mound are accumulated is very singular, the bird never using its bill, but always grasping a quantity in the foot, throwing it backwards to one common centre, and thus clearing the surface of the ground for a considerable distance so completely that scarcely a leaf or a blade of grass is left. The mound being accumulated, and sufficient time allowed for heat to be engendered, the eggs are deposited, not side by side, but at a distance of 9 to 12 inches of each other, and buried at nearly an arm's depth, perfectly upright, with the large end upwards. They are covered up as they are laid, and allowed to remain until they are hatched." The male bird watches the temperature of the mound very carefully, and during hot days he will nearly bare the eggs two or three times so as to moderate the heat. Upon the young bird chipping out it remains for 12 hours immovable, and is as carefully watched and covered by the male as the eggs. On the second day it emerges covered with feathers, not down ; and on the third day it is capable of strong and rapid flight.

These mound-builders form a distinct sub-family, the megapodidæ. Of the structures, those of the leipoa are the smallest, the turkeys' next, and the jungle fowls' the largest; indeed, so large are the latter, that the early settlers thought they must be the graves of the natives.

The turkey lives in the dense bush, through which it can run, when pursued, with great deftness. It is gregarious, as the size of the mounds testify, and very suspicious. It affords excellent sport, and is splendid eating. The colour of the body is blackish brown above, and the same below, with silver grey, produced by the tips of the feathers. The

cheeks are naked, the head and neck covered with short, hair-like, dark black feathers ; and the neck is furnished with a fleshy wattle, something like that of a turkey, of a bright yellow, changing to orange at its junction with the neck. The bill is black, and the legs a dark brown. It is somewhat larger than the domestic turkey. It is found all over Australia, and its mounds are in the densest scrub in some dry and desert spot.

The megapodius is confined to the thickets along the eastern shores. It is brown on the head, blackish grey on the neck, cinnamon brown on the back and wings, and the legs are orange.

The leipoa, or native pheasant, is an inhabitant of the north-western districts. The head, with its tuft, and the neck are blackish brown ; the back of the neck gray, and the front covered with long black pointed feathers, each having a white stripe along its centre. The feathers of the back and wings are brown, with three bands of greyish white, brown, and black, forming a series of eyes upon the feathers ; the bill is black, and the legs are brown. The bird is about the size of a female turkey.

(*e.*) The scansores have four toes, two turned forwards and two backwards, thus enabling them to climb with ease. Their powers of flight are moderate. The order is very largely represented in our country. The psittacidæ, or parrots, are the most numerous and representative.

The parrots, parrakeets, and lorrikeets differ considerably from each other. The parrots have the tail short and broad ; the parrakeets and lorrikeets have the tail long, and generally consisting of only two feathers at the tip ; the lorrikeets have their thick tongues covered with hair, hence the generic name, trichoglossus (*thrix*, a hair ; and *glossa*, the tongue).

The parrots include the beautiful cockatoos ; the parrakeets, the rosella, parrakeet cockatoos, warbling grass

parrakeet, blue-banded grass parrakeet; the lorrikeets, the scaly-breasted tricoglossus.

To enumerate and describe the order in full would occupy whole pages, but the student is probably already well acquainted with many members of this gorgeous and attractive group.

(*f.*) The insessores, or sitters, or perchers, have the legs slender and short, three toes in front and one behind, the two interior being joined by a very short membrane. The brain attains in this order the greatest relative size, the organs of voice rise to their highest complexity, and the beauty of the plumage acquires its highest development.

The most representative genera are—the laughing jackass, lyre bird, magpie, bower birds, emu wren, and the honey-eaters.

The laughing jackass—dacelo gigas—has a long bill, broad at the base, pointed and hooked at tip; wings of moderate length, and claws long and curved. It is a very powerful bird, of an olive brown, with a brownish-white abdomen. Unlike most of the kingfishers, it rarely fishes, preferring to wage a successful war against snakes and other reptiles. It is an inhabitant of eastern and southern Australia, and receives its uncomplimentary name from the rollicking sound with which it ushers in the dawn and notes the return of darkness. The dacelo Leachii, a handsome kingfisher, is an inhabitant of the north-east; and in the north-west the genus is represented by the buff dacelo. Both these birds make a deafening, disagreeable noise. The halcyon, or Australian kingfisher, utters a cry like the human voice in distress.

The menura superba is by far the grandest bird among the insessores. It belongs to the wren family, and is called the lyre bird from its gorgeous tail, which resembles the lyre of the ancients. The two outer robust feathers form the frame-

work, and the delicate white central feathers, the strings. The tail is often 10 feet long. The bird is very shy, seldom takes wing, but runs over rocks and down gullies with amazing agility. It is a wonderful imitator, not only mimicking the voice of every bird and animal, but truly rendering sounds from the scraping of a saw to the pop of a champagne bottle.

The menura Alberti is a closely allied species, shorter in the tail, but, if possible, superior as an imitator.

The lyre bird has a circumscribed area—seldom found north of the Liverpool Range or west of the Dandenong Range.

The magpie, or piping crow shrike, is a true crow, and is found all over the continent. It received its familiar name from its resemblance to the true magpie of Europe. In consequence of its trustfulness and great hunting capacity it is the valued friend of the gardener.

The emu wren—stipiturus malachurus—is a pretty little bird, with a long tail consisting of six feathers. The two central ones are twice as long as its body. It seldom flies, but darts along the ground with great rapidity. It is brown on the back and white on the abdomen.

The bower birds are the most beautiful representatives of the starlings. The plumage of the male satin bower bird is a very glossy satin purple, and that of the female is an olive green. It is an inhabitant of the brush country along the eastern coasts. The spotted bower bird prefers the interior of the continent. The male is of a rich brown colour, with buff spots, and wears down its neck a fringe of long, rose-pink feathers. Mr. Gould thus describes their bowers :—"They are usually placed under the shelter of some overhanging tree in the most retired part of the forest. They differ considerably in size, some being larger, while others are smaller. The base consists of an exterior and somewhat convex plat-

form of sticks, firmly interwoven, on the centre of which the bower itself is built. This, like the platform on which it is built, is formed of sticks and twigs, but of a more slender and flexible description, the tips of the twigs being so arranged as to curve inwards and nearly meet at the top. In the interior of the bower the materials are so placed that the forks of the twigs are always presented outwards, by which arrangement not the slightest obstruction is offered to the passage of the birds. The interest of these curious bowers is enhanced by the manner in which they are decorated, at and near the entrance, with the most gaily coloured articles that can be collected, as blue tail-feathers of the Rose Hill and lorry parrots, bleached bones, shells of snails, &c. Some of the feathers are stuck among the twigs ; while others, with the bones and shells, are strewed about near the entrance. The propensity of these birds to fly off with any attractive object is so well known that the blacks always search the runs for any missing articles." The bowers seem to be used as playgrounds only, where both sexes assemble in numbers for sport.

The honey-eaters—meliphagidæ—are a very large genus of small birds, which delight to frequent the topmost boughs of the trees, and are for the most part extremely noisy. The vast number of flowering trees and shrubs, to the receptacles of which innumerable flies and bees resort, has, no doubt, greatly aided in making the honey-eaters almost the commonest birds in some parts of our country. The principal species are the New Holland honey-eater, confined to the south-eastern and southern districts ; the white pinioned honey-eater of the northern parts, the garrulous honey-eater of the south-east, the friar bird, and the brush wattle bird, which is most abundant in South Australia.

The morepork—podargus—is represented by two species, the podargus numeralis and the New Holland goat-sucker.

The podargus is a nocturnal bird, during the day being utterly helpless through extreme drowsiness. Its beak is broader than the head at the base, and is hooked at the tip. It is brown on the back, tawny coloured on the shoulders and tail. Its name comes from its peculiar cry.

The New Holland goat-sucker is a rich brown bird, with a grey abdomen speckled with buff. In appearance it resembles the owls. Its habits are nocturnal, but if disturbed during the day it is able to overcome drowsiness much more readily than the morepork. Round its nostrils are black, brown, and white feathers, inclining backward over the head as in some of our fancy pigeons. It loves the hollows of gum trees, laying its eggs on the soft decayed wood, and hatching them in the usual way.

(*g.*) The raptores, or birds of rapine, are all characterized by the shape of the bill, which is strong, curved, and sharp-pointed. The upper mandible is the longest, and strongly hooked at the tip. The body is very muscular; the legs short and strong, armed with long talons; and the wings of great size.

The bold eagle, found in all the southern parts, is of a blackish brown, becoming lighter towards the edges of the wings. The back of the neck is of a reddish hue, and the tail slightly barred. The wings are commonly 8 feet across from tip to tip. The bird has received its appellation of "bold" from the audacity which it showed upon first coming into contact with Europeans. This audacity it has not lost; even now it may be seen swooping down at a shooting-match upon the pigeons, which are its daintiest morsel, in absolute defiance of the group of sportsmen. It is a terrible enemy to hares, rabbits, kangaroos, and to the imported game birds.

The caracara (milvago Australis) or brown hawk, is 18 inches high; is of a greyish brown colour on the back, and some-

what paler on the abdomen. They are most daring birds when hungry, but at other times are said to take no notice of the presence of booty.

The cream-bellied falcon, or brown hawk, is also an Australian native ; as also are the white eagle (astur), and Jardine's harrier, with its strange grey collar.

The owls are diurnal, and feed on insects and young mammals.

REPTILIA.

All the recent orders of reptiles are present in Australia. The chelonia—tortoises and turtles—are not numerous ; the ophidia, or snakes, are represented by 60 or 70 species ; the lacertilia, or lizards, by 140 species ; and the crocodilia are also present within the tropical districts.

The general characters of the ophidia are so well known to us that a very brief sketch of the order will suffice.

The black snake—pseudecys porphyriacus—is found all over Australia, and is more numerous in the warmer climates than in the south. The head, back, and tail are of a purplish hue ; the lateral scales and abdominal plates are a rich carmine lake ; the under side of the head and tail is lighter than the back. The average length of head is 1 inch ; of body, 5 feet ; and of tail, 6 inches. It is also recognizable by having the anterior sub-caudal scales in one row, and the posterior in two rows. It is of a very deadly character.

The hoplocephalus superbus, or copper-headed snake, varies from light brown to nearly black, and has a dark V-shaped mark on the head. The abdomen is a pale yellow, turning to a grey along the middle and tail. It is a resident of the south, and is extremely dangerous.

The hoplocephalus curtus, or diamond snake, has the back of an olive brown colour ; the head of a darker olive

bronze ; and the abdomen of a dark yellow to a pale straw colour. The abdomen is flat, and the back ridged. The head is $\frac{3}{4}$ inches, the body about 2 feet, and the tail 4 inches. It is the most vicious of the Australian species, and when angry flattens its head and spreads it laterally like the Indian cobra. It is everywhere present, and is richer in individuals than any other species.

The vermicella annulata, or black and white ringed snake, has a thick blunt head, and is perfectly ringed with alternate rings of black and white. A black ring consists of six rows or scales and a white of three rows. The total number of rings is 40. The head is $\frac{1}{2}$ inch, body 20 inches, and tail $1\frac{1}{4}$ inches. It is poisonous, and is rarely found south of the Murray.

The morelia variegata, or carpet snake, is a python. It is often 10 to 12 feet long, and receives its name from its peculiar markings. On a pale brown ground are large patches of a yellowish colour, with a black spot in the centre and a blackish ring. Down the back are two black lines with an intervening space of a ground colour. The head and abdomen are yellow ; the teeth solid and curved backward, without groove or poison fang. It is able to hang from the bough of a tree, and kills by coiling.

The seas on the north are infested with sea snakes, one of which—the hydrus Stokesii—is as thick round the body as a man's thigh. Some of them are venomous, and all are very dangerous in the water. Though distributed all over the north coast, they are greatest in size and most numerous on the north-west.

It is a noteworthy fact in connection with the ophidia that no vipers are found with us. Most of our snakes belong to the elapidæ, which have permanently fixed and erect poisonous fangs in a head, shield shaped, and not wider than the body.

The **lacertilia**, or lizards, are found all over the country. The largest are the monitors, which resemble their congeners of the Nile ; the agamo muricata, generally called the iguano ; the varanus varius, or great lace lizard of the scrub ; and the clamydosaurus lingu, of the north, which is distinguished by the immense frills which surround the neck, and fold back like wings when the animal is not excited.

The **crocodilia** are represented by the glavial. They abound in the northern and north-western rivers, and are very daring, attacking Gregory's horses during his exploration of the Victoria river. They are black or blackish yellow, furnished with jaws 2 feet long, in which are set irregular teeth $1\frac{1}{2}$ inches in length. The fore feet have five toes, the inner three furnished with long, slightly curved nails. The hind legs have four webbed toes. Along the back, and spreading from it along the shoulders, is a high, notched ridge of a black colour.

PISCES.

The fish are well represented when we consider the paucity of flowing rivers. The salmons and carps are absent, but very many old-world forms are present. Of the varied genera it is unnecessary to speak here, but the ceratodus and Port Jackson shark demand a passing notice.

The most remarkable river fish is the ceratodus Fosteri, or mud-fish. It belongs to the dipnoi, which are represented in South America by the lepidosiren paradoxa, and on the banks of the Gambia by the lepidosiren annectens. They all bury themselves in the dry season in the muddy beds of the rivers in which they are found, forming for themselves a chamber, within which they coil themselves up until the rains fill the river channels. The ceratodus, or barramunda of the natives, attains a length of 6 feet, and has the body

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covered with large scales. The dipnoi were formerly placed among the amphibia, but recent zoologists have considered them a species of ganoid.

The Port Jackson shark is the solitary representative of the cestraphori, which have the whole of the upper palate paved with large, flat teeth, by means of which they crush the hardest molluscs.

No account has been given of the amphibia and insecta; but it is hoped that the brief descriptions of some of the wonders of our plants and animals will be of sufficient interest to induce the student to seek further information from books; and, what is far better, to go abroad and observe for himself in the great school of nature.

CHAPTER XI.

AUSTRALIA—ITS GEOLOGY.

DEFINITIONS.—**Stratified** rocks are formed through and by the agency of water. The surface of high land is carried by the winds and rain into the waters below, and there deposited in layers of varying thickness.

Unstratified rocks are formed through and by the agency of fire. These, rising up from below, intrude through the stratified rocks, making up in some way for the loss caused by atmospheric forces.

Denudation is the act of carrying away a portion of the land, and thereby laying bare a lower stratum.

A **Formation** is a series of layers having the same physical character.

A **Period** is a great epoch of time during which certain forms of life prevailed.

For the purpose of this sketch, the following table will suffice for the stratified rocks of our country :—

Periods.	*Formations.*
Palæozoic (old life)	1. Silurian. 2. Devonian. 3. Carboniferous.
Mesozoic (middle life)	1. Upper New Red Sandstone, or Carbonaceous. 2. Oolitic. 3. Cretaceous.
Cainozoic (recent life)	1. Eocene. 2. Miocene. 3. Pliocene. 4. Post Tertiary.

Silurian rocks are the basement on which the mountains of the east, south-east, and south coasts rise, and of which these chains are mainly composed. In South Australia the silurian formation extends from Spencer's Gulf to the Alberga river. In the west, patches of the Darling Range and the Weld Mountains are silurian ; and so are two tracts—one west of the Bogan, the other west of the Darling.

Devonian rocks are very largely met with from 18° to 29° S. lat. in the north-east ; are found in patches from the Darling eastward ; and are also present in south-east.

Carboniferous rocks extend over a great area of the east ; are very sparsely scattered over the south-east ; and, as far as is known at present, are found nowhere else. The exact localities are the valleys of the Burdekin and Belyando ; west of the Broad Sound Ranges, where the formation is narrow to 27° S. lat. ; here it spreads west from the Taylor Range to the Maranoa river ; a large area between the Macintyre and Gwydir, between the Shoalhaven and Clyde, between the New England and Nandewar Ranges ; the Liverpool Plains ; the valley of the Hunter ; small patches along the valleys of the Mitchell (Gippsland), Avon,

Thompson, Latrobe, and Ovens ; and the Victoria and Serra Ranges. In this formation true coal is found, and is present in large quantities in Queensland and New South Wales. It has been sought for in Victoria, and found in seams of extreme thinness, but it is nowhere present in payable quantity.

Upper new red sandstone, or carbonaceous rocks, are somewhat more generally distributed than the carboniferous, and for the most part adjoin the true coal measures. On the north is a large triangular area lying between the Victoria river, the Nicholson river, and Cape Arnhem ; another between the Palmer and Mitchell (Queensland) rivers ; an irregular patch extends from the Peak Range to the Bunya Bunya ; another from the Condamine to the slopes of the Peel Range ; and, from Broken Bay to Shoalhaven river, bounded on the west by the Dividing Chain, is a vast carbonaceous formation. In the south-east small areas are met with at Corner Inlet, between Capes Liptrap and Patterson ; between Geelong and the Otway, and between the Wannon and Casterton.

In the east coal is found in the areas just described ; and, in Victoria, seams from 2 to 12 inches are present. A 3-feet seam is found at Cape Patterson in the Kilcunda mine at a depth of 684 feet ; and at Griffiths Point. But, though the analyses of Mr. Cosmo Newbery show the mineral to be of very good quality, the extent of the seams is too small to pay for working them.

In the south this formation does not appear ; but in the south-west, from East Mount Barren to Port Two People, is a narrow area. Carbonaceous strata line the west coast from the Moore river along 115° E. long. to the Lyons, but no coal has been found.

The cretaceous and oolitic formations cover a large tract of irregular shape bounded on the north by 18° S. lat. On

the west it follows the Queensland frontier to the Barcoo, where cainozoic rocks intrude, and below the river is bounded by the Canaway Range and the highlands terminating in Mount Babbage. A line from Mount Babbage to the north of Wilcannia, and thence along the right bank of the Darling as far east as the junction of it and the Culgoa, forms the southern boundary. Thence in an irregular line it extends to the Mungallala Creek, and then nearly due north through Mts. Playfair and Sentinel to the sources of the Flinders.

The cainozoic rocks are the most largely represented of all. On the east they cover the slope of the Pacific chain to the shores of Carpentaria, and all the country lying between the silurian, carboniferous, and carbonaceous on the east, and the cretaceous on the west. On the south it includes the north-west districts of Victoria. Here it is bounded by the Glenelg as far as Dartmoor. To the west this formation is bounded by the silurian formation of South Australia, and the metamorphic rocks which extend from the Alberga to Port Darwin.

From the Glenelg to 143° E. long., this formation stretches along the shore from Cape Otway to Goolwa, flanks the shores of Port Phillip, and extends in a narrow strip from Corner Inlet to the Snowy river.

To the west, probably, the Great Victoria Desert, the Spinifex Desert, and the Great Sandy Desert are all cainozoic, except where igneous and metamorphic rocks intrude. Miocene rocks are present in the south coast of Victoria, and the desert sandstone is probably of pliocene age. Pliocene rocks underlie the auriferous drifts of central Victoria, and are found at elevations of 4,000 feet overlying unconformably all the older formations, igneous and stratified. No marine fossils are found in those rocks which rise higher than 600 feet above sea level. The Great Desert

sandstone, which occupies one-third of the continent at least, contains no marine fossils, and has been formed by the denudations of great ranges and tablelands once occupying the sides of a huge country whose centre was an inland sea. It lies, almost certainly, on a great cretaceous formation containing an unlimited supply of water. This water seems to burrow passages for itself underground in directions varying from south-west to west—in fact, it flows in the very same directions as the great bulk of surface water. Direct evidence of this statement is seen in the caves of Narracoorte, in the east of South Australia; in the wonderful hewing out by Nature's hand of the Chambers Pillar; and in the strange pillar groups discovered by Captain Grey in his ill-advised expedition to the North-west in 1837.

All visitors to Australia should see these wonderful places; and all Australians, who have the means to travel for amusement and instruction, should visit these wonders of their own land before they think of doing the sights of other countries. So wonderful are they that they deserve a lengthened notice. The Narracoorte caves, many of which are found on the Mosquito Plains station of the late hospitable and open-handed Mr. John Robertson, are in the midst of fairly grassed, sandy, tertiary country, plentifully covered with stringy-bark trees (eucalyptus obliqua). The entrances to them are through small round holes in the surface of the ground. Being let down 10 to 25 feet by a rope, through one of these holes, and proceeding from the place of landing 20 or 30 feet, a visitor finds himself in shrines unsurpassed in beauty by the most elaborate of human structures. Rev. J. E. Tenison Woods thus describes his visit to one of them: "The observer finds himself at the entrance of a large oblong square chamber, low, but lighted by an aperture in the other end, and all around, above and below, the eye is

bewildered by a profusion of ornaments and decorations of Nature's own devising. It resembles an immense Gothic cathedral, and the number of half-finished stalagmites which rise from the ground, like kneeling or prostrate forms, seem worshippers in that silent and solemn place. At the farther end is an immense stalactite, which appears like a support to the whole roof; not the least beautiful part of it being that it is tinted by almost every variety of colour, one side being a delicate azure, with passages of blue, green, and pink, intermingled; and again, it is snowy white, finally merging into a golden yellow." Of another cave he writes :—"The chamber is so thickly studded with stalactites, that it seems like a carefully-arranged scene, which, from the interminable variety of form and magic effect of light and shade, might easily be taken to represent some fairy palace. Very soon the cavern becomes dark as night, and further exploration of the numerous chambers and fissures beyond has to be made by the assistance of torches." Of a third he says :—"Proceeding a little way down, a large vaulted chamber is reached, so perfectly dark and obscure that even torches can do but faint justice to its beauty; here, above all other portions of the caves, has Nature been prodigal of the fantastic ornament with which the whole place abounds. There are pillars so finely formed, and covered with such delicate trellis-work, there are droppings of lime making such scroll-work, that the eye is bewildered with the extent and variety of the adornment. It is like a palace of ice, with frozen cascades and fountains all around." In the Narracoorte caves the excavating agent—water—has not been near enough to the surface to make the roof so thin that collapse must result; but, in the case of the Chambers Pillar, already described, and in that of the pillars of the north-west, the water has so undermined the surface that the caves are now only great natural depressions. Captain Grey

says that during his attempted journey from Hanover Bay to Perth he came upon several acres of land covered with high sandstone pillars of singularly grotesque forms. One cave resembled a vast unroofed cathedral lined with massive pillars over 40 feet high.*

In another, pedestals, supporting what looked like the ruins of statues, stood forth in solemn and lonely grandeur. The sound of running water explained to him the cause of these fantastic shapes ; for, forcing himself through a fissure into a cave, the roof of which had not yet collapsed, he beheld the mighty subterranean motor-power which had carved out such strange designs.

These scenes of our country must recall to the mind of the reader the "Hall of the Virgin" in the Hérault, the grotto of Han in Belgium, and the Mammoth Cave of Kentucky, U.S.; all of which owe their formation to subterraneous water.

To the question so often asked, "What has become of the water?" the answer is, "It has percolated through the soil." It will percolate until it reaches an argillaceous or limestone stratum ; and then, if the formation of the beds be basin-shaped, it will be stored ; if it be sloping, it will flow with the decline as a subterranean river. Both these conditions, but more generally the latter, exist in Australia. The quantity of water which disappears by percolation must be enormous, as a few figures will show. The rainfall for the interior averages at least 18 inches annually. Of this amount less than 2 inches get into the rivers ; and, making a due allowance for evaporation, by far the greater part of the balance goes underground. The formation of stalactitic caverns and pillars, as well as the fact that the porous

* The writer has visited these wondrous structures of nature ; and, by the aid of a bonfire, has been enabled to see the weird aisles of snowy whiteness as they stretched far away in the deep gloom.

surface strata do not become saturated, leads to the conclusion that the subterraneous water finds its way to the ocean. The velocity of this underground water must be very slow, for the fall in the water-bearing cretaceous beds is very gradual, and the caverns are not of great extent. The head waters (if we may be allowed to use the term) of this subterraneous flow are close to the Pacific mountain system. Here the annual accession to it is equivalent to 20 inches of rainfall; and, as it moves westward, it is further swollen by percolated water; so that, notwithstanding the escape to the ocean, we must feel quite certain that the underground supply of water is inexhaustible.

On many stations borings have been made. At 160 feet Mr. F. L. Parker obtained a plentiful supply of water on the Buckalow station, near the Stanley or Barrier Ranges. At 430 feet, in cretaceous beds, Sir S. Wilson found water rising to 100 feet of the surface at Urisino. At 488 feet, in cretaceous beds, water rose at Mount Wilson to within 90 feet of the surface; and, 20 miles to the west, at 572 feet, in cretaceous beds, water rose to within 10 feet of the surface. And at Wee Watta, on the Kallara run, Mr. David Brown, at 144 feet, struck water which rose 26 feet above the surface, and discharged 60,000 gallons daily. These borings conclusively prove the actual existence of subterraneous water, and point out that it may be expected at a depth of about 600 feet: a shallow depth when compared with the 2,000, 3,000, nay, even 4,000 feet borings in the Old World. The expense of boring is small, and the time occupied in sinking is short; it is, therefore, amazing that our settlers are not, as a rule, forming artesian wells, which will transform the parched surface into luxuriant pasture lands. It has been already stated that, in the arid plains of Mexico, immense vineyards now flourish in consequence of the almost magic power of artesian irrigation.

The auriferous drifts are in this period. They occur in all the formations from the miocene to the post tertiary, and always lie upon the silurian "bed-rock." The drift depth varies greatly in consequence of the crumpled nature of the bed-rock, so that gold may be found at a depth of 500 feet in the drift in one place, and within a short distance at a few feet from the surface.

The "oldest" drift is of miocene age, and in it gold has not been found in payable quantity. It is believed that the non-auriferous character of this drift is due to the appearance of the great quartz veins at different periods; that the first quartz veins preceded the miocene age, and were almost barren; and that the second rich quartz veins followed the miocene gravels.

The "older drifts" are pliocene, and are often very rich in gold. Lying on the bed-rock they incline as the surface inclines. Thus, in Victoria—the greatest gold-bearing colony—the gutters slope towards the sea at Ballarat, while at Sandhurst they slope towards the Murray.

The middle drifts are newer pliocene, and are separated from the older drifts by what the miner calls the "fourth" rock. The recent drifts are separated from the middle drifts by the "third" rock. The most recent drifts lie upon the "second" rock, and may, or may not, be covered by the "first" rock. These intervening rocks are lava flows, which, during eras of volcanic activity, poured over the ancient river valleys. It is by no means necessary that they should all be present; and cases have occurred in which they were all absent in a shaft having three auriferous gold-bearing strata.

The principal quartz-veins which supply the drifts, and which are themselves most rich in gold, appear as intrusive rocks in the upper and lower silurian strata. In these, as well as in the drifts, the gold appears in small particles, sometimes as crystals, but more frequently without shape.

Some shapeless masses of great size have been found—the "Welcome Stranger" weighed 2,302 ozs. 18 dwts. 5 grs.; the "Precious" Nugget, 1,691 ozs. 2 dwts.; the "Viscount Canterbury," 1,105 ozs. Eight others, weighing over 300 ozs., have been found in Victoria. The formation of large nuggets has given rise to much speculation among geologists. Mr. Selwyn, late government geologist, gives excellent reasons for his opinion, that "nuggets may have been formed and may have *gradually increased* in size through the deposition of metallic gold (in manner analogous to the electroplating process) from the meteoric waters which circulate through the drifts, and which must have been, during the time of our extensive basaltic eruptions, of a thermal, and, perhaps, highly saline character, favourable to their carrying gold in solution."

The post tertiary formation is mainly pleistocene. The caves in the Wellington Valley, on the Macquarie, and its tributary, the Bell, as well as those found in other parts, branch off through the rocks in different directions; and the roofs and floors are covered with stalactitic and stalagmitic forms. In these, bones have been found, scattered, broken, but not water-worn. Some embedded in the loose earth; but most found in breccia, which is of the same age as the bony breccia of the Mediterranean caves. The bones are of marsupials—giant kangaroos; the head of one of these, in the British Museum, is 3 feet long; wombats, as tall as bears; the thylacoleo, a huge and predatory phalangist, equal in size to a lion; extinct forms, such as the elephantine diprodoton; the nototherium, as large as a rhinoceros; and forms, now absent from the continent, but existing elsewhere, as the dendrolagi of New Guinea; the thylacinus (native wolf), and the sarcophilus (native devil) of Tasmania.

In addition to these genera of mammals, differing only from their present representatives by their superior size,

there have been found a monitor lizard 20 feet long, and an emu—the dromornis—10 feet high, and having a massive osseous structure. The drifts and the alluviums frequently contain timber slightly modified—trees *in situ* have been found at Ballarat, and fossil fruits in the gold-bearing gravel at Smythesdale. These remains, as well as the desert sandstone, lead us to the conclusion that during and since pliocene time there has been no marine submergence of the continent, but rather, an age of gigantic denudation.

At the present time there are agencies at work; but so gradual are they, that we do not perceive them. It is probable that the great era of submergence, attested by the formation of the barrier reef, is not yet over; and that a counterbalancing rising of land is still taking place along the shores of the south and south-west.

IGNEOUS ROCKS.

Igneous rocks are unstratified, and are formed by and through the agency of fire. They are—

1. Granite, associated with the earliest sedimentary strata.
2. Trap, associated chiefly with the mesozoic period.
3. Volcanic, associated with the cainozoic period.

1. Granite is found largely as an intrusive rock in the silurian formation of the east; in the New England, Maneroo, Muniong, and Wanderers' Chains; and is present in patches in the Benambra, Bogong, and Tambo Spurs of the Bowen Range; and in the Barry Mountains of the south-east. Along the south coast it appears from Mt. Baw Baw to Mt. Dandenong; in a large tract bearing the higher tributaries of the Goulburn River; at Mts. Arnold, Disappointment, Tarrangower, Alexander, Korong, Cole, Beckworth; to the east of the Grampians; in the Serra Range; and between the Glenelg and Wannon Rivers. It

also occurs at Wilson's Promontory, Arthur's Seat, Mount Eliza, and Station Peak in the extreme south of Victoria. It forms the principal peaks of the Stanley or Barrier Range ; of the Gawler Range ; of the Musgrave Range ; and covers an immense area of Western Australia. This area extends along the southern shore from Point Culver to the Leeuwin ; is bounded on the west by 117° E. long. to the Ashburton River ; and is of very irregular outline on the east, protruding into the Victoria Desert, narrowing to one-third of its southern width at 30° S. lat., again pushing to the very base of the silurian rocks of the Weld Mountains, and terminating in a rectangular block about 60 miles wide. The sources of the Yule, De Grey, and Oakover are in granite ; and on the north and centre granitic hills appear sparingly near the Daly and Darwin Rivers, and in the Ashburton, M'Douall, and Macdonnell Ranges.

Granite rocks are younger than the lower silurian strata, and older than the carboniferous. They appear upon the surface in patches without any defined axis, or any physical connection with the main geographical contour. The cause of their appearance is the removal by denudation of the once super-incumbent masses. In almost every district where they are found, they afford good durable building stone. Non-auriferous quartz veins are often found traversing the granite.

2. Trap rocks, so called from their stair-like appearance, are of rarer occurrence than granite. They are associated with the upper silurian and carboniferous stratified rocks, which, near the points of contact, become very hard and flinty.

The auriferous quartz veins are found for the most part in the decomposed trap dykes. These decomposed dykes are local and irregular ; even in the same dyke, portions will be decomposed for several hundred feet, while other portions will be of crystalline hardness.

The principal localities are—on the extreme north of York Peninsula, near the sources of the Gilbert ; at Rockhampton and Port Stephen ; in the area lying between the earlier waters of the Macintyre and Gwydir ; along the Liverpool Mts. ; to the west and parallel to the Snowy river in Victoria, and to the east of the same river in New South Wales ; at Woods Point, the Dandenong Ranges, Mount Juliet, Macedon, Bacchus Marsh, the Wannon basin, the Cavenagh, Jamieson, Barrow, and Warburton Ranges, the Victoria river in Northern Australia ; Mt. Mueller on the Strangways ; and on the left bank of the Nicholson.

3. Volcanic rocks appear mostly as basalt, dolerite, ash and lava. The basalt of the earlier volcanic rocks is not unfrequently columnar, like the great masses of Fingal's Cave in the south of Scotland, and the Giants' Causeway on the north-east coast of Ireland ; whilst the later basalts are present as bluestones of every texture from light, open, honeycombed rock, to the hard gloomy building stone of our engineering and less ornamental edifices. In some districts it is associated with beds of regularly stratified ashes, and is then so soft as to be easily sawn into blocks. This stone is found in Warrnambool and neighbouring places, and is a tolerably durable material. The older lavas seem to have flowed down through rents and fissures of considerable width ; but the later ones, which must have been of much greater extent, seem to have spread over the country in vast sheets of molten matter, even after our present flora and fauna made their appearance. The volcanic localities are few, except in Queensland and Victoria.

In Queensland 30,000 square miles of downs, peaks, and mountain chains are volcanic. Dome-shaped craters and conical hills are especially present near 20° S. lat. Near Mts. Lang and Dalrymple, along the Cape river, between the Suttor and Maranoa, and in the vicinity of Gympie and

Ipswich are the most extensive areas. In the central and southern part of the Great Dividing Chain no truly-formed craters are seen; though the older basalt crowns the summits of some of the highest mountains, and modifies the mineral-bearing districts to no small extent. The low-lying lands of the Yule and adjoining rivers, the Leopold Ranges, the south of the Roper, the M'Kinley Ranges, and a few points in the Reynold's Chain, are volcanic; but, in the south-west of Victoria, there must at one time have existed a state of volcanic activity which rivalled anything ever witnessed in Italy, or the Mediterranean. The traveller is struck by the beautiful pyramidal hills which stand out upon the level plains and plateaux as landmarks to guide him. Beginning at the Saltwater river near Williamstown, and pushing north to 37° S. lat., this area of recent volcanic disturbance extends westward to Mt. Gambier, and seems to have displayed its fiercest activity in the vicinity of Portland, near which Mts. Rouse, Napier, Eccles, Tower Hill, Gambier, and Schanck, perhaps simultaneously, vomited forth, amidst terrific roarings, their lurid fires and mighty floods of red-hot lava. Within this district are 83 distinctly-marked volcanic hills; the most remarkable are—Franklin, 2,092 feet, near Yendon; Buninyong, 2,452 feet, and Warrenheip, 2,437 feet, near Ballaarat; the Anakies, 1,350 feet, and Cotterill, 697 feet, near the Werribee river; Aitken, 1,683 feet, near the Saltwater river; and Holden, 1,452 feet, in the same neighbourhood. Further to the west are Tower Hill; Rouse, 1,220 feet; Pierrepoint, 891 feet; Eccles, 570 feet; and Napier, 1,440 feet, which must have been a giant among volcanoes, if we can judge anything from its magnificent proportions, and from the miles of lava, which, issuing from its fiery crater, have covered the surrounding lands. Just across the border are Mt. Schanck and the grand Gambier, with its beautiful lake, already described. Nor is the list

even now complete, for the Rev. J. E. Tennison Woods has shown conclusively, that, to the south of Portland, and at but a short distance from the present shore, there once existed a sub-marine volcano which poured its igneous products into a seething ocean.

Over this volcanic area numerous lagoons and basin-shaped cavities occur, and it is probable that they too are the sites of extinct volcanoes. Lake Purrumbete is 150 feet deep, and 4 miles in circumference. Gnotuk is 300 feet deep; Terang and Keilambete are still smaller depressions.

Wherever the older volcanic rocks occur the land is of an extremely rich character, affording an almost inexhaustible depth of rich chocolate soil to the agriculturist. The character of the country varies much more in the vicinity of recent lava flows. In some places it is extremely stony and barren; in others, excellent for pastoral pursuits; whilst in not a few places it equals in fertility the older rocks.

The physical condition of our country in the times prior to, and contemporaneous with, the appearance of the volcanoes deserves our attention. During the deposition of the vast mesozoic strata, which are largely represented on the surface, and, perhaps, even more largely below the surface of the continent, all Australia, excepting the south-east corner, must have been below the ocean. The bed of the ocean was undisturbed by earthquake action, and the surface unruffled by fierce storms. In this peaceful period the beautiful fossil-shells and corals of our cretaceous formation were deposited. As time went on the land to the north of the Victoria arose above the ocean, and changes in climate and life took place, until the miocene age was reached. Towards its close the long-threatened convulsion took place along our southern coast, then buried beneath the sea, the deep and ominous roll of the earthquake was followed by the appearance of volcanic vents, which poured

their lava streams into the surrounding waters. Whether the outbursts of Gambier and Napier, of Eccles and Tower Hill, were synchronous we cannot tell; whether the now sub-marine crater near Portland belched forth its flames contemporaneously with the high-crested Franklin is hidden from us; but this we certainly know, that during the later miocene era all these ocean-girt peaks were at certain times in fierce activity.

While, in imagination, we are contemplating this strange spectacle, with panoramic suddenness the scene is changed—the land rises 600 feet, bearing on its surface the stately volcanoes, which still continued to disgorge their contents over the new-born land.

One by one these monuments of the past expired, a few perhaps surviving long enough to give rise to a tale of wonder among the traditions of the blacks.

METAMORPHIC ROCKS.

These are made from the sedimentary rocks by some crystallizing process, and vary exceedingly in the crystallization which they have undergone. The most common ingredients are quartz, felspar, mica, hornblende, talc, chlorite, serpentine, garnet, andalusite, tourmaline, topaz, graphite, sapphire, and quartzite.

The principal localities are near Mt. Garnet and the Gilbert River, in York Peninsula; near the sources of the Belyando; at Port Bowen and Port Curtis; at Yass; between the Bogong Mountains and the Murray River; surrounding the granite patch near the Wannon; the highlands from the Macumba to Van Dieman Gulf; from the M'Kinley Range to within 70 miles of the Gulf of Carpentaria; and on the west coast near the mouth of the Fortescue; and at the Ashburton, Murchison, and Greenough Rivers.

CONCLUDING REMARKS.

Over this land of extreme isolation a primeval race, forming a distinct and special type of the human family, spread itself long before the first historical record was penned. Compared with the other peoples of the world, the Australian natives are mere children. Though brave, they are cautious ; though skilled in hunting and deft in the use of weapons, they know nothing of so simple an arm as the bow and arrow. Though weakly in constitution, they have no knowledge of healing herbs. Though recognizing certain rigid rules of conduct, they are absolutely without forms of government. Though speaking a language rich in expression and full of harmony, they have not a poem nor a rhythmical legend. Though quailing before the spirit of evil, they possess not an idol, not a religious ceremony, not even an idea of a Heavenly Father.

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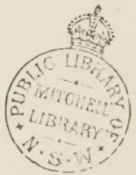
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