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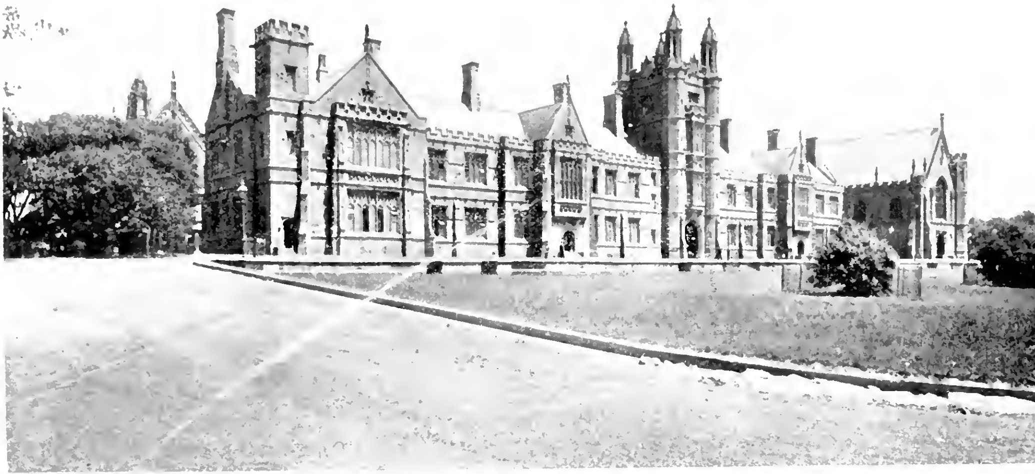

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1914.

HANDBOOK

FOR

NEW SOUTH WALES.

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INTRODUCTION.

This handbook has been prepared on the occasion of the first visit to Australia of the British Association for the Advancement of Science, and is intended to give an outline of some of the more important problems and studies of Social, Economic and Natural Science within the State of New South Wales. It is now 126 years since the founding of Australia was effected by the formation of a settlement at Sydney, and it may fairly be claimed that much has been done in this young country during the subsequent years to secure the advancement and comfort of its inhabitants; to increase the facilities for education; to establish industries, both in regard to direct production from the soil, and in manufactures; to provide an efficient system of commerce with the rest of the world; and to study and investigate the natural science resources of the country, in order that there may be an interchange of products and knowledge for the mutual benefit of the whole community. From the articles contained in this handbook which refer to Social, Economic, Legislative, Agricultural and Scientific subjects in their broadest aspects, some idea may be gleaned of what has been accomplished in the various directions above indicated, and also what is in progress, and it is confidently felt that this visit to our State of some of the world's highest scientific intellects will result in giving a stimulus to scientific effort in numerous directions which will be reflected in the economic sections, and ultimately be of untold advantage to our people.

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SECTION I.

SOCIAL SCIENCE.

SOCIAL SCIENCE.

Chapter I.

HISTORY OF NEW SOUTH WALES.

By John B. Trivett, F.R.A.S., F.S.S., Government Statistician.

There is no echo of the martial music of a conquering army, nor the account of a notable victory as a preliminary to the occupation of this fair country. The native inhabitants made no organised attempt to repel the invader, but offered merely a passive resistance to the seizure of their territory. The events recorded in the history of New South Wales, therefore, constitute a peaceful and almost unbroken chain of development and progress unique in the world's history.

Apart from the earliest discoveries of other portions of Australia, the history of New South Wales may be said to have commenced with its discovery by Captain Cook, commanding the ship "Endeavour," 370 tons, in the year 1770.

It is interesting to scientists, and especially to meteorologists, that this voyage was undertaken primarily in the interests of science, the chief object of the expedition being to take observations of the transit of Venus, at the Island of Tahiti. Mr. Chas. Green was commissioned to conduct the astronomical observations, and Sir Joseph Banks and Dr. Solander acted as botanists. The transit of Venus having been duly observed, Captain Cook set sail, in accordance with the second part of his commission, to ascertain "whether the unexplored part of the Southern Hemisphere be only an immense mass of water or contain another continent."

After carefully surveying the coast of New Zealand, Cook steered due west; and, on the 19th April, 1770, the eastern coast of Australia was sighted at a place which he named Point Hicks, after the lieutenant who first saw it. The voyage of discovery was continued in a northerly direction along the coast, and from the ship's deck Cook saw and named Mount Dromedary, Point Upright, the Pigeon House, Red Point, and Cape St. George.

On the 28th April, 1770, the "Endeavour" was anchored in a bay to which the name of Botany Bay was subsequently given from the description of the great variety of vegetation upon its shores, and here Cook's historic landing in Australia was made. At the place now called "Kurnell," Captain Cook unfurled the Union Jack and formally took possession of the territory for the British Crown.

Cook and members of his party landed on several occasions and made attempts to establish friendly communication with the natives, but without success.

After a short stay, the voyage was resumed northward. Apparently no close inspection of the coast was made, and consequently the magnificent harbour of Port Jackson was merely named and marked on the chart as a boat harbour.

Broken Bay and many other inlets and a number of headlands were seen and named by Cook, who also took observations in Bustard Bay and Thirsty Sound; but apart from such stoppages, the ship was navigated northerly a distance of 1300 miles without incident worthy of mention, complete notes being kept for the purpose of compiling a rough chart of the coast.

Near the mouth of the Endeavour River the ship struck a reef, but was careened and repaired in the small river which was named after the vessel.

Again sailing northerly, Cook completed his survey of the eastern coast, and eventually sighted and named Cape York, the most northern point of Australia. Landing at Possession Island, he took possession of all the newly discovered territory on behalf of King George III., and gave the name of New South Wales to all the land extending northward from latitude 38 degrees S. to latitude 10½ degrees S.

In England great interest was taken in the account of the voyage of the "Endeavour," and later it appeared from the description of the new territory that a suitable country had been discovered most opportunely for the founding of a British Colony, to take the place of the North American colonies which had just been lost. A proposal for the establishment of the Colony having been approved by Viscount Sydney, Secretary of State for the Colonies, a number of ships were assembled in 1787 to convey persons and equipment for the new settlement. The fleet consisted of the frigate "Sirius," the armed tender "Supply," three store-ships, and six transports. The total tonnage of all these ships was not equal to half the tonnage of a modern Australian mail steamer. The vessels carried 10 officers and 168 marines, 5 medical men, a few mechanics, 40 women (wives of marines) and 13 children; also 564 men and 192 women convicts who had been sentenced to transportation. Captain Phillip, R.N., was in command of the expedition with a commission as Governor and Captain-General of New South Wales.

The fleet left England in March, 1787, and arrived at Botany Bay early in January, 1788. A short stay sufficed to convince Governor Phillip that this place was quite unsuitable for a settlement, and thereupon he set out to explore Broken Bay, which Captain Cook had described as an extensive inlet. On his way, however, he entered Port Jackson, and immediately perceived that he had found a harbour admirably suited for his purpose. A forest of fine trees assured an abundant supply of timber for the erection of buildings, and there was a plentiful supply of fresh water. A magnificent harbour afforded shelter for shipping in bad weather, and the deep water close to the shore rendered the erection of extensive wharves unnecessary.

Returning to Botany Bay, he arranged for the removal of the settlement to the new site; and, on the 26th January, 1788, the fleet anchored in Sydney Cove, the colonists disembarked, and Governor Phillip formally proclaimed the foundation of the new Colony.

The store of provisions being very small, it was necessary to raise food locally without delay, but unfortunately the settlers contained no practical agriculturists within their ranks, and the first attempts at wheat culture failed miserably.

Prior to leaving England it had been arranged that the stores of the settlement should be replenished at intervals; and, in accordance with this agreement, the store-ship "Guardian" was despatched from England in August, 1789, with a full supply of provisions and stores. Unfortunately the vessel struck an iceberg after rounding the Cape of Good Hope, but was towed into Table Bay, only to be completely wrecked in a gale.

The failure of the first efforts at wheat-growing, and the non-arrival of the expected store-ship, made the position of the infant Colony very serious, and the outlook for the future was not improved by the arrival of another convict ship without stores. In this extremity Governor Phillip despatched the "Sirius" to Cape Colony and the "Supply" to Batavia for provisions, but they returned with stores barely sufficient to last a few weeks. For a considerable time the community had been on short rations and was faced with the prospect of absolute starvation; but a better harvest in 1789 and the opportune arrival of three well-laden store-ships in June, 1790, placed the settlement beyond immediate risk of famine, and the discovery of better agricultural land removed serious danger upon this score. Before the close of the year 1791, over 700 acres were under cultivation at Parramatta, and in December of the same year a crop of about 1,000 bushels of wheat and 500 bushels of maize were obtained at Norfolk Island, where a settlement had been formed in 1788.

The early history of New South Wales is clearly marked off in periods corresponding with the terms of office and personal characteristics of the various Governors, who, with practically absolute power, controlled the conditions under which the new settlement was developed.

The first colonists owed much to the wise administration of Governor Phillip. Realising the important advantages which were likely to accrue from the immediate settlement of the territory under his control, he began the issue of land grants to settlers, and up to 18th August, 1791, eighty-seven grants of land had been made, with a total area of over 4000 acres. He also urged upon the Home Government the desirableness of encouraging the emigration of free settlers, and it was largely through his energy that the Colony progressed in spite of its early privations and hardships. The strenuous nature of this early struggle undermined Governor Phillip's health, and he returned to England in 1792.

Within a few months of the establishment of the Colony he had explored Broken Bay and had led a party inland to the foot of the mountains. A year later the Hawkesbury River, with its large tracts of rich alluvial soil, and the Nepean River were discovered.

In 1789 a signal station was established at South Head, and three years later the first foreign trading vessel—the "Philadelphia"— arrived. The first church was erected in 1793.

After Governor Phillip's departure, and until the arrival of Governor Hunter in 1795, the government was administered by the two senior military officers.

The new Governor brought with him a number of free settlers, mainly farm laborers, consequently agriculture made great progress, and, within a comparatively short space of time, over 6000 acres on the banks of the Hawkesbury River were under cultivation for wheat and maize. Whaling and sealing had already been established as remunerative industries, and, with the progress of agriculture, the importance of the new Colony increased rapidly.

Attempts at cattle raising had been unsuccessful, but as to other live stock, they were more propitious, and in 1797, merino sheep were brought from the Cape of Good Hope and sold to John Macarthur and others. Macarthur was so successful in his efforts at wool-growing at Camden, that six years later he was able to take his first sample of wool to England, and was thus the first to establish the staple industry of Australia. The first parcel of merchantable wool (245 lbs.) was shipped to England in 1807.

Further exploration of the northern coast resulted in the discovery of the Hunter River, with its tributaries, the Paterson and Williams Rivers, with splendid coal seams in the vicinity, and a settlement was formed at Newcastle, at the mouth of the river.

Southward, Bass and Flinders sailed the coast as far as Wollongong on their first voyage; and whilst returning, discovered Port Hacking. On a second voyage of discovery, Bass examined and charted the coast for 600 miles south of Port Jackson and discovered the Strait which bears his name, and on a third voyage, in conjunction with Flinders, circumnavigated the Island of Tasmania in 1798.

Governor Hunter left the Colony in 1800. Before his departure the first printing-press had been set up (1795), and a school and a theatre had been erected (1796).

The population at this time (including 961 persons at Norfolk Island) numbered 6,508, of whom 2,500 were in Sydney, and the remainder chiefly in the neighbourhood of Parramatta.

Captain King, R.N., was appointed Governor in 1800. For some time the Colony had suffered through the disgraceful traffic in liquor—principally rum—in which many of the local military officers were engaged. In his endeavours to end this pernicious trade, the Governor met with great opposition, and his action in sending away enormous quantities of spirits and wine aroused the enmity of the persons interested to such an extent that there is reason to believe his term of office was cut short by their machinations. He returned to England in 1806, and the administration was placed in the hands of Captain Bligh, who had established a reputation for courage and determination by his long voyage in an open boat, after being cast adrift by the mutinous crew of the "Bounty."

The new Governor was confidently expected to put down the traffic which was debasing the community, and one of his first actions was to issue a general order prohibiting the bartering of spirits for grain, for the ordinary necessaries of life, and in payment of wages to labourers. The order was not generally observed, and the spirit traffic continued to retard the progress of the community. The Governor's persistent attempts at regulation, however, increased the ill-feeling which had been felt against his predecessor, and the climax was reached when John Macarthur was committed for trial upon a charge of high misdemeanour. Macarthur appeared before a Court consisting of six military officers and the Judge Advocate, and after a stormy sitting, the Judge Advocate left the Court and eventually procured a warrant for Macarthur's arrest. Meanwhile the officers sent a memorial to the Governor requesting the appointment of a new Judge Advocate. The Governor summoned the six officers to appear before him in explanation of their conduct, but they did not obey his summons, and Major Johnston, commanding the forces, was then requested to confer with the Governor upon the conduct of his subordinates. He declined, and was subsequently persuaded by the excited populace to place Governor Bligh under arrest. Marching at the head of his regiment to Government House, Major Johnston ordered Governor Bligh to be seized and placed in confinement, and thereupon assumed the government.

Upon ascertaining the facts, the British Government appointed Major-General Macquarie as Governor, with instructions to re-instate Governor Bligh for twenty-four hours, and then to assume the administration himself. He was also instructed to send Major Johnston to England under close arrest. As Bligh had left the Colony, his re-instatement was impossible, but Johnston was sent to England, tried by court martial, and dismissed from the service.

Governor Macquarie entered upon his administration on 1st January, 1810, and retained office until December, 1821. At the time of his arrival the country was impenetrable beyond 40 miles from Sydney. He wisely encouraged exploration by every means in his power, with the result that extensive and important discoveries were made in all directions. Perhaps the most important was the discovery in

1813 of a track over the hitherto impassable mountains by Blaxland, Lawson, and Wentworth. In the same year, following in their tracks, Evans discovered the rich Bathurst Plains and the Macquarie and Lachlan Rivers. The construction of a road over the mountains was immediately commenced, pushed forward with much energy, completed within eighteen months, and was formally opened by Governor Macquarie in May, 1815. The pent-up settlers immediately poured into the fertile plains of the interior, and the town of Bathurst was founded.

In 1817 Oxley traversed the country of the Lachlan and Macquarie Rivers, and in the following year crossed the Liverpool Plains and discovered the Hastings and Manning Rivers; in 1817 Hume and Meehan discovered Lakes George and Bathurst, and explored the district of which Goulburn is now the centre, while in 1819 Hume reached the Murrumbidgee River.

By these discoveries the known area of the Colony was increased twenty-fold, and the rich land thus thrown open was speedily settled.

Under Macquarie's judicious control the Colony in all respects made very substantial progress. Schools were established in which children were taught the rudiments of education, together with useful handicrafts; churches were built, and public buildings (some of which still exist) were erected for the housing of the administrative staff. Splendid work was also acomplished in the formation of roads; and, as a result, Sydney began to assume the appearance of a well-ordered city in place of a straggling settlement. The Sydney Hospital was founded in 1816, the Bank of New South Wales in 1817, and two years later a Savings Bank was established.

At the close of 1821 the population (including military) numbered 38,778. The area under cultivation was 32,267 acres, and of live stock there were 102,939 cattle, 290,158 sheep, 33,906 pigs, and 4,564 horses. During the year ten ships were despatched to England laden with products of the Colony.

Upon Macquarie's retirement in 1821, he was succeeded by Sir Thomas Brisbane, under whom the work of exploration was steadily continued, and the names of Oxley, Cunningham, Hume, and Hovell may be mentioned as explorers to whom New South Wales owes an everlasting debt of gratitude for their exertions during this period. By their discoveries vast areas of good agricultural and pastoral country were made available for the free settlers, whom it was the Governor's policy to introduce.

Apart from the discoveries made by explorers, the most important events of this period were the institution of trial by jury in 1824, and the constitution of a Legislative Council of five members to be nominated by the Governor as his advisers. This was the first measure of self-government granted to New South Wales.

The Council met in May, 1824, and continued its sittings until November, 1825. During this period laws were passed for regulating the granting of spirit licenses; for the relief of imprisoned debtors; for the regulation of shipping; for the collection of Customs and other duties, and to prevent smuggling; for the regulation of postage; and for the naturalisation of aliens.

In 1825, during the first year of Governor Darling's administration, Van Diemen's Land (Tasmania) was separated from New South Wales.

The spirit of exploration was still abroad, and Cunningham continued to add lustre to his name, but his achievements were overshadowed by those of Captain Sturt, who was perhaps the most famous explorer of his time.

New South Wales had now become self-supporting, and its total trade began to assume large proportions, amounting to £477,000 in 1826, and £814,000 in 1831. Further evidence of progress was shown by the institution in 1827 of a scheme for Sydney's water supply.

Illustrative of land values, it may be mentioned that in 1831 it was officially notified in the *Gazette* that in future Crown Lands would be disposed of only by auction, and at a minimum price of five shillings per acre.

In 1831 Governor Bourke arrived, and almost immediately, at his suggestion, a policy of assisted immigration was initiated, the first immigrant ship arriving in the same year. Under his able administration the Colony made great progress, and in recognition of his important services, a statue was erected in his honour by public subscription.

During his term of office the knowledge of Australian geography was greatly extended by Major Mitchell's exploration of the interior, and of the courses of the Darling and Murray Rivers.

Governor Sir George Gipps assumed office in 1838. At this time the community was in the throes of a violent agitation for the abolition of the transportation system;

and public feeling grew so strong that in 1840 the system, so far as it related to New South Wales, was abolished by an Order-in-Council, to the great satisfaction of the colonists. An attempt to revive it in 1849 met with such indignant protest that the project was immediately dropped, and the last convict ship arrived in that year.

In 1841 New Zealand, which had been a dependency of New South Wales, was proclaimed a separate colony.

An event of great importance took place in 1843, when an Imperial Act was passed, providing for the appointment of a Legislative Council of 36 members, 12 of whom were to be nominees of the Crown, and 24 to be elected, the franchise qualification being £20 rental, or freehold to the value of £200. The first Council elected under this constitution met in August, 1843.

In 1844 Norfolk Island was annexed to Van Diemen's Land, and in the same year a movement for separation was begun by Port Phillip settlers, on the ground that the district was too far distant from the seat of government (Sydney) for proper administration. Seven years later (in 1851) their petition was granted and the country south of the Murray was proclaimed a separate colony.

At this time the population of New South Wales was 191,000, and that of the new colony, Victoria, numbered 77,000.

The necessity for quicker means of communication having become apparent, an agitation was begun in 1846 for railroad construction, and two years later a Railway Commissioner was appointed. The first line of railway, between Sydney and Parramatta, was commenced in 1850; and, on 26th September, 1855, was opened for traffic.

In 1851 the community was thrown into a great state of excitement by the announcement of Hargraves' discovery of payable gold near Bathurst. All other forms of industry were immediately neglected; food rose to famine prices, as farm labourers, mechanics, tradesmen, and even shopkeepers, all joined in the wild rush to the diggings; while for some time gold-seekers poured into the Colony from all parts of the world. Within a few years, however, many disappointed fortune-hunters returned to their former occupations on farms and stations, and industry resumed its normal condition. The discovery of gold gave a wonderful impetus to the progress of the Colony, and between 1851 and 1854 the total trade increased from £3,360,000 to £10,031,000.

In 1852 the Sydney University, which had been incorporated in 1850, was formally opened.

For some years prior to 1851 there had been pronounced dissatisfaction with the existing Constitution, and the desire for greater political freedom became intensified with the increase of free settlers and the influx of gold-seekers. The Imperial Act of 1851, constituting Victoria a separate Colony, also provided that a Constitution would be conferred on New South Wales, and in 1852 a Committee of the Legislative Council was appointed to draft proposals. The Committee submitted proposals for the establishment of an elective Assembly and a nominated Council, by which the members of the Upper Chamber were to be chosen from the ranks of a proposed hereditary order of nobility; in spite of the indignation and ridicule aroused by the latter proposal, it was somewhat reluctantly removed by the Committee. The qualifications for electors were: as freeholders, the possession of estate to the value of £100; as householders, lodgers or leaseholders, the payment of a rental value of £10 for three years; as boarders, the payment of £40 per annum; persons receiving £100 in salary and pasture-license holders for one year were also entitled to exercise the franchise; electors were entitled to vote in each electorate in which they possessed the necessary qualification. The measure, with some considerable amendment, was passed by the British Parliament in 1855, and the new Constitution was inaugurated by Sir William Denison, who opened the first Parliament under the new regime on 22nd May, 1856. Mr. Stuart Alexander Donaldson was entrusted with the duty of forming the first responsible Ministry.

By an Act passed in November, 1858, the franchise was extended to every male adult with six months' residence in any electorate, the salary qualification was abolished, and vote by ballot was introduced.

The granting of the Constitution had been delayed by the war with Russia, which also caused an interruption in steamer communication with England, and occasioned considerable apprehension locally, leading to the fortification of Sydney Harbour in 1854, and to the establishment of a volunteer defence force.

Despite protests by the Legislature against the separation of the Moreton Bay district as being premature and inexpedient, the separation was effected in 1859, and Sir

George Bowen was appointed Governor of the new Colony of Queensland.

A census of the people, taken in 1861, showed the number to be 350,860.

With the rapid development of the Colony, the need for greater facilities for land settlement became pressing, and this was met by the passage in 1861 of Sir John Robertson's Land Act, introducing the principle of free selection before survey. A year later another important land measure—the Real Property (Torrens) Act—was passed. This law provides for the easy and safe transfer of property, and for simple and efficacious certification as to ownership of land.

The influx of Chinese at this time occasioned much concern. Their arrival in large numbers at Burrangong—the scene of a new gold rush—in 1861, led to rioting, which was quelled only by the appearance of the military; the immediate result was the passing, within a few months, of the Chinese Immigrants Restriction Bill. A similar measure had already been passed in Victoria, an early evidence of the united feeling in favour of a White Australia, which has since grown to be a national sentiment.

A greater difficulty which confronted the successive Ministries of the period was the suppression of bushranging. For years armed bands of lawless men had infested the country districts, and neither life nor property was safe from their attacks. It was not until railway and telegraphic communication were extensively established that these outlaws were suppressed.

An important change in the system of education was made in 1866 by the introduction of the Public Schools Act. Since 1848 public instruction had been under the control of a Board of National Education. The Board was abolished by the new Act, which placed educational matters entirely under the control of a Council and made provision for a more comprehensive scheme of public education.

Tho Centenary of the discovery of New South Wales by Captain Cook was celebrated in 1870; an Intercolonial Exhibition was held in Sydney, and a monument was erected at Kurnell, the scene of Cook's first landing place, in commemoration of the event.

The Constitution Act, passed in 1855, provided that the term of Parliaments should be limited to five years, but, by an Act passed in 1874, the present system of Triennial Parliaments was instituted.

Evidence of the Colony's progress at this period is furnished by the connection of Sydney and Brisbane by telegraph in 1861, the establishment of the Eskbank Iron Company in 1869, the foundation of the National Art Gallery in 1871, the completion of the cable to England in 1872, the completion and opening of the Sydney General Post Office in 1874, and of the Sydney Town Hall in 1875, the foundation of the Royal Zoological Society in 1879, and the dedication to the public of the beautiful National Park in the same year. The first steam tramway ran in the streets of Sydney in 1879; in the following year telephones were established in the city, and railway communication was effected with Melbourne.

An event of much greater importance, however, to New South Wales and to Australia generally, was the discovery of artesian water by means of a bore sunk at Kallara Station, near the Paroo River, in 1879. Many bores, public and private, have since been sunk in those portions of Australia within the artesian basins, and thousands of stock are now watered from them.

The Council of Education, established in 1866, was abolished in 1880, when the Public Instruction Act (Parkes) was passed, establishing the present system of compulsory secular education. The minimum charge of 3d. per scholar per week, imposed under the Act, was abolished later (1906), and primary education was made entirely free.

A welcome addition to the Colony's mineral resources was made in 1883 by the discovery of the rich silver fields at Broken Hill; the Broken Hill Proprietary Syndicate was immediately formed, and two years later mines were opened.

The outbreak of war in the Soudan afforded the Colony an opportunity of showing its loyalty to the Empire, and a military contingent was despatched to the scene of operations in 1885.

During that year a change was made in the system of land administration, the Colony being divided into Territorial Divisions, and Local Land Boards being appointed to deal with applications for land within their districts.

An enactment of considerable importance from the point of view of public health, viz., the Dairies Supervision Act, was passed in 1886. Two years later the Metropolitan Board of Water Supply and Sewerage was established. After the introduction of government inspection of dairies and the establishment of an improved sewerage system the metropolitan death-rate almost immediately exhibited a marked improvement.

In 1887 a terrible disaster occurred at the Bulli Mine, by which 83 miners lost their lives.

On 26th January, 1888, exactly one hundred years had passed since Governor Phillip took formal possession of New South Wales in the name of H.M. King George III., and the day was celebrated with great rejoicing throughout the Colony. During the same year the New South Wales and Queensland railway systems were connected, and in 1889 through communication by rail was established between Brisbane and Adelaide (via Sydney and Melbourne) by the completion and opening of the Hawkesbury River Bridge.

Industrial conditions were very unsettled during this period. Wages began to fall in 1886, and in the following year there was a scarcity of employment, which necessitated the inauguration of Government relief works. In 1888 there was a strike among the coal miners in the Northern district; in 1890, and again in 1892, the miners at Broken Hill went on strike, while in 1890 also there was a strike among seamen which paralysed intercolonial trade while it lasted. It was not until after the financial crisis of 1893 that industrial conditions became normal.

Coincident with the industrial disturbance of the period there was a gradual tightening in the money market and a fall in land values. Their effect was seen in 1891, when several building societies collapsed as the result of over-investment in land at inflated values. Their failure engendered a feeling of financial distrust, which was accentuated by a run on the Government Savings Bank in February, 1892, and the climax was reached in the following year, when bank after bank suspended payment. During the early part of 1893 thirteen out of the twenty-five banks of issue were forced to suspend operations, and complete financial disaster was averted only by the timely legislation of the Dibbs Government, which made bank notes a legal tender, and guaranteed their payment by the Government from 15th May to 13th November, 1893, after which the expedient was no longer needed.

In 1890 an Act was passed providing for the payment of an allowance of £300 per annum to members of the Legislative Assembly. This allowance was subsequently increased (1912) to £500 per annum.

In 1893 an important change was made in the Parliamentary electoral franchise by the introduction of universal manhood suffrage and the principle of "one man—one vote." The disqualification of the police as voters was removed in 1896, and the franchise was extended to women in 1902, thus establishing universal adult suffrage—the most liberal type of representation in the world.

Prior to 1896 the only form of direct taxation was in the nature of Stamp Duties, but in that year Land and Income Taxes were imposed. A land tax of 1d. in the £ was levied on the unimproved value of land, an exemption of £240 being allowed; and an Income Tax of 6d. in the £ was levied on incomes in excess of £200. The general exemption under the Income Tax was raised to £1000 in 1907, and lowered to £300 in 1911, and certain other deductions were allowed, but a sliding scale was introduced ranging from 6d. in the £ on income chargeable up to £700 to 12d. in the £ on income over £9700.

In 1898, for the first time, New South Wales had a surplus of wheat available for export.

Another striking indication of the Colony's loyalty was given in 1899 by the despatch of soldiers to aid the British troops in South Africa; during the following two years additional forces were despatched, and won golden opinions by their behaviour under fire. In 1900 a naval contingent was also sent to China.

The rapid development of Sydney and suburbs had severely taxed the powers of the existing tramway system for a number of years prior to 1899, and in order to provide a more efficient and extensive service the electrification of the tramways was begun in that year. There are at the present time (1913) 205 miles of electric trams in the metropolitan area.

On the 1st January, 1901, the formal inauguration of the Commonwealth of Australia took place at Sydney, the members of the first Federal Ministry being sworn in by Lord Hopetoun.

The question of the federation of the Australian Colonies was mentioned as early as 1846, prior to the separation of Victoria, and was revived at various times within the next forty years, but the first really definite step was taken in 1890, when a conference from the six Colonies was held in Melbourne, and arrangements were made for a Federal Convention of members appointed by the various Parliaments to draft an adequate scheme for a Federal Constitution. The Draft Bill produced by this Convention lapsed on account of the lack of enthusiasm on the part of the people, although it ultimately formed the basis upon which the Federal Constitution was constructed. It was not until 1895 that the movement again became active. In that year another conference was held at Hobart, and a Constitution was drawn up and submitted to the electors by referendum in 1898. The Bill was accepted in Victoria, South Australia, and Tasmania, but in New South Wales the majority of votes secured was insufficient, while in Western Australia the referendum was not taken, since in that State acceptance of the Constitution by New South Wales was a prior condition. The Constitution Bill was amended at a conference in 1899, and was subsequently accepted by all of the six States of Australia. The first Parliament of the Commonwealth was opened in Melbourne on 9th May, 1901, by H.R.H. the Duke of York.

As an immediate result of Federation, the Postal, Customs, and Defence Departments were transferred to the Commonwealth during 1901. As a natural sequence also a movement was initiated in favour of a reduction in the number of members of the State Legislative Assembly, and a referendum favouring a reduction in the number from 125 to 90 was carried in 1903. The Parliament which met in the following year was constituted on the reduced basis.

In 1905 the policy of assisted immigration, which had been discontinued for nearly twenty years, was again revived, as it was recognised that a much greater population was required in order to properly develop the vast resources of the State, and to provide adequate defence.

Notwithstanding the arrival during the next six years of nearly 16,000 assisted immigrants, there was a general shortage of labour in 1911, and a Royal Commission, which was then appointed to inquire into the matter, estimated that there was a shortage of 3,247 workers.

The whole area of the State, with the exception of the Western Division, was brought under Local Government in 1905 and 1906, and is now administered by elected bodies with well-defined powers and responsibilities.

The City of Sydney was incorporated as early as 1842, and certain country districts were incorporated in succeeding years, but it was not until 1858 that any appreciable extension of the system was made. Under the authority of an

Act passed in that year, 35 districts were incorporated as municipalities; but the Act was repealed in 1867, and the existing municipalities were continued as boroughs, and all areas incorporated in the future were to be classified as boroughs or municipal districts, according to area and population. Incorporation of any district was optional, and the same principle obtained in the Municipalities Act of 1897 and its amendments.

The Local Government (Shires) Act, 1905, however, provided for the compulsory division of the State, with the exception of the Western District, the City of Sydney, and existing municipalities, into local government areas. In the following year the Local Government Extension Act was passed, and later the Local Government Act, 1906, which repealed the 1905 Act and the 1906 Extension, and consolidated their provisions.

The Parliament of New South Wales during the last twenty years has given much attention to legislation relating to the improvement of the industrial condition of the people generally, for the settlement of trade disputes, and for the regulation of hours of employment and rates of wages.

Three well-defined phases of legislation may be clearly seen:

The first dates from 1892, when the Conciliation and Arbitration Act became law. Voluntary conciliation and arbitration without compulsory acceptance of award were the features of the Act, which proved quite ineffective, and in 1899 the Conciliation and Arbitration Act, 1899, was passed, authorising the Minister to take certain steps for the prevention and settlement of disputes, but still adhering to the principle of conciliation.

A departure from this principle was made when the Arbitration Act of 1901 was passed. This Act constituted a Court of Arbitration for the hearing and determination of disputes, and provided for the enforcement of its awards.

This Act, with some amendment in 1905, remained in force until the Industrial Disputes Act, 1908, was passed. In this Act an effort was made to combine the relatively simple procedure of Conciliation Courts with the compulsory powers of the Arbitration Court. The Act was amended from time to time, and was finally repealed by the Industrial Act, 1912, in which mediation and conciliation are made prominent features.

Under the provisions of the Act last mentioned, upon proper application to the Industrial Court, a Board may be constituted for each industry or group of industries. Each Board consists of a chairman and two or four other members, one-half of whom are employers and the other half employees. The Board may fix the rates of wages, hours of employment, determine any industrial matter, and rescind or vary any of its awards, which are binding on all persons engaged in the industry. Penalties are provided for.

With a view to promote the friendly settlement of disputes, the Minister is authorised to constitute District Conciliation Committees to inquire into any industrial matter connected with coal mining or metalliferous mining, and in any case where a question has arisen which may lead to a strike or lock-out, a special commissioner appointed under the Act is authorised to require the parties to meet in conference.

An event of considerable scientific importance occurred in 1908, when Lieutenant Shackleton and his party visited Sydney with the steamer "Nimrod," prior to undertaking their search for the South Pole. They were accompanied on their southward journey to the ice regions by several Australians, and although the party did not attain their ambition in the discovery of the Pole, they were successful in collecting much valuable scientific data. To Professor David and Dr. Mawson—two Australian scientists—fell the honor of locating the South Magnetic Pole.

Two years later the State welcomed and then bade farewell to Captain Scott, the gallant leader of the "Terra Nova" Antarctic Expedition. The story of his subsequent journeyings and of the tragic deaths of the leader and of the members of his party after reaching their goal caused a great wave of sympathy to spread over the whole State.

In 1912 the first sub-division of the Murrumbidgee Irrigation Area became available for settlement—satisfactory evidence of the success of what is perhaps the most ambitious scheme of water conservation in the world.

In view of the magnitude of the work and of its importance to the State, the following details are given:—The site of the storage dam is at Burrinjuck, three miles below the confluence of the Murrumbidgee and Goodradigbee Rivers. The dam is being constructed of cyclopean masonry and concrete, and will be high enough to conserve a depth of 200 feet of water. The reservoir will have a capacity of

33,381 million cubic feet, and by means of canals, an area of about 357,000 acres of high-class irrigable land will be brought under intense cultivation; in addition, about 1,000,000 acres of pastoral land will be supplied with water for stock.

Chapter II.

GEOGRAPHY OF NEW SOUTH WALES.

By John B. Trivett, F.R.A.S., F.S.S., Government Statistician.

Boundaries and Area.

New South Wales occupies the middle position of the three eastern States of Australia, being bounded on the north and south by Queensland and Victoria respectively, on the west by South Australia, and on the east by the Pacific Ocean.

The northern boundary extends from the 141st meridian of east longitude (which marks the western limit of the State) along the 29th parallel of south latitude till it meets the Barwon River; thence the boundary is continued successively along the Barwon, MacIntyre and Dumaresq Rivers and the Macpherson Range to Point Danger.

The southern boundary is marked along a surveyed line from Cape Howe to the source of the Murray River, thence along the course of the Murray westward to the 141st meridian.

Lord Howe Island, situated about 300 miles off the coast of New South Wales, forms part of the State.

At the foundation of settlement in 1788 the territory of New South Wales embraced all the eastern portion of the continent of Australia from 135th meridian of east longitude to the coast, the Island of Tasmania (then known as Van Diemen's Land, and supposed to be joined to the mainland) and New Zealand.

Various changes have since been made; in 1825 Van Diemen's Land was constituted a separate Colony under the name of Tasmania; in 1827 the western boundary of New South Wales was extended to the 129th meridian of east longitude. In 1836 the Colony of South Australia was proclaimed; in 1841 New Zealand was separated, also in 1851 Victoria, and in 1859 Queensland. During the years 1861 and 1863 outlying areas lying to the west and north of South Australia were transferred to South Australia and to Queensland.

As a result of these changes, the area of New South Wales was reduced to 310,372 square miles. A further diminution took place since the beginning of the year 1911, when the Federal Capital Territory and land at Jervis Bay for the purposes of a Commonwealth port, amounting to 900 square miles approximately, were ceded to the Commonwealth.

The present area of New South Wales (including Lord Howe Island—five square miles) is 309,472 square miles, or about one-tenth of the total area of the Commonwealth of Australia.

A comparison with the area of other States shows that New South Wales is somewhat smaller than South Australia, half the size of Queensland, and one-third the size of Western Australia, while it is 3½ times as large as Victoria and nearly twelve times as large as Tasmania.

New South Wales is in area about 2½ times as large as the United Kingdom, and is larger than any European country, except Russia. It is about one-twelfth the area of Canada, and over a quarter that of the Argentine.

The length of the State measured along the coast directly from Point Danger to Cape Howe is 683 miles. The breadth along the 29th parallel is 756 miles, while a diagonal line from the south-west corner, where the Murray passes into South Australia, to Point Danger would measure 850 miles.

Capes and Headlands.

The coast of New South Wales is remarkably regular, and does not present any striking topographical features. It consists of rugged cliffs alternating with sandy beaches, broken at frequent intervals by crescent-shaped bays and wide river estuaries. Few capes project more than a few hundred yards into the sea.

The general trend of the coast is N. N. East and S. S. West.

Proceeding from north to south, the principal headlands are:—Point Danger, the most northerly point on the coast; Tweed Heads, a popular holiday resort; Fingal Point, near the Tweed River; Cape Byron, two miles in length, the most easterly point of Australia, shelters Byron Bay from southerly and south-easterly gales; Evan's Head, the termination of the Richmond Range; Clarence Heads, at the north of the Clarence River; Smoky Cape, near Trial Bay; Tacking Point, south of Port Macquarie; Indian Head, near Camden Haven; Crowdy Head, north of the Manning River, affords shelter to coastal vesels; Cape Hawke, near Wallis Lake; Sugarloaf Point, near Myall Lake; Point Stephens, at Port Stephens. Nobby's, which marks the entrance to Newcastle Harbour, was once a sea-cut island, owing its preservation to the action of volcanic dykes in hardening its rocks; it is now connected with the mainland by a breakwater. Red Head is between Newcastle and Lake Macquarie; Bungaree Norah, near the entrance to Tuggerah Lakes; Cape Three Points, north of Broken Bay; Broken Bay Heads—Box Head on the north and Barranjoey on the south—at the entrance to Broken Bay; Port Jackson Heads mark the entrance to Sydney Harbour; Capes Banks and Solander, the north and south heads of Botany Bay; Port Hacking Point, at the southern entrance to Port Hacking; Coalcliff, rising abruptly from the sea at Clifton, marks the commencement of the Illawarra Range; Bulli and Bellambi Points shelter coal shipping roadsteads; Red Point is south of Wollongong; Point Bass is between Shellharbour and Kiama; Black Head, south of Gerringong, is noted for fossils and geological specimens; Point Perpendicular and St. George's Head are at the entrance to Jervis Bay—an important signal station is established on the former; Point Upright, north of Bateman Bay; Moruya Heads, at the mouth of the Moruya River; Cape Dromedary, between Montague Island and Bermagui; Tathra Head, at the mouth of the Bega River; Green Cape, south of Twofold Bay; and Cape Howe, the most southerly point of New South Wales.

Lighthouses have been erected on all the prominent headlands; the lights at Smoky Cape, Cape Byron, and on the South Head of Port Jackson are amongst the most powerful in the world.

Islands.

There are a number of islands adjacent to New South Wales, but they are too small to be of practical value. They consist of rugged weather-beaten rocks, lying close to the mainland, to which most of them were formerly attached. The principal are:—Cook Island, near Point Danger; Juan and Julia Islands, near Cape Byron; Solitary Islands, a series of rocky islets devoid of vegetation; on South Solitary a powerful lighthouse has been erected. North and South Coff's Islands and Mutton Bird Island, near Coff's Harbour; Seal Rocks, near Sugarloaf Point; Broughton Island, the largest on the coast, is near Port Stephens, and is a centre of lobster and other fishing. Bird Island is near Tuggerah

Lakes; Five Islands are close to Port Kembla. On Montague Island, south-east of Moruya River estuary, a lighthouse has been erected, and excellent building granite has been obtained.

Gabo Island lies off the Victorian coast, about four miles south-west of Cape Howe, and is of importance by reason of its lighthouse and signal station, from which shipping intelligence is supplied by telegraph to commercial centres.

Lord Howe Island is situated in the Pacific Ocean about 300 miles off the coast—the distance from Sydney being 436 miles. The island is seven miles in length, and from $\frac{1}{2}$ to $1\frac{3}{4}$ miles in width; the area is five square miles. The highest point is Mount Gower, 2,840 feet. The soil is rich and fertile.

Ports and Inlets.

The numerous inlets of the coast of New South Wales are remarkable for complexity of outline. There are some fine natural harbours, with deep water and steep rocky shores, which owe their existence to the subsidence, in past ages, of the coastline, which caused the submergence of the valleys of the coastal rivers and converted them into magnificent harbours.

Numerous small ports, estuaries, and roadsteads provide shelter to shipping and afford facilities for trade. The entrances to most of the estuaries are obstructed by sand-bars, formed by the combined action of ocean currents and waves and wind. To obviate the difficulty caused by these obstructions, efforts are made to dredge the sand from the entrances, and extensive works have been designed to control the sand movement. These works consist of northern and southern breakwaters to prevent the ingress of sand from the ocean beaches, and training walls to define the channels. Ocean jetties have been constructed at most of the roadsteads.

The oversea trade is confined almost exclusively to Port Jackson and Port Hunter, the former for general trade and the latter mainly for coal. The trade of other ports is chiefly coastal—produce for export being transhipped to deep-sea vessels at Sydney. Inter-state cargoes are shipped at Byron Bay on the north and at Twofold Bay on the south. Wollongong, Port Kembla, Bulli, and Bellambi are the outports for the southern coalfields; from the other ports the trade is principally the produce of dairying districts.

The most northerly port is the estuary of the Tweed River, used for coastal trade. Byron Bay provides fair shelter, the depth of water at the ocean jetty being about

19 feet at low tide. The estuary of the Richmond River and Shoal Bay, at the mouth of the Clarence River, are important ports of rich dairying districts, but, on account of sand-bars at the entrance, are used by coastal vessels only. Woolgoolga Bay and Coff's Harbour afford safe anchorage for small vessels; it is proposed to establish a deep-sea port by the construction of breakwaters at Coff's Harbour, through which the trade of the rich Dorrigo district passes. The estuaries of the Bellinger and Nambucca Rivers are bar harbours, used for coastal trade.

Trial Bay, at the mouth of the Macleay River, affords safe anchorage for coastal vessels. With the object of forming a harbour of refuge for larger vessels, the construction of a breakwater was commenced, but, owing to a change in shipping conditions, the project was abandoned. Port Macquarie is the estuary of the Hastings River. Between Port Macquarie and Port Stephens small vessels are afforded shelter at Camden Haven, Crowdy Bay, Harrington and Farquhar Inlets (at the mouth of the Manning River), Cape Hawke Harbour, and Sugarloaf Bay.

Port Stephens, the estuary of the Karuah River, 21 miles north of Newcastle, is a first-class natural harbour, nearly as large as Port Jackson, containing an extensive area of still, deep water. No practical efforts have been made towards developing its magnificent natural advantages for deep-sea shipping, and the trade of the port is insignificant, being confined to fish and timber. A fine anchorage, known as Fly Road, situated near the entrance to Port Stephens, affords excellent shelter for shipping in southerly weather.

Port Hunter, Newcastle Harbour, at the mouth of the Hunter River, is next in importance to Port Jackson. Extensive breakwaters and training walls have been constructed at the entrance to prevent the formation of a sand-bar. The maximum depth of the entrance channel is 26½ feet at neap tides.

Port Hunter is primarily a coal-shipping port, being the outlet of the most extensive coalfields of the State. There are about 16,500 feet of wharfage, with 2,400 feet under construction. The wharves are fitted with modern appliances for loading coal and other cargoes. Vessels 560 feet long and of 27 feet draught can be berthed. Schemes have been projected for the construction of a large floating dock, and for the establishment of extensive iron and steel works, at Newcastle.

Broken Bay, 15 miles north of Port Jackson, at the mouth of the Hawkesbury River, is a good natural harbour, but, on account of its proximity to Port Jackson, it has not been developed as a shipping centre. Broken Bay has three large branches, viz., Brisbane Water, Hawkesbury Mouth, and Pittwater, all noted for their magnificent scenery.

Port Jackson, the port of Sydney, ranks first in importance by reason of extent, natural facilities, and volume of trade. The entrance, which is about a mile in width, and not less than 80 feet in depth, lies between bluff headlands, on the south of which powerful lights have been installed. Numerous leading lights and buoys have been installed within the harbour to facilitate the navigation of the port.

There are two entrance channels—the eastern has a depth of 40 feet at low water, and the western is being dredged to an equal depth, so that the port will have separate deep-ship channels for incoming and outgoing vessels. The bottom of these channels is sand, so that deeper water can be provided without difficulty if required. As there is no effective river flowing into Port Jackson, it is remarkably free from silt, and deep water extends close to the shores.

After passing through the channels, vessels can navigate in water of a depth ranging from 40 to 50 feet for a distance of four miles to the wharves. The total area of water surface in Port Jackson is 14,284 acres, or about 22 square miles, of which 3000 acres have a depth ranging from 35 to 160 feet. The length of the foreshores is nearly 200 miles.

The wharves are situated along the southern shore of the port, the large mail and passenger liners being berthed close to the centre of the city. Exclusive of numerous ferry wharves and private jetties, there are 55,000 feet of wharfage in actual use, and 12,000 feet under construction. On nearly all the wharves there is storage accommodation, provided with modern appliances for handling cargo.

The docking accommodation in Port Jackson is superior to that of any other port in Australia. There are four large graving docks, five floating docks, and five patent slips. The principal dock for the Australian Navy is situated in Sydney Harbour.

The coal supplies of the port are maintained by a fleet of 32 colliers, which trade from the northern and southern coal ports, and considerable quantities are brought by rail from the Blue Mountain and southern collieries. There is also the output of the colliery at Balmain, on the foreshore of the port itself.

The control of the port is vested in the Sydney Harbour Trust.

Botany Bay is notable as the first Australian port entered by Captain Cook. On account of its proximity to Sydney, its trade is small, and it is used mainly as a fishing ground and tourist resort.

Port Hacking, a few miles to the south, is also utilised as a fishing and pleasure resort, the National Park being situated on its shores. At the roadsteads of Bulli and Bellambi ocean jetties have been built for the shipment of coal. At Wollongong an artificial harbour of comparatively small area and depth has been constructed, and affords facilities for shipping in fair weather. At Port Kembla, a few miles south of Wollongong, works are in progress to form a close harbour of about 334 acres, suitable for ocean-going steamers. This port will be used for the shipment of coal and coke and for the trade in connection with the dairying industry and ore-treating works conducted in the vicinity. Shellharbour and Kiama Harbour are small artificial harbours. Gerringong Harbour and the mouths of the Shoalhaven and Crookhaven Rivers afford anchorage for small vessels.

Jervis Bay, 82 miles south of Sydney, is a fine expanse of water near the mouth of the Shoalhaven River. The entrance, between precipitous headlands, is 1¾ miles in width, with a depth ranging from 90 feet to 120 feet. The area of the bay carrying a greater depth than 24 feet is about 38 square miles. On the southern side of the bay an area of land has been ceded to the Federal Government for use as a port for the Federal capital, Canberra, with which it will be connected by rail. Fishing is now the principal industry in the Jervis Bay district. A large area of thickly timbered land, as yet undeveloped, is situated to the westward of the bay.

At Ulladulla a small artificial harbour has been constructed. Bateman Bay, at the mouth of the Clyde River, the estuary of the Moruya River, Bermagui Bay, Tathra Bay, at the mouth of the Bega River, and Merimbula Bay, are ports where small steamers load dairy produce for the Sydney market. Twofold Bay, near the southern boundary of the State, was formerly the headquarters of an extensive ocean whaling trade; there are indications that this industry may be revived.

At intervals along the coast there are several fairly large sheets of water, partly estuarine and partly marine, having communication with the sea by narrow channels. Though locally termed "lakes," they are not so in the strict sense of the term; many of them can be entered by small vessels, and are important fishing grounds and tourist resorts.

The largest are:—Terranora Broadwater, near Point Danger, forming part of the estuary of the Tweed River; Burrawan or Lake Innes, near Tacking Point; Wallis Lake, near Cape Hawke; Myall Lake and the Broadwater—a chain of lakes lying between Cape Hawke and Port Stephens, surrounded by richly-timbered country. Lake Macquarie is eight miles south of Newcastle; a few small vessels trade to the Lake, which has an area of 44 square miles; large smelting works and several collieries are situated on its shores. Tuggerah Lakes are north of Broken Bay; Lake Illawarra is between Wollongong and Kiama, and St. George's Basin is a little to the south of Jervis Bay.

Natural Divisions.

The surface of New South Wales is divided naturally into three main divisions, the Coast District, the Tablelands, and the Western Plains. The tablelands occupy the summit of the Great Dividing Range, which traverses the State from north to south and marks the division between the coast district and the plains.

In past ages a great part of the interior of Australia was occupied by a vast mediterranean sea, bounded by a line of highlands which probably extended considerably to the east of the present coastline. The slope of these hills was towards the west, and rivers flowed down from them into the inland sea, carrying thither the sand and silt which now seals down the Artesian Basin. Later a gradual uplift took place in the northern part of Australia, accompanied by a depression in the southern portion; thus streams formerly flowing north-west and entering the sea by separate mouths became diverted to the south and conjoined with the Darling River.

The southern depression allowed the sea lying to the south of Australia to encroach inland and spread over the region now known as the Riverina. A subsequent uplift pushed the southern sea back to its present boundary and brought about the combination of the western rivers into one great system, the Murray-Darling.

During the upward movement in the interior a marked elevation took place in the coastal portion, the uplift being greater towards the coast. Thus an elevated plateau with a short, steep slope to the eastern seaboard was produced. Rivers which then commenced to flow down this slope were able, by their great erosive power, to work their way inland and extend the coastal plain, placing the Great Dividing Range more westward.

Subsequently a submergence of the coast took place, which converted valleys of the coastal rivers into harbours, such as Port Jackson, Broken Bay, Port Stephens, and others.

The Coastal District is a strip of undulating, well-watered country of an average width of about 30 miles. At Clifton the tableland abuts on the ocean, while the widest part (150 miles) is in the valley of the Hunter River, where the relatively soft rocks of the coal basin have offered least obstruction to river erosion. The Great Coal Basin (extending from Port Stephens to Jervis Bay) underlies the central part of the Coastal region; the seam emerges to the surface at Newcastle and Bulli, while at Sydney it lies about 3,000 feet below the surface. Valuable coal seams are also found in the Clarence River district, but for the most part, the northern and southern sections of the coast district are devoted to dairy-farming, and the cultivation of such crops as maize and lucerne. Valuable timbers are also obtained. Sugar cane is grown in the extreme north, but is steadily giving place to dairy-farming.

There are two Tablelands—the Northern and Southern—comprising an extensive plateau region, furrowed in many parts by deep rugged valleys. Generally they present on the eastern side a steep escarpment towards the ocean, while on the west they slope gradually towards the plains.

The Tablelands vary in width from 30 to 100 miles, the highest portions being near the Queensland and Victorian borders.

The chief industries are cereal and fruit cultivation, sheep and dairy-farming; gold, tin, silver, and other metalliferous mines are worked in various parts.

Level upland plains occur throughout the Tablelands, such as the Dorrigo, forming the elevated hinterland of the coastal tract round Coff's Harbour, and the Bathurst, Goulburn, Yass, and Monaro Plains on the Southern Tableland.

Numerous sunken valleys, hollowed out in past ages by running water, form notable features of the Southern Tableland; the principal are those of the Blue Mountains, the Burragorang Valley, through which the Wollondilly River flows, the Kangaroo Valley, between Moss Vale and the Shoalhaven River, and the Araluen Valley further south.

The far-famed limestone caves—Jenolan, Wombeyan and Yarrangobilly—are also situated in the Southern Tableland District.

The Great Plain District stretches from the base of the Tablelands to the western boundary of the State. The Plains are not quite horizontal, but slope very gently from the bed of the Darling eastwards towards the Great Dividing Range, and westward towards the South Australian border. Only a few trifling elevations occur, and the plains are for the most part devoid of timber.

The Plains are watered by the rivers of the Murray-Darling system; the Darling and its tributaries are liable to considerable shrinkage in periods of dry weather, but, on the other hand, in wet seasons these streams overflow their banks and flood the surrounding country for miles, rendering it extremely fertile.

The surface of the Plains consists of rich red and black soils—the red soil is particularly rich in plant food. The black soil formations represent the silted-up channels of old rivers which, during flood times, spread a fertile silt over the surrounding country. The black soil plains occupy large areas along the middle courses of the Castlereagh, Namoi, and Gwydir Rivers.

In the western portion of the Plain district the rainfall is not adequate for successful agriculture, but the dryness of the atmosphere favours the production of wool of a quality which is unsurpassed in any other part of the world. In favourable seasons the rich natural grasses provide pasturage for millions of sheep, while in dry seasons the salt bush, with its drought-resisting qualities, is valuable as food for stock.

The eastern portion is admirably adapted for wheat-growing, and with the development of irrigation and dry farming, the area of profitable agriculture is steadily extending westward.

Several portions of the Plains are distinguished by special names, such as the Liverpool Plains, between the Peel and Liverpool Ranges, devoted to sheep-farming and agriculture; and the Riverina, stretching northward from the Murray, and intersected by a network of streams, noted for its sheep, wheat, fruit, and wines. There are also the

Bulloo Plain between the Paroo River and the Grey and Barrier Ranges; the Bland, between Cootamundra and Lake Cowal; and the Pilliga Scrub, between Narrabri and Coonabarabran, which is to be settled in small holdings devoted to sheep and wheat.

Mountains.

The mountains of New South Wales may be described under three classes—the Great Dividing Range, the Coastal Ranges, and the ranges of the interior.

The Great Dividing Range is the name given to the portion within New South Wales of a continuous chain of mountains stretching along the whole eastern portion of Australia. The Great Dividing Range has the form of a broad plateau rising steeply from the Coastal Plain on the east, but sloping gently towards the Plains on the west.

Except for a horseshoe bend skirting the valley of the Hunter River, it runs for the most part parallel to the coastline, and a number of lateral spurs branch off from each side.

Proceeding from north to south, the names distinguishing the various portions of the Great Dividing Range are: Macpherson, New England, Liverpool, Main or Blue Mountain, Cullarin, Gourock, Monaro, and the Muniong Ranges.

The Macpherson Range extends from Point Danger along the Queensland border to the source of the Dumaresq River, after which it turns in a southerly direction to form part of the Great Dividing Range, extending as far as Bald Rock, near Tenterfield. This range serves as a watershed for the Tweed and Richmond Rivers, and by intercepting the moist north-east winds which blow in this region, causes the large rainfall of the Richmond River Valley. The highest peak is Mount Lindsay, 4,064 feet. The Richmond Range branches off the Macpherson and separates the Richmond and Clarence River basins.

The New England Range extends from Bald Rock as far as the parallel of Port Macquarie. Its highest peak is Ben Lomond, 5,000 feet. On the east side the lateral spurs of the New England Range are the Macleay and Hastings Ranges, and on the west the Nandewar and Moonbi. The Macleay Range forms the watershed between the Clarence and Macleay River basins, and the Snowy Mountain, a branch of the Macleay, forms part of the boundaries of the Bellinger and Nambucca basins. The Hastings Range leaves the New

England near its southern end, runs between the Macleay and Hastings River basins, and terminates near Crescent Head on the Coast. The Nandewar Range forms portion of the watershed between the Gwydir and Namoi River basins.

The Liverpool Range, commencing at the termination of the New England Range, runs westerly between the Liverpool Plains and the Hunter-Goulburn Valley, and serves as a part of the connecting link between the Northern and Southern Tablelands. The highest part is Oxley's Peak (4,500 feet). In a spur of the Liverpool Range stands Mount Wingen, a burning mountain; its fires are attributed to the burning of a thick bed of coal some distance underground. It has been estimated that they have been burning for at least 800 years, and probably originated in bush fires. Mount Wingen attracts a large number of tourists. The Mount Royal Range branches off the east side of the Liverpool Range; its numerous spurs penetrate the Valleys of the Hunter and Manning Rivers. The Peel Range branches off the west side.

The Warrumbungle Range is practically a continuation of the Liverpool Range, extending in a north-easterly direction. These mountains represent the denuded stumps of a series of volcanoes which burst into activity near the shores of the old mediterranean sea not long before it finally became silted up. The sand and stone beds of portion of the Warrumbungle Range form a portion of the intake beds of the great artesian basin. The Castlereagh River and its feeders rise in this range.

The Main or Blue Mountain Range extends from the Liverpool Range to the vicinity of Goulburn. Its spurs are the Hunter Range and Blue Mountains from the east side, and the Macquarie Range from the west side.

The Hunter Range forms portion of the southern boundary of the Hunter River Valley, and its numerous branch ridges penetrate far into the Hunter and Hawkesbury River basins.

The Blue Mountains consist of a rugged plateau furrowed by deep gorges, such as the Grose, Kanimbla, Jamieson and Capertee Valleys, which have been carved out of solid sandstone by the action of running water.

The soil is for the most part barren except for a few rich patches which form the capping of high hills, their fertility being due to the presence of decomposing basalt. The Blue Mountains are noted for coal seams and beds of ironstone, kerosene shale, and limestone. The coal and iron deposits are worked in the Lithgow district; at Portland extensive cement works are in operation, and in the Wolgan Valley large buildings have been equipped for the production of kerosene oil and allied products.

The Blue Mountain district, with its magnificent scenery and bracing climate, contains many popular tourist and health resorts, situated within easy distance of the metropolitan area. The highest peak is Mount Clarence, 4,000 feet.

The Macquarie Range separates the upper tributaries of the Macquarie from those of the Lachlan. The highest peak is Mount Canoblas, a group of volcanic crags, 4,610 feet high.

The Cullarin Range extends from the Liverpool Range to the southern end of Lake George; its average height is about 2,500 feet. The highest peak is Mount McAlister (3,390 feet). This range rises in places to rugged precipitous cliffs, but consists for the most part of gently sloping uplands. The Hawkesbury and Lachlan Rivers rise in the Cullarin Range. The Mundooran Range, branching off the west side, separates the upper basins of the Lachlan and Murrumbidgee Rivers.

The Gourock Range extends southward from Lake George, and for some distance forms the edge of the Southern Tableland.

The Monaro Range stretches from the Gourock Range and, turning in a westerly direction, forms the southern boundary of the Monaro Plains, a rich pastoral region. The highest peak is the Head of the Kybeyan River, 4,010 feet.

The Muniong Range extends from the Monaro Range into Victoria, where it is continued under the name of the Australian Alps. The most southern portion of the Muniong Range in New South Wales is sometimes known as the Snowy Mountains.

The Muniong Range is the highest portion of the Great Dividing Range, its average height being about 6,000 feet. Mount Kosciusko (7,328 feet) is the highest peak in Australia. It is almost wholly composed of gneissic granite, although belts of slate and patches of basalt also occur. Mount Townsend (7,238 feet), Mount Twynan (about 7,200 feet), Ram's Head (6,600 feet), and The Pilot (6,020 feet), are also prominent elevations. The Kosciusko region is the coldest portion of Australia, and snow-drifts are met with even in the middle of summer. The striated rock masses and accumulations of moraine matter occurring in various parts furnish evidence of the former existence of glacial ice.

Large numbers of tourists visit Kosciusko and the Snowy Mountains, which are noted for their magnificent scenery—special attractions being trout-fishing and, in winter, alpine sports.

The Murrumbidgee, Tumut, and Murray Ranges are spurs of the Muniong. The Murrumbidgee Range separates the upper basin of the Murrumbidgee from its tributary, the Goodradigbee. Several of its peaks approach 7,000 feet in altitude. Gold is found in many places in the Tumut Range, which separates the course of the Goodradigbee and Tumut Rivers. The Murray Range is the most southern of the lateral branches of the Great Dividing Range; it separates the upper portions of the Tumut and Murray River basins.

A disconnected chain of mountains, the Mittagong Range, commences in the eastern side of the Wollondilly River and runs transversely along a portion of the Southern Tableland till it meets the Illawarra Range.

Four well-defined ranges lie in the Coastal District, running, as a rule, parallel to the Tablelands. The North Coast Range runs from the Richmond Range to the Hastings River district; it is not a continuous chain, being intersected by the Clarence and Macleay Rivers. The Illawarra Range rises abruptly from the sea at Clifton and runs southward close to the seaboard to the valley of the Shoalhaven River. It is capped by sandstone masses and is traversed by valuable coal seams. The Currockbilly Range stretches between the south bank of the Shoalhaven and the north bank of the Moruya River. The South Coast Range is a spur of the Monaro Range, and forms the eastern and southern boundaries of the upper basin of the Snowy River.

Two fairly well-defined ranges of moderate elevation, the Grey and the Barrier Ranges, lie near the extreme west and north-west of the State. They form the western boundary of a vast depression, through which the Darling and its tributaries flow. Gold is found on the slopes of the Grey Range, and extensive lodes of silver and lead ores are worked in the Broken Hill district of the Barrier Range.

New South Wales does not lie within the zone of actual volcanoes and earthquakes, though numerous indications are to be found of violent volcanic activity and earthquake disturbances in former ages.

Traces exist of a series of volcanoes which extended near the shore of the old inland sea, from Mount Canoblas, near Orange, northwards through the Warrumbungle and Nandewar Ranges into Queensland.

The Kiama basalt or blue metal, used largely for making roads and for ballasting railway lines, is a solidified lava, ejected during the Permo-Carboniferous period—to which the coal seams of Newcastle and Illawarra belong. At Nobby's, Newcastle, and at many places in the neighbourhood of Sydney, extensive volcanic dykes occur. The basaltic cappings of the hills and great sheets of basalt found on the Tableland and the slopes of the Great Dividing Range are also relics of extinct volcanoes. The fertility of the soil in many parts, and some of the most striking features of the scenery of New South Wales, are the result of former volcanic action, while the flow of basic lava along old watercourses has preserved the alluvial gold from subsequent distribution.

The earthquakes now experienced in New South Wales are infrequent and barely perceptible, though evidences of past movements—uplifts and depressions, folds and fractures—are met with in many districts throughout the State. The peculiar direction of the Murray, Murrumbidgee and Lachlan Rivers in their upper courses, and of the Wollondilly, Snowy, and other streams, and the steep escarpment on the east side of the Blue Mountains, are all attributable to ancient earth movements.

RIVERS.

The Great Dividing Range is the main watershed of New South Wales, and divides the rivers into two groups—the Coastal and the Western.

The Coastal rivers discharge into the Pacific, and on account of the proximity of the mountains to the ocean, are, for the most part, short, rapid streams. The Hunter and the Hawkesbury, by reason of their winding courses, are the longest. Generally, the rivers south of Sydney, where the coastal strip narrows considerably, are of less importance than those of the north.

The physical aspect of the eastern rivers is somewhat similar; their upper courses are amidst broken and mountainous country, and the lower basins consist of undulating land, with rich alluvial flats devoted to agriculture and dairy-farming. Where uncultivated, the land is densely timbered and yields the finest hardwood and, in the north, cedar and pine.

In the north are the Tweed, Brunswick, and Richmond Rivers, which flow through rich, flourishing country, devoted to dairy-farming and the cultivation of semi-tropical products; large supplies of cedar and hardwoods are obtained in these districts. The Richmond, 160 miles long, is navigable for small craft to Lismore, 65 miles from the sea.

South of the Richmond is the Clarence, the finest of the northern rivers. Its length is 190 miles, and the area of its basin is about 8,000 square miles. It rises in the Macpherson Range and waters one of the richest districts in the State. For a distance of about 70 miles from the sea the Clarence is about half-a-mile in width, and is navigable for ocean-going steamers of moderate draught as far as Grafton, 45 miles.

Two short rivers, the Bellinger and Nambucca (navigable for short distances by small craft) enter the Pacific between the Clarence and Macleay.

The Macleay discharges into Trial Bay after a course of 160 miles. The country through which it flows is thickly timbered; the upper part of the basin is wildly rugged, but the lower basin consists of rich alluvial flats, yielding maize, potatoes, citrus fruits, and dairy produce. Vessels drawing seven feet can trade for a distance of 30 miles from the sea.

The Hastings River rises in the Hastings Range and, after a course of 110 miles through rich undulating country, well timbered with cedar and mahogany, flows into the sea at Port Macquarie. Dairy produce, maize, and hardwood sleepers are the principal products of the district. A proposal has been made to connect the Hastings and Macleay by a canal 6 miles long and about 30 feet wide.

The Manning rises in the Mount Royal Range and has a course of 150 miles, navigable for 30 miles from the mouth. The valley through which it flows is densely wooded and the land on both sides is remarkably fertile. Butter, maize, fish, marble and lime are the chief products of the Manning district.

The Karuah is a small stream rising in the Mount Royal Range and discharging into Port Stephens.

The Hunter is one of the most important rivers of New South Wales. It rises in the Mount Royal Range and flows south-west till it is joined by the Goulburn, which flows in an easterly direction from the Main Range. Below the Goulburn junction the Hunter turns eastward and enters the sea at Newcastle, after a course of 340 miles. Its chief tributaries are the Williams, Paterson, and Wollombi. The main stream is navigable for ocean-going vessels to Morpeth (35 miles), while small craft ascend the Paterson and Williams Rivers for short distances.

The upper valley of the Hunter is hilly, sheep and dairy-farming being the chief industries. The middle and lower portions consist of rich alluvial flats, where grapes, lucerne, millet, etc., are grown. In the lower Hunter Valley lies the most productive coalfield of Australasia. Coal, hay and wines are the chief products of the Hunter River district. The water supply of Newcastle and adjacent townships is drawn from this river.

The Hawkesbury drains an area of about 8,000 square miles to the west and south-west of Sydney. Various portions of this stream are known by different names, bestowed by early explorers before it became known that they formed parts of one river. It rises under the name of Wollondilly in the Cullarin Range and flows through the fertile Goulburn Plains and the sunken valley of Burragorang. After the junction of the Cox's River, which drains the southern portion of the Blue Mountains, it is known as the Warragamba, till it is joined by the Nepean River from the western slopes of the Illawarra Range. The united stream then retains the name of Nepean and flows along the foot of the Blue Mountains, through rich cultivated flats. After junction with the Grose, the river is known as the Hawkesbury, and discharges into Broken Bay, after a course of 335 miles. The country through which this river flows is noted for magnificent scenery, especially at the junction of the Warragamba and in the lower Hawkesbury basin. The water supply of Sydney is obtained from the Upper Nepean and a tributary stream, the Cataract.

In the neighbourhood of Sydney some small streams fall into Botany Bay, such as the Woronora and George's River.

The principal river in the south coast district is the Shoalhaven. This river drains part of the Southern Tableland lying between Gourock and Currockbilly Ranges, and flows in its upper course through mountainous country and deep gold-bearing gullies; the lower course lies through rich agricultural and dairy-farming lands. The Shoalhaven is 220 miles long, but is navigable for only a few miles. Part of the waters of the Shoalhaven enter the sea through the Crookhaven, five miles to the south, with which it is connected by a canal.

Further south, in the narrow belt between the ranges and the sea, flow the Clyde, Moruya, Tuross, Bega, and Towamba Rivers, draining a prosperous dairy-farming district. The upper basins of the Clyde and Moruya are auriferous, and superior building granite is obtained in their neighbourhood.

The Snowy River belongs to another river system; it drains the southern slopes of the Monaro Range, and crosses the southern boundary into Victoria before discharging into the Tasman Sea. Of the total length (265 miles), 170 miles are in New South Wales.

The rivers of the Western Slope belong to one great system—the Murray-Darling. They drain an immense area, including the whole of the western portion of New South Wales and large portions of Queensland and Victoria, and discharge into the sea through a single mouth. In consequence of the gradual slope of the plain country, these rivers, unlike the coastal streams, are long and slow in discharge.

The Murray, the southern branch of this system, rises in the most southern portion of the Muniong Range. It flows along the boundary between New South Wales and Victoria, and passing into South Australia, discharges its waters through Lake Alexandrina into the Southern Ocean. The Murray has a total course of 1,600 miles, of which 1,200 miles are within New South Wales. Its tributaries above Albury are for the most part mountain torrents, fed by the snows of the southern highlands; in its lower course it receives the waters from the extensive catchment area of the Murrumbidgee and Darling. The fall of the Murray between Albury and the Darling Junction is less than six inches in the mile, and this circumstance, as well as the loose nature of the soil, has led to the formation of a network of anabranches, which intersect the country in every direction between the Murray and Murrumbidgee, and carry into the Murray a large portion of the drainage of the Riverina. The largest of these is the Edwards River, which receives the united waters of Yanco Creek and the Billabong, and, after a course of about 150 miles, returns to the main stream near the Murrumbidgee Junction. The upper course of the Murray is through rocky, barren cliffs; the lower basin is devoted to sheep-farming, wheat-growing, dairying, and the cultivation of grapes and stone fruits. The river is navigable for large river boats as far as Wentworth for about seven months of the year, and for smaller craft as far as Albury.

Of the Murray's tributaries, the Darling drains the largest area, extending over the greater portion of the western district of New South Wales and embracing nearly all southern Queensland. The Darling is formed by the union of several streams, and is known by various names in different parts of its course. One branch, the Macintyre, rises near Ben Lomond and is joined by the Dumaresq, a stream which has its source near the Queensland border. At the junction of the Gwydir the name Macintyre is changed to Barwon, and, after the junction of the Bogan, the river becomes known as the Darling. The total length of the river from its source to the sea is 2,310 miles; it is navigable during freshets as far as Walgett, 1,910 miles from the sea.

Its chief tributaries within New South Wales are the Gwydir, Namoi, Castlereagh, Macquarie, and Bogan. Portions of the Culgoa, Warrego and Paroo, which drain southern Queensland, are within New South Wales territory, but the two last-named are not permanent tributaries, and only reach the Darling during floods.

An irrigation settlement has been established at Wentworth, near the junction of the Darling and Murray Rivers.

The Gwydir rises in the New England Range, and, assisted by several small tributaries and anabranches, waters a large area of good agricultural and pastoral country. The lower basin is riddled with artesian bores, some of which yield over a million gallons daily and are of immense importance to the sheep-farming industry. The Namoi, after a course of 430 miles, joins the Barwon near Walgett. The upper basin consists of rugged gold-bearing country, succeeded by rich undulating pastoral and agricultural land; the lower course consists, on the north side, of good sheep land, and, on the south, sandy plains. The fertile Liverpool Plains and the Pilliga Scrub, suitable for mixed farming, lie within the Namoi basin.

The Castlereagh rises in the Warrumbungle Range, and after a winding course of about 340 miles, joins the Macquarie near its junction with the Darling. In its upper course it flows through basaltic gorges, with occasional swamps and grassy tracts devoted to sheep and wheat.

The Macquarie has a course of 590 miles. The upper basin is well-grassed and utilised for sheep and dairy-farming. The river flows in a north-westerly direction, through excellent wheat country, to Narromine, thence through wide sheep-grazing plains intersected with belts of gum and box forests, till it loses itself in the Macquarie marshes. The marshes in turn drain into the Barwon by various channels; the largest is called the Macquarie, and is joined by the Castlereagh.

The Bogan joins the Darling between Bourke and Brewarrina, after a course of 370 miles. The catchment area is very small in comparison with its length, and in dry seasons the Bogan, like most of the rivers of the interior, becomes a mere chain of ponds. Its lower basin is occupied by large sheep stations; wheat-growing is the principal industry of the upper basin. Silver and copper mines also are worked in this district.

The Murrumbidgee, 1,050 miles in length, ranks next to the Murray in regularity of flow and volume of discharge. It rises in a northerly spur of the Kosciusko Plateau. At first its course runs in a southerly direction, but near Cooma it curves sharply and runs in a northerly direction until it approaches the town of Yass, whence it runs westward almost parallel to the Murray to the Lachlan junction, after which it runs south-westerly and discharges into the Murray. In its upper course the Murrumbidgee flows through rugged gold-bearing country and receives, on the right bank, the Umaralla, Molonglo, Queanbeyan, and Yass Rivers; and on the left, the Cotter, Goodradigbee and Tumut; near the junction of its tributaries extensive level tracts of great fertility usually occur. After the confluence of the Tumut, it flows through plains devoted to wheat-growing and sheep-farming, and drains with numerous billabongs or shallow watercourses the fertile Riverina district. The Murrumbidgee flows through the Federal Capital Territory—Canberra being situated on its tributary, the Molonglo.

A huge storage reservoir is nearing completion at Burrinjuck, below the confluence of the Goodradigbee and Murrumbidgee Rivers, to retain the floodwaters for the irrigation of an extensive tract on the north bank of the Murrumbidgee below Narrandera. An irrigation settlement has been established also at Hay, on the lower Murrumbidgee.

The Lachlan, 850 miles long—the chief tributary of the Murrumbidgee—rises in the Cullarin Range, and is fed, in its upper courses, by numerous minor streams—the Crookwell, Abercrombie, Belubula, and Booroowa Rivers. After receiving the Booroowa, the Lachlan flows through fertile plains without receiving any permanent tributary; the watercourses which drain the plains on each side reach the river only in time of flood. The upper and middle portions of the basin consist of excellent wheat and fruit-growing country, interspersed with rich auriferous tracts; the lower portion is devoted to pastoral purposes.

Lakes.

Apart from the lakes of the Coastal tract, already described, the lakes of New South Wales belong to three distinct systems—those of the Tablelands, of the Western Plains, and the lakes or tarns of the Kosciusko Plateau.

With few exceptions, the lakes of the Tablelands are found in the south; they owe their origin to volcanic and other active geological disturbances of former ages. The largest is Lake George, which occupies a depression in the Cullarin Range. It is 16 miles long and 6 miles wide and, when full, covers an area of 60 square miles. It is fed by several small streams, but has no visible outlet; its waters are lost by evaporation and by soakage through the slate formation of its bed. The lake is full only after a prolonged period of wet weather, and in average seasons a large proportion of its bed is utilised for grazing sheep.

Lake Bathurst lies 10 miles east of Lake George. When full its area is about 5½ square miles, but it shrinks considerably in dry weather. Both these lakes are elevated over 2,000 feet above sea.

The lakes of the Western Plains occur usually along the courses of the western rivers; they are natural depressions which are filled by the overflow of the rivers during floods. Along the Darling the most important are: Lakes Cawndilla, Menindie, and Tandou, on the right bank; and Poopelloo and Gunyulka on the left. Like the western rivers, these lakes vary with the rainfall, presenting the appearance of inland seas in wet seasons and dwindling to a succession of ponds and mud basins in continued dry weather, but they serve a useful purpose in droughty seasons by maintaining the flow of the rivers below the lakes for some months after the upper course is dry. It is probable that these western lakes will, in course of time, be used as storage basins for irrigating large areas now unsuitable for agriculture through scanty water supply.

Within the Lachlan basin, Lakes Cowal and Cudgellico are the most important; the former, situated about 40 miles south-west of Forbes, receives the drainage of the Bland Plain. Much of the floodwaters of the Lachlan is conserved for irrigation purposes in Lake Cudgellico.

Lake Victoria is on the right bank of the Murray in the south-western corner of New South Wales. It is connected with the Murray by the Rufus River, and covers an area of 26,000 acres.

The Kosciusko Lakes owe their formation to the blocking-up of water by moraine material left behind by glaciers. They are situated about 6,000 feet above sea-level. The principal are the Blue Lake, Lake Albina, Cootapatamba, and Club Lakes, and Hedley Tarn. These lakes are noted for their scenic beauty, and the last-mentioned is of great interest to geologists on account of a peculiar terminal moraine which forms its southern boundary.

Towns.

Sydney, the capital of New South Wales, stands on the shores of Port Jackson. It is the main commercial and industrial centre, and contains more than one-third of the total population.

Outside the metropolitan area, the largest towns in the coastal division are situated in the northern coalfields; in the other portions, dairy-farming and agriculture are the main industries, the extension of the former having given great impetus to settlement along the Northern Rivers.

On the Tablelands, the population is engaged mainly in agriculture and sheep-farming. The coal mines, iron works, and other manufactories around Lithgow, in the Blue Mountain area, and metalliferous mines in other parts, give employment to many industrial workers.

On the Western Slopes of the Great Dividing Range and along the eastern edge of the Plain district, the cultivation of wheat is steadily extending, and, with sheep-farming and dairying, form the chief industries.

In the far Western Plains there are only two large centres of population, viz., at the mineral fields of Broken Hill and Cobar, the remainder of the land being occupied in large pastoral holdings.

The principal towns in each division are:—

Coastal Division.

Towns.	Population.
North—	
Lismore	8,200
Grafton	6,900
Casino	4,200
Kempsey	2,900
Murwillumbah	2,800
Ballina	2,600
Hunter and Manning—	
Newcastle	56,750
Maitland	11,700
Singleton	3,050
County of Cumberland—	
Sydney	694,800
Parramatta	12,600
Granville	8,600
Liverpool	3,950
Penrith	3,750
Windsor	3,490
South—	
Wollongong	4,900
Bega	2,050

Tablelands.

Northern—	
Armidale	5,100
Inverell	4,900
Glen Innes	4,400
Tenterfield	2,900
Central—	
Bathurst	8,650
Lithgow	8,600
Orange	6,850
Katoomba	5,400
Cowra	3,650
Mudgee	3,000
Southern—	
Goulburn	10,100
Yass	2,150
Cooma	2,100

Western Slopes and Riverina.

Northern—	
Tamworth	7,400
Narrabri	3,380
Gunnedah	3,150
Moree	3,100
Quirindi	2,350

Towns.	Population.
Central—	
Forbes	5,000
Dubbo	4,600
Wellington	4,100
Parkes	3,200
Coonamble	2,500
Southern and Riverina—	
Wagga Wagga	6,750
Albury	6,600
Young	3,350
Temora	3,100
Cootamundra	3,000
Narrandera	2,750
Junee	2,600
Deniliquin	2,600
Hay	2,500
Corowa	2,250
Murrumburrah	2,200
WESTERN DIVISION.	
Broken Hill	32,500
Cobar	5,000

The Federal Capital Territory is situated in New South Wales. It consists of an area of about 900 square miles in the Yass district. It is watered by the Murrumbidgee River and its tributaries—the Molonglo and Cotter Rivers. The territory embraces the whole catchment area of the Cotter and that part of the Molonglo between the junction of its tributary, the Queanbeyan River, and its confluence with the Murrumbidgee.

A site on the Molonglo about 12 square miles in extent has been selected for the capital city, Canberra, and will be connected with Jervis Bay by a railway line, 120 miles in length.

The Military College of Australia has been established at Duntroon, near the western boundary of the capital city area.

Chapter III.

STATISTICAL ACCOUNT OF THE DEVELOPMENT OF NEW SOUTH WALES.

By John B. Trivett, F.R.A.S., F.S.S., Government Statistician.

Population.

It is rather more than fifty years since New South Wales, the mother State of Australia, was restricted to its present boundaries. Queensland was separated on 10th December, 1859, and on 7th April, 1861, the date of the first census taken after the separation, the population of New South Wales was 350,860. On 2nd April, 1911, fifty years later, the population was 1,650,470, the increase being nearly five-fold. During the interval the growth of population at successive census periods was:—

Census Year.	Population.	Index Number.
1861	350,860	100
1871	503,981	144
1881	751,468	214
1891	1,132,234	323
1901	1,359,133	387
1911	1,650,470	470

In the quotation for 1911 is included the population (1724) of the Federal Capital Area at Canberra, which was transferred to the Commonwealth on 1st January, 1911. The estimated population of the State, as at 30th June, 1913, excluding the Canberra area, was 1,809,125.

The sources of increase to the population since the Census of 1861 have been as follows:—

	Natural Increase.	Excess of Immigration.	Total Increase.
1861-1871	106,077	47,044	153,121
1871-1881	140,382	107,105	247,487
1881-1891	211,301	169,465	380,766
1891-1901	226,676	223	226,899
1901-1911	247,871	43,466	291,337
(30th June) 1911-1913	72,168	88,211	160,379

Births.

The birth rate in 1860, the first year after the separation of Queensland, was 42.11 per 1,000 of population. This rate, however, was not maintained, as the following figures show:—

For	1860-1869,	rate	41.88	per	thousand
,,	1870-1879	,,	38.90	,,	,,
,,	1880-1889	,,	37.31	,,	,,
,,	1890-1899	,,	31.11	,,	,,
,,	1900-1909	,,	27.09	,,	,,
,,	1910-1912	,,	28.93	,,	,,

The rate declined in each decennial period and reached its lowest point in 1903, when it was 25.43. It has since been improving, and in 1912 was 29.90, the highest rate since 1895.

Deaths.

The mortality rates have improved greatly during the fifty-two years, and are now amongst the lowest in the world. From 1860-69 the death rate was 17.04 per 1,000 of population; from 1870-79, 15.43; from 1880-89, 14.92; from 1890-99, 12.49; from 1900-09, 10.87; and during 1910-12, 10.41. These figures disclose a very decided and continuous drop in the death rates of the community, and, if allowance were made for the alterations in the age and sex distribution of the population since 1860, it would be found that the decline has been even greater than shown in the crude rates quoted above. Among both sexes, and at all ages, the improvement has been general. It was gradual during the 30 years from 1860 to 1890, and rapid during the 22 years from 1890 to 1912. At ages under 5 the improvement has been especially gratifying, so that now the mortality rate at those ages is only half what it was 50 years ago.

With the exception of cancer, heart disease and Bright's disease, which unfortunately are increasing here, as in other parts of the world, it may be said that there has been a great and continuous fall in the death rates from all diseases since 1876, the first year for which complete records are available. For instance, typhoid fever, from which 664 deaths per million of population occurred in 1870, caused only 136 deaths per million in 1912. In 1890 the rate was 278; and in 1900, 294 per million. Diphtheria and croup in 1876 were responsible for 608 deaths per million, as against 153 in 1912. Scarlet fever was epidemic in 1876 and caused 1,815 deaths per million, in 1877 the rate was 149; in 1884, 259; in 1893, 150; and in 1912, 6 per million.

Phthisis causes more deaths than any other disease, except cancer. In 1876 the death rate was 1,024 per million of population. It is now about two-thirds of that rate, namely, 620 per million. The decrease has been steady throughout the whole period, although more rapid during the last two years. Diarrhœa and enteritis, which are so fatal at the extremes of life, show a decline in the rate from 1,251 per million in 1876, to 1,001 in 1912. The rate fluctuated to some extent in the intervening period, but the tendency has been downward. Accidents, which used to be very numerous, are not now so common. From 1876 to 1912 the rate decreased constantly till in 1912 it was 591 per million, or about half the rate, 1,152, in 1876.

MARRIAGES.

With the increasing prosperity during the last five years the marriage rate has increased greatly, until in 1912 the number of marriages per thousand of population was the highest recorded since the commencement of registration in 1856. In 1860 the marriage rate was 8.60 per 1,000; in 1870 it was 7.85; in 1880, 7.65; and in 1890, 7.15; the decrease in the thirty years being remarkably steady. In 1892 there was a sudden decline, which continued until 1895, when the rate was 6.42. After 1895 the rate increased, although in 1900, when it was 7.38, it was only equal to the rate of 1891. Since 1903 there has been a constant improvement. In 1910 the rate was 8.81; and in 1912 it was 9.58.

BIRTH-PLACES.

The great majority of the people of New South Wales—to the extent of 98 per cent.—are of British origin, and probably the population of this State (and of Australia generally) is more homogeneous than of any other country. The countries where the people were born, as ascertained at the Census of 1911, were as follows:—

Birthplace.	Number.	Per cent.
New South Wales	1,218,857	74.51
Other Australian States	158,362	9.69
New Zealand	13,963	0.85
United Kingdom	204,761	12.51
British Possessions	7,344	0.45
Foreign Countries	31,150	1.90
At Sea	1,479	0.09
Not stated	10,818	—
Total	1,646,734	100.00

From this it will be seen that 74½ per cent. of the people were born in New South Wales; 10½ in other parts of Australasia; 12½ in the United Kingdom, and only 2 per cent. in foreign countries.

Religion.

There is no established religion in New South Wales, and everybody is quite free to practise the rites of his own particular belief. At the Census of 1911 the religions of the people were as folllows:—

Religion.	Number.	Per cent.
Church of England ..	734,000 ..	45.46
Roman Catholic	412,013 ..	25.54
Presbyterian	182,911 ..	11.33
Methodist	151,274 ..	9.37
Other Protestant	113,048 ..	7.00
Other Religions	13,856 ..	0.86
No Religion	7,163 ..	0.44
Object to specify	21,986 ..	—
Not stated	10,483 ..	—
Total	1,646,734 ..	100.00

Climate.

Mention has been made of the extremely low death rates of New South Wales, and when the healthy and temperate nature of the climate is considered, they can be understood. New South Wales is situated between the 29th and 36th parallel of south latitude, and has a more temperate climate than America or Africa, when places in each are compared latitude for latitude. A similar comparison with the Northern Hemisphere is even more favourable to this State.

Speaking generally, it may be said that from Kiandra, on the Southern Tableland, to Bourke, on the Western Plain, its climate may be compared with that of the part of Europe from Edinburgh to Messina, but more generally it resembles that of southern France and Italy. Sydney, for instance, in latitude 33° 52′ S., has a mean annual temperature of 63° Fahr., corresponding with that of Barcelona, in Spain, in latitude 41° 22′ N., and Toulon, in France, in latitude 43° 7′ N. The range in Sydney is only 17°, the mean summer temperature being 71°, and the mean winter 54°. At Naples, which has about the same mean temperature, the range is 27°, from 74° to 47°. Over the whole State, January is the hottest, and July the coldest month, and the temperatures of spring and autumn represent approximately the mean of the whole year.

The rainfall of New South Wales is very variable. The wet season usually extends over the first six months of the year, although occasionally serviceable rains come in the spring in October and November.

New South Wales may be divided naturally into four climatic divisions, each with characteristic features, namely: the Coastal division, the Tableland, the Western slopes, and the Western Plain. The Coastal division has most equable temperatures, and is subject to the heaviest rainfalls, ranging from 30 inches per annum in the south to 70 inches in the north. At Sydney the annual rainfall is 48 inches.

On the Tableland the temperatures are cool and bracing; the southern tableland is the coldest part of the State, and at Kiandra, 4,640 feet above sea-level, the mean annual temperature is 45°. Over the whole Tableland the rainfall as a rule is consistent, ranging from 30 to 40 inches per year.

To the west of the Tableland division, where the land slopes away to the great plain of the interior, the rainfall is distributed uniformly, and varies from 20 to 30 inches per annum. The greater part of the wheat area is situated on the Western Slopes, an average rainfall of 25 inches being sufficient to ensure good yields. The mean annual temperature ranges from 60° to 69°.

The Western district consists of a vast plain, where the annual rainfall over a great part does not exceed 10 inches. Tho mean annual temperature ranges from 62° to 69°. The summer readings of the thermometer are sometimes high, being 10°, and even 20° higher than on the coast, but the heat is not distressing, being free from moisture. In fact, the dryness of the Western division renders it extremely healthy, and it is there that the best merino wool in the world is grown.

Education.

Education in New South Wales is under the administration of a responsible Minister of State, and is free, compulsory, and unsectarian. The Public Instruction Act, passed in 1880, requires that every child between the ages of 6 and 14 must attend school for a minimum period of 70 days in each half-year. No part of our progress has been more real than that of education. In 1860 there were 798 schools of all kinds, with 34,767 scholars on the roll. These figures represent one school to every 437 persons, and ten scholars to every 100 persons. In 1880 there were 1910 schools, with 169,441 scholars, or one school to 392 persons, and 23 scholars to 100 persons. In 1900 the number of schools was 3,657, and of scholars, 270,031; while in 1912 the numbers were: schools, 3,988, scholars, 290,273; the proportions having changed to one school to 447 persons, and 16 scholars to 100 persons. Included in the figures for 1912 are 754 private schools, with 61,744 scholars. The majority of the private schools are denominational.

The coping-stone of the Education system is the University of Sydney, which, from small beginnings in 1852, has advanced steadily to its present important position. When the University was opened, on 11th October, 1852, there were 24 matriculated students. Twenty years later the number was only 39, but in 1892 there were 540, and in 1912 1,048 matriculated students. The University is strictly undenominational, and does not confer degrees in Theology or Divinity. There are four faculties, Arts, Law, Medicine, and Science, and under Royal Charter, the same rank, style, and precedence are granted to graduates of the Sydney University as are enjoyed by graduates of the Universities of the United Kingdom. In 1912 the University was subsidised to the extent of £43,956 by the State Government. Many benefactions have been bestowed on the University, among which those given by Mr. J. H. Challis and Sir P. N. Russell, stand out prominently. The income of the University from this source in 1912 was £24,398.

The improving influence of the system of education may be tested by the census returns and by the marriage registers. In 1861, 18.7 per cent. of the adult males, and 14.5 per cent. of the adult females could not read nor write. Fifty years later the proportions were 2.7 for males, and 2.0 for females. In 1860, out of every thousand persons married, 265 could not sign the marriage register; in 1870, the number was still large, namely, 182; in 1890, it had fallen to 27; and in 1912 there were only 4 per thousand. During the year ended 30th June, 1912, the State expended altogether a sum of £1,604,944, or 18s. 11d. per inhabitant, on education.

Law and Order.

Australians are a law-abiding people, and most orderly. In 1912 there were 54,715 arrests by the police, being 31-46 per thousand of population, but this number does not appear nearly so formidable when allowance is made for the fact that 80 per cent. of the arrests are for infringing regulations imposed by the demand of the community for orderliness in public places. When these cases come to be dealt with at the Magistrates' Courts, about 96 per cent. are treated summarily, and in only 4 per cent. is imprisonment compulsory. The total gaol population at the end of 1912 was 1,275, or 1 in every 1,395 of the population. This represents the lowest level on record, and the following statement shows that the actual gaol population has decreased greatly, notwithstanding the general population has increased.

Year.	Gaol Population at end of Year.	Rates per 100,000 of Population.
1860	947	272
1870	1,438	288
1880	1,961	262
1890	2,290	204
1900	1,791	131
1910	1,238	76
1911	1,173	69
1912	1,275	72

Between 1890 and 1911 the gaol population decreased absolutely by one-half, and relatively by two-thirds.

RAILWAYS.

The proper development of a country like New South Wales, $2\frac{1}{2}$ times the size of the United Kingdom, and ill-supplied with navigable rivers, requires many railways. This was recognised at an early period, and in spite of the natural difficulties in opening up the large territories of the State, railway construction has been prosecuted with vigour. The largest portion of the Public Debt of the State has been contracted for railway purposes—and in the last year they made a net return of 3.76 per cent. on the cost of construction. As affecting the return from the railways, it should be noted that State properties are not expected to earn as a maximum a much higher net return than will represent fair interest on the capital expended. When the result is much in excess, public opinion at once demands a reduction in the traffic rates and charges.

There were 70 miles of railway open in 1860; these lines, after paying working expenses, earned an amount of £11,842, equal to a return of £169 per mile; the mileage under traffic is now 3,930, and the net earnings last year were £2,104,104, representing £535 per mile.

The following facts illustrate the extent of railway development during the last 53 years:—

Period.		Population per Mile of Line Open.		Net Earnings.		Capital Expended on Lines Open.		Train Miles per Inhabitant.
1860	..	4,979	..	£11,842	..	£1,422,672	..	0.52
1870	..	1,471	..	101,139	..	5,566,092	..	2.04
1880	..	881	..	513,298	..	11,778,819	..	4.44
1890	..	523	..	967,251	..	30,555,123	..	7.27
1900	..	482	..	1,394,052	..	38,477,269	..	6.57
1910	..	445	..	2,209,306	..	48,925,348	..	9.57
1913	..	460	..	2,104,104	..	57,653,778	..	10.60

Postal.

Taking into consideration its large area, New South Wales possesses an excellent system of postal and telegraphic communication; and very striking progress has been made in the development of the facilities, and in the advantage taken of them by the public. The interstate system is good, and New South Wales is in direct communication with Europe and the rest of the world by means of cables. In 1860 there were 289 post offices, of which 36 were also telegraphic stations. In 1880 the number of post offices was 2,000; and of telegraphic stations, 1,384. While the letters carried in 1860 numbered 4,230,761; the newspapers, 3,668,783; and the parcels and books, 83,736; the corresponding figures for 1912 were: 191,227,935 letters and post cards; 68,696,648 newspapers; and 36,523,997 parcels and books. The telegrams in 1860 were 74,000, as compared with 1,489,613 in 1880, and 6,364,990 in 1912. Reduced to a basis at per thousand of the population, the postal figures appear as below:—

Year.		Letters and Postcards.		Newspapers.		Parcels, Books, Packets.		Telegrams.
1860	..	12,517	..	10,854	..	248	..	219
1870	..	14,456	..	7,785	..	322	..	355
1880	..	30,034	..	18,925	..	976	..	2,044
1890	..	57,810	..	36,846	..	8,132	..	3,722
1900	..	58,777	..	38,027	..	10,749	..	2,377
1910	..	101,321	..	41,433	..	25,136	..	3,469
1912	..	109,990	..	39,513	.	21,008	..	3,661

To transact the postal business of the State, mail conveyances travelled 1,461,518 miles in 1860; 5,246,373 miles in 1880; and 16,390,393 miles in 1912. The revenue collected in New South Wales by the Postal Department in 1912-13 from postage, telegrams and telephones was £1,628,177, equal to 18s. 4d. per head of population.

Shipping.

The rate of increase in shipping of New South Wales has been much faster than that of population, despite checks occasioned by unfavourable seasons and by the low prices which rule occasionally for staple products in the European markets.

The trade of the State, oversea, and with other Australian States, required the services of 1,424 vessels in 1860; of 2,108 in 1880; of 2,784 in 1900; and of 3,354 in 1912. A bare statement of the number of vessels, however, does not give an adequate idea of the development of the shipping trade of the State, since the tonnage of vessels inwards in 1860 was 427,835; while in 1912 it was 7,490,046, or 17½ times as much. A statement of tonnage at each decennial period shows continued progress. In the first year the average capacity of the vessels was 300 tons, and in the last year, 2,233 tons.

Year.	Tonnage Inwards.	Average tons per Vessel.
1860	427,835	300
1870	689,820	371
1880	1,242,458	589
1890	2,340,470	1,006
1900	4,014,755	1,442
1910	6,290,119	2,137
1912	7,490,046	2,233

There are several ports on the coast of New South Wales, but only two, Sydney and Newcastle, can be considered of any importance. Sydney possesses great natural facilities for shipping, and both there and at Newcastle ample wharfage accommodation has been provided for the large deep-sea vessels which now visit Australia. The tonnage of the ships which entered Sydney Harbour in 1912 was 5,732,055, and Newcastle, 1,570,581.

Trade.

The very large tonnage of the shipping which enters the ports of New South Wales is evidence of considerable trade. The value of the exports from year to year forms the surest index of the progress of a country in the formative stage, which is a large producer of raw materials; and the result of a rise or fall in the prices of staple commodities, or of a decline in production, may be traced readily in the corresponding rise or fall of the export values. Imports must be considered in connection with loans raised outside the State, as these loans reach the State in the shape of goods which are included in the Import Returns. The trade of New South Wales may be divided into two classes, viz., oversea, or trade with countries outside Australia, and interstate, or trade with the other Australian States. Both classes are of considerable magnitude, but it is, unfortunately, not possible to distinguish the interstate trade, as the Customs Department, under Federal control, does not now record the figures. In 1909, the latest year for which information is available, the interstate trade was valued at £32,939,551.

In 1912 goods to the value of £32,303,630 were imported oversea, of which £30,006,129 were retained for consumption in Australia, and £2,297,501 were re-exported.

The value of the goods exported oversea in 1912 was £32,958,529, of which £30,661,028 was the produce of Australia. Relatively to population, imports were £18 11s. 7d. per head; and exports, £18 19s. 1d. per head. In the following summary are given the oversea trade in decennial periods since 1860:—

Period.	Annual Value of Oversea Imports. Total.	Annual Value of Oversea Imports. Per Capita.	Annual Value of Oversea Exports. Total.	Annual Value of Oversea Exports. Per Capita.
	£	£ s. d.	£	£ s. d.
1860-69	5,892,118	14 15 2	4,882,493	12 4 7
1870-79	7,275,618	12 10 11	6,612,597	11 8 0
1880-89	13,249,471	14 13 10	10,446,162	11 11 8
1890-99	11,961,607	9 14 4	15,062,134	12 4 9
1900-09	17,075,903	11 15 1	23,572,369	16 4 6
1910-12	27,628,684	16 10 3	32,385,127	19 7 1

These high amounts of trade per head are exceeded in very few countries, and are evidence of the large productive power of the State. The principal articles imported into the State are (*a*) food, drink, narcotics, and stimulants, and (*b*) manufactured goods. In 1912 the value of the imports of articles of the first-named group was £4,769,278; while manufactured articles imported were valued at £22,039,188. Included in the latter amount, textiles and dress were valued at £7,285,929, and metal manufactures at £5,173,151. The next largest groups included building materials, valued at £1,562,268; books, stationery and paper, valued at £1,222,930; and vehicles, harness and equipment, valued at £889,415. The remaining groups ranged from fancy goods, £614,893, to works of art, £40,213.

The exports consist of raw materials, principally pastoral, agricultural and mineral. Of the exports in 1912, animal and vegetable foods were valued at £4,743,430; staple animal and vegetable substances, at £15,287,046; and staple minerals and metals, at £11,154,234. Stated otherwise, wool in 1912 constituted 35 per cent. of the exports, and other pastoral products, 13 per cent.; butter, 3 per cent.; wheat and flour, 6 per cent.; minerals, 22 per cent., and all other articles, 21 per cent. The trade of New South Wales with the United Kingdom is greater than with any other country. The following statement shows the oversea trade in 1912:—

Country.	Imports.	Per Cent.	Exports.	Per Cent.
United Kingdom	£18,093,957	56.01	£10,316,918	31.30
British Possessions	4,970,892	15.39	6,096,028	18.50
Foreign Countries	9,238,781	28.60	16,545,583	50.20
Total	£32,303,630	100.00	£32,958,529	100.00

AGRICULTURE.

New South Wales has a wide range of climate and fertile soils of varying characteristics, so that it is possible to cultivate plants indigenous to cold, temperate, and even tropical regions. Very few parts of the State are so barren or so unwatered as to be thereby unfit for cultivation. However, speaking broadly, New South Wales may be said to have only just emerged from the first phase of agricultural settlement. This has always been a pastoral country, and, therefore, agriculture has not received, until recent years, the attention it deserves. Nevertheless, the value of agricultural products is considerable, and amounts to about one-fifth of the total value of production from the primary industries of the State. The progress in cultivation will be seen from the following statement:—

Year.	Area under— Cultivation, Including Grasses. Acres.	Area under— Crops. Acres.	Average Area under— Cultivation. Acres Per Head.	Average Area under— Crops. Acres Per Head.
1860	260,798	209,794	0.75	0.60
1870	426,976	317,581	0.86	0.64
1880	710,337	629,180	0.95	0.84
1890	1,241,419	852,704	1.11	0.76
1900	2,868,305	2,445,564	2.10	1.79
1910	4,437,224	3,381,921	2.74	2.08
1912	4,889,674	3,737,268	2.75	2.10

During the first 30 years agricultural development was very slow. Even including grass-lands, the average area cultivated only slightly exceeded one acre per capita, and the total area under crop did not reach a million acres until 1892. From that year expansion was much more rapid, until in 1912 the area under crop was 3,735,793 acres. The relative increases in population and in area under crop, in decennial periods since 1860, have been as follows:—

Increase per cent.	1860-70.	1870-80.	1880-90.	1890-1900.	1900-10.	1910-12.
In Population	43.0	50.0	50.0	21.6	20.2	8.5
In Area under Crop	51.4	58.3	35.5	186.8	38.2	10.5

Since 1890 the area under crop has increased more rapidly than the population. During the last seven or eight years agriculture has been checked partly by one or two adverse seasons, but principally by the increased attention paid to dairy-farming.

In this, as in most other countries, the area devoted to wheat far exceeds that of any other cereal, the proportion being fairly constant at about three-fifths of the whole area under cultivation; and it is in this form of cultivation that the returns show the greatest expansion. The year 1897 may be said to mark the commencement of the present era of wheat-growing in this State, as it was in that year that the production for the first time exceeded the consumption and left a surplus available for export. The statement below shows the progress of wheat-growing since 1860:—

Period.	Average Area Under Wheat. Acres.	Average Annual Yield. Bushels.	Yield Per Acre. Bushels.
1860-69	137,843	1,595,970	11.58
1870-79	173,834	2,439,843	14.03
1880-89	300,394	4,110,121	13.68
1890-99	758,593	7,546,368	9.95
1900-09	1,611,961	17,209,245	10.67
1910-12	2,246,833	28,492,487	12.68

From the above it is apparent that lack of capacity to produce a payable average has not been the cause of the tardiness in development of wheat cultivation. The yield of wheat in 1912 was the highest experienced, being 32,475,813 bushels from 2,230,964 acres, equal to 14.6 bushels per acre.

A considerable portion of the new land brought under wheat is farmed on the shares system, especially in the southern districts. Under this system the owner leases his land to the farmer for the purpose of wheat growing only, the tenant possessing the right of running upon the estate the horses necessary for working the farm, and the owner the right of depasturing his stock when the land is not in actual cultivation. It is usual for the owner to provide the seed, and the tenant the labour; and up to a specified yield the parties to the agreement take equal shares of the produce, any excess going to the farmer as a bonus. In 1912, 618,333 acres were cultivated on the shares system.

After wheat, the principal crop is hay, the area harvested in 1912 being 947,062 acres, which returned 1,108,275 tons of hay. About one-fifth of the whole area under crop is usually devoted to hay. The principal grain cultivated after wheat is maize, which occupies 4.7 per cent. of the total area under crop. Then we have oats, with 2.28 per cent. The yield of maize in 1912 was 5,111,990 bushels; and of oats, 1,674,075 bushels. In addition to the above many minor crops are grown, the most important being fruit, potatoes, and sugar cane.

The value, as at the farm, of the production of the agricultural industry in five-year periods since 1880, the first year in which the valuation was made systematically, is shown below:—

Period.	Average Area Under Crop. Acres.	Average Value of Production. £	Value Per Acre. £	s.	d.
1880-84	662,085	3,594,355	5	8	7
1885-89	835,367	3,845,967	4	12	1
1890-94	1,048,554	3,788,017	3	12	3
1895-99	1,894,857	5,200,779	2	14	11
1900-04	2,436,765	6,165,427	2	10	7
1905-09	2,824,253	7,975,162	2	16	5
1910-12	3,582,886	10,350,000	2	17	9

The highest relative value received was in the first period. Since that time values on the whole have declined, on account of the fall in prices, particularly of wheat.

Closely associated with agriculture is the bee-keeping industry; but so far it has not attained any importance, and there is ample room for expansion. The number of hives in 1912 was 63,308, of which 13,023 were unproductive. The yield of honey was 2,410,000 lbs., and of beeswax, 49,734 lbs.

In order to obtain a knowledge of local conditions, and to afford an education in agriculture on scientific and local bases, the Government has established altogether 16 agricultural colleges and experiment farms, and has engaged agricultural lecturers and experts to guide and assist the farmers. The experiment farms have been established in various districts, and the experiments and teaching vary with the particular climatic conditions of the several districts. The agricultural colleges provide accommodation for resident students, and afford practical and theoretical instruction in a three-years' course, which embraces every branch of agriculture. Instruction is also given in dairying, pig-raising, and poultry-breeding; and all branches of farm labour are taught, including blacksmithing, carpentering, sheep-killing, etc.

Pastoral Industry.

The pastoral is the principal industry of the State, and its products constitute the chief element in the wealth of the community. In fact, the prosperity of the pastoral industry is reflected in the prosperity of the whole body politic. The wool clip is the most important item of production of New South Wales, and the prosperity of the State depends to a considerable extent upon the conditions prevailing in the wool market. Altogether, since 1860, wool to the value of £397,053,000 has been exported from New South Wales; the suitableness of the land for grazing was undoubtedly the means of inducing the early colonists to take up pastoral pursuits, and the relative ease with which operations could be conducted as compared with the effort required in other primary industries confirmed their choice.

The commencement of wool-growing was made when Macarthur introduced some Spanish sheep into the State in the year 1797. Natural conditions in Australia have somewhat varied the character of the Spanish fleece; but, on the whole, the quality has improved under the influence of the climate, and Australian wool is now the best in the world. The number of sheep in the State at decennial intervals since 1860 has been as follows:—

Year.	Sheep.	Annual Increase during each Period. Per Cent.
1860	6,119,163	1.0
1870	16,308,585	10.3
1880	35,398,121	8.1
1890	55,986,431	4.7
1900	40,020,506	(-) 3.4
1910	45,560,969	1.3
1912	39,044,502	(-) 8.0

Approximately half the sheep in Australia are in New South Wales. The largest number of sheep was recorded in 1891, when it was 61,831,416; but there is little doubt that the State with that number was overstocked, and steps were taken by pastoralists to restrict the numbers of their flocks. Moreover, the year 1891 was followed by a succession of bad seasons, so that in 1902 the number of sheep had fallen to 26,649,424, or over 35,000,000 less than in 1891. From 1902 the number increased more or less regularly to 44,947,000 in

1911; but, owing to an unfavourable season, dropped again to 39,044,502 in 1912.

The annual increase in the number of sheep has at times exceeded 20 per cent., the last occasion having been in 1904. At the present time the demand for wool is increasing, which will induce an increase in the flocks, but the demands for sheep for slaughtering, both for home consumption and for export are so heavy, that even with the best of seasons it will probably be several years before the number of sheep again reaches the higher figures of former years.

The decrease in the total has been accompanied by changes in the sizes of individual flocks. For instance, in 1891 there were 13,187 holdings on which sheep were depastured, while in 1912 the number of holdings was 25,549. In 1891 there were 73 holdings which each carried more than 100,000 sheep; in 1912 the number of such was 4. The sheep in flocks of more than 20,000 were 62 per cent. of the total in 1891; but only 27 per cent. in 1912. Roughly speaking, about nine-tenths of the sheep are merinos.

The following statement shows the quantity of wool produced, stated as in the grease, and the value (as at the place of production) in periods since 1876, the first year for which complete records are available.

Period.	Quantity. lbs. (Greasy).	Value. £
1876-1880	718,397,000	31,298,600
1881-1885	943,814,000	40,563,100
1886-1890	1,294,781,000	44,772,500
1891-1895	1,813,630,000	49,024,600
1896-1900	1,408,240,000	42,983,700
1901-1905	1,302,585,000	46,719,100
1906-1910	1,817,162,000	73,610,100
1911-1912	698,350,000	26,087,000

These figures prove the magnitude of the wool industry in New South Wales, and show how a fluctuation in the market value of the staple may affect the wealth of the people.

Of late years considerable attention has been given to the question of breeding, and the result is seen in the steady improvement in the average weight of the fleece. In fact, the improvement has been so marked that the quantity produced in 1911 with 45,000,000 sheep was very nearly equal to the quantity produced in 1891 with 62,000,000 sheep. The average yield of wool per sheep since 1881 is shown below:—

1881-1885	..	5.24	lbs. per sheep
1886-1890	..	5.42	,, ,,
1891-1895	..	6.44	,, ,,
1896-1900	..	6.71	,, ,,
1901-1905	..	7.61	,, ,,
1906-1910	..	8.12	,, ,,
1911-1912	..	8.31	,, ,,

Formerly, nearly all the wool was shipped to London and sold there, but during the last ten years over four-fifths has been sold in the Sydney market, as buyers have realised the advantage of purchasing on the spot.

Although of importance, cattle-breeding is a long way secondary to sheep-rearing, and, moreover, does not occupy so prominent a position as formerly. As long ago as 1876 the number of cattle in the State exceeded 3,000,000, and in 1912 the number was no more. After 1876 the number declined considerably until 1886, and with fluctuations, has increased up to the present time. The increase of recent years is due to the attention paid to dairying, whereby the number of milking cows has increased steadily.

Horses, with slight exceptions, have increased steadily from year to year, especially during the last five years, during which there has been a growing demand for them for defence purposes, and on account of closer settlement. New South Wales is especially suitable for the breeding of saddle and light-harness horses, and it is doubtful whether in those respects our horses are surpassed anywhere. They are widely and favourably known on account of their value as army remounts.

The number of cattle and horses in the State, at intervals since 1860, was as follows:—

Year.	Cattle.	Horses.
1860	2,408,586	251,497
1870	2,195,096	337,597
1880	2,580,040	395,984
1890	2,091,229	444,163
1900	1,983,116	481,417
1910	3,140,305	650,636
1912	3,040,834	716,457

It has already been said that the returns from the pastoral industry constitute the greatest source of wealth in the State. The following figures, therefore, will be of interest.

They show the approximate amounts received by the producers from the different kinds of stock in 1901 and 1912:—

Item.	1901.	1911.	1912.
Sheep for food ..	£2,071,000	.. £2,811,000	.. £3,127,000
Wool	8,425,000	.. 12,933,000	.. 12,497,000
Cattle	1,374,000	.. 1,689,000	.. 1,753,500
Horses	682,000	.. 2,001,000	.. 2,062,500
Total	£12,552,000	.. £19,434,000	.. £19,440,000
Per head of population	£9 3 8	.. £11 13 6	.. £11 3 8

Variations in the values are, of course, caused by the two factors, amount produced and price received. The value of the machinery in use on pastoral holdings in 1912 was estimated at £1,515,107.

Dairying.

Mention has been made of the increased attention which has been given to dairying in recent years, so that it is now an important factor in the wealth and prosperity of the State. Dairying was established at an early period in the history of New South Wales, but it has been the introduction of the factory system at convenient centres, together with the use of the cream separator, which has extended the industry. Creameries and factories were established first in the South Coast district, and for some years dairying was confined practically to that district.

Eventually it was established on the North Coast, especially on the Clarence and Richmond Rivers, where the advantages are so great that many farmers have migrated from the South to the North Coast.

Although dairying is conducted principally in the coastal districts, where grass is available for food throughout the year, it is also pursued actively in the more favoured of the remaining parts of the State for the purpose of supplying local wants. In those localities the industry is generally conducted in conjunction with wheat-growing or sheep-breeding, and enough fodder must be grown to carry the stock through the winter.

Farming on the share system is very much in favour, in connection with dairying, especially on the North Coast. As a general rule the farm and stock are the property of one party, and the other carries on the farm work. In 1912 the area farmed under this system was 100,413 acres, of which 68,753 acres were in the northern coastal districts.

Particulars of the quantity of butter and of cheese made are not available for the period prior to 1888. The following statement shows the production of each at intervals since that year:—

Year.	Butter. lbs.	Cheese. lbs.
1888	15,550,440	5,687,702
1890	18,534,130	4,796,567
1895	23,295,512	2,938,785
1900	41,479,794	3,558,823
1905	53,040,250	4,625,980
1910	76,624,830	5,191,089
1911	83,204,568	5,460,652
1912	76,609,528	5,454,685

The largest quantity of butter made in any year was 83,205,000 lbs., in 1911, which was nearly $5\frac{1}{2}$ times the quantity made 23 years previously. The drop in the quantity in 1912 was due to a rather unfavourable season.

Of the quantity made in 1912, 4,187,758 lbs. were made on farms, and 72,421,770 lbs. in public factories, and each year shows that the proportion made in factories is increasing.

The butter made is not all consumed in the State. A considerable quantity is exported, the United Kingdom being the largest purchaser. In 1912, 20,456,300 lbs. of butter were exported oversea from New South Wales, of which 18,266,128 lbs. went to the United Kingdom.

An industry usually carried on in conjunction with dairying is the breeding of swine, which has been rather neglected in New South Wales, as the following figures show:—

Year.	No. of Swine.	Quantity of Bacon and Ham made. lbs.
1860	180,662	—
1870	243,066	—
1880	308,205	—
1890	283,061	7,429,971
1900	256,577	10,863,125
1910	321,632	12,620,067
1912	293,653	16,526,376

It is apparent that both the number of swine and the quantity of bacon made have fluctuated, until now the swine do not number so many as they did 30 years ago. The value of the production of the dairying industry, including the products of swine, in 1912, was as follows:—

Item.	1912.
Butter	£3,895,000
Cheese	168,000
Milk (not used for butter or cheese)	750,000
Milch Cows	406,000
Swine	539,000
Total	£5,758,000
Per head of population	£3 6 3

Mining.

Almost all the principal metals of economic value are found in this State. It was the discovery of gold in payable quantities in 1851 which first caused appreciable settlement in New South Wales, and consequently in Australia, as large numbers of men were attracted here in the hope of making their fortunes readily.

Other metals have been discovered since that time, only coal being known before, and the mineral industry is now of importance among the primary industries of the State.

Up to the end of 1912 the total value of the minerals won in New South Wales was approximately £226,000,000, to which gold contributed £59,463,000; silver and lead, £60,222,000; tin, £9,328,000; copper, £11,784,000; coal, £69,088,000; kerosene shale, £2,323,000; zinc spelter and concentrates, £7,540,000; and opal, £1,330,000.

The value of the minerals won at decennial intervals since 1860 was as follows:—

Year.	Value of Mineral Production.
1860	£1,701,727
1870	1,288,995
1880	1,770,669
1890	5,044,187
1900	6,362,078
1910	8,455,170
1912	11,228,676

The value in 1912 was the highest ever recorded in any year; circumstances were favourable, and high prices stimulated production.

Among the metals which are found in the State, gold occupies a high position, both on account of the quantity which has been raised, and the influence of its discovery on the settlement of the country. Native gold is the only true mineral species which has been found in New South Wales, and was first met in easily-worked alluvial deposits. The gold formation is widely diffused throughout the State, and it has been estimated that the extent of country covered by formations (in which gold always occurs) exceeds 70,000 square miles. The quantity of gold won in 1912 was 165,295 fine ozs., valued at £702,129.

Until 1882 the quantity of silver raised in New South Wales was very small. In 1883 the Broken Hill field was discovered, and in subsequent years further fields were discovered in other localities.

The silver lead ores of the Barrier Ranges and Broken Hill districts of New South Wales have attracted attention more than any other. They are situated beyond the River Darling, near the boundary of South Australia, and extend over 2,500 square miles. The district has developed into one of the principal mining centres of the world.

The total value of the minerals won at Broken Hill in 1912 was £4,186,200, made up as follows:—Silver-lead ore and concentrates, 314,023 tons, £2,865,534; zinc concentrates, 433,054 tons, £1,320,666. The production of silver and lead is influenced largely by the prices of those metals in the markets of the world. The most important question at the present time in connection with Broken Hill, is the profitable extraction of zinc from the immense heaps of tailings which have accumulated since the opening of the mines about 30 years ago. Since the opening of the Broken Hill fields it is estimated that minerals to the value of £70,200,000 have been obtained.

Copper and tin are of considerable importance, and have contributed largely to the mineral wealth of the State. The production of both these metals depends largely on the prices to be obtained for them. In 1912 copper to the value of £579,800, and tin to the value of £338,000, were produced. Copper is found principally at Cobar, and tin in the New England district.

The coal-fields of New South Wales are of much greater importance as to area and as to quality of coal than in any other part of Australia; in fact, coal from New South Wales is exported to all the other States. It has been estimated that the area within which payable coal-measures are situated is 16,550 square miles. At present the industry is confined to those centres which, from their close proximity to ports of shipment and to railway lines, afford ready means for distribution. Newcastle is the centre of the local coal trade, and is peculiarly well situated to supply the other Australian States and foreign countries. There are also excellent seams of coal in the Illawarra district, the products of which are exported largely. The deposits in the Lithgow district, in the Blue Mountains, supply part of the requirements of Sydney and other industrial centres in its neighbourhood.

The production of coal at intervals since 1860 was as follows:—

Year.	Quantity. Tons.	Value. £
1860	368,862	226,493
1870	868,564	316,836
1880	1,466,180	615,337
1890	3,060,876	1,279,089
1900	5,507,497	1,668,911
1910	8,173,508	3,009,657
1912	9,885,815	3,660,015
Total to end of 1912	181,595,980	69,087,688

The production in 1912, the highest recorded, was 9,885,815 tons, valued at £3,660,015. Of this quantity 6,347,667 tons were consumed within the Commonwealth, and 3,538,148 tons were exported outside Australia.

The number of coal mines operated in New South Wales in 1912 was 122, which gave employment to 17,795 persons, of whom 13,089 were employed underground and 4,706 above

Manufactories.

The majority of the manufactories and allied processes of New South Wales may be termed domestic industries—that is to say, industries arising naturally from the circumstances of the community, or connected with the treatment of perishable products. The population at present is hardly large enough to support manufactories on an extensive scale, but there are, nevertheless, several of a complex character. Statistics in regard to early years are not very complete, but a statement regarding the number of establishments, persons employed, and value of machinery and plant since 1880 is shown below:—

Year.	Establishments.	Persons Employed.	Value of Machinery and Plant.
1880	2,779	28,259	—
1885	3,541	41,677	—
1890	2,583	46,135	—
1895	2,723	48,030	£5,255,129
1900	3,077	60,779	5,707,640
1905	3,700	72,175	8,031,948
1910	4,821	99,711	11,578,620
1912	5,162	115,561	13,795,195

The total wages paid in 1912 to the employees, exclusive of 4,572 working proprietors, was £11,592,052.

A better idea of the extent of the manufacturing industries of the State will be obtained from the following statement, which shows the number of different branches of the industry and the number of persons employed in each in 1912:—

Class of Industry.	Establishments. No.	Persons Employed. Males. No.	Females. No.	Total. No.
Treating Raw Materials, Product of Pastoral Pursuits, etc.	287	3,785	87	3,872
Oils and Fats—Animal, Vegetable, etc.	45	692	203	895
Processes in Stone, Clay, Glass, etc.	297	5,875	57	5,932
Working in Wood	684	8,815	65	8,880
Metal Works, Machinery, etc.	536	25,357	193	25,550
Connected with Food, Drink and Narcotics	765	10,773	3,476	14,249
Clothing and Textile Fabrics and Materials	994	7,808	19,251	27,059
Books, Paper, Printing and Engraving	426	7,051	2,390	9,441
Musical Instruments, etc.	14	376	40	416
Arms and Explosives	6	178	10	188
Vehicles and Fittings, Saddlery, Harness, etc.	393	4,319	96	4,415
Ship and Boat Building	47	3,168	1	3,169
Furniture, Bedding and Upholstery	220	3,583	391	3,974
Drugs, Chemicals and By-Products	87	943	604	1,547
Surgical and other Scientific Instruments	13	79	18	97
Jewellery, Timepieces and Platedware	53	763	100	863
Heat, Light and Power	203	3,334	53	3,387
Leatherware, n.e.i.	24	408	87	495
Minor Wares, n.e.i.	68	871	261	1,132
Total	5,162	88,178	27,383	115,561

The chief seat of the manufacturing industry is in and around Sydney, where population is most dense. The factories in the metropolitan district are not so numerous, but they are of far greater importance than in the country districts, where the principal works are saw mills, smelting works and flour mills, and industries of a domestic character intended to meet a day-to-day demand.

The value of lands and buildings used in 1912 in connection with manufactories and works was £12,540,000, and of machinery and plant, £13,795,000, so that the fixed capital invested amounted to £26,335,000. The amount of active capital involved is not available. The value of the goods manufactured or of work done in 1912 was £57,265,091. Of this amount £34,801,153 represented the value of materials and fuel used, leaving a balance of £22,463,938, representing the value added by the processes of treatment, which is the real value of the production from manufactories. The proportion of the total output which the various items represent are shown below:—

Item.	Value.	Per Cent.
Value of raw materials used	£33,466,544	.. 58.44
Value of fuel used	1,334,609	.. 2.33
Wages paid	11,466,609	.. 20.02
Balance which accrued to proprietors	10,997,329	.. 19.21
Value of output	£57,265,091	.. 100.00

TOTAL PRODUCTION.

In 1912 the number of persons employed in manufactories was 115,600; in the rural industries, 151,600; in mining, 37,800; in forestry and fisheries, 7,500, and in rabbiting, 2,500. These add to 325,000 persons and embrace the so-called productive industries. The value of production in the same year was £74,100,000, thus distributed:—

Industry.	Value of Production.
Manufactories	£22,464,000
Pastoral	19,440,000
Agricultural	11,817,000
Mining	11,229,000
Dairying	5,758,000
Forests and Fisheries	1,303,000
Minor Primary	2,089,000
	£74,100,000

The total value as above represents £42 12s. 5d. per head of population—a rate of production which is not attained by any country outside Australia.

The value of production from the industries of the State at decennial intervals since 1871 are shown below. The values are in thousands—000 omitted:—

Industry.	1871. £	1881. £	1891. £	1901. £	1911. £	1912. £
Manufactories	2,424	5,025	7,799	9,742	19,143	22,464
Minor Primary			14,725	12,552	19,434	19,440
Dairying ..	8,709	13,151	2,735	3,046	5,215	5,758
Pastoral					2,055	2,089
Agricultural	2,220	4,216	3,615	7,060	9,749	11,817
Mining	1,626	2,138	6,434	5,681	9,410	11,229
Forests, Fisheries ..	400	650	758	733	1,195	1,303
Total	15,379	25,180	36,066	38,814	66,201	74,100
Per head	£9 4 9	£15 2 6	£21 13 4	£23 6 4	£39 15 5	£42 12 5

The above figures are sterling evidence of the potentialities and of the development of New South Wales, and help to explain why it is so prosperous.

Banking and Saving.

There is a highly organised system of banking in New South Wales which effectively sustains the commercial, industrial and productive activities of the community. At the end of 1912 there were 16 banks operating in the State, with a total capital of £25,812,608. The amount on deposit at that date in these banks was £57,155,402, of which £26,863,689 was on current account and £30,291,713 on fixed deposit. At decennial intervals since 1860 the amounts on deposit in the banks and the amounts advanced by them were as follows:—

Year.	Deposits.	Advances.	Proportion of Advances to Deposits. Per cent.
1860	£5,164,011	£5,780,700	111.9
1870	6,107,999	7,814,116	127.9
1880	17,883,024	17,210,205	96.2
1890	35,460,118	43,009,559	121.3
1900	32,233,591	34,385,388	101.2
1910	51,893,524	40,854,690	78.7
1912	57,155,402	47,741,319	83.5

In addition to these trading banks there are also two savings banks which take money on deposit. The amounts so deposited since 1860 in all banks were as follows:—

Year.	Deposits in Trading Banks and in Savings Banks. Amount. £	Per head of Population. £	s.	d.	Deposits in Savings Banks noly. Amount. £	Per head of Population. £	s.	d.
1860	5,721,208	16	8	3	557,197	1	11	11
1870	7,044,464	14	2	6	936,465	1	17	6
1880	19,958,880	26	13	8	2,075,856	2	15	6
1890	40,190,587	35	16	6	4,730,469	4	4	4
1900	43,134,973	31	12	2	10,901,382	7	19	9
1910	74,347,448	45	7	8	22,453,924	13	14	1
1912	85,527,303	48	1	6	28,371,901	15	18	11
1912-13	16,057,298	9	0	6	16,798,500	9	8	11

In 1860 the amount on deposit in all banks represented £16 8s. 3d. per head, which at that time was considered a remarkable achievement, and rightly so. Deposits, however, increased rapidly, and in 1890 they were £35 16s. 6d., and in 1912, £48 1s. 6d. per head of population. The most satisfactory feature in connection with the accumulation shown by the increase in deposits is the amount of money at the credit of small depositors. The savings banks had on their books at the end of 1912 about 604,000 depositors with over £28,000,000 to their credit. The number of depositors is one in less than three of the population, and shows an extraordinary capacity for saving.

Public Finance.

It is not possible to compare the public finances of New South Wales with those of other countries, unless it be with the few States where the Government undertakes similar functions. In this State large debts have been incurred for the purpose of constructing railways, telegraphs, and other utilities which are the property of the State; the revenue from the public lands is very large, and the State pays annually large sums as endowment to aid the various local governing areas. These facts explain why New South Wales has so large an expenditure per head as compared with other countries of like area and population.

The total net revenue and net expenditure of the State at intervals since 1860 were as below:—

Year.	Revenue. Amount.	Revenue. Per Head.			Expenditure. Amount.	Expenditure. Per Head.		
	£	£	s.	d.	£	£	s.	d.
1860	1,308,925	3	17	5	1,312,777	3	17	8
1870	2,102,697	4	5	10	2,154,211	4	7	11
1880	4,806,389	6	11	11	5,460,315	7	9	10
1890	9,305,691	8	8	11	9,389,346	8	10	5
1900-01	10,612,422	7	15	6	9,991,983	7	6	5
1910-11	13,839,139	8	8	11	13,807,538	8	8	7
1911-12	15,776,816	9	5	9	15,277,001	8	19	10

The revenue from the several sources in the year ended 30th June, 1913, was as follows:—

Taxation	£1,405,360
Land Revenue	1,835,948
Other Revenue	3,119,626
Railways and other services	9,696,364
Total	£16,057,298

Included in the amount of £3,119,626 is a sum of £2,178,683, representing the payment made by the Commonwealth Government out of its surplus revenue to the State. This is really taxation, as the great bulk of the Commonwealth revenue comes from Customs and Excise duties.

The expenditure of the State in 1912-13 was distributed as follows:—

Interest on Public Debt and Sinking Funds	£1,401,497
Public Instruction	1,490,205
Other Expenditure	4,409,197
Railways and other services—	
Working Expenses	6,760,243
Interest on Capital Cost	2,737,358
Total	£16,798,500

The Public Debt of New South Wales on 30th June, 1913, was £106,170,747, or £59 13s. 7d. per head, on which £3,516,233 was paid as interest. Of this large sum the major portion, namely, 89 per cent., was expended on works from which direct revenue is derived, viz.:—

Railways	£59,448,339
Tramways	7,174,696
Water Supply and Irrigation ..	11,171,644
Sewerage	6,321,133
Docks and Wharves	7,854,072
Darling Harbour Resumptions ..	1,212,696
Posts and Telegraphs (now under control of Commonwealth) ..	1,761,845
Total	£94,944,425

The balance, £11,126,322, was expended on works only partially reproductive or unproductive, such as roads and bridges and public buildings, although even these have been required in developing the country.

An indebtedness of over one hundred and six million pounds, or £59 13s. 7d. per head, certainly appears large, but there is another view of the case. The tangible assets of the Government are the public works, which, in 1912-13, yielded an income of £2,936,000 after all working expenses had been paid, and the public lands, of which 126,024,074 acres are leased for pastoral or mining purposes, and 16,529,008 acres sold on deferred payment, the balance due in respect of which is £9,708,137. From the public estate there is obtained an annual net revenue of about £1,500,000, so that the State has a revenue of £4,436,000, or £920,000 in excess of the whole charge for the Public Debt without having to resort to taxation of any kind, and without parting with any more of the public lands. But the greatest security enjoyed by those who hold the debentures of the State lies in the energy and integrity of the people.

Local Government.

In 1906 a complete system of Local Government was established in New South Wales, whereby the part of the State except the Western Division, which had not been incorporated previously, was divided into Shires. Practically three-fifths of the State is now incorporated, there being 190 Municipalities and 134 Shires.

The Councils of these local areas are empowered to administer certain powers, such as construction and maintenance of roads, streets, wharves and buildings, control of public places, regulation of traffic, street lighting, water supply, nuisance prevention, etc. The revenues of the Councils are derived principally from rates levied on the unimproved capital value of land. Shires are granted annually by the Government as endowment a sum not exceeding £150,000. The amounts granted are based on the area, revenue and expenditure of the several Shires.

The valuations made in 1911 of the lands within the various local areas were as follows:—

	Unimproved Value.
Municipalities	£69,844,477
Shires	94,189,939
Total	£164,034,416

Based on these values, Municipalities raised £1,051,320 in rates, and Shires £470,054. The rates raised by Municipalities ranged from 1d. to 7d. in the £. Shires may not levy a rate of less than 1d. or more than 2d. in the £. The sources of income of the local areas in 1911 were as follows:—

	Municipalities.	Shires.	Total.
Rates	£1,051,320	£470,054	£1,521,374
Government Grants	26,136	355,286	381,422
Property	73,524	6,731	80,255
Other	350,940	48,959	399,899
Total	£1,501,920	£881,030	£2,382,950

From this it will be seen 63.8 per cent. of the income is received from rates, and 16.0 per cent. is in the shape of Government grants.

In the same year, 1911, the Councils expended as follows:—

	Municipalities.	Shires.	Total.
Administration	£140,503	£128,126	£268,629
Public Works	452,890	647,220	1,100,110
Public Services	356,969	33,950	390,919
Other	483,034	22,910	505,944
Total	£1,433,396	£832,206	£2,265,602

The administrative expenses of Municipalities represent 9.3 per cent., and of the Shires 14.5 per cent. of their income. 56.5 per cent. of the expenditure of Municipalities and 81.8 per cent. of the expenditure of Shires is on Public Works and Services, in which by far the largest part is taken by roads and streets. At the end of 1911 the Municipalities had loans outstanding to the amount of £5,327,228. By far the greater part of this amount (70 per cent.) had been raised for permanent improvements—roads, street, etc.—and for town halls. In addition, fairly large sums (27 per cent. of the total) had been raised to establish gas and electric light works.

The length of roads and streets in the State is approximately 83,000 miles, of which 9,500 are controlled by Municipalities, 67,500 by Shires, and 6,000 are in the Western Division, and are under the control of the central Government. Wherever the roads cross a watercourse a bridge or culvert in most instances has been erected. In all there are in the State 4,279 bridges over 20 feet span, with a total length of 359,857 feet, and 33,545 culverts, having a length of 383,730 feet. Where local conditions and limited traffic have not favoured the erection of a bridge, a punt or ferry has been established. Altogether there are 123 such ferries. In the most important cases these ferries are worked by steam, in all others by hand.

CHAPTER IV.

A HISTORY OF SCIENCE IN NEW SOUTH WALES.

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OUR knowledge of the natural history of New South Wales dates from the visit of Captain Cook to these shores. The collections of Sir Joseph Banks carried to Europe were examined in different countries, where the many novel forms attracted much notice. As the result, in the early years of the foundation of the State, there was much inquiry for Australian material, so that the earliest contributions to our knowledge of fauna and flora are widely scattered. Of the Banksian collections, the fishes, insects and plants were most carefully examined.

When the Colony was settled, Dr. John White accompanied Governor Phillip's expedition as Colonel Surgeon. He made great collections of plants and animals, which were transmitted to Europe and examined there. Colonel Patterson did much collecting during 1794 and 1795 when acting as Governor. From 1800 to 1805 the Princeps Botanicorum, Robert Brown, examined minutely the plants of the Colony. In 1810 his "Prodromus Flora Novæ Hollandiæ" was published in England. In 1816 Allan Cunningham came out as King's botanist His vast collections, made during fifteen years, went to Kew, and from there many were sent to the British Museum. Since these early years many collectors have visited these shores, taking away for examination much material. Gradually as the Colony became established the residents began to take interest in Nature around them. Thus arose the scientific institutions of New South Wales.

One of the earliest scientific institutions founded in Sydney was the Botanic Gardens. With the arrival of Phillip's fleet a farm was commenced on the alluvial land along the banks of a creek flowing into what is now known as Farm Cove. Since then this land has been continuously cultivated. In 1816, on the completion of Mrs. Macquarie's Road, the Botanic Garden became defined, and Governor Macquarie appointed a superintendent of the botanic garden.

* The author asks for the indulgence of the reader for many omissions, as this article was written hurriedly during the printing of the remainder of the Handbook.

The collections of plants made in the next thirty years were distributed to many herbaria in Europe, so that in 1847, when Charles Moore became director, not a vestige of the herbaria of his predecessors remained. Under the care of Moore a National Herbarium was commenced, which has grown under the able direction of J. H. Maiden, his successor, to be the largest collection of Australian plants.

The first association of residents in Sydney for the study of science was formed in 1822. Sir Thomas Brisbane, a veteran of the Peninsular war, who devoted his spare time to the study of astronomy, arrived as Governor in November, 1821. By January 2nd, 1822, he had gathered together nine associates and formed the Philosophical Society of Australia. It is difficult for us to imagine the state of affairs in Sydney at this date. Sir Thomas Brisbane had been accustomed to study the stars in the hours snatched from military duties in the continental war. He had commenced his work on astronomy in the course of a voyage and had recognised the importance of astronomy for navigation. His arrival in the Colony was coincident with his desire to promote the study of science. His military training had given him an insight into the use of organisation, so that he proposed to bind together those in the Colony who had knowledge in any branch of science. Although the company styled themselves in the fashion of those days, the Philosophical Society of Australia, the subjects of their papers and discussions were those now classified as scientific. We know that they listened to papers on the aborigines of New Holland and Van Dieman's Land, on the geology of part of the coast of New South Wales from Hunter River to the Clyde, on the astronomy of the Southern Hemisphere, on the maritime geography of Australia, and on the temperature and humidity of the air. The members of this first society were: Alexander Berry, H. G. Douglas, M.D.; Baron Field, Major Goulburn, Captain Irwin, Captain P. P. King, John Oxley, C. L. Rumker, E. Wolstencraft, with Sir Thomas Brisbane as president. This society which started with such good promise was not destined to live many months. An unfortunate controversy on the currency severed the friendship of its members. The society thus ceased to meet and was not revived when the question that divided its members was settled.

Sir Thomas Brisbane laid the foundation of astronomical work in Australia. Within one hundred yards of Government House, Parramatta, he commenced the building of the Observatory. Within a month of his arrival some of his instruments were mounted, and his notes bear witness that they had been employed. Five months later the building was finished and the two co-workers brought from England were installed. Unfortunately, in 1823, a quarrel led Mr. Rumker to leave the observatory, but Dunlop, trained by Sir Thomas, worked with such assiduity that in two years eight months he had made 40,000 observations and catalogued 7,853 stars, a feat for which he received gold medals from the Royal Astronomical Society, the Institute of France and the King of the Belgians.

Alexander Macleay arrived in Sydney in 1825 as Colonial Secretary to the Government of New South Wales. He had already devoted his attention to entomology and was reputed to have had the finest and most extensive collection of insects possessed by any private individual at that time in Europe. Amid arduous official duties he soon found an outlet for his scientific tastes in the formation of the collections which became the nucleus of those of the Australian Museum. In 1832 Dr. George Bennett mentions that he visited the recently inaugurated Colonial Museum housed in a small room in the new Council House. He notes the presence of a splendid collection gathered in a country so prolific in rare, valuable and beautiful specimens of natural productions. A few years later, in 1837, the first "Catalogue of the Specimens of Natural History in the Australian Museum" was published. In this pamphlet appears a list of the Committee of Management of the Australian Museum. Such was the beginning of the Australian Museum, destined to grow under the curatorships of Wall, Krefft, Ramsay and Etheridge, into the largest museum in Australasia.

In the beginning of 1850 the Philosophical Society of 1821 was revived as the Australian Philosophical Society for the encouragement of Arts, Science, Commerce and Agriculture in Australia. Alexander Berry and Dr. Douglas, two members of the original society, were members of this Society, and the latter, who took a considerable share in the revival, was secretary. The rush to the gold diggings checked the activity of the society in 1851, but in 1856 Sir Wm. Denison, the Governor-General, succeeded in re-establishing it as the Philosophical Society of New South Wales. Since then the society has continued its activity. However, in 1867 its president, Sir John Young, obtained permission to use the style of Royal Society of New South Wales, and so the society continues to be known to this day. The Governor was at first its president and later, as the State grew, its patron. Since 1867 the "Journal of the Royal Society of New South Wales" has been published each year.

In 1862 a meeting of a few gentlemen interested in entomology was held at Sir Wm. Macleay's residence to consider the formation of a local entomological society. This society started its career in 1862 and continued intermittently to July, 1873. The papers read were published in two volumes of Transactions.

In 1874 a meeting was held to establish a society to cultivate natural history in all its branches, and it was resolved to form the Linnean Society of New South Wales, with Sir Wm. Macleay as president. This society has continued to the present day. Owing to the munificent donations of Sir Wm. Macleay the society has its home, its library and its journal. Further, Sir William gave a large sum of money, amounting to close on seventy thousand pounds, for the encouragement of research and the purposes of the society. It is only within the last few years that this money has become entirely available. As a result, the Linnean Society maintains a bacteriologist and bacteriological laboratory and four research fellows in various branches of natural history. The proceedings, now in their fortieth volume, form a record of the labours of the band of biological workers of the State. While the bulk of the papers have been taxonomic, there have not been wanting contributions to anatomy, embryology, physiology and biochemistry in recent years. This extension in the range of inquiry is mainly due to the work of the University of Sydney. Although founded in 1855 the teaching of science was of a most perfunctory nature until the beginning of the eighties. Another decade passed before the first fruits of the increased instruction became available. At this same period the great experimental sciences of chemistry and physics first attracted workers in New South Wales with the establishment of the laboratories of chemistry and physics in 1889 and 1888.

In 1883 the foundation of the Medical School of the University was laid by the appointment of Anderson Stuart as Dean. The growth of the school in a quarter of a century to the fourth position in size of any medical school in the Empire has led to the establishment of large laboratories in anatomy, physiology and pathology. From these laboratories contributions to general medical science have been published mainly in European journals, as so far it has not been practicable to carry on an Australian publication.

In 1884, on the suggestion of Archibald Liversidge, steps were taken to inaugurate an Australasian Association for the Advancement of Science. This movement, inaugurated at the Royal Society's House, Sydney, has led to the association of the various scientific bodies in the different Colonies and States, and has done much to allay the interstate jealousies among men of science. Every two years a meeting is held in one of the larger towns of Australia or New Zealand. These meetings have served to draw the attention of many persons to the usefulness of scientific knowledge. As a consequence large numbers of persons attend the meetings besides those actively engaged in scientific pursuits.

Reference must also be made to the growth of scientific pursuits in the Government Departments. In the Departments of Mines, Lands, Agriculture and Public Health, scientific experts have been engaged to prosecute their labours in the economic service of the State. The publications of these Departments contain some of the most valuable contributions to science, especially in geology, made in New South Wales.

Chapter V.

THE LITERATURE OF NEW SOUTH WALES.

By M. W. MacCallum, M.A.,

Professor of Modern Literature, University of Sydney.

In any attempt to give an account of the literature of New South Wales one is faced with the initial difficulty of deciding what falls within the definition. During its century and a quarter of existence, Australia has produced a body of literature which, if neither very great nor very distinguished, need nevertheless fear no comparison in point of quality or quantity with that of other new countries. But it is by no means easy to allot to the various States of the Commonwealth their precise share in the whole. Each State has had its own political history, but the literary development of all has been interwoven. Artificial geographical boundaries and tariff walls have not applied to men of letters. Many of these have moved from one State to another as occasion demanded, and it is often hard to determine what State is entitled to claim them.

Thus, Lindsay Gordon belongs equally to South Australia and to Victoria as far as residence is concerned; Rolf Boldrewood to Victoria and to New South Wales; Kendall did some of his finest work in Melbourne, and the list might be extended almost indefinitely. The place of birth is even more arbitrary and unsatisfactory a test. The most that one can do is to include in the literature of New South Wales the works of those whose literary activities have been chiefly associated with that State. It is at best but a rough-and-ready rule, and the reader's indulgence is craved for sins, both of commission and omission.

A further word of explanation and apology. The literature of New South Wales is, critically speaking, more interesting if regarded as a matter of general tendencies rather than of individual achievements. There are a few figures who stand out from among their contemporaries, and these can claim to be judged on the strength of their own performances. But there is also a considerable and growing number of writers of lesser note, men of one book, men who perhaps have not even attained to the dignity of a book. It would be manifestly impossible to discuss these in detail, yet together they often illustrate a phase in the development of literature in this State which is worthy of mention.

Finally, in this sketch "literature" is confined to imaginative literature. New South Wales can boast many admirable books on historical, scientific and critical subjects, but this is hardly the ... con-
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Line 4.—For "M. W. MacCallum, M.A., Professor of Modern Literature, University of Sydney," read "M. L. MacCallum, M.A., B.C.L."

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were not of the kind for which the Arts have much appeal. Even when a different type began to immigrate, the conditions of the young community hardly encouraged literature. There was no leisured class; the educated class was a very small one; all were busily engaged in securing their material welfare, and intellectual amenities were neglected. Isolation from Europe made their lives circumscribed and their interests parochial. No doubt there was much of the picturesque in their surroundings, and their task—the conquest of nature and the establishment of a new nation in the Southern Seas—had all the elements of the true romance. But they were too close to realise this and found no inspiration from it. Wordsworth defines poetry as "Emotion recollected in tranquility." New South Wales in its early days seems to have afforded neither the one nor the other.

Thus the years from 1788-1852 are singularly barren in literary production of any kind. There are official reports and journals and records whose historical value is immense, but whose literary value is nil. The poet's was a voice crying in the wilderness, and not very melodiously at that. Judge Barron Field's "First Fruits of Australian Poetry" (1819), the first verse printed in New South Wales, was favourably received by Charles Lamb, but its sole redeeming feature was that it proved the loyalty of Elia's friendship under even the most trying circumstances. W. C. Wentworth was a better patriot than poet, and of his sonorous commonplaces only two lines survive. Dr. Lang wrote better hymns than many which are to be found in the "Ancient and Modern," and the political disputes of the day produced a crop of squibs, lampoons and pasquinades which at times showed considerable mastery of the art of denunciation. This is the sum total of achievement during the first sixty years of the history of New South Wales, that is to say, during the first half of its existence.

With the appearance of Charles Harpur (1817-1868), however, the poetry of New South Wales received a new impulse. Harpur is the first poet whose contribution to our literature can be taken seriously. To-day, as the grey forefather of Australian verse, he is praised rather indiscriminately and rarely read. Admirers have dubbed him the Australian Wordsworth, but the comparison is only justified by the fact that he imitated Wordsworth, both in subject and manner. He has a true feeling for nature, and in such poems as "The Creek of the Four Graves" he shows considerable descriptive power, but to modern ideas there is a curious unreality in much of his work. The reason perhaps is that Harpur, like many of his successors, was too much under the influence of British writers. Though he was an Australian born and bred, his reading coloured his whole outlook. He regarded Australia through alien eyes and endeavoured to paint it as Wordsworth might have done.

This tendency to imitation is characteristic of the whole middle period of Australian literature. It was, of course, inevitable, but in proportion as a man avoided it and was himself rather than a pale reflection of someone else, he came nearer to achieving greatness. This is well illustrated by Henry Clarence Kendall (1841-1882). Kendall wrote in the "golden age" of Australian literature. Contemporary with him were Lindsay Gordon and Marcus Clarke, and the supremacy of each of the three in his respective sphere has not yet been challenged. Much of Kendall's work may be dismissed as commonplace; some is little more than a creditable metrical exercise after the manner of Swinburne; but there remains a residuum of genuine poetry. His most successful verses are in the minor key, and for this we must blame the unhappy circumstances of his life. He sees the beauty of the mountain streams and forests amidst which his happiest days were spent and translates it into melody. He can interpret the poignancy of grief and the bitterness of unavailing remorse. An atmosphere of gentle melancholy pervades the best of his poems. To him beauty means sadness, and love regret. But he was a true seer and a sweet singer; and few will deny him the first place among our poets. That his fame has spread beyond his own land is shown by the inclusion of two of his poems in the "Golden Treasury."

Since Kendall's time there have been few outstanding figures in the literature of New South Wales. It has been a matter of movements rather than of men. First came a number of writers, P. J. Holdsworth, T. W. Heney and others whose individual performances may not have been very great, but whose services have been considerable. They taught Australians to look at things with Australian eyes and they expressed their own thoughts rather than those of other poets. This gradual awakening to the fact that our own country could supply subjects of poetic inspiration led, in the 'Nineties, to the appearance of the "Bush School," whose sensational career confounded those who declared that there was no market for poetry in Australia. The Bush School, founded by John Farrell (1851-1907), tells in simple and vigorous language, rich in local colour, of droving, racing, shearing, of the manifold activities of life outback, and of the loves, joys and sorrows of those that dwell there. Poetry it may not be, but it is very excellent verse, much of which in its kind could hardly be bettered. The characteristics of its members are the same with individual variations. A. B. Paterson brings to his work a humour and cheery optimism which makes us overlook his metrical shortcomings. Will Ogilvie is a less energetic but more poetic Paterson. E. J. Brady does for the seafarer and longshoreman what the other two have done for the bushman. Henry Lawson also writes of life outback, which he paints in sombre colours, but he is more than a bush balladist. He is the laureate of the under-dog, and in his verse we detect a note of class consciousness which has of recent years become by no means uncommon in our literature. His work is infused with a vigorous, if occasionally somewhat flamboyant, spirit of nationality.

The activity and popularity of the Bush School rather overshadowed other poets who made a less direct bid for general favour, but it is quite a mistake to suppose that the bush ballad flourished to the exclusion of all other forms. There was a select band to whom "horse poetry" was anathema, and they continued to woo other muses than those who preside over the stockyards and racecourses. V. J. Daley (1858-1905) wrote much that is fine, but a good deal of his work is reminiscent. Roderic Quinn has brought a touch of Celtic mysticism into the rather matter-of-fact regions of our poetry. Bayldon and others continued to show that to be an Australian poet it is not necessary to sprinkle one's lines with native names and local allusions.

The vogue of the Bush School seems of late to have declined. The secret of its success lay in the fact that it appealed to many to whom poetry was a sealed book. It dealt with subjects within the knowledge of everyone, and it flattered the patriotic sentiment of everyone. Therein also lay its weakness. Poetry should be universal, but in the Bush School it tended to become insular. Writers thought that they were helping to found a national poetry by the simple expedient of laying on local colour with a lavish hand; they did not realise that nationality in literature should be implicit rather than explicit. The service of the Bush School was that it showed Australians that in the every-day life of the community there was a wealth of picturesque material, but its appeal was circumscribed and under its influence our poetry was in danger of becoming parochial.

Since the beginning of this century there have been fresh and encouraging developments. Federation provided a genuine national impulse which our literature had hitherto lacked. There are many who sing of the glorious destinies of Australia with commendable, if sometimes extravagant, enthusiasm. The political divisions of the day are not unreflected in its verse. But on the whole there are signs that our poetry is becoming more cosmopolitan and less preoccupied with the local and accidental. A group of younger men, such as C. J. Brennan, J. le Gay Brereton, Hugh McCrae and L. H. Allen, differ entirely in subject and method, but agree in their determination to write poetry rather than specifically "Australian" poetry. Their nationality reveals itself unconsciously if at all; their inspiration is the universal rather than the particular. They have introduced an academic element into contemporary verse which was formerly noticeably absent. Miss Dorothea McKellar has much in common with this group, but unlike them she rises to her highest level when she is expressing her passionate love for her country.

So much for the poetry of New South Wales. Both in quality and in quantity it is a credit to the land which produced it, and if it will not stock a library, it at any rate affords material for a very fine anthology. But in other departments of imaginative literature the achievement is less. The reason for this has been lack of opportunity. There are various periodicals in which room can be found for verse, but there are difficulties in the way of the production of plays and novels which have not yet disappeared. In drama for instance, New South Wales has practically nothing to show. Locally-written plays have been staged, sometimes with success, but their literary value is nil. A. H. Adams is the one local playwright whose work can be taken at all seriously, and it shows promise for the future rather than actual accomplishment.

Of fiction, however, much more can be said. Various persons have written novels which describe with a greater or less degree of success, different aspects of life in New South Wales. Perhaps the most widely known is Rolf Boldrewood (1826 —), whose "Robbery under Arms" is quite a classic. Rolf Boldrewood could not be described as a great novelist in any sense of the word, but he has written a series of straightforward healthy tales of love and adventure which give an excellent picture of gold-mining, squatting and the like during the middle period of Australian history. Another writer whose name has travelled beyond her own land is Ethel Turner (Mrs. Curlewis), whose delightful stories of children appeal to the youth of Britain as much as to that of Australia.

But if the novel in New South Wales has had few illustrious exponents, there is one form of fiction in which we have shone, and that is the short story. Here, again, it was a case of opportunity producing the result. Even to-day it is not easy to get a novel published, but for long there has been a market for the short story in various periodicals, and some of our writers have attained to a remarkable proficiency in this medium. Henry Lawson's stories of "out-back" and of slum life in the city are excellent of their kind. Lawson is apt to dwell on the darker side of things, but his ruthless fidelity, his sympathy and, (at any rate in the earlier books), his restraint have won for his prose a high place. Louis Becke's vigorous tales of the South Seas exploited a new and rich field, and many of them will survive their author; while a number of other writers have produced and continue to produce creditable work in this direction.

A few years ago there began in fiction a movement similar to that which has been noticed in verse. Hitherto the country had provided most of the subjects, and the country only in its more exotic aspects at that. Novelists had not emancipated themselves from the red shirt and buckjumper tradition. One felt that they were writing with one eye on a reading public who regarded these as essential features in any picture of Australian life. Certainly the British reader took this view, and both the Australian reader and the Australian writer blindly accepted the convention. The Australian novel was almost always concerned with adventure in the bush. Apparently it occurred to no one that in the great cities there was a wealth of splendid material that might be turned to account. To Mr. A. H. Adams belongs the credit of being practically the first to realise this and of using his knowledge to good purpose. Mr. Adams is also a poet, but his poetry belongs to his New Zealand days. His important contributions to the literature of New South Wales consist of two novels, "Galahad Jones" and "A Touch of Fantasy." The scene of each is laid in Sydney, and sensation is conspicuous by its absence. They are transcripts of the life of the lower middle classes, whose existence had hitherto been completely ignored by Australian writers. It was quite a new departure and a thoroughly successful one. Louis Stone, whose "Jonah" has been described by competent judges as the best novel ever written in New South Wales, is also a student of modern social types. He has taken as his theme life in the industrial suburbs of Sydney, inhabited by the humbler classes of the community, factory hands, small shopkeepers, larrikins and the like and his book gives a more faithful picture of an important aspect of our national development than could be gathered from a whole library dominated by the picturesque but antiquated figure of the bushranger.

Here this brief and inadequate survey of the literature of this State must close. The record of a hundred and twenty-five years is nothing to be ashamed of; it is even meritorious when we consider what the circumstances of that hundred and twenty-five years have been. And even if we can boast no very striking achievement in the past, we can comfort ourselves with the thought that our literature is in a thoroughly healthy state and that the future is full of promise.

CHAPTER VI.

CONSTITUTIONAL LEGISLATION IN NEW SOUTH WALES.

By N. DE H. ROWLAND, B.A., LL.B., Barrister-at-Law.

IN the constitutional development of New South Wales from a Crown Colony to its present position as a State in the Commonwealth of Australia, legislation has beeen directed towards three great objects. They are: firstly, the securing of the fullest measure of Colonial liberty consistent with the Imperial tie; secondly, the application of local taxation for local purposes; and thirdly, the principle of responsible government.

Between 1788 and 1824, New South Wales was practically governed by a military commandant.

The increase of free settlers and the growth of primary industries, notably that of sheep-farming, soon resulted in the formation of an element in the Colony to whom the despotic control of a military commandant was irksome. In consequence of the reports of an Imperial Commissioner, published in 1822, certain important changes were made in the government of the Colony, which may be summed up as the grant of civil institutions which, however, were not representative.

So, by the temporary Act 4 Geo. IV. c. 96, for the better administration of justice in New South Wales and Van Dieman's Land (Tasmania), not only was a Charter of Justice provided, authorising the creation of a Supreme Court and a Court of Appeal, but the Crown was empowered to appoint a Council of from five to seven members, whose function was to advise the Governor in making laws, but who could not over-ride him. Laws passed by the Governor with the advice of this Council had to be laid before the Imperial Parliament.

This Act was replaced by 9 Geo. IV. c. 83, which on the whole re-enacted the provisions of the former Act. The Legislative Council, however, was increased so as to comprise not less than ten nor more than fifteen members, still appointed by the Crown and holding office at its pleasure. The Council's powers were also increased to this extent that the Governor could no longer legislate without the Council. It is noteworthy, too, that the Home Government kept a firm control over the Council's legislation by retaining the right to disallow any measure. Powers of taxation for local purposes were given.

An important advance was made in 1839, when by the Act 2 and 3 Vict. c. 70, the Colony was empowered to change its judicial system.

Acts were passed from time to time continuing 9 Geo. IV. c. 83, and it was finally, with some alterations, made permanent by the Constitution Act of 1842.

An examination of the Acts passed by the Legislative Council between 1824 and 1842 shows that its energies were largely occupied in perfecting the machinery of constitutional government, especially with respect to the administration of the law. One important step was the gradual but finally complete introduction of the jury system in criminal as well as civil trials before the Supreme Court.

Agitation continued from time to time for further constitutional reforms, and a new period in the history of the Colony is marked by the Constitution Act of 1842, 5 and 6 Vict. c. 76.

This Act was in the main directed to two points: firstly, the introduction of a representative element into the Legislative Council; and secondly, of local government. The Council was increased to 36 members, two-thirds of whom were to be elected upon a franchise which was, in the circumstances, sufficiently liberal and which was further liberalised in 1850 by 13 and 14 Vict. c. 59. The Council was to sit every year and to continue for five years, subject to prior dissolution. Customs duties could be imposed and general laws made which were not to be repugnant to English law. Crown lands and revenue therefrom were outside the Council's sphere of action.

In the matter of local government, District Councils might be established by the Governor.

This advance in constitutional reform was followed up by the Act of 1850 before mentioned, which gave power to increase the Legislative Council, keeping the same proportion of representative to nominee members. An important provision was contained in Section 32, which gave power to the Governor and Council to remodel the legislature, (but so that its powers and functions were not to exceed those of the then Legislative Council), and the qualifications of members and electors, provided that any Bill for such purposes should be reserved for the assent of the Crown of England. Under this authority the number of the Council was increased to 54 by 14 Vict. No. 48.

In response to a growing demand for further constitutional reform, a new constitution was drafted under cover of the Act of 1850, which aimed at an increase of the powers of the Council, especially in the matter of legislation with regard to Crown Lands. This was sent to England for the Crown's assent. Certain clauses touching the reservation and disallowance of Bills were not acceptable to the Home Government, and the Council had otherwise exceeded their powers. But the difficulty was got over by including the constitution in an amended form as the schedule to an Imperial Enabling Act, 18 and 19 Vict. c. 54, assented to in July, 1855, known as the New South Wales Constitution Statute, while the scheduled constitution was called the Constitution Act.

This Act, virtually the production of the local council, is an outstanding landmark in the history of the Colony, as with it came, not only vastly increased powers of legislation (*e.g.*, power to deal with the Crown lands) and a bi-cameral legislature, but also the present system of responsible government.

With a few amendments and subject to the changes made by the Commonwealth of Australia Constitution Act 1900, the Act was consolidated in the present Constitution Act 1902, which has since been amended in one or two not very important respects.

S. 2 of the Statute vested the waste lands of the Colony in the local legislature; S. 3 preserved the provisions of former Acts as to the reservation, allowance, and disallowance of Bills and the instructions to the Governor respecting the same; and Section 4 gave power to the legislature to repeal and alter the provisions of the reserved Bill (*i.e.*, the scheduled constitution) subject to the conditions imposed therein.

The Constitution Act dealt in the main with the establishment of the new legislature. There were to be two Houses; the Upper House or Legislative Council was to consist of persons nominated by the Governor in Council, not fewer than twenty-one in number, of whom not more than one-fifth might hold office of emolument under the Crown, with certain exceptions in favour of army and navy officers; the members of the first Legislative Council were to hold office for five years, and subsequent Councillors were to be summoned for life. Provision was made for the appointment of a president who could take part in debate, but had no vote except a casting vote.

The Lower House, or Legislative Assembly was to be convoked from time to time by the Governor. Its members were to be 54 in number.

Members of the Legislative Council could not be elected or sit or vote as Members of the Legislative Assembly. No person holding an office of profit under the Crown or being a Crown pensioner could be a member of the Assembly, with certain exceptions, viz., the Colonial Secretary, Colonial Treasurer, Auditor General, Attorney General and Solicitor General or one of such additional officers not more than five as might be proclaimed as capable of being elected to the Assembly. A Secretary of Lands and Works was so proclaimed. The Assembly was to continue for five years unless previously dissolved A Speaker was to be elected by the Assembly after a general election or upon a vacancy occurring. The Speaker had a casting vote, but no ordinary vote.

The Parliament was to meet at least once in every year. Its general powers of legislation were contained in Section 1 of the constitution, namely, that Her Majesty should have power by and with the advice and consent of the Council and Assembly to make laws for the peace, welfare, and good government of the Colony in all cases whatsoever. It was provided, however, that taxation and appropriation bills should originate in the Assembly, and by Section 54 it was enacted that no money vote or bill should be lawful unless recommended by a message of the Governor.

In particular each House was empowered by Section 35 to make from time to time Standing Rules and Orders for the orderly conduct of its business. It is noteworthy that the general question of the privileges of the Parliament and its members have never been put upon a satisfactory footing, though more than once bills have been introduced for that purpose.

The legislature was also empowered (S. 36) to alter the constitution of the Legislative Council subject to a two-thirds majority in both Houses and to reservation of the bill.

With regard to the judiciary, the commissions of the Judges of the Supreme Court and of all future judges were to continue during good behaviour, notwithstanding the demise of the Crown, but they might be removed by the Crown on the address of Parliament. Their salaries were secured during the continuance of their commissions; pensions were provided for the Judges of the Supreme Court by Section 51.

Section 43 empowered the legislature to make laws regulating sale and other disposal of waste lands. Customs duties might be imposed, but not differential and not inconsistent with treaty.

In place of the statutable provisions in the Schedule to 13 and 14 Vict. c. 59, the Legislature resolved to grant a civil list to Her Majesty out of the consolidated revenue. Such civil list was fixed at £64,300, and its acceptance was to be accompanied by surrender of all revenues of the Crown arising in the Colony. The consolidated revenue was only to be appropriated by Act of Parliament, and no part of it was to be expended without the Governor's warrant.

It will be noticed that nothing was done by the Act in respect of local government. The scheme of District Councils before alluded to had been a failure, chiefly owing to the attempt to charge the policing of the districts upon the local authorities, and although that grievance was remedied later, the idea of local government developed very tardily and was practically confined to municipalities for many years.

By virtue of this constitution the Colony was now provided with a practical system of responsible government. It needed only the Colonial Laws Validity Act, 1865, to set the New South Wales legislature practically free in the sphere of domestic legislation. By that Act it was provided that no colonial law should be deemed to be void on the ground of repugnancy to the law of England unless it should be repugnant to the provisions of some *Act* of the Imperial Parliament or order or regulation made thereunder which extended to the Colony in question and in the case of such repugnancy it was only void to the extent of the repugnancy.

The chief checks upon the local legislature were now the Imperial Government's power of disallowance (under 5 and 6 Vict. c. 76) within two years of local acts and the necessity of reserving certain bills for the pleasure of the Crown of England, except in urgent cases.

The duty of reserving certain bills depends partly upon Imperial statutes and partly upon the Governor's instructions.

The latest Imperial Statute on the question is 7 Ed. VII. c. 7. This binds all the States of the Commonwealth and provides (Section 1) that bills must be reserved if they alter the constitution of the legislature of the State or of either House thereof, or affect the salary of the Governor of the State or are required to be reserved by any State Act subsequent to 7 Ed. VII. c. 7 or by any provision in a bill itself. Otherwise it shall not be necessary to reserve any bill. The Act does not affect reservations required by the Governor's instructions nor does it prevent a Governor from disposing with reservation in cases of urgency or where he vetoes a bill forthwith or has the prior assent of the Imperial Crown.

By Section 2 the meaning of Bills altering the constitution of the legislature is more exactly defined by excluding matters merely concerning numbers and distribution of members and qualification of electors and members.

The other bills to be reserved are those mentioned in the Governor's instructions. It will be sufficient if the instructions of 1900, issued at the commencement of the Commonwealth, be glanced at, as they have not been greatly altered from previous instructions. These provide in Clause VIII. that the Governor shall reserve bills for divorce, bills for grants of land or money or other donations to the Governor, bills affecting the currency of the State, bills appearing to be inconsistent with treaty obligations, bills of an extraordinary nature prejudicing the prerogative or the rights and property of British subjects not resident in New South Wales or the trade and shipping of the Empire, and bills containing provisions to which the royal assent has been once refused or which have been disallowed.

We may now briefly note what changes have been made in the various branches of the constitution.

With respect to the legislature, attempts have been made from time to time to reconstitute the Upper House on an elective basis, but so far they have failed in one House or the other.

Triennial parliaments were introduced in 1874 by Act 37 Vict. No. 7.

The number of members of the Assembly, the number and boundaries of electorates and the system of conducting elections have been changed from time to time. The Electoral Act of 1858, 22 Vict. No. 20, provided for an Assembly of 80 members from 67 districts, to be increased to 81 when the University had one hundred graduates on its books who were Masters of Arts or Doctors of Law or Medicine. This occurred in 1876, and for some time the University continued to send a representative, until the privilege was removed in 1880. It is curious to notice that the present State of Queensland, then not separated, had seven electoral districts. West and East Sydney were to return four members each; seven other districts, two each, and the balance one each. There were three goldfields districts, the production of a miner's right or license or lease being necessary before voting in any such district. The suffrage was adult male, with a residential vote in one district, and a property vote in any other district or districts. The framing of the voters' lists was in the hands of the Courts of Petty Sessions, and provision was made for the revision of such lists. There was nothing unusual in the issue of writs, appointment of returning officers and conduct of elections except that the voting was done by marking a secret ballot paper, an innovation which has been widely copied throughout the world and is commonly known as the "Australian Ballot." Disputed elections were to be dealt with by a sessional committee of seven appointed from the Assembly, and known as the "Committee of Elections and Qualifications."

In 1866 the police were authorised to be employed in collecting the Electoral Roll, a duty which they still continue to perform. In 1880, by 44 Vict. No. 13, the number of members became 108, representing 72 districts, and the University was dropped. A scheme of increase was provided whereunder the numbers finally reached 140. This was felt to be excessive, and the Parliamentary Electorates and Elections Act of 1893, with certain amending Acts consolidated in 2 Ed. VII. No. 33, provided for a scheme of 125 equal districts, each returning one member. The franchise was now to be residential and no person was to vote in respect of more than one district. Each elector had to furnish himself with an "elector's right" or certificate of his being qualified to vote. This had to be produced at the polling booth, and was there marked with a perforating stamp so that it could not be used again in respect of the same election. Provision was made for issue of new rights on change of residence or loss of right.

A far-reaching change was made in 1902 by No. 54 of 1902, which extended the franchise to women equally with men, but debarred them from nomination as candidates for election.

By No. 1 of 1904 the electoral districts and members were reduced to 90. No. 41 of 1906 made certain changes in the machinery of elections, doing away with electors' rights and providing for taking of persons' votes absent from their own district on polling day.

In 1910, by No. 18 of 1910, the principle of a second ballot was introduced whereby, if no candidate obtained an absolute majority of the votes polled, the two leading candidates were voted for on a subsequent day not less than seven and not more than twenty-one days after the first voting, according to the situation and accessibility of the electorate. No. 9 of 1911 further amended the Electoral Law in some slight respects, and the whole law is now to be found consolidated in No. 41 of 1912. A further redistribution of seats took place during 1913.

In 1889 the principle of payment of members of the Legislative Assembly was adopted—£300 per annum being the rate. This was increased in 1912 by Act No. 19 to £500 per annum, with an extra £250 per annum for the leader of the opposition. If the allowance is not drawn within seven days after the expiry of Parliament it reverts to the Treasury. The members of the Legislative Assembly who can hold offices of profit under the Crown now comprise the Colonial Secretary, the Colonial Treasurer, the Attorney General, the Secretary for Lands, the Secretary for Public Works, the Minister of Justice, the Minister of Public Instruction, the Secretary for Mines and the Minister for Agriculture.

The Department of Justice and Public Instruction was created in 1874. At the same time the Attorney General was removed from the Cabinet and Executive Council, but reappeared four years later. The Solicitor General was dropped as an executive officer by the Act of 1884. He still continued to act in another capacity in order to exercise the functions of the Attorney General as a grand jury. The executive office was revived in 1901, and the practice for some years has been to make a member of the Upper House Solicitor General.

The office of Minister of Mines was created in 1874, the Departments of Public Instruction and Justice separated in 1880, and the latter amalgamated with that of the Attorney

General in 1901. A Department of Agriculture, with a Minister in charge, was created in 1907.

Any member of the Legislative Assembly who took an office of profit as a Minister, was forced to seek re-election under the Constitution of 1855 unless he were already one of the officers mentioned in the schedule before alluded to, and was simply changing or taking another office. This was slightly altered in 1884 by narrowing the new offices which might be accepted so as to include only those in the schedule. This continued to be the law when the Constitution Acts were consolidated in 1902, by Act 2 Ed. VII. No. 32, *vide* Sections 26 and 27, but a change was made in 1906 by the Parliamentary Elections Act, 1906, No. 41 of 1906, which so amended Section 27 of the Constitution Act, 1902 as to preclude the necessity for re-election of a member who took executive office for the first time. By the Ministers' Salaries Act of 1907 the Constitution Act of 1902 was further amended by revising the list of scheduled offices and altering the scheme of salaries. The various electoral Acts have now been consolidated in the Parliamentary Electorates and Elections Act, 1912.

Until 1908 local government was restricted to the municipalities, and throughout the larger part of New South Wales the functions usually assigned to local governing bodies were discharged by the central government. In 1905 a comprehensive scheme of local government was initiated. By the Acts now consolidated in the Local Government Act, 1906 (amended in 1908), the State, with the exception of the Western Division, was distributed into local governing areas under two types of local government. The more populous areas were placed under a fairly elaborate form of municipal government with considerably larger powers than had previously existed under the Municipalities Act, 1867 (consolidated in the Municipalities Act, 1897). The sparsely populated areas were placed under a simpler form of local government, with the name of Shires, the Shire Councils having fewer, but still very important powers.

The machinery for the administration of justice has naturally been expanded from time to time. The original Supreme Court was established by virtue of the Charter of Justice of 1823, under 4 Geo. IV. c. 96. This provided for a Supreme Court to be a Court of Record, with proper officers, having a common law and an equitable jurisdiction, similar to those of the Courts at Westminster and the Chancery

Court in England, as well as a limited jurisdiction in insolvency and an ecclesiastical jurisdiction limited to probates and letters of administration of personalty of inhabitants of New South Wales dying in the Colony. Provision was also made for appeals to a Court consisting of the Governor and Chief Justice, with a final appeal to the Privy Council. 4 Geo. IV. c. 96 also empowered the establishment of Courts of General and Quarter Sessions to deal with criminals, and Courts of Requests with an inferior civil jurisdiction.

The powers conferred upon the Supreme Court were modified by 9 Geo. IV. c. 83 which, *inter alia*, took away the insolvency jurisdiction. Section 13 provided for the institution of Circuit Courts held by a Supreme Court Judge. The Court of Appeal was dropped, and with it any appeal as of right to the Privy Council. No appeals as of right existed from this time until the Order in Council of 1851, regulating the matter.

It will be remembered that 9 Geo. IV. c. 83 was made permanent by the Constitution Act of 1842.

The various local acts which have modified and extended the system take their origin from the powers conferred by Section 2 of 2 and 3 Vict. c. 70, which gave the local legislature power to make further provision for the better administration of justice. This provision was confirmed in the Constitutions of 1842 and 1850.

The Supreme Court Bench, originally consisting of a Chief Justice, Sir Francis Forbes, was increased to three by 1827. The Acts 4 Vict. No. 22 and 19 Vict. No. 31, had given power to increase the judges, but these were repealed by 28 Vict. No. 7, which authorised the appointment of a fourth judge, the qualification under this Act as heretofore being five years' standing at the bar of England or Ireland. Colonial barristers became eligible under 25 Vict. No. 9. The number of judges was increased from time to time, and by the Supreme Court and Circuit Courts Act, 1900, No. 35, which consolidated the law up to that point, the number provided for was six puisne judges in addition to the Chief Justice. It is curious that the Judge in Bankruptcy could be a barrister or solicitor of seven years' standing, while a barrister of five years' standing could hold any other seat on the Supreme Court Bench. This anomaly has been removed by an amending Act, No. 9 of 1912, which brings the Judge in Bankruptcy in line with the other judges, and further allows for an indefinite number of puisne judges, but no increase is to be made beyond seven without resolutions of both Houses of Parliament. The present bench consists of the Chief Justice and seven puisne judges. Their salaries rest upon Statute 46 Vict., No. 15, now consolidated in Supreme Court and Circuit Courts Act, 1900, Section 11. Pensions are provided after fifteen years' service or in case of retirement before fifteen years, but in the latter event the scale is a graduated one. This matter is dealt with by Section 12 of the last-mentioned Act as amended by No. 27 of 1906. Under No. 9 of 1912, Section 4, provision is made for an Acting Chief Justice with the powers and privileges of the Chief Justice.

By Section 16 of No. 35 of 1900, consolidating 6 Will. IV. No. 12, Section 1, when any Act in force in England on the 1st March, 1829, applicable to New South Wales or any Imperial Act adopted and directed to be applied in New South Wales authorises any Act to be done in the administration of justice by the High Court Judges in England, the said Act shall be performed by the Judges of the Supreme Court in New South Wales.

The various jurisdictions of the Supreme Court are Common Law, Equity, Lunacy, Bankruptcy, Matrimonial Causes, Probate and Admiralty.

The Common Law jurisdiction is based upon the Charter of Justice and 9 Geo. IV. c. 83. The procedure is that which obtained in England after the Common Law Procedure Act 1852 and before the Judicature Acts. That procedure began to be adopted in New South Wales in 1853, and though some modifications have been made with a view to greater simplicity and effectiveness, the system has never been abandoned, and New South Wales is the only State in the Commonwealth which has not adopted the system of the Judicature Acts. The Court may be constituted by a single judge with or without a jury for *nisi prius* work, or by judges sitting in Banco as an appeal Court, being two or more according to the nature of the appeal. An appeal lies from the Banco Court to the High Court or Privy Council, subject to certain conditions.

The Equity and Lunacy jurisdictions of the Court are also derived from the Charter of Justice and 9 Geo. IV. c. 83, and were at first exercised by the Full Court, but by 4 Vict. No. 22 Section 20, the equitable jurisdiction of the Court was committed to a single judge. There was an appeal from the single judge to the Full Court, without prejudice to a direct appeal to the Privy Council, as the decree of the primary judge was the decree of the Court. The powers of the Full Court in Lunacy and Infancy did not pass to the single judge. Notwithstanding this the single judge exercised such powers, and 11 Vict. No. 27 was passed to validate his decrees and to confer the Court's jurisdiction in Infancy upon him. The Lunacy jurisdiction was given to the single judge—then known as the primary judge in Equity—by 22 Vict. No. 14. By 55 Vict. No. 26 Section 4 it was provided that the Judge in Bankruptcy should have the powers of the Primary Judge in Equity and should be styled Judge in Equity when sitting in that jurisdiction, and that the hitherto Primary Judge should in future be styled Chief Judge in Equity. Lunacy is still strictly a separate jurisdiction. The law as to the Court's jurisdiction in lunacy is now consolidated in the Lunacy Act 1898.

The procedure in Equity has been simplified by a series of statutes (and rules thereunder), the most important of which is the Equity Act of 1880, consolidated in 1901.

It will be remembered that a limited jurisdiction in ecclesiastical matters was given to the Supreme Court by the Charter of Justice and 9 Geo. IV. c. 83. This was exercised at first by the Full Court, then afterwards by the Primary Judge in Equity, and finally by a Judge in Probate, appointed under the Probate Act 1890 (54 Vict. No. 25 Section 4), now consolidated in the Wills, Probate and Administration Act 1898. The Court's jurisdiction has been extended to embrace real and personal property in New South Wales belonging to any deceased person. As the Judge in Probate exercises the powers of the Court, there is an appeal direct to His Majesty in Council as well as to the Full Court and the High Court of Australia.

The Bankruptcy jurisdiction is now governed by the consolidated Bankruptcy Act 1898. No mention is made of the matter in the Charter of Justice, but a series of local Acts, beginning with 5 Vict. No. 17, and including 25 Vict. No. 8 and 38 Vict. No. 1, had conferred an insolvency jurisdiction on the Supreme Court or a judge thereof and on a Chief Commissioner for Insolvent Estates. These Acts proved unsatisfactory and the English Bankruptcy Act of 1883 was practically adopted in 1887 by 51 Vict. No. 19. Section 127 and the following sections transferred all existing jurisdiction to the Supreme Court to be exercised by a Judge in Bankruptcy. His judgments are the judgments of the Court, and therefore a direct appeal lies to the Privy Council and High Court.

The jurisdiction in divorce and other matrimonial matters was not vested in the Supreme Court until 36 Vict. No. 9. Prior to this the only remedy was by private act or action. 36 Vict. No. 9 vested in the Supreme Court jurisdiction in all causes, suits and matters matrimonial (except marriage licenses) and provided for the exercise of such jurisdiction by the Chief Justice, or if he declined, by one of the Puisne Judges appointed therefor. The jurisdiction of the Court is now to be found in the consolidated Matrimonial Causes Act 1899. The decision of the Judge in Divorce is the decision of the Court, with right of direct appeal to the Privy Council and High Court.

Admiralty matters prior to the 1st July, 1911, were dealt with by an Imperial Vice-Admiralty Court with a statutory civil jurisdiction, and presided over by the Chief Justice as Judge Commissary, or his deputy. The Colonial Courts of Admiralty Act 1890 (53 and 54 Vict. c. 27) had provided that every court of unlimited civil jurisdiction in a British possession should be a Colonial Court of Admiralty, with the admiralty jurisdiction of the English High Court of Justice. This Act was not to come into force in New South Wales until so directed by Order in Council and until the date named in such order. This was done on 4th May, 1911, and the date fixed for the coming into force of the Act was 1st July, 1911. Consequently the Vice-Admiralty Court is now displaced by the Supreme Court in its admiralty Court jurisdiction as a Colonial Court of Admiralty.

The Circuit Court system has been much simplified. Prior to 1912 there were certain fixed circuit towns, which Supreme Court Judges visited as a Circuit Court. This system was replaced by No. 9 of 1912 by a system which allows any town to be proclaimed as a circuit town and a Supreme Court Judge sitting as such may visit such town and exercise the civil and criminal jurisdiction of the Court. The Supreme Court at Sydney is made a Court of Gaol delivery for the whole State.

An effective system of appeal exists from single judges of the Supreme Court and inferior Courts to the Full Court or Banco Court, the latter name being given to the Court of Appeal on its common law side. In 1912 provision was made for criminal appeals on the lines of the English Criminal Appeal Act 1907.

There has also been provided a system of inferior Courts. The District Courts, similar to English County Courts, with a civil jurisdiction limited in amount and locality, were established in 1858 and are now governed by the District Courts Act No. 23 of 1912, which consolidates the former law.

Criminal jurisdiction in all but capital cases, has been conferred upon Courts of Quarter Sessions, at one time held by Justices of the Peace, who are now replaced by a chairman who is a District Court Judge. The powers and procedure of the Quarter Sessions Courts are dealt with chiefly under the Crimes Act 1900 and the Justices Act 1902.

Courts of Petty Sessions have been dealt with by a variety of Acts now consolidated in the Justices Act 1902. Courts of Petty Sessions have a limited jurisdiction as Courts for the recovery of small debts, under the various Acts consolidated in the Small Debts Recovery Act 1912. In several of the largest cities stipendiary magistrates have replaced police magistrates and honorary justices in these courts.

Apart from these courts there are special courts for dealing with various matters under the Mining Act 1906, the Navigation Act 1901, the Crown Lands Act (now consolidated in the Crown Lands Act 1913), and the Industrial Arbitration Act 1912.

In conclusion it may be briefly mentioned that by the Commonwealth of Australia Constitution Act 1900 various powers formerly vested in the State were transferred to the Commonwealth or made exercisable by Commonwealth and State concurrently, although, in the latter case, when a law of the State is inconsistent with a law of the Commonwealth, the latter is to prevail, and the former is, to the extent of the inconsistency, to be invalid. But, subject to the Commonwealth constitution, the constitution of the State is to continue as at the establishment of the Commonwealth until altered in accordance with the constitution of the State.

PRINCIPLES OF LAND LEGISLATION IN THE STATE OF NEW SOUTH WALES.

Prepared by the DEPARTMENT OF LANDS, Sydney.

UNTIL the year 1843 the Crown Lands in New South Wales could be disposed of by the Crown wholly at its own discretion. This prerogative was limited in the year 1842 by an Act of the Imperial Parliament regulating the future disposal of the lands of the Crown.

In the year 1855 the Imperial Acts, so far as repugnant to the Constitution Act, were repealed and the entire management and control of the lands belonging to the Crown in New South Wales was vested in the Parliament of New South Wales.

In the year 1861 the New South Wales Parliament passed the Crown Lands Alienation Act regulating the alienation of Crown Lands, and also the Crown Lands Occupation Act, regulating the occupation of Crown Lands.

Since then a large number of Acts dealing with Crown Lands have been passed, and these Acts have now been repealed and consolidated under the Crown Lands Consolidation Act, 1913.

The main principles of the existing law under which Crown Lands within the State of New South Wales are alienated, leased or otherwise dealt with are as follows:—

DIVISION OF THE STATE OF NEW SOUTH WALES.

The State is divided into three Divisions, viz., the Eastern, Central and Western Division.

WESTERN DIVISION.

The control and management of the lands within the Western Division is vested in the Western Lands Commissioners appointed under the Western Lands Act of 1901.

LAND DISTRICTS AND LAND AGENTS.

The State is divided into Land Districts, the boundaries of which are proclaimed by the Governor.

A Crown Land Agent is appointed for each Land District. His office is in the District, and his business is to give information to the public and to perform such other duties as are imposed on him by the Crown Lands Acts.

DISTRICT SURVEYORS.

A District Surveyor is appointed for every Land District or for several Land Districts.

LOCAL LAND BOARDS.

A Local Land Board—consisting of three members—is appointed for each Land District or for several Land Districts.

The Board sits as in open Court to hear and determine all references, complaints and other matters brought before it; and its procedure is the same as that before a Court of Petty Sessions.

It has the power to summon and compel the attendance of witnesses.

Such formal matters as are prescribed may be dealt with by the Chairman of the Board on its behalf.

LAND APPEAL COURT.

A Land Appeal Court, consisting of a President and two Commissioners, is established.

The Court has power sitting in open Court to hear and determine all appeals and all matters referred to it by the Minister or by a local land board.

Either party to any proceeding before a local land board may appeal to the Land Appeal Court against the board's adjudication, decision or award; but such appeal must be lodged within 28 days.

When questions of law arise the Land Appeal Court may, on its own motion or if required by either party, state and submit a case for decision by the Supreme Court.

DEDICATION AND RESERVATIONS.

The Minister may:—

(*a*) set apart sites for cities, towns, villages and of suburban lands.

(*b*) dedicate Crown Lands for public purposes.

(*c*) temporarily reserve Crown Lands from sale, lease or license;

(*d*) set apart routes and camping places for travelling stock.

These may be revoked or modified in the prescribed manner.

SALES BY AUCTION.

The Minister may cause to be sold by auction Crown Lands not exceeding in the aggregate for the whole State, 200,000 acres.

Town lands not to exceed in area half an acre, suburban lands twenty acres, and country lands 640 acres.

The upset prices per acre not to be lower than £8 for town lands, £2 10s. for suburban lands, and 15s. for other lands.

The terms are a deposit of 25 per cent. of the purchase money at time of sale, balance within three months. But the Minister may make special terms of payment on sales of town lands, suburban lands or lands which may have been subdivided for sale into areas not exceeding 20 acres, or any portions of country lands of a less area than 40 acres. Time not to exceed five years, with interest at five per cent.

Tenures under the Crown Lands Acts.

Who May Apply.

Any male person who is of the age of 16 years or upwards and any female who is of the age of 18 years or upwards is competent to apply for or otherwise acquire Crown Lands, except by way of non-residential conditional purchase—in which case the age competency is 21 years—provided such person is not otherwise disqualified, *i.e.*, being an alien in certain cases, by previous acquisition of Crown Lands, or by reason of ownership of land which, with the area applied for, would exceed a home maintenance area, or the statutory limit of area allowed by law for the particular class of holding required.

An alien may apply for and acquire a homestead farm, suburban holding, Crown lease or a lease within an irrigation area, but he must become naturalised within five years. A married woman not separated from her husband can apply for a homestead farm or Crown Lease with moneys belonging to her for her separate estate; but she is disqualified from applying for other holdings.

Applications to be Made in Good Faith.

An applicant for any of the principal tenures has to satisfy the local land board that his sole object in making the application is to obtain the land or a lease thereof in order that he may hold and use it for his own exclusive benefit. If the board finds that the application is not so made it is disallowed and the moneys lodged may be declared forfeited. If it be at any time found by the local land board that the application was not so made or that the land is not so held, forfeiture of the holding is declared.

LODGMENT OF APPLICATIONS.

Applications are to be lodged with the Crown Land Agent for the District in which the land is situated, but such lodgment may be in person or by a duly authorised agent or by post. A deposit of five per cent. of the purchase money or a half-year's rent, as the case may be, and an instalment of the survey fee is required to be paid.

All applications received from Monday to Saturday, both inclusive, are, if conflicting, deemed to have been received simultaneously on the Monday. The order of priority is determined by the local land board; and where there are equal claims to priority the board directs that a ballot be held.

AVAILABLE LANDS.

All Crown Lands in the Eastern and Central Divisions of the State are open to ordinary conditional purchase at the price of one pound per acre, and also for conditional lease, provided the lands are not within a city, town, village, suburban area, population area, special area, irrigation area, reserve, under lease other than an annual lease or within an area set apart for a different class of holding. If, however, the land be specially set apart for conditional purchase the price may exceed or be less than £1 per acre.

Provision is made that the Minister may by notification in the "Gazette" set apart lands for any of the following classes of holdings:—

Conditional purchase.
Conditional lease.
Conditional purchase lease.
Special conditional purchase lease.
Homestead selection.
Settlement lease.
Homestead farm.
Suburban holding.
Crown lease.

Lands so set apart are available only for the class or classes of holding or holdings specified in the Minister's notification, and in addition to the conditions prescribed by law are subject to any special conditions which may be mentioned in the notification.

CONDITIONS GOVERNING THE DIFFERENT TENURES.

CONDITIONAL PURCHASE.

This is a purchase from the Crown by deferred payments.

Area.—The area of the original conditional purchase, together with any additional conditional purchases or conditional leases, cannot exceed 1,280 acres in the Eastern Division or 2,560 acres in the Central Division. But if lands within a reasonable working distance of a conditional purchase holding are specially set apart for additional holdings of that class, the holder might be allowed by the local land board to exceed the maximum areas mentioned if satisfied that a larger area is required for home maintenance.

Residence for ten years has to be carried out on the holding and a transfer cannot be effected until after five years' residence has been performed.

Fencing or Improvements.—The boundaries of the holding must be fenced within five years, or in the alternative the selector may in lieu of fencing effect improvements—which may include any fencing—to the value of at least 6s. per acre within three years and to the value of at least 10s. per acre within five years. But in no case need the value of improvements effected within three years exceed £384, or 30 per cent. of the price of the land and the value of the improvements effected within five years need not exceed £640, or 50 per cent. of the price of the land.

Price.—The price of an ordinary conditional purchase is £1 per acre; but if the land be specially set apart for conditional purchase the price may be fixed at a higher or lower rate.

Instalment of Purchase Money.—A deposit of five per cent. of the price of the land is paid on application. No further payment is required for three years; but thereafter an annual instalment of five per cent. of such price is required until the balance of purchase, together with interest at the rate of $2\frac{1}{2}$ per cent. per annum, shall have been paid. Provided that if the selector desires it his annual payment need not exceed 9d. for each pound of the purchase money.

Subdivision for the purpose of transfer may be effected with the approval of the Minister.

Crown grant will issue upon completion of all conditions.

CONDITIONAL LEASE.

Area.—A conditional lease may be acquired in virtue of any original or additional conditional purchase to the extent of three times the area of the purchase in virtue of which it is made.

Rent only is payable, the rent being fixed by the local land board for periods of 15, 15 and 10 years respectively.

Term.—The term of the lease is 40 years.

Conversion into conditional purchase may be effected during the term of the lease.

Residence, Fencing and Improvements are required to the same extent as made applicable to a Conditional Purchase.

CONDITIONAL PURCHASE WITHOUT RESIDENCE.

These conditional purchases are subject to the same conditions as ordinary conditional purchases, except that no condition of residence attaches to them; the area is limited to 320 acres; the deposit, price and annual instalments are double those of ordinary conditional purchases. The holding is required to be fenced within twelve months and improvements to the value of £1 per acre must be effected within five years. Selector may effect improvements to the value of thirty shillings per acre wholly or partly in lieu of fencing.

HOMESTEAD SELECTIONS.

Title.—A Crown grant is issued after fulfilment of five years' residence, but the grant contains conditions for the performance of perpetual residence—the minimum term of residence being seven months in each year—and payment of rent annually.

Area.—The maximum area is 1,280 acres; but the area of each selection is that notified by the Minister when setting the land apart for selection. If the area proves to be insufficient for home maintenance an additional homestead selection may be obtained out of land within a reasonable working distance which may be set apart for that purpose.

Rent.—The rent for the first five years is 1¼ per cent. of the capital value of the selection, but after issue of grant the rent is 2½ per cent. of the capital value. The capital value of the selection for each fifteen years period after the issue of the grant is determined by the local land board.

Improvements on the land are to be paid for by not more than four equal yearly instalments.

Conversion into a conditional purchase may be effected.

Subdivision for the purpose of transfer may be effected with the approval of the Minister.

SETTLEMENT LEASES.

Title.—A lease for 40 years.

Area.—The maximum area is 1,280 acres for agricultural land, or 10,240 acres for grazing land, but the farms must be taken in accordance with the areas as set apart by the Minister. If the area proves to be insufficient for home maintenance an additional settlement lease may be obtained out of land within a reasonable working distance which may be set apart for that purpose.

Rent.—The rent for the first fifteen years period is that notified when the land is set apart, subject to appraisement by the local land board if applicant requires it and makes application for same within the prescribed time. For the two succeeding periods of fifteen and ten years respectively the rent may, on application by the lessee or on a reference by the Minister, be determined by the local land board.

Residence has to be performed for the full term of the lease.

Fencing.—The farm must be fenced within five years.

Tenant Right in improvements on the expiration of the lease is given.

Improvements on the land must be paid for by not more than four equal yearly instalments.

Subdivision for the purpose of transfer may be effected with the approval of the Minister.

Conversion into Conditional Purchase and Conditional Lease may be effected, but only sufficient area for home maintenance may be acquired as a conditional purchase.

Conversion into Homestead Selection. After the expiration of the first five years of the lease the holder may convert an area not exceeding 1,280 acres into a homestead grant.

CONDITIONAL PURCHASE LEASE.

Title.—A lease for 40 years, with a right to convert into a conditional purchase.

Area.—The area of each block is fixed by the Minister when setting apart the land for lease.

If the area proves to be insufficient for home maintenance an additional conditional purchase lease may be obtained out of land within a reasonable working distance which may be set apart for that purpose.

Rent.—The rent for the first fifteen years period is $2\frac{1}{2}$ per cent. of the capital value notified when the land is set apart, subject to appraisement by the local land board if the applicant requires it and makes application for same within the prescribed time. For the two succeeding periods of fifteen and ten years respectively the capital value is determined by the local land board.

Residence for ten years has to be performed, but the entering into residence may be deferred for not more than five years.

Improvements on the land are to be paid for by not more than four equal yearly instalments.

Subdivision for the purpose of transfer may be effected with the approval of the Minister.

Conversion into Conditional Purchase.—If the lease be converted into a conditional purchase the purchase price is the capital value upon which the holder's rent for the lease is payable. The purchase money is payable by instalments, with interest at the same rate as for ordinary conditional purchases.

SPECIAL CONDITIONAL PURCHASE LEASES.

Available Land.—The land must have been for six months available for some class of residential holding before it can be set apart for this form of lease.

Title.—The same as conditional purchase leases.

Area.—Not less than 20 acres and not more than 320 acres.

Residence.—No condition of residence.

Rent.—Same as conditional purchase leases.

Improvements to the value of £1 per acre must be effected within three years. The Minister may, however, in certain cases, accept a lesser value—not below ten shillings per acre of improvements.

HOMESTEAD FARMS.

Title.—A lease in perpetuity.

Area.—A home maintenance area as set apart by the Minister.

Rent.—For the first five years the lessee may substitute improvements on the farm for rent, subject to this the rent for the first twenty-five years period is $2\frac{1}{2}$ per cent. of the capital value notified or, if the applicant requests it within six months, the capital value determined by the local land board. For each succeeding twenty years the capital value is determined by the local land board, irrespective of improvements effected or owned by the lessee, and the rental is $2\frac{1}{2}$ per cent. of that capital value.

Residence.—Perpetual residence has to be performed.

Improvements.—Any improvements belonging to the Crown are considered in fixing the capital value of the land, but the lessee has to pay for improvements which are privately owned, as agreed upon by the owner and the lessee, or failing agreement, as determined by the local land board. If the value of such improvements exceeds £40 the Crown may pay the owner and the lessee pays the Crown. Payment is made by not more than four equal annual instalments where the value of the improvements does not exceed £40, but where in excess of that sum the amount must be paid in not more than 10 equal yearly instalments, with interest in either case at the rate of 4 per cent.

SUBURBAN HOLDINGS.

The object of this tenure is to provide homes which may be maintained by pursuits other than farming.

Title.—A lease in perpetuity.

Area.—Such area as the Minister may determine when setting apart the blocks.

Rent.—The annual rent is $2\frac{1}{2}$ per cent. of the capital value as notified for the first twenty years.

For each succeeding twenty years $2\frac{1}{2}$ per cent. on the capital value, to be determined by the local land board, irrespective of any improvements owned or effected by the lessee. The minimum rent in any case is £1 per annum.

Improvements on the land at date of selection are dealt with in the same manner as is set forth with regard to homestead farms.

Qualification.—A person who is the holder of any land cannot acquire a suburban holding.

CROWN LEASES.

Title.—A lease for forty-five years.

Area.—Such area as the Minister may determine when setting apart the land.

Rent.—The annual rent for the first period of fifteen years is $1\frac{1}{4}$ per cent. of the capital value as notified, or if the lessee requests it within six months, the capital value as determined by the local land board. For each succeeding period of fifteen years the capital value is determined by the local land board, irrespective of improvements effected or owned by the lessee, and the rental is $1\frac{1}{4}$ per cent. of that capital value.

Residence is required during the whole term of the lease.

Improvements on the land at date of selection are dealt with in the same manner as is set forth with regard to homestead farms.

Conversion into Homestead Farm.—During the last five years of the lease the lessee may, with the consent of the Minister, convert so much of the farm as will not exceed a home maintenance area into a homestead farm.

Subdivision.—With the consent of the Minister the Crown Lease may be subdivided for the purpose of transfer of portions thereof to any of the lessee's sons who are above the age of sixteen years and otherwise qualified to apply for a Crown Lease.

IRRIGATION AREAS.

Lands which are proclaimed "Irrigation Areas" are subdivided into farms or blocks in such areas and at such capital values and rentals as are determined by the Commissioner for Irrigation and Water Conservation. They are subdivided into "irrigable lands," non-irrigable lands and town lands.

Application for these farms or blocks is made to the Commissioner, and the granting of the application is entirely at his discretion.

Town lands may also be offered at auction.

Title.—A lease in perpetuity.

Residence.—Perpetual residence has to be performed, but the residence may be suspended by the Commissioner with or without conditions.

Rent.—Two and a half per cent. of the capital value. The minimum rent for a Town Lands block is £1 per annum.

After the first 25 years period of the lease the rent for each succeeding 20 years period is determined by the special Land Board on the same basis as that provided for fixing the capital value in the first instance, but irrespective of any improvements effected or owned by the lessee.

Improvements on the farm or block are to be paid for by 10 equal yearly instalments, together with interest at the rate of four per cent. per annum.

Two or more non-irrigable blocks may be jointly leased for the common use and benefit of a number of lessees.

Three adjoining town blocks for the purpose of residence or four adjoining blocks for business purposes, and no more, may be held by any one person or in his interest.

Tenant Right in improvements. On surrender of a lease the Commissioner may grant tenant right in improvements.

LEASES.

The Acts provide for the following classes of Leases:—

Occupation licenses for grazing purposes may be issued by the Minister at a rental to be determined.

The lands occupied may at any time be sold or leased for other purposes.

ANNUAL LEASES.

These leases are for pastoral purposes, and may be acquired by application or by auction or tender.

Area.—Not to exceed 1,920 acres.

Term.—The lease may be renewed from year to year; but it may at any time be cancelled by the Minister by giving not less than three months notice in the "Gazette."

The lands may at any time be sold or leased for other purposes.

SPECIAL LEASES.

Special leases may be granted for wharfs, jetties, dams, tanks, irrigation works, bathing places, saw mills, brick kilns, slaughter houses, tanneries, quarries, etc., etc.

Area.—Not to exceed 320 acres.

Term of lease not more than 28 years.

Rent to be determined by local land board.

Conditions as prescribed.

SCRUB LEASES.

These leases are granted over Scrub Lands on improvement conditions and such other conditions as may be specified.

Area.—Such area as may be recommended by the local land board.

Term of lease, not more than 21 years, but the Minister may extend the lease to a term not exceeding 28 years.

Rent as determined by the local land board, or bid at auction or offered by an accepted tender.

Tenant Right in improvements may be granted.

Homestead Grant out of Lease.—During the last year of the term of the lease the holder may apply for the land which contains his dwelling house—not exceeding 640 acres—as a homestead grant.

SNOW LEASES.

Lands which are usually covered with snow for a part of each year and unfit for continuous use and occupation may be leased.

Term of lease, seven years, with right of extension for three years, but the Minister may terminate the lease by giving notice not later than one year before the expiration of the term of the lease.

Area.—Not to exceed 10,240 acres.

Not more than two of these leases can be held by or in the interest of one person.

Rent as determined by the Local Land Board.

INFERIOR LANDS LEASES.

Lands of inferior character may be leased by auction or tender.

Area.—Such area as may be recommended by the local land board.

Term of Lease, not more than 20 years; but the Minister may extend the term to a term not exceeding 28 years.

Homestead Grant out of Lease.—During the last year of the term of the lease the holder may apply for the land which contains his dwelling house—not exceeding 640 acres—as a homestead grant.

Rent.—The Minister determines the upset rent after report by the local land board.

Conditions of the lease as specified in the "Gazette" offering the land for lease.

RESIDENTIAL LEASES.

Lands within a gold field or mineral field may be leased to holders of a miner's right for the purpose of *bona fide* residence.

Term of lease not to exceed 28 years.

Area.—Not more than 20 acres.

Rent as fixed by the local land board.

The last holder of the lease has tenant right in improvements.

Conversion into Purchase.—Upon application after the first five years of the lease the holder may be permitted to purchase the land at a price to be determined by the local land board. The Minister may allow time to pay the purchase money.

IMPROVEMENT LEASES.

Lands which by reason of inferior quality, heavy timber, scrub, noxious animals, under-growth, marshes, swamps or other similar cause, are not suitable for settlement until improved, and can only be rendered suitable by the expenditure of large sums in the improvement thereof, may be leased by the Minister upon the recommendation of the local land board.

Term of the lease not to exceed 28 years.

Area not to exceed 20,480 acres.

Rent.—The amount bid at auction or offered by an accepted tender is the yearly rent.

Conditions of the Lease.—Such conditions as to improvement and expenditure on the land, etc., etc., as may seem expedient in the circumstances of each case.

Tenant Right in improvements may be granted.

Homestead Grant out of Lease.—During the last year of the term of the lease the holder may apply for the land which contains his dwelling house—not exceeding 640 acres—as a homestead grant.

MISCELLANEOUS PROVISIONS.

Forfeiture.—Provision is made for the forfeiture of any holding for any breach of conditions attached thereto. Such forfeiture carries with it the forfeiture of any improvements effected.

Tenant Right in Improvements.—Upon the expiration of the term, or the accepted surrender of certain leases, tenant right in improvements may accrue. Such right entitles the outgoing tenant to receive from the incoming tenant payment of the value of the improvements. The value is determined by the local land board unless agreed upon on the basis of value to the incoming tenant, but such value cannot exceed the cost of effecting the improvements. Tenant right lapses on the expiration of 13 years.

Fencing.—Contribution—half cost—for fences on boundaries of adjoining holding is provided for. Claims can be made to and are assessed by the local land board.

Transfers.—Provision is made for the transfer of holdings with the Minister's consent. The principal tenures are not transferable to a person who would hold more than a home maintenance area.

Liability of Minors.—Any person between the ages of 16 and 21 years who becomes the owner of any holding under the Crown Lands Acts is made liable in respect of all contracts and agreements entered into in respect of his holding as if he were of the full age of 21 years.

Suspension or Remission of Residence.—The local land board may, on application and on sufficient cause being shown and with or without conditions, suspend or remit the condition of residence attaching to any holding, or permit the holder to reside in a town or village for the purpose of educating his children.

Residence on One of Two Holdings.—Any person who is the holder of two holdings requiring residence may, with the permission of the local land board, fulfil the residence condition by residing on one of such holdings.

Death or Unsoundness of Mind of Selector.—Residence in the case of conditional purchases is suspended until a transfer takes place. In certain other cases the holdings may be held by the representatives, but the selector's or lessee's interest has to be sold within 12 months, or, with the Minister's aproval, a deputy may be appointed to reside on the land.

Residence in Respect of Family Holdings.—Where members of one family have certain holdings within working distance of each other, the residence condition attaching to such holdings may be performed by their residing on any of the holdings; but the permission of the local land board must be obtained.

Deferring of Payments.—The Minister may, on application, grant extension of time for payment of any amount due or to become due. The payment deferred bears interest at the rate of five per cent. per annum until date of payment.

PROTECTION OF CERTAIN HOLDINGS.

The holder of a homestead selection, homestead farm, suburban holding, Crown lease or a lease within an irrigation area may, by registered instrument, protect his holding from being sold under any writ of execution or from vesting in an official assignee upon bankruptcy or assignment for benefit of creditors or from being taken away from the holder for the satisfaction of any debt or liability.

But such registration cannot affect the validity of any charge or encumbrance created before registration of the instrument, and cannot have any effect if the holder was in insolvent circumstances at the date of the registration.

INDUSTRIAL LEGISLATION IN NEW SOUTH WALES.

By JOHN B. TRIVETT, F.R.A.S., F.S.S., Government Statistician.

CONCILIATION AND ARBITRATION.

IN 1882 a Bill was introduced into Parliament for the establishment of a council composed of members of Employers' Unions and of the Trades and Labour Council, to provide for conciliation on the lines adopted in France. The Bill was shelved. In 1887 a scheme, based upon English precedent, was drawn up by a joint committee of the Employers' Union and of the Trades and Labour Council, but was rejected. In the same year a Trades Conciliation Bill was introduced to the Legislature, the machinery projected being purely voluntary, following the lines of the voluntary conciliation which had for some years proved satisfactory in the building trade. This measure also failed to become law; but Parliamentary attention was focussed on the subject of mediation in industry, and during the last twenty-three years the Parliament of New South Wales has given much attention to legislation having for its object the improvement of the industrial conditions of the people generally, and involving particularly the settlement of trade disputes and regulation of the hours of employment and rates of wages.

The effective history of mediatory legislation dates from 1890, when a Royal Commission of Inquiry was appointed, following on the maritime strike in that year, to investigate the causes of industrial disputes and to indicate means for their prevention. A result of this Commission was the Trades Disputes Conciliation and Arbitration Act, 1892. As the preamble of the Act declares, the establishment of Councils of Conciliation and of Arbitration for the settlement of disputes between employers and employees should conduce to the cultivation and maintenance of better relations; and of more active sympathy, between employers and their employees, and be of great benefit in the public interest by providing simple methods for the prevention of strikes and disputes (through which industrial operations are liable to serious and lasting injury) against the welfare and peaceful government of the country.

The Act was intended to be operative for four years from 31st March, 1892; its initiation was facilitated by the progress made by trade unionism, both in the way of organisation of trades and by securing direct representation in Parliament.

Councils of Conciliation and of Arbitration were established, to which applications were to be referred from employers and employees regarding disputes or claims. Pending the division of the State into industrial districts, a general Council of Conciliation was projected, to be composed of twelve to eighteen representatives elected by employers and employees. The district councils were to be elected for two-year terms, and to be composed of two representatives of employees registered under the Trade Union Act, and two of registered employers' associations. Apart from the ordinary Councils of Conciliation, special conciliators might be appointed by the parties to a dispute. Then, supplementary to the Councils of Conciliation, there was a Council of Arbitration elected for a similar term of two years, but composed of three members, being representatives selected by employers and by employees, with a third chosen by mutual agreement of the first two. To this council matters might be referred after failure of the Council of Conciliation, or directly, and the Council of Conciliation might sit as assessors to the Council of Arbitration, if the parties so agreed. The latter council sat as an open court, and was guided by the principles of equity and good conscience. Representation by attorney was not permissible, but the council had full power to summon witnesses and to enter upon premises for inspection. Awards, which had to be issued within one month of conclusion of sittings, were enforceable by legal process only by prior agreement of the parties, and the claims were to deal with matters of wages, workmanship, conditions of work, quality of food supplied to employees, and sanitation of workshops.

As this Act did not compel either party to a dispute to submit its case to the Council of Arbitration and Conciliation, nor to abide by any award made if a case were submitted, it proved ineffective. From the date of appointment of the two councils to the end of 1894, only one case for conciliation and one for arbitration were taken. Negotiations in other cases were unsuccessful. The Parliamentary vote for administration lapsed on 31st December, 1894; and, though the Act remained in force till 31st March, 1896, its machinery having broken down, it was inoperative. During this period, however, the first regulative legislation in regard to factories and shops was passed, viz., the Factories and Shops Act, 1896.

The Conciliation and Arbitration Act, 1899, aimed at the prevention, as well as the settlement, of trade disputes; it authorised the Minister, in cases where a disagreement was pending, or probable, between an employer and employees, to direct inquiry into the causes and circumstances of the difference, and to take steps to enable the parties to meet together under the presidency of a chairman mutually selected, with a view to an amicable settlement. In the event of failure, the Minister could direct a public inquiry into the causes of the difference, and on the application of either employers or employees, or of both, could appoint a board of conciliation. On the application of both parties an arbitrator could be appointed, but parties to a dispute were not compelled to submit their cases, and to remedy the imperfections disclosed, further legislation was enacted.

These initiatory enactments aimed at the elimination of the strike as an instrument in the settlement of industrial disputes, or at least at minimising the disastrous consequences to which the community becomes liable. Contemporary with these mediatory measures, legislation was originated in Victoria to deal with sweated industries, and to determine fair wage rates generally. Subsequent legislation in this State, associated these two ideals by embodying in a specific enactment the combined objective, the prevention of strikes and lock-outs, and the assessment of fair wages and working conditions.

ARBITRATION.

The Industrial Arbitration Act, 1901, provided for the registration and incorporation of industrial unions and the making and enforcing of industrial agreements; constituted a Court of Arbitration for the hearing and determination of industrial disputes and matters referred to it; defined the jurisdiction, powers and procedure of such Court, and provided for the enforcement of its awards and orders. This Act remained in force until 30th June, 1908; but in the year 1905 it was so extended by the Industrial Arbitration (Temporary Court) Act that if the Registrar, or in cases of appeal, the Court were satisfied that compliance had been made with the Act, there could be registered, as an industrial union, any person or association of persons, or any incorporated company or any association of incorporated companies, employing on an average, taken per month, not less than fifty employees; and any trade union or association of trade unions.

An industrial union could make with another industrial union or with an employer, an agreement in writing relating to any industrial matter; the Court had jurisdiction to hear and determine, according to equity and good conscience, industrial disputes and industrial matters referred to it, and to make orders or awards in pursuance of such hearing and determination. An industrial dispute was defined to be a dispute in relation to industrial matters arising between an employer, or industrial union of employers, and an industrial union of employees or a trade union, and included a dispute arising out of an industrial agreement.

This Act, in providing for the prevention of strikes and lock-outs, made it a misdemeanour for any person who, before a reasonable time had elapsed for a reference to the Court of the matter in dispute, or while any proceedings were pending in the Court in relation to an industrial dispute, did any act or thing in the nature of a lock-out or strike; or suspended or discontinued employment or work in any industry; or instigated to or aided in any of the above-mentioned acts.

The Industrial Arbitration Act, 1901, was a tentative measure which was intended to remain in operation for seven years. Principally on account of the slowness of the Court in dealing with disputes, and the consequent congestion of cases, it was superseded, on its effluxion, by the Industrial Disputes Act, 1908.

Industrial Disputes and Wages Boards.

In the Industrial Arbitration Act, 1901, the principal innovation lay in the extension of the definition of industrial disputes, so as to include consideration of conditions prevailing in industries in which no legal dispute existed. Under the Act of 1908, which represents the third stage in the development of a perfect industrial code, a social ideal was evolved into a definite process by which every normal individual is entitled to a reasonable standard of comfort consistent with the welfare of the community.

All awards, orders and directions of the Court of Arbitration, and all industrial agreements current and in force at the commencement of the Act, remained binding on the parties, and on the employers and employees concerned, for the period fixed by the Court, or by the award, or agreement, or where no period was fixed, for one year from 1st July,

1908. Any industrial agreement might be rescinded or varied in writing by the parties, any such variation, if filed with Registrar, to be binding as part of the agreement.

Provision was made for the registration of trade unions as industrial unions, and the expiration of the Industrial Arbitration Act, 1901, did not affect the incorporation of industrial unions registered under that Act, while any trade union registered under the Act might make a written agreement with an employer relating to any industrial matter.

The Industrial Court consisted of a judge, sitting with assessors, when necessary.

A board could be constituted for an industry on application to the Industrial Court by—

(*a*) an employer or employers of not less than twenty employees in the same industry;

(*b*) a trade union registered under the Act having a membership of not less than twenty employees in the same industry;

(*c*) an industrial union whose members are such employers or employees; or

(*d*) where there is no trade or industrial union of employees in an industry having membership and registered as aforesaid, or where such union fails to make application, then not less than twenty employees in such industry.

Each board consisted of a chairman and not less than two (nor more than four) other members as determined by the Industrial Court, one half of whom were employers and the other half employees at some time engaged in any industry or group of industries for which the board was constituted. Where the employers or employees consisted chiefly of women and girls, the Court could waive this qualification of quondam employment.

A board with respect to the industry or group of industries for which it was constituted might—

(*a*) decide all disputes;

(*b*) fix the lowest prices for piece-work, and the lowest rates of wages payable to employees;

(*c*) fix the number of hours and the times to be worked in order to entitle employees to the wages so fixed;

(*d*) fix the lowest rates including allowances as compensation for over-time and holidays and other special work;

(e) fix the number or proportionate number of apprentices and improvers, and the lowest prices and rates payable to them, according to age and experience;

(f) appoint a tribunal, other than the board itself, for the granting of permits allowing aged, infirm, or slow workers, who are unable to earn the lowest rates of wages fixed for other employees, to work at the lowest rates fixed for aged, infirm or slow workers. If no such tribunal were provided by the board, the Registrar had jurisdiction to grant such permits;

(g) determine any industrial matter;

(h) rescind or vary any of its awards.

At any time within one month after publication of an award by a board, any trade or industrial union or any person bound by the award could apply to the Industrial Court for leave to appeal to such Court. The Court alone had power to rescind or vary any award or order made by it, or any award of a Board which had been amended by the Court, or any award of a Board which had been dissolved or was no longer in existence; but where public interests were endangered, the Crown might intervene in proceedings, and make any necessary representations; or, further, the Crown might at any time after the making of an award, apply for leave, and appeal to the Industrial Court. Under the Amending Act of 1910 proceedings for the enforcement of awards and penalties were made referable to a Magistrate's Court, and in accordance with this proviso the Industrial Registrar's Court was constituted as a Court of Petty Sessions.

CONCILIATION AND ARBITRATION.

The laws in force in the first period of attempted legislative intervention in industrial difficulties, viz., the Trades Disputes Conciliation and Arbitration Act, 1892, and the Conciliation and Arbitration Act, 1899, were based on the principle of voluntary conciliation as the most effective instrument in the adjustment of grievances. The latter was short-lived, being replaced by the Arbitration Act of 1901, which remained in force for seven years, viz., from 1901 to 1908. From this Act the principle of pure conciliation was omitted, its ineffectiveness having been shown, primarily in the lack of a legal tribunal to enforce the findings of the Court. The basis of the rejection of conciliation lay in the precedent established in New Zealand, where also its ineffectiveness was regarded as proven, and the principle was being abandoned in favour of arbitration. Into the Act passed by the State Parliament in 1901 was introduced a principle quite new to the earlier arbitration enactments, viz., the extension of the arbitration principle beyond the area of an existing dispute, to the regulation of wages and working conditions generally.

On account of the large number of cases promptly cited before the Industrial Court, and the possibility of securing an injunction against the Court, there ensued a state of congestion ultimately culminating in considerable industrial unrest, when experience had proved the Act to be cumbered by technicalities.

In the Industrial Disputes Act of 1908 an effort was made to combine the relatively simple procedure of conciliation courts with the compulsory powers of the Arbitration Court as to enforcement of findings and awards, while still maintaining the machinery for regulating wages and working conditions in industry generally. But after some three years' experience, adverse criticism was directed against this the fourth attempt at settlement of the industrial problem, the most serious objection being found in the multiplicity of boards and the danger of overlapping of awards, due to an entire absence of co-ordinating principles.

In 1911-12, while the Industrial Disputes Act, 1908, and its amendments, were still operative, provisional conciliatory machinery was established pending reconsideration by Parliament of the whole position as to mediatory and regulative legislation. The results of this measure of intervention were deemed so satisfactory as to be worthy of permanence; and in the Industrial Arbitration Act, 1912, mediation is a prominent feature.

INDUSTRIAL ARBITRATION.

In the Industrial Arbitration Act, 1912, provision is made for the registration of industrial unions of employers and employees, and also for the cancellation of registration by request, or by determination of the Court. Unions of employees may make industrial agreements with employers, or with any other industrial union, such agreements to be filed, and binding for five years.

In the constitution of the Court of Industrial Arbitration, as a superior Court, and Court of Record, governed in procedure and decisions by the rules of equity and good conscience, provision was made for the appointment of an additional Judge or of a deputy, and for the constitution of Industrial Boards, of two or four members equally representing employers and employees, with a Chairman appointed by the Minister. The Court is empowered to recommend "such transposition, division, combination, rearrangement or regrouping of" scheduled industries as may be desirable, and where question arises as to the demarcation of callings, may constitute a special board to determine such question. The maximum tenure of office by Board members is three years. Where public interests are, or would be, likely to be affected, the Crown may intervene in proceedings before a Board or the Court, or appeal from an award of a Board, and make such representation as may appear necessary to safeguard the public interests.

Conciliation committees and a special commissioner are features of the Act, as also is the procedure regarding lock-outs, strikes, and breaches of awards. In the enforcement of awards and orders, "any property of a union, whether in the hands of trustees or not, shall be available to answer any such order."

Appeal from the Registrar or other Industrial Magistrate lies to the Court, any decision of the Court to be final.

Penalties imposed are recoverable in courts of summary jurisdiction, and are payable to the public revenue.

DEVELOPMENT OF JURISDICTION.

The Industrial Arbitration Act, 1901, aimed at the determination of disputes referred to it rather than at the constitution of a regulative tribunal. The jurisdiction of the Court of Arbitration extended to all industries except domestic service, and its awards applied without limitation of area throughout the State.

The Industrial Disputes Act, 1908, aimed at the constitution of Wages Boards to determine the conditions which should govern employment in specified industries. Boards could be constituted for industries or occupations or local sections of industries or for any division or combination of employees in industries as might be judged expedient by the Court. In practice, boards were constituted for industries, but employees were associated according to trades, to materials worked in, or to goods made, with the result that there were boards for trades, for business, and for industries or associations of trade—all with exemptions for certain classes of employees or employers.

Under the Industrial Arbitration Act, 1912, the powers of the Court and of its subsidiary tribunals are not limited to the relationships of employment. The range of industries and callings is defined by schedule, and boards may be constituted for any industry or calling or for division or combination in such industry or calling. In practice, old boards have been re-established so far as is consistent with the conditions of the Act. Thus a material distinction between the Wages Board system as operative under the Industrial Disputes Acts, 1908-1910, and the Industrial Boards, provided under the Industrial Arbitration Act, 1912, lies in the grouping of allied industries under one chairman, and in the arrangement of such boards more upon the basis of craft or calling than of industry, the ultimate aim being the maintenance of some twenty-eight subsidiary Arbitration Courts, each having power to deal with a group of allied industries, but subject to the general control of the Court of Industrial Arbitration, which in its supreme direction will co-ordinate the work of the minor courts.

FUNCTIONS OF BOARDS.

The powers of the boards in making awards include—

(*a*) fixing the lowest prices for work done by employees, and the lowest rates of wages payable to employees, other than aged, infirm, or slow workers;

(*b*) fixing the number of hours and the times to be worked in order to entitle employees to the wages so fixed;

(*c*) fixing the lowest rates for overtime and holidays and other special work, including allowances as compensation for overtime, holidays, or other special work;

(*d*) fixing the number or proportionate number of apprentices and improvers and the lowest prices and rates payable to them;

(*e*) determining any industrial matter;

(*f*) rescinding or varying any award made in respect of any of the industries or callings for which it has been constituted;

(*g*) declaring that preference of employment shall be given to members of any industrial union of employees over other persons offering their labour at the same time, other things being equal: Provided that where any declaration giving such preference of employment has been made in favour of an industrial union of employees such declaration shall be cancelled by the Court of Arbitration if at any time such union, or any substantial number of its members, takes part in a strike or instigates or aids any other persons in a strike; and if any lesser number takes part in a strike, or instigates or aids any other persons in a strike, such court may suspend such declaration for such period as to it may seem just.

Awards are binding for a maximum period of three years on all persons engaged in the industries or callings and within the locality covered Appeal lies to the Court, but the pendency of an appeal does not suspend the operation of the award.

Proceedings before a board may be commenced by—

(*a*) reference to the board by the Court or the Minister; or

(*b*) application to the board by employers or employees in the industries or callings for which the board has been constituted.

To induce agreement in case of an application or reference the board will inquire expeditiously and carefully into the matter and anything affecting the methods thereof; it is empowered to enter, for inspection, premises used in the industry, to conduct its proceedings in public or in private, and in respect of witnesses to compel attendance and evidence as under section 136 of the Parliamentary Electorates and Elections Act, 1902. Advocates or agents appearing before the board must be, or have been, actually and *bona fide* engaged in one of the industries or callings in respect of which proceedings are taken.

COST OF BOARDS.

The expenditure for Boards, apart from administration, for years ended 30th June has been as follows:—

1909	£3,498
1910	9,665
1911	8,795
1912	11,264
1913	13,635

In addition there is cost of administration, which in 1912-13 was £6,808.

Fees and travelling expenses, in addition to fares, payable to members of Boards and Committees, as determined by Regulation of 23rd October, 1912, are as follows:—

Chairman—£1 per hour for the aggregate of hours occupied by sittings of the Board.

Members—6s. 8d. per hour for the aggregate of hours occupied by sittings of the Board.

When his place of residence is so situated that he cannot reasonably return home at night from the place of meeting—

Chairman, at the daily rate of 17s. 6d.; minimum payment, 10s.

Member, at the daily rate of 12s. 6d.; minimum payment, 7s. 6d.

OPERATIONS OF INDUSTRIAL BOARDS.

The main operations under the Industrial Arbitration Act, 1912, during the year 1912-13 were as follow:—

Boards were constituted to the number of 211, and 13 were dissolved, while 21 Boards constituted under the 1908 Act, and having matter before them partly heard at the commencement of the 1912 Act, were in operation.

One hundred and six awards were made during the year, of which six were dealt with by the Court of Industrial Arbitration sitting as an Industrial Board, on reference by the Minister. The remaining awards made by Industrial Boards include 19 made by Boards appointed under repealed Acts, two on reference by the Minister, and one heard before a Special Board (Demarcation). Seventy awards were varied, and two rescinded, including one under repealed Acts, and 29 varied by the Court.

Prosecutions on account of strikes or lock-outs numbered 420 and 362 convictions were obtained. For breaches of awards penalties were imposed in 840 cases, while in 212 cases no order was made, and 81 cases were withdrawn, etc. For "non-payment of full amount fixed by an award," orders were made in 35 cases, while in 51 others no order was made, and 11 cases were withdrawn, dismissed, etc. In cases for recovery of fines and subscriptions payable to unions, 30 orders were made, no orders were made in two cases, and 39 cases were withdrawn, etc. For failing to keep time-sheets and pay-sheets of employees, 589 penalties were imposed, while 41 cases were withdrawn or dismissed; and for failing to exhibit copy of award, 420 penalties were imposed, 32 cases being withdrawn or dismissed.

Injunctions were granted by the Court in two cases to restrain persons from continuing to instigate to or aid in a lock-out or strike, and three writs of injunction were granted to restrain persons from committing further or other breaches of awards or industrial agreements.

In proceedings on appeal from the Industrial Registrar and Industrial Magistrates, 11 cases were upheld, 15 were dismissed, and six were struck out, reversed, etc.

Three applications for cancellation of registration were dealt with, of which two registrations were cancelled, and in the other a settlement was effected.

During the year ended 30th June, 1913, 18 applications were made by employees and nine by employers for registration of Industrial Unions. Of the former, 16 were granted and two refused, and of the latter eight were granted and one was still pending at the end of the year.

Four hundred and three permits were granted to aged, infirm and slow workers. One hundred and thirty-nine were refused, and 80 were withdrawn, etc.

The approval of the Registrar of applications by secretaries of Industrial Unions of employees for orders to receive money for breaches of awards was given in nine cases.

In miscellaneous proceedings under awards and agreements before the Registrar, 334 were granted, 29 refused, and 31 withdrawn, etc.

Indentures of apprenticeship lodged numbered 674, and notifications lodged under various awards included—

Execution of indentures of apprenticeship ..	159
Cancellation of indentures of apprenticeship	24
Assignments of apprentices	3
Industrial agreements registered	44

Proceedings for payment of arrears of wages amounting to £4,839 were taken during the year 1912-13, the number of employers concerned being 501, and employees 876.

INDUSTRIAL INSPECTION.

In May, 1911, while the Industrial Disputes Act, 1908, and its amendments, were still operative, an Investigation Officer was appointed, whose chief function was to receive and record complaints as to breaches of awards and failures to comply with obligations imposed under the Act, to review the reports of inspectors, and to direct prosecutions consequent thereon. In October, 1911, an active policy of conciliatory intervention between industrial disputants was undertaken, anticipating by voluntary processes the expedients subsequently embodied in the Industrial Arbitration Act, 1912.

During the year ended 30th June, 1913, some 3,684 complaints were received; 1,931 prosecutions were initiated, of which 104 were withdrawn, and 104 were dismissed upon the merits. The penalties in fines and costs amounted to £2,731.

Concurrently with this procedure for the enforcement of awards, etc., the Investigation Officer was engaged in mediatory services wherever disputes or dislocations were known to be pending.

With the commencement of the Industrial Arbitration Act, 1912, statutory authority was given to this process of intervention. The Investigation Officer was appointed an Industrial Commissioner on 1st July, 1912, and subsequently in practice his intervention was sought in many cases.

During the year 1912-13 intervention occurred in 67 cases.

INDUSTRIAL AGREEMENTS.

Trade Unions were empowered under the Industrial Arbitration Act, 1901, to make written agreements with employers in regard to any industrial matters, the practice of collective bargaining, which had been followed by well-organised unions for years, then first receiving statutory sanction. Agreements relating to any industrial matter could be made by an industrial union with another industrial union or with an employer, and when filed, were binding between the parties. Recissions and variations of agreements also had to be made in writing and duly filed.

Under the Industrial Disputes Act, 1908, the power of the industrial union of employees to make an agreement was continued. Each agreement would be binding on the parties and on every person while remaining a member of the contracting trade union or branch. Under the Industrial Arbitration Act, 1912, the agreement is enforceable in the same manner as an award; its maximum duration is fixed at five years, as against three years under the previous enactments. Otherwise, conditions relating to agreements were not altered materially.

PREFERENCE TO UNIONISTS.

The question of preference to unionists is of vital importance in relation to industrial organisation.

In the majority of awards made by boards, a clause has been inserted granting, unconditionally, preference to unionists, all other things being equal. In occasional cases preference has been made subject to a restriction, viz., in the case of Trolley Draymen (Newcastle) providing that the existing employment of non-unionists should not be prejudiced, and in the Caterers (Metropolitan) Award, in which the preference was not extended to women.

Awards granting preference are far more numerous than those in which restricted preferences are given; of 153 awards in August, 1912, 119 granted preference absolutely or with some limitation.

Apparently there has been no general rule governing the decisions of boards in this matter, for where there are several awards relating to various branches in an industry, it will generally be found, as in the iron trades, that in one or two branches the preference is unconditional, while in other branches there is no preference whatever in favour of unionists.

In a few cases the preference clause is in the nature of a prohibition of discrimination against unionists.

MINIMUM WAGE.

The Minimum Wage Act, 1908, which is consolidated with the Factories and Shops Act, 1912, provided that the minimum wage should be not less than 4s. per week in respect of any person employed in preparing or manufacturing any article for trade or sale, or in any factory under the Factories and Shops Act, or working at any handicraft; or any shop-assistant as defined by the Early Closing Act.

The provisions do not apply where all persons employed as workmen and shop-assistants are members of the employer's family, related in the first or second degree by blood or first degree by marriage to the employer.

Overtime for the workman is any time worked beyond 48 hours per week, or after 6 o'clock in the evening, or, for a shop-assistant, after half an hour after closing time of the shop.

CURRENT STANDARDS AS TO WAGES.

Since 1908 the number of trades in which wages are regulated by awards has extended so rapidly that but few occupations remain without the jurisdiction of industrial tribunals. The principle running through the awards of boards, etc., is the stipulation of an adequate living wage, and the minimum adult wage ranges between 7s. 6d. and 8s. per day for any class of labour. The question of the cost of living enters into the determination of a living wage, and judgments and awards tend more and more to embody all the factors determining effective wages, rather than to compromise between the standards of employer and employee.

AGED, INFIRM AND SLOW WORKERS.

Applications for variations from award rates were made, under the Industrial Disputes Act, 1908, and its amendments, to the Registrar of the Industrial Court, and to any tribunal which might be constituted for the purpose by an Industrial Board.

Under the Industrial Arbitration Act, 1912, the Registrar alone has power to determine when and how such variations shall be permitted.

HOURS OF WORK.

In 1855, after a strike, the principle of an eight-hour working day for operative masons was established. In the fifteen years following, the spread of the movement was not great, but in 1871 the Eight-hour Day celebration (since held annually) was inaugurated by the four classes then working the eight-hour day, viz., stonemasons, brickmakers, carpenters, and general labourers; since that inauguration, a 48-hour week has become the standard of custom for the majority of trades, and in recent years has been fixed by the awards of boards as the legal standard. In practice the eight-hour principle is expressed in five working days of eight and three-quarter hours each, and four and a quarter hours on Saturday.

The majority of Wages Boards awards have legalised the 48-hour normal working week, but the awards in which that standard is not specified are numerous. On the other hand, there are cases in which a shorter working week has been prescribed. The shortest week fixed is 36 hours, and this applies to rock-choppers and sewer-miners, and to employees engaged on night-duty for the Metropolitan Board of Water Supply and Sewerage and the Sydney Municipal Council.

A strict eight-hour day is observed only by two trades of the full number of 105 which in October, 1912, were working a 48-hour week; the strict eight-hour day, with a half day of four hours on Saturday, involves a 44-hour week.

Out of 153 awards listed, 105 cover limitations of the working week to 48 hours or less. The industries for which less than 44 hours per week are stipulated are notably unhealthy trades, *e.g.*, rock-chopping and sewer-mining, 36 hours per week, or 6½ hours per day; printing trade machine operaters on night work are limited to 42 hours per week.

In six trades the limit ranges between 44 and 48 hours per week; stonemasons and quarrymen have a 44-hour week, or a strict eight-hour day; process engravers a 44½-hour week; jewellers (watch and clock makers and repairers) and clerical workers under the Government Railway and Tramway award, $46\frac{3}{4}$ hours; storemen and packers in two sections of the industry a $47\frac{1}{2}$-hour week.

In two industries the hours of female workers have been specially limited, viz., in meat packing, preserving and canning, to 44 hours; and sail, tent, and tarpaulin making to 47 hours.

In several awards relating to the Government Railways and Tramways, the hours are limited by fortnightly computation to 96, but subject to a provision that such hours are to be worked, as far as practicable, in 12 shifts of eight hours each. The persons affected by this provision are chiefly shunters, guards, labourers, firemen, signalmen, conductors, drivers, pointsmen, starters, examiners, shed foremen, checkers and washers.

Of the trades working more than 48 hours per week, the most prominent are those connected with transport services and food supplies.

It is to be noted that most of the occupations for which the short week is fixed are regarded as more than usually unhealthful or strenuous.

STRIKES AND LOCK-OUTS.

The primary object of the mediatory and regulative legislation enacted in New South Wales is to obviate strikes; but, though a large measure of success has resulted from the operation of the various Acts, the absolute elimination of strikes from industrial operations has not yet been secured.

The provision for repression of strikes and lock-outs in the Industrial Arbitration Act, 1901, in which the principles of mediation and regulation were first displayed as converging ideas, implied misdemeanour only if the action or condition occurred (*a*) before a reasonable time elapsed for reference to the Court of the matter in dispute, or (*b*) during the pendency of proceeding in the Court in relation to an industrial dispute. Actions tending to suspension or discontinuance of employment, in circumstances with which the arbitral system was not capable of dealing, were not imputable as misdemeanours.

Penalising provisions were embodied in the Industrial Disputes Act, 1908, enacted "to prohibit strikes and lock-outs." Its discipline for offences met with opposition from a section of the community to whom strikes appeal as the readiest means of redress of all grievances; and, in spite of the prohibition and penalising of strikes and lock-outs, a strike was declared which involved all the coal-fields of the State—Northern, Southern and Western.

To cope with the position, the Industrial Disputes Amendment Act, 1909, provided for a penalty of twelve months' imprisonment for any attempt to instigate or aid in anything in the nature of a strike or lock-out or discontinuance of work in any industry. Power was given to officers of police to enter buildings, by force if necessary, and to seize documents, when there was reasonable ground for the belief that such buildings were being used for the purpose of fostering the continuance of a strike or lock-out; and where the strike or lock-out related to a necessary commodity (defined as coal, gas, water, or any article of food, the deprivation of which might tend to endanger human life or to cause serious bodily injury) meetings intended to foster such a strike or lock-out were illegal. Persons taking part in such meeting became liable to imprisonment for twelve months. A penalty of £500 was attached to any attempt to restrain the trade of the State in a necessary commodity, or to monopolise or combine to the detriment of the public.

The Industrial Arbitration Act, 1912, in replacing the Act of 1908, aims at obviating strikes and lock-outs. The inefficiency of penal proceedings for all cases is postulated, and the characterisation of a strike or lock-out as criminal gives way to its characterisation as an extravagant expedient, liable to penalisation extending to a charge on any moneys then or thereafter due to the person ordered to pay such penalty. The Court also may grant a writ of injunction to restrain any person from continuing to instigate or to aid in a lock-out or strike, the maximum penalty being imprisonment for six months.

THE LABOUR MOVEMENT.

By J. C. WATSON.

LABOUR politics in Australia may be said to have originated with the maritime strike of 1890. Prior to that time, speaking generally, trades unionists were followers of one or other of the older parties, and, except to demand some law of interest to a particular trade, politics were not discussed at union meetings. The "big strike," however, wrought a complete change. It gained its importance, not so much because of the numbers affected and the fact that the men were defeated, as because it turned the minds of thinking unionists towards politics, and was thus responsible for the political birth of the Labour Party. After the strike, the cry was raised throughout Australia that the workers should aim at direct representation in Parliament, and at the next elections in the eastern colonies platforms were formulated and candidates put forward. Apart from its purely industrial proposals, the Labour Party at once associated itself with the demand for cheap land, and thus secured considerable support in the country districts. At its inception the party met with a fair measure of success, and since then, allowing for defections and internal dissensions, one may say that it has grown with each succeeding election.

As the Labour Party is to-day one of the dominant forces in Australian politics, and even where not in power has helped to colour the proposals of its opponents, it may not be amiss to attempt some analysis of its ideals and methods. Starting essentially as a class party, and depending almost entirely upon artisans and manual labourers, it has gradually attracted wider support, until it now includes amongst its adherents a large proportion of brain workers. Many of the smaller employers are also members of the party, but the vitality and strength of the movement still depends upon trades unionism. With the adoption of compulsory arbitration, or cognate methods of settling industrial disputes, new unions have been everywhere established, mainly with a view to securing better conditions through the law. Once associated for industrial purposes, it is found that working men exhibit a much livelier political interest, and therefore the formal organisation of Labour in politics relies extensively upon trades unions.

SOCIALISM.

The declaration of the party in favour of Socialistic ideals dates from its formation, but in this respect it is far from satisfying the aspirations of the direct Socialists. These latter desire immediate or revolutionary Socialism; the Labour Party declares for evolutionary Socialism. Its objective as formally adopted runs:—

"(1) The cultivation of an Australian sentiment based upon the maintenance of racial purity and the development in Australia of an enlightened and self-reliant community;

"(2) the securing of the full results of their industry to all producers by the collective ownership of monopolies and the extension of the industrial and economic functions of the State and municipality."

It will be seen that, while Socialism is not specifically mentioned, the objective clearly aims at substantial steps in that direction, and therein typifies the general trend of the movement. There is no doubt that popular opinion in Australia, even outside the Labour Party, is strongly tinged with Socialistic ideas. Probably the early adoption by Australia of the principle of State-owned railways (first forced upon local politicians by the unwillingness of private enterprise to meet public requirements, and later continued as intrinsically desirable) has had a great influence in reconciling the people to further extensions of collective ownership. The tendency towards Socialism, or Socialistic restrictions upon the individual, has, however, been largely due here, as elsewhere, to the steady development of business combinations—formed, in many cases, for quite justifiable objects, but in others used for the purpose of imposing undue exactions upon the public. In Australia these injurious combines have not reached proportions similar to those obtaining in some other countries, but locally they have at least made their presence felt and aroused popular antagonism. The State-owned railways have in some measure secured the people against exploitation, and by their success encourage many to seek an extension of the principle. In any case, the position to-day is that politicians of all parties profess a willingness to use collective agencies to protect the public from private extortion. In its concrete proposals, however, the Labour Party goes considerably further than its opponents. As against the endeavour of the Liberals to regulate monopolies into good behaviour, following generally the lines of the Sherman law of the United States, the Labour Party urges that monopolies should be nationalised, on the ground that only the owners can successfully regulate a business. Apart from this general demand, Labour Ministers have established quite a number of governmental enterprises, while further extensions of the principle are promised.

THE CAUCUS.

Starting in each of the States (then Colonies) as a third party, it was natural that "solidarity" methods should be adopted. Obviously, a party standing between two older rivals could exert little influence unless its members voted solidly on all important questions, and therefore Labour candidates were asked to pledge themselves to vote upon the "planks" of the platform and the fate of a Ministry as the party caucus might decide. Ever since its adoption, this disciplinary provision has been fiercely attacked by Labour opponents. We are told that it prevents the Parliamentarian from voting according to his conscience, and generally is subversive of representative government. In reply, it may be pointed out that only members of the political organisations can become candidates on behalf of the party, and these have already agreed to the platform upon which the appeal is made to the electors. As all are agreed upon the principles involved, there only remain questions of detail upon which disagreement can arise, and upon these it should be no hardship to accept the direction of a majority of the party. As to its baneful influence upon representative government, it must be recollected that the essence of party government is that all in the party must vote together upon questions of principle. The most striking illustration of this is the Cabinet. Whatever differences of opinion may exist among Ministers, every member of the Cabinet must conform to its decisions or resign his office. As with the Cabinet, so with members generally—they are expected to be loyal on important issues. The only real difference between the Labour Party's methods and those of its opponents is that the "caucus-bound" Labourite has a voice in the decision arrived at, while the "free" Liberal or Conservative usually has to follow blindly at the heels of his leader. In each case there is the alternative of definitely seceding from the party and appealing to the electors.

IS IT A CLASS MOVEMENT?

The Labour Party is accused of concerning itself only with the interests of the wage-earner, but a glance at its programme (or "platform") will prove that interest is manifested in the affairs of the community generally. All sympathisers with its ideals are admitted as members of the organisation, and brain-workers are welcomed as freely as those who labour with their hands. The charge of being a class party is most frequently associated with the Labour demand for preference to unionists, to which principle some attention may well be devoted. At first sight it might appear illiberal and unjust to inform the non-unionist that he must join a union before employment can be given him, but deeper investigation will show that there is some reasonable ground for the attitude. The whole matter hinges on the question: Is "freedom of contract" beneficial to the community? It is generally admitted that the lot of the wage-earner has been immensely bettered through unionism, and that a reversion to unrestricted competition amongst workers, especially since the comparative displacement of the individual employer by companies, would result in a general lowering of social conditions. Perhaps the best-reasoned objection to "freedom of contract" yet put forward in Australia was contained in a contribution to the press by the Hon. B. R. Wise during the 1890 strike. He argued the question from the standpoint of the community as a whole, and forcefully contended that its adoption would inevitably involve retrogression. If "freedom of contract" is inimical to the interests of the community, the encouragement of unions is the natural alternative. When Mr. Wise, as New South Wales Attorney-General, passed the Industrial Arbitration Act in 1901, he acted consistently with his opinions of eleven years earlier, and set out to secure "collective bargaining" by encouraging the registration of organisations of employers and employees alike. The Arbitration Court was empowered to grant preference to unionists if thought desirable, and in many cases the power has been exercised. The Right Hon. C. C. Kingston, who drafted the Federal arbitration law, adopted the same principle, as did the Hon. Pember Reeves when passing the Arbitration Act in New Zealand. The theory underlying these efforts to encourage unionism is that "collective bargaining" is only possible where there exists on each side responsible entities to act for and bind the respective parties. Preference to unionists gives an incentive to all workers to enrol themselves in appropriate unions and thus make themselves a part of the legal machinery. As a safeguard against possible tyranny, the court is given power to insist that the rules of any union asking for preference should provide for the ready admission of anyone desiring to become a member. It is fairly clear that the case for compulsory arbitration is built up largely on preference to unionists. The argument put forward by the unionist himself is simply that the union secures benefits for all workers in a given calling, either by the reduction of hours or increase of wages, and therefore all those benefitting should contribute towards the cost. It might also be noted that in many callings the unions have secured "preference" without legislative assistance, as they are strong enough to prevent non-unionists being employed. From the foregoing it will be seen that the Labour Party is supported on this question by eminent authorities outside its ranks, and that it is possible to advocate the principle of "preference to unionists" without necessarily being actuated by class motives.

IS ARBITRATION SUCCESSFUL?

The references to industrial arbitration in the preceding paragraph will naturally evoke the question: Is Arbitration Successful? Of course, the reply will probably depend largely upon the point of view of the person addressed. Many employers would undoubtedly say that the experiment has proved a failure; some extreme Socialists would say that it is deservedly meeting the fate of all merely ameliorative measures; but in the writer's opinion it has accomplished a vast deal of good for the community. So far as the well-established craft unions are concerned, it has not probably secured more for them than would have been obtained by the old-time strike, especially as during its operation times have been fairly prosperous. Yet where they have been loyal to the law their victories have been secured at infinitely less cost to themselves and with a corresponding saving to the community as a whole. The real value of the arbitration courts and wages boards (in essence they are the same), however, has been in the benefits conferred upon the large aggregate of women and other workers who were practically incapable of organisation until encouraged and protected by the law. A woman whose hours have been reduced from 60 or 70 to 48 and less per week, and whose wages have been increased from 10s. to 25s. for the reduced period, will emphatically declare that compulsory arbitration has been completely successful.

The main contention put forward by those opposed to the law is that it has failed to prevent strikes. True enough, strikes have occurred since the principle was adopted; but how many more should we have had without it? It is a natural result of prosperous times that employees should ask for improved conditions. The law of supply and demand, though it may be tempered in times of depression by our wide-spread unionism, operates to the full when the country is progressing rapidly. One might go further and say that unionism enables the workmen to take advantage more rapidly of the opportunities which prosperity affords. It is clear, then, that without arbitration laws we should in the recent good times have had industrial troubles, and probably in immensely larger proportion.

It should also be pointed out that some of the strikes which have occurred despite arbitration laws have really been protests against the denial of arbitration. The law's delays have thus been responsible for several strikes. Owing to cumbrous and inadequate machinery, claims have been on the file sometimes for a couple of years without being decided, and naturally the irritation of the men affected found expression in strikes. Summed up, the arbitration laws have considerably minimised strikes, with their attendant loss to the participants and the community generally, and above all have brought immense relief to the unorganised and helpless.

"WHITE AUSTRALIA."

To those unacquainted with local conditions the cry for a "White Australia," may seem somewhat hysterical, but there is no question upon which Labourites are more united and determined. The objection to coloured immigration originally arose through the influx of Chinese in the gold-digging days. After the first rush of adventurers (in the best sense) had demonstrated the richness of the fields, thousands of Chinese were attracted by the same golden magnet, and in many places secured rich areas claimed by the whites as theirs by right of discovery. Much rancour was engendered, and in some places riots occurred sufficiently serious to call for military intervention. The antagonism was for a time confined to the gold-seekers, but as the Chinese increased in numbers and extended their activities to trading and other occupations the classes affected joined in a general complaint. Then proposals were made to exclude Chinese immigrants, and after considerable negotiation with the Imperial Government, became law, though not until the Chinese numbered many thousands. Since Federation the laws have been consolidated and extended to prevent the immigration of Asiatics generally, though travellers, students and merchants are allowed to land for limited periods under regulation.

It will be seen that the original objection to coloured immigrants was a purely economic one, but as experience was gained of their habits and standards of living, it was realised that they could not be absorbed into the community without risk of serious deterioration socially. The abhorrence of racial admixture added force to the original objection, and to-day we find practically a unanimous demand for a "White Australia." It may appear somewhat selfish for a mere handful of people, who cannot themselves adequately develope the immense resources of the continent, to object to the immigration of anyone desirous of exploiting the unused areas; but, when outsiders appreciate the menace involved in the proximity to our empty north of hundreds of millions of land-hungry Asiatics, they will perhaps sympathise with the view now commonly held in Australia. Asiatic settlement in our Northern Territory (which is sometimes advocated by would-be exploiters) would, as no "Dixie's Line" could be maintained, involve a steady drift to the South, and with free ingress the preliminary trickle would soon become a resistless tide. The people are determined, to the utmost of their resources, to preserve Australia as a heritage for the white races. The aboriginal natives are numerically a negligible quantity, so there is every opportunity for the building up of a great white democracy if the community can maintain possession against the natural desire of the brown and yellow races to participate in the good things to be found in the Commonwealth. That the Asiatic will for ever tamely submit to be excluded from a country which, while presenting golden opportunities, is yet comparatively unpeopled, can hardly be expected. Therefore Australians are realising that to maintain their ideals they must fill their waste spaces and prepare for effective defence.

IMMIGRATION.

In this relation the Labour Party has steadily advanced the view that before entering upon any large scheme of immigration it is necessary to ensure that land should be readily available. The position is that, in the States where the conditions most nearly approximate to those of Great Britain, much land suitable for close settlement is held by large pastoralists, who make a sure and profitable return by stock-raising. These people have rendered good service to Australia in the past, but altered circumstances now demand that room must be found for the farmer. The Labour Party's proposal to make the land more readily available by imposing penalising taxation upon the large estates has been approved by a majority of the electors, and the tax is now law. Whether it will achieve all that is expected from it is perhaps doubtful, but already it has been the cause of many large areas being made available for close settlement. It is not contended by the Labour Party that immigration should be confined to farmers. As a matter of fact, Federal and State Labour Ministries have recently assisted many thousands of artisan immigrants to reach Australia, and these in the main have been found profitable employment. It is argued, however, that land occupation should form the basis of any comprehensive attempt to attract additional population. In West Australia and Queensland large areas of good land still remain in the hands of the Crown, and are rapidly being made available to settlers. The Northern Territory, an immense area with a fair proportion of good land, is now in the hands of the Federal Government, and will probably be opened up shortly. In the writer's opinion, however, it would be unwise to dump any large number of immigrants in the Territory before it has been thoroughly tested by those accustomed to Australian conditions. That white settlement will be successful there seems reasonably certain, but the pioneering should be done by those who have been trained in the adjacent States. The same caution should be exercised in the northern portions of Queensland and West Australia, though perhaps not necessary in the same degree. Although these areas are within the Tropics, it does not seem that the climate will prove any serious handicap, as on the whole it has so far proved to be healthy for whites. The real point to be determined is whether Northern Australia is suitable for close settlement. That it can raise fine horses and cattle is already amply demonstrated, but continued experimental work is necessary before anyone can honestly say that old-country people would be justified in attempting settlement on small areas in the far North. In any case, there is room enough and to spare for many additional millions in districts already proved as ensuring a handsome reward to the industrious. Generally, it may be said that the Labour Party recognises the urgent need for augmenting the population, and is prepared to assist the immigration of those likely to help in building up a homogenous community.

ATTITUDE ON DEFENCE.

The Labour Party's attitude towards Defence has undergone an immense change since its first entrance into politics. In 1890 the New South Wales platform (there was little variation in the other Colonies) proposed the "establishment of our military system upon a purely voluntary basis," as against the mixed militia and permanent system then prevailing. Whilst the platform thus approved a voluntary defence force, there was a strong current of opinion among the rank and file that the whole question was negligible. This indifference was generally maintained until the Colonies federated in 1901. The wider outlook necessitated by the responsibility of caring for the affairs of a continent had its most important influence in regard to defence. The members of the first Federal Labour Party were almost exclusively drawn from the various State parties, yet the men who in the State Parliaments had been careless of defence problems soon developed a keen interest in the question as affecting Australia. At first that interest was manifested merely by attempts to secure expenditure upon armament and munitions of war, as against the pre-Federation method of training men without guns. Gradually, however, it was realised that only a radical change of policy could ensure even an approach to adequate defence. The emergence of Japan as a world power certainly accelerated the conversion of many of the Party's followers. With a fertile continent and only a small population, it was evident that other nations would probably seek concessions which could not be granted without a complete sacrifice of our ideals. It was therefore recognised that efforts should be made to secure the military training of every citizen, and thus make the most of our slender resources. The leader in this new conception among the Party was the Hon. W. M. Hughes, who tabled a motion in the first session of the Federal Parliament favouring compulsory military training, but secured only a few supporters. Thenceforward he continued to advocate the principle, in and out of the House, and gradually won over the other members of the Party. The adoption of compulsory military training as a definite plank of the Labour Party's programme in 1908 marked a distinct departure from the traditional policy of Labour and Radical parties elsewhere. It is true that this change of view was partly brought about by the peculiarly isolated position of Australia as the "white outpost of the Pacific," but it was also recognised that in Australia more than elsewhere the working man had something to defend. His individual property might not amount to much, but his hard-won rights and glorious opportunities were worth some sacrifice to retain. So the proposal was incorporated in the Party's platform by an overwhelming majority, and has since become law so far as the rising generation is concerned. Of course, some few still object to compulsory training on the ground that it commits the community to militarism. These people ignore the fact that the term "militarism," used in criticism or reproach, connotes something quite different from a purely citizen force such as is provided for in Australia. Here no men are compulsorily withdrawn from industry for more than a few days at a time, and with practically no professional force there is little probability of those in training advocating war for the mere sake of fighting. The system has naturally met with initial difficulties, but already it is becoming evident that it will be completely successful. The young men affected are showing an aptitude for the work and usually do it cheerfully. Apart from the military value of the training, its importance from the civic standpoint is being recognised. The physique and morals of the trainees has shown considerable improvement, and with this feature becoming more marked in each succeeding year there is little doubt that the system has come to stay.

On the naval side of defence the Labour Party was the first to associate itself with the idea of a fleet locally owned and controlled, now accepted by all parties as most desirable. This attitude does not involve any antagonism to common action with the Imperial Navy in times of crisis, but rather emphasises the fact that Pacific defence demands immediate and personal attention from those whose shores are washed by Pacific waters. The large sum spent on naval defence by the Fisher Ministry during its three years of office demonstrates that the Labour Party takes a comprehensive view of its defence duty. Whatever may be thought of the "separate fleet" idea, it is reasonably certain that no such large sum would be available during any similar period as a money contribution to the Imperial Navy, while for a force which they can regard as their own the people have been and still are prepared to make considerable sacrifices.

CONCLUSION.

The foregoing remarks are not intended as a full exposition of the Labour Party's methods or ideals, but they may serve to make clearer the point of view from which various problems have been approached. No one can claim that success has attended all the Labour Party's efforts, but it may at least be said, generally, that it has advanced the cause of humanity by another step. It has taught the rank and file to know their strength, and stressed the fact that the golden opportunities existent in Australia have never-ending responsibilities as their necessary accompaniment.


CAPE YORK
GULF OF CARPENTARIA
Port Darw
Burketown
Normanton
Cairns
Townsville
Charters Towers
Woolgar
Cloncurry
Mackay
NORTHERN TERRITORY
QUEENSLAND
GREAT AUSTRALIAN ARTESIAN BASIN
Winton
Longreach
Rockhampton
Mt Morgan
Charlotte Waters
Oodnadatta
Maryborough
Charleville
Chinchilla
BRISBANE
W. AUSTRALIA
STH AUSTRALIA
MURRAY RIVER DRAINAGE AREA
Cunnamulla
Hungerford
Bourke
Brewarrina
Tarcoola
Wilcannia
Broken Hill
Port Augusta
NEW SOUTH WALES
Manilla
Gunnedah
Dubbo
Newcastle
Wentworth
GREAT AUSTRALIAN BIGHT
ADELAIDE
Renmark
SYDNEY
Jervis Bay
Echuca
Albury
VICTORIA
Ballarat
Portland
MELBOURNE
C. Howe
PACIFIC OCEAN
SOUTH
Commissioner for Water Conservation and Irrigation
— MAP —
shewing the
Murray River Drainage Area
& Great Australian Artesian Basin
Scale of Statute Miles

CHAPTER VII.

WATER CONSERVATION AND IRRIGATION IN NEW SOUTH WALES.

By L. A. B. WADE, M. INST. C.E.

THE island continent of Australia occupies a greater space in the Southern Hemisphere than does the continent of Europe in the Northern. Its situation between the 11° S and 39° S parallels of latitude renders it subject to a range of climatic conditions varying from tropical to temperate. The southern half of the island is under Antarctic influences, the maximum rainfalls occurring during the winter; the northern half is under tropical influences, the maximum rainfalls occurring in the summer. These influences diminish gradually until they meet and overlap along a line running approximately east and west through the centre of the continent—here the rainfalls are fairly evenly distributed throughout the year. The State of New South Wales being centrally situated on the Eastern seaboard, contains separate areas, each subject to one of these three conditions.

The continent of Australia contains one mountain range running from extreme north to south, parallel with the eastern seaboard. The maximum altitudes are reached in the south, where climatic conditions are temperate. Here the summits are subject to regular snowfalls in the winter. The accumulations of snow melt in the early spring. The coastal slopes of the range are generally fairly precipitous. The inland slopes are more gradual and terminate at the edge of the great alluvial plains which form the interior of the eastern portion of the continent. The general altitudes of the plateau forming the range where it passes through the State of New South Wales is from 2,000 to 4,000 feet—the portion of the great alluvial plains within the State are from 300 to 600 feet above sea-level.

The depth of rainfall precipitated varies with the altitude of the land. The average annual rainfall within the State of New South Wales ranges from 10 to 18 inches on the great alluvial plains, from 19 to 30 inches on the slopes and plateau; and to 50 and 70 inches on the highest summits.

Owing to the proximity of this mountain range to the coast, the numerous streams are of comparatively short length, flowing from the coastal slope to the ocean. The rivers flowing from the inland slope of this great range form the one great river system of Australia, known as the Murray. This system gathers ultimately into two main tributary streams, the Darling River, flowing from the north, fed by monsoonal rainfalls; the Murray River, flowing from the south, fed by antarctic rainfalls and winter snows. Both of these main tributary streams pass through the State of New South Wales and joining together in its south-west corner, form a single stream, the Murray River. Certain of the rivers which are tributary to these two main streams take their rise on the inland slopes of the main range in New South Wales. Of these, the Murray and Murrumbidgee are the more important. They flow through the southern portion of the State, from the part of the main range which forms the ascent to Kosciusko, the highest peak in Australia. The catchments are subject to temperate climatic conditions and to Antarctic rainfall influences. The McIntyre, the Gwydir and the Namoi Rivers flow through the northern portion of the State and are subject to monsoonal rainfall conditions. The Macquarie, Bogan, and the Lachlan Rivers flow through the centre of the State—where the monsoonal and Antarctic influences meet and overlap. The rivers which are subject to Antarctic and monsoonal rainfall influences have their maximum flows in the winter and the summer coincident with these rainfalls so soon as their catchments become saturated by the early falls. The even distribution of rainfall throughout the year on the other rivers does not, except in abnormal years, saturate the catchment as to cause large volumes of water to run off and flow in the river channels. Their maximum flows are, however, usually during the winter, when evaporation on the catchment areas is least. A characteristic of the Murray basin is the comparatively small proportion of effective to ineffective catchment area. The effective catchment area is represented by the slopes of the main range which shed the rainfall into the watercourses which traverse it; the ineffective is represented by the great alluvial plains which are intersected by the tributary streams and the main river, and where the low rainfall is absorbed by the soil almost immediately as it falls. The total area of the Murray basin is 414,253 square miles, of which 159,889 square miles may be regarded as effective catchment, and 254,364 square miles as ineffective.

Australia was first settled under a pastoral occupation, the most important requirements being a permanent supply of water for stock purposes. There are distinct wet and dry seasons in Australia. At times the minor watercourses on the slopes cease to run, and it is necessary to afford supplies of water for stock purposes by artificial storage works. These works usually take the form of dams across depressions and watercourses. There is always in the wet seasons sufficient water in the watercourses on the slopes to make pastoral occupation possible, it remained only for the occupier to improve the natural conditions. On the great alluvial plains it was different. The rain falling on the soil was almost immediately absorbed. This plain country was occupied very gradually by the untiring perseverance of the pioneer settlers by excavating large storage tanks in suitable locations where water could be collected by many miles of drains. The only water available for men and beasts when these tanks were being excavated was that carted from adjoining storages or collected in shallow depressions after rainfall. Thus settlement gradually advanced and the plains were conquered.

The history of irrigation to the present time is the history of the evolution of the small farm unit from the large pastoral holding. Australia for many years after its colonisation was subject to the common law of Great Britain in regard to Riparian Rights, which provided for the conditions of a country where the drainage of water from the land is much more necessary than its application for irrigation purposes. This law for many years retarded the progress of irrigation. The State of New South Wales was the first to pass a Water Act defining the rights of the Crown to the use and control of the water flowing in the river channels and confined within lakes, and making provision for the construction of works of irrigation on a small scale by the individuals, and on a large scale by the State. The existing Acts have served their purpose well in the past, but their scope requires to be extended to meet the developments that are coming in the future. In such of the streams as are not perennial in their flow, water is frequently stored in the channels by the dams constructed under the provisions of the Water Rights Act. In the first instance such works may have been provided for the purpose of affording supplies for stock purposes. Gradually pumps have been installed under the provisions of the same Act, both in connection with these dams and on the larger permanent streams, for the purpose of filling stock tanks excavated at a distance away from the stream, channels to convey the water from the pumps extending many miles. The supplies of water being made practically permanent by these means, the carrying capacity of the pastoral holding was increased, and allowed of a higher class and more valuable stock being depastured with certainty. Small patches of irrigation were established under these pumps for the purpose of supplying fodder to stud stock, and as an insurance against drought. Thus irrigation became established as a portion of the pastoral industry of the State. Many of the large holdings at that time carried on a small amount of irrigation of vegetables and fruit for the use of employees and homestead. There is room for immense expansion of irrigation in connection with the pastoral industry of the State. In the past, prices of wool and meat have been such that expenditure in this direction was justifiable only for the feeding of very high class stock. The world's demands have now placed prices for these products on a more permanent basis. At the present time there are about 1,500 licenses in existence within the State under the provisions of the Water Rights Act for works for the storage and for the diversion and distribution of water by either gravitation or pumping. There are possibilities for the construction of great numbers of such works by the individual, and it is anticipated that, in the future, the aggregate areas under irrigation by this means will approach the aggregate areas under irrigation from the great works which will be constructed by the State. A further reason for the increase in numbers in the future of the small works by the individual is the great advance in late years in the efficiency of the modern pump and the economy of power-producing plants. As the large pastoral holdings become sub-divided and aggregation of smaller farm units come about, so the demand for more intensive forms of cultivation under irrigation increases. Dairying, the growing of fruit, vegetables, tobacco, and other high-priced crops is undertaken. Already for this reason the pumping plants installed by the individual are depleting many of the minor streams, and demands are being made on the State for the construction of large works of storage for the purpose of regulating and supplementing the low flow of these streams.

The first definite steps taken towards the development of a policy of furthering irrigation and water conservation in the State was the appointment of a Royal Commission to inquire and report in 1884. The result of the Commission's report was the establishment of a Water Conservation and Irrigation Department in 1890. This Department has since that date until the end of 1912 been engaged preparing legislation, in measuring and recording river flows, preparing and carrying out schemes of Water Conservation and Irrigation from these rivers, and investigating the phenomena, and sinking bores within the Artesian Area. This work at the beginning of 1913 was placed under a single Commissioner, with independent statutory powers.

The legislation enacted provides:—

1. For the construction of minor works of water conservation and irrigation by the individual.
2. For the construction of works of water conservation by the State for the use of groups of individuals, the management being in the hands of a Trust elected from ratepayers, and the payment of interest and principal being met from rates levied on the beneficiaries within the Trust Area.
3. For the construction of large works of irrigation by the State which are subsequently managed by the State.

The streams forming the Murray system have their origin and in their courses pass through the States of New South Wales, Victoria, and South Australia. Each State consequently claims a riparian interest in the whole system as regards the maintenace of the flow in the particular streams passing through their territory. The State of South Australia, in addition, claims that the diversion of water by other States be so limited that navigation on the navigable portions of the streams passing through any of the States be not interfered with. The three States are mutually interested in the fair division of the available volumes of water to be applied to the lands most suited for irrigated agriculture. The State of South Australia being situated at the mouth of the Murray River is directly interested in the trade of the navigable portion of the system. A Royal Commission of Interstate character, consisting of representatives of the States of New South Wales, Victoria, and South Australia, sat in 1902, and furnished a report. A Committee of Engineers representing the same States sat in 1912-13, and also presented a report and recommendation as to the allotment of the available waters to the various States, and the works necessary to be constructed for the purposes of that allotment. Numerous Conferences of the Premiers of the interested States have discussed this vexed question, but up to the present time no agreement has been come to. The diversion of supplies of water for irrigation on a large scale by any of the States must ultimately so lower the levels of flow in the navigable portions of the rivers that the periods of navigation will be materially reduced. The State of South Australia has given Parliamentary authority for the construction of a system of locks and weirs which will make permanently navigable that length of the Murray River situated within that territory and further, with the concurrence of the other States, to the junction of the Darling River. The State of South Australia, before agreeing to large diversions of water for irrigation purposes by the other States, asks for some undertaking, or for a joint arrangement for the construction of locks and weirs which will provide permanent navigation over certain lengths of the rivers situated in these other States. In spite of this deadlock as regards an agreement between the three interested States, large State irrigation projects are being undertaken in the States of New South Wales and Victoria, each of these States utilising to their fullest extent the waters of the Murrumbidgee and Goulburn Rivers, which are situated respectively wholly within those States; the quota due to South Australia being delivered from the main stream of the Murray River and from the Darling River.

The conditions of climate and soil most suitable for irrigated agriculture are those prevailing in the great alluvial plains of the Murray Basin. Here the rainfall varies from 10 to 18 inches per annum. Sunshine prevails throughout the year, accompanied in the summer months by the degrees of heat necessary to promote luxuriant growth with a plentiful supply of moisture. The soils where rainfall is low have not lost their chemical constituents by leaching, and under cultivation and irrigation give results far in excess of those obtained from the soils of the humid regions. The diversity of climate and soil is such that the most diverse forms of agriculture and production under irrigation may be successfully undertaken in different localities. The immense areas of land in these great alluvial plains that may be supplied with water from the rivers by gravitation are greatly in excess of the volumes available in years of normal flow. It is thus economically essential that the water be applied only to the highest class lands, and that the lands selected be situated climatically to suit the variety of production contemplated. The whole of the irrigable lands in the Murray Basin are classified as a preliminary to irrigation. The western portion of the alluvial plains, owing to its low rainfall and high summer temperature, is admirably suited for the economical production of the highest class of dried fruits, the more easterly portions with greater rainfall and lower summer temperature to mixed farming operations combined with the preserving of fruit by canning. There are markets in the Commonwealth for all that can at the present time be produced from the lands being irrigated. The Australian Continent being in the Southern Hemisphere can supply citrus fruits, apples and grapes to the countries of the Northern Hemisphere at the time that their markets are bare of these products. The irrigated lands are intersected by railways, and fodder can be transported from them direct to the arid pastoral areas when dry seasons make prices highly remunerative. In this respect the large State irrigation projects may be regarded in the light of insurances against droughts. Animal husbandry, particularly the raising of pigs and lambs, will play an important part in the mixed farming areas. There is at the present time an expanding overseas market for all that can be produced.

The tributaries of the Murray River in New South Wales, from which water for irrigation may be supplied on a large scale, are the Murray, the Murrumbidgee, and the Darling Rivers.

The Murray River forms the boundary between the States of New South Wales and Victoria. Its principal feeders have their sources under Mount Kosciusko and adjoining peaks, which are the highest in Australia, and subject to Antarctic rainfall and regular winter snowfalls. It is proposed to construct a large storage reservoir on this river at the joint cost of the States of New South Wales and Victoria, for the purpose of regulating its flow. The regulated waters will be equally shared by the two States, less any volumes that may have to be passed down to South Australia to satisfy her riparian requirements. The capacity of the reservoir will be 1,000,000 acre feet, or sufficient to cover that area of land with water to a depth of one foot. The regulated flow of this river, which will be shared equally by the States of New South Wales and Victoria will, in normal seasons, equal an annual volume of 240,000 acre feet per month for the nine irrigating months of the year.

No works have yet been constructed by the State of New South Wales for the utilisation of the waters of this stream for irrigation purposes.

The Murrumbidgee River for the major portion of its length follows a course parallel with the Murray, which it joins later. It has its source under peaks of slightly lower altitude than those at the head of the Murray, and which are subject consequently in a lesser degree to antarctic rainfalls and regular snowfalls. A large project is under development which will practically utilise the whole of the available waters of the river in normal seasons for irrigation and other purposes. The project comprises the construction of a large regulating reservoir at Burrinjuck, the dam wall having a height of 240 feet, the total storage capacity being 733,000 acre feet. The river system consists of two main branches—the Murrumbidgee and the Tumut; the regulating reservoir is situated on the former. The unregulated flow of the Tumut River, together with the regulated flow of the Murrumbidgee will be capable of supplying an area of about 250,000 acres for irrigation purposes. The waters stored at Burrinjuck will be liberated and conveyed a distance of 200 miles in the river channel to Berembed, where they are diverted into a main canal which winds round the base of the last foothill of the Dividing Range, and commands the whole area of the great alluvial plains lying to the westward. The whole of the lands that may be commanded by this canal have been classified, and it has been found that those most suited for agriculture under irrigation are those lying immediately under the foothills and most recently shed from them. The lands which will be irrigated under the project form a strip practically parallel with the foothills about forty miles in length.

From an engineering aspect, this scheme is most interesting. This wall, which is amongst the highest in the world, is founded on an instrusion of red granite; the storage area consists of sandstones and limestones. Steps are being taken to instal pendulums at two selected points for the purpose of recording any earth movement that may occur due to the weight of the stored waters. The works for the development of the irrigated lands include the construction of all the supply and drainage channels necessary for the distribution of the water, the roads affording access to farms, all works incidental to towns and villages, such as water and electric supply, street construction, drainage, etc., undertakings for dealing with settlers' produce, such as butter and bacon factories.

The policy adopted for the settlement of the lands to be irrigated is on lines hitherto untried in other countries. It being a State project, it was considered desirable that the State acquire and dispose of the whole of the lands that would be benefited by the carrying out of the scheme. These lands, owing to their low annual rainfall, have always been under pastoral occupation, and retain all of their virgin constituents. They are sub-divided into farms varying from 10 to 200 acres, according to the quality of the soil, and its suitability for production. No farm has more than 50 acres under irrigation. A water right of an acre foot to each irrigated acre up to a maximum of 50 is attached to each farm. Where individual crops require more than one acre foot during the irrigating season, additional water can be arranged for. All water is measured through a meter to each settler. The farm and town lands are disposed of under a perpetual leasehold tenure, the conditions being payment of rent and residence in the case of farm lands. The residence condition requires that the lessee shall make the farm his or her principal place of residence, or, in other words, their *bona fide* home. Rentals are at the rate of 2½ per cent. on capital values. A Crown grant is issued five years after grant of lease when the land may be disposed of by the lessee subject to the conditions of the lease. The leases are subject to a reappraisement of rent based on the unimproved capital value at periods of twenty years intervals after issue of grant. The State assists the settlers after entry by supplying fencing posts and preparing and grading a proportion of the farm, the payments for which extend over a period of ten years. Residences are built, the payments for which are spread over twelve years, the annual amount for each of the first four years being half of the annual amount for the succeeding eight years. Half water rates are charged for the first year, increasing until full rates are paid in the sixth year. Horticultural stocks true to name, and dairy stock are supplied on terms. A butter factory was established for the treatment of settlers' cream prior to any land being made available for application. An experiment farm was planted four years prior to the first settlement. A staff of instructors afford instruction to settlers in connection with all the various forms of production. The settler is liable to pay water rates and rent. The water rates meet interest on cost and upkeep of the storage dam and all main channels for the conveyance of water to the main points of the settlements, and also the cost of the distribution of the water. The rentals provide for interest on cost of acquisition and disposal of land, cost of construction and upkeep of minor channels for the conveyance of water to each individual farm, the cost of drainage channels to convey water from, and of roads to give access to each individual farm. This policy will be applied to the other large State irrigation projects as they are undertaken.

The catchment area of the Darling River is situated partly in Queensland and partly in the State of New South Wales. It is subject to monsoonal or summer rainfalls, none of the tributary streams are snow-fed. The effective catchment is traversed by a number of small tributary streams upon which there are no facilities for the storage of water on a large scale. There are many sites, however, where water may be stored in comparatively small volumes for supplying individual irrigators, and from which strips of rich alluvial along the banks of the rivers may be brought under irrigation. Storage of water on a large scale for irrigation purposes may only be effected in connection with the lake systems of the great alluvial plains in the vicinity of the main stream. These lake systems are considered to be of Æolian origin, and consist of more or less circular depressions in the alluvial plains, with adjoining sandhills on the southern and eastern sides. The largest of them have areas up to 30,000 acres, and depths up to 20 feet. There are two systems on the Lower Darling, known as the Menindie and Talyawalka Systems, where water may be stored on a large scale, and from which a total area of about 250,000 acres may be perennially irrigated. Preliminary investigations as to possibilities have only been undertaken.

The Lachlan and Macquarie Rivers are situated in the intermediate rainfall zone between the antarctic and monsoonal influences. Here, owing to the more even distribution of rainfall over the yearly period, the run-off from the catchments in normal years is small, and therefore supplies of water are not available for large irrigation projects. Much may, however, be done by the individual irrigator, and in the way of small State projects. The Lachlan River affords an example of what may be done by the individual.

A series of overshot weirs, six to eight feet in height, have been constructed by licensees under the Water Rights Act, from which water is pumped for irrigation purposes. The low flow of the river is accumulated in the small storages between each period of irrigation. These works cover a length of about 200 miles of river channel.

Agriculture may be successfully undertaken without the aid of irrigation within the valleys of the whole of the rivers in the coastal slopes. Productiveness in all classes of crops may be greatly increased in the Valleys of the Hawkesbury and Hunter Rivers by the artificial application of water. A very large storage site has been located on the Warragamba River in the Valley of the Hawkesbury, the stored waters from which it is proposed to utilise, both for irrigation purposes and for the supply of the metropolis for domestic and trade purposes. The lands to be irrigated under this project, being in close proximity to the immense metropolitan market, will have an unlimited outlet for their produce. The capacity of this reservoir will be 275,480 acre feet, the dam will be 250 feet in height. The tributary streams of the Hunter River are being examined for storage sites. The valley lands of the basin with the aid of irrigation may be for productivity made equal to anything in the world.

Irrigation in the valleys of the other coastal rivers may be regarded as an adjunct only to agriculture. It will later be used to increase production in dry years, and to obtain perfection in high-class products in other years by the application of small volumes of water at the proper time. It may be necessary to construct storages for the purpose of such works which might necessarily be idle for a large proportion of their time, and which will not be undertaken until the demand arises at payable prices for the high-priced products that may be grown under them.

One of the most notable physical features of the Australian Continent is the existence of the great artesian basin which covers a total area of 499,300 square miles, 327,000 of which are within the State of Queensland, 69,900 within the State of New South Wales, and 102,400 in the State of South Australia. An Interstate Conference on artesian water, which recently issued a report, had no hesitation in stating that, in their opinion, the ascertained facts indicated that the water in the artesian beds is partially, if not entirely, derived from rainfall; that it percolates the porous beds under the influence of hydraulic conditions. The porous beds outcrop the surface along the eastern margin of the artesian basin and absorb a portion of the rain which falls on them, and flows across them in the stream channels. These intake beds are estimated to cover an area of 60,000 square miles, 50,000 of which are in Queensland, and 10,000 in New South Wales. The bores which tap the supplies of this great basin vary from a few hundred up to 4,000 feet in depth. The total number sunk in New South Wales is 512, 468 of which are flowing, and 44 have been failures. The total volume of water flowing from 391 bores which have been measured in the State of New South Wales is at the rate of 109,214,237 gallons per day. The total length of 512 bores sunk in that State is 158 miles. The sinking of bores has been undertaken by the State and by the private individual. Those sunk by the private individual are licensed under the Artesian Wells Act, and must conform to certain specifications in regard to the manner of their construction. The flow in the artesian wells is utilised almost entirely for pastoral purposes. It being recognised by the competent authorities that there are limitations to these supplies, an endeavour has been made to utilise to the fullest extent the supplies of water that come to the surface. The flow from the bores is conducted by a system of cheaply constructed drains through the various pastoral holdings, so as to afford perennial supplies of water to the stock. It may be here mentioned that the artesian basin is situated almost entirely within the area of the great alluvial plains. These plains have a slight but definite fall, and there is very little difficulty experienced in conveying waters by means of drains to any particular points desired. Large areas of pastoral country are watered by artesian bores and drains constructed by the State and subsequently handed over to and administered by trusts, who undertake to pay off principal and interest within a stated term of years. The total number of trusts in operation is 70. The total flow from the bores in connection therewith is at the rate of 40,750,515 gallons per day. The area watered is 4,245,316 acres. The length of drains constructed in connection therewith is 2,520 miles.

The State Department in charge of water conservation and irrigation is undertaking extensive investigations in connection with the phenomena surrounding the flow of artesian water. The boundaries of the artesian basin have been determined. The areas of the intake beds have been surveyed. The measurements of the pressure and flow of the majority of the bores have been taken. Investigations are in hand as to the nature and volumes of the gases issuing from the bores, and contained in the waters. In certain limited zones, rapid corrosion of the steel casing in bores has been found to take place. Investigations have been carried out to ascertain the best means of dealing with the corrosion trouble in these zones.

Chapter VIII.

THE RAILWAY AND TRAMWAY SYSTEMS OF NEW SOUTH WALES.

By The Railway Department.

The State Railways.

The State railways in New South Wales in operation on 30th June, 1913, totalled 3,930 route miles, gauge 4 feet 8½ inches, the capital cost for construction and equipment being, in round figures, £58,000,000.

The lines are divided into four systems: the Southern, South Coast, Western and Northern, all of which have the Central Station, Sydney, as their starting-point. There is an isolated section in the north-eastern corner of the State connecting Grafton, on the Clarence River, with Murwillumbah, on the Tweed River, a distance of 147 miles of single line, with a branch from Casino to Kyogle, a distance of about 18 miles. There is also a single line, of 3 feet 6 inches gauge, about 40 miles in length, in operation between Broken Hill and Tarrawingee in the far western corner of the State.

Of the total route mileage in operation, 3,589 miles, equal to 91 per cent., are single line. 316 miles 67 chains are double, 5 miles 65 chains consist of three lines, and 18 miles 4 chains are quadruple.

The Southern System.

The Southern system ends at Albury (392 miles from Sydney), where connection is made with the Victorian State Railways (5 feet 3 inches gauge). Albury is the changing station for passengers proceeding to Mélbourne, Adelaide, etc.

From Junee (292 miles from Sydney) a branch runs to Hay, with a sub-branch from Narrandera to Finley and Berrigan, serving the rich wheat and pastoral district of Riverina. Branches also run from The Rock to Oaklands, and from Culcairn to Corowa and Culcairn to Germantown. From Cootamundra (257 miles from Sydney) there are branch lines to Temora, Wyalong and Barellan, all large wheat-growing centres. A branch also runs from Cootamundra to Tumut. At Harden (230 miles from Sydney) a branch line (110 miles in length) connects the Southern and Western systems, and from this connecting line branches run to the wheat-growing districts of Grenfell and Canowindra. At Goulburn (136 miles from Sydney) two branch lines run off, one to the north to Crookwell, and the other south to Cooma and Nimmitabel, the latter bringing into communication with Sydney the rich pastoral district of Monaro.

The South Coast System.

The South Coast Line leaves the main line at Redfern (two miles from Sydney) and ends at Bomaderry (Nowra) on the north bank of the Shoalhaven River, 92 miles from Sydney. It serves the Illawarra district, with its coal-fields and many points of attraction for tourists. A branch of this line extends from Sydenham to Bankstown, being a Sydney-Suburban Line.

The Western System.

The Great Western Line crosses the Blue Mountain Range at an altitude at the highest point of 3,503 feet (Newnes Junction), and after traversing the Great Western Plains has its terminus at Bourke (508 miles from Sydney). Leaving the main line at Byrock, a branch runs to Brewarrina (58 miles) and another from Nyngan to the important copper-mining district of Cobar (464 miles from Sydney). Other branches run from Nevertire to Warren (12 miles), Narromine to Peak Hill (36 miles), Dubbo to Coonamble (95 miles), Orange to Condobolin (139 miles), with branches to Tullamore and Forbes, and from Wallerawang to Mudgee and Dunedoo (238 miles from Sydney). Nearer Sydney there is a small branch from Blacktown to Windsor and Richmond.

The Northern System.

Leaving the Main Suburban Line at Strathfield (seven miles from Sydney) the Great Northern Line runs to Newcastle, where it connects and serves the coal deposits in the Newcastle and Maitland districts, and thence to Wallangarra (492 miles from Sydney). At the latter station it connects with the Queensland State Railways (3 feet 6 inches gauge) and is the route for the Interstate traffic between Sydney and Brisbane. Branch lines run from Werris Creek to the north-western wheat, wool and stock districts, terminating at the following towns, the distance from Sydney being shown in each case:—Inverell (509 miles), Garah (451 miles), Collarenebri East (445 miles), and Walgett (457 miles). There is also a branch which serves wheat-growing districts from West Tamworth to Barraba (342 miles from Sydney).

At West Maitland the North Coast branch leaves the Main Northern Line and terminates for the present at Taree (235 miles from Sydney). This line will ultimately be connected with the Grafton-Tweed Line already referred to, the connecting links between Taree and Grafton being now under construction, and will eventually be the Interstate route between Sydney and Brisbane. A short line, about 13 miles in length, branches off the Main Northern Line at Hornsby and runs to Milson's Point on the northern shore of Sydney Harbour, opposite Circular Quay.

There are also a number of short branch lines in operation, viz., Clyde (13 miles from Sydney) to Carlingford (length, 4 miles), Campbelltown (34 miles from Sydney on the Southern Line) to Camden (length, 8 miles), Yass Station (189 miles from Sydney on the Southern Line) to Yass Town (length, 3 miles), and East Maitland (18 miles from Newcastle on the Northern Line) to Morpeth (length, 3 miles).

Suburban Passenger Traffic.

The Sydney-Suburban passenger traffic is conducted principally on the Main Suburban Line to Parramatta (14 miles from Sydney); on the Southern Line to Liverpool (22 miles from Sydney); on the Illawarra Line to Hurstville (9 miles from Sydney) and Bankstown (11 miles from Sydney); on the Main Northern Line to Hornsby (21 miles from Sydney), and on the branch, already referred to, running to Milson's Point.

There is also a considerable suburban traffic conducted between Newcastle and West Maitland (20 miles) and Toronto, on Lake Macquarie (18 miles from Newcastle).

Metropolitan Goods Traffic.

A short goods line leaves the Main Suburban Line near Sydney Station and runs to Darling Harbour, the principal goods depot, and to Darling Island, the wheat shipment depot.

A new line from Flemington to Belmore and Wardell Road to Glebe Island and Darling Harbour, a distance of 11 miles 31 chains, to provide independent access to the goods depot and give relief to main line traffic is now under construction. In conjunction with the work provision has been made for a depot for the export business at Glebe Island, and the re-arrangement of the present goods depot so as to provide for the more economical and expeditious handling of the rapidly-increasing inwards and outwards goods business. The estimated cost of the work is £813,000.

New Lines.

The following extensions were under construction on 30th June, 1913:—

	Length. Miles.	Chains.
Southern System—		
Stockinbingal-Forbes	83	40
Wagga-Tumberumba	76	20
Finley-Tocumwal	11	40
Galong-Burrowa	17	60
Western System—		
Parkes-Peak Hill	31	0
Dunedoo-Coonabarabran	76	60
Northern System—		
Taree-South Grafton (part)	110	0
Moree-Mungindi	77	0
Muswellbrook-Merriwa	51	6
Total	534	66

The following extensions were authorised, but construction had not been commenced, on 30th June, 1913:—

	Length. Miles.	Chains.
Southern System—		
Barellan-Mirrool	32	0
Wyalong-Cudgellico	70	40
Western System—		
Condobolin-Broken Hill	373	0
Tullamore-Tottenham	33	0
Northern System—		
North Coast Railway (part)	85	40
Glenreagh-Dorrigo	42	0
Total	636	0

Safety Appliances.

The provision of safety appliances throughout the lines is a matter which receives special and continuous attention. 7 miles 26 chains of track block and automatic signalling have been provided in the Sydney-Suburban area between Redfern Tunnel and Sydenham Junction, this being the first automatic signalling to be introduced in Australia, and the system is being extended as opportunity offers.

At many of the principal stations the points and signals are interlocked, and at the Central Station, Sydney, there is in operation an electro-pneumatic system of signalling, the largest of its kind in Australia.

The following are the particulars of the various systems of safe working now in operation:—

	Length. Miles.	Chains.
Double Line—		
By Absolute Block	348	23
By Permissive Block	3	40
By Telephone	0	33
By Automatic Signalling and Track Block	7	26
Total	359	42

	Length. Miles.	Chains.
Single Line—		
By Electric Tablet	417	13
By Electric Train Staff	728	44
By Train Staff and Ticket with Line Clear Reports	1,669	38
By Train Staff and Ticket Without Line Clear Reports	763	28
By Train Staff and One Engine only ..	6	14
Total	3,584	57

During the year ended 30th June, 1913, 79,490,012 passengers were carried by the New South Wales railways, an increase of 8,783,284 on the number carried during the preceding year, without any train accident resulting in loss of life to any of the passengers.

Results of the Working.

The following are the principal figures of the working for the year ended 30th June, 1913:—

Capital Expenditure	£57,653,778
Gross Earnings	£6,748,985
Working Expenses	£4,644,881
Balance, after paying Working Expenses ..	£2,104,104
Surplus, after paying Working Expenses and Interest on Capital	£186,904
Percentage of Profit to Capital Invested ..	£3 15 2
Percentage of Working Expenses to Earnings ..	68.82
Passenger Journeys (No.)	79,490,012
Goods (Tons)	4,004,712
Coal and Coke (Tons)	7,114,502
Live Stock ,, ...	547,036
Train Miles Run (No.)	19,184,247

Expansion of the Traffic.

The increasing railway business of the State has been well sustained and the following tables, showing the results for the six years ended 30th June, 1913, indicate the remarkable development which has taken place and the provision which has been made to cope with it:—

Traffic Earnings, Number of Passengers, Tonnage of Goods, Live Stock, and Coal and Coke carried:—

Description.		Six Years ended 30th June, 1907.	Six Years ended 30th June, 1913.	Increase.	Percentage Increase.
Earnings from Coaching Traffic		£9,108,639	14,408,960	5,300,321	58%
Earnings from Goods and Live Stock		£12,101,188	17,521,050	5,419,862	45%
Earnings from Coal and Coke		£1,838,378	2,810,952	972,574	53%
Total Earnings		£23,048,205	34,740,962	11,692,757	51%
Number of Passengers	No.	211,133,806	364,299,225	153,165,419	73%
Tonnage of Goods and Live Stock	Tons	15,967,301	24,034,638	8,067,337	51%
Tonnage of Coal and Coke	Tons	26,900,790	36,765,086	9,864,296	37%
Total Tonnage	Tons	42,868,091	60,799,724	17,931,633	42%

Particulars of Rolling-Stock available for Traffic on 30th June, 1907, compared with similar particulars at 30th June, 1913:—

Description.		30th June, 1907.	30th June, 1913.	Increase.	Percentage Increase.
Engines.					
Number in Stock		656	998	342	52%
Total Tractive Power	lbs.	13,039,820	21,558,351	8,518,531	**65**%
Tractive Power per Engine	lbs.	19,878	21,602	1,724	9%
Coaching Stock.					
Number of Vehicles		1,187	1,775	588	50%
Carrying Capacity	Persons	12,010	74,328	32,318	**77**%
Carry Capacity per Vehicle (excluding non-passenger-carrying Stock)	Persons	52	53	1	2%
Goods Stock.					
Number of Vehicles		12,719	19,153	6,434	51%
Carrying Capacity	Tons	111,452	213,250	101,798	**91**%
Carrying Capacity per Vehicle (excluding brake vans, gas vans, accident vans, etc.)	Tons	9	11½	2½	28%

Capital Expenditure incurred in providing Rolling-Stock, Additions to Lines, Stations, Buildings, Duplication of Lines, etc., for the six years ended 30th June, 1913:—

Particulars.	Amount. £	s.	d.	£	s.	d.
Rolling-Stock—						
Locomotives	1,622,414	0	0			
Coaching Stock	1,031,735	0	0			
Goods Stock	1,297,832	0	0			
				3,951,981	0	0
Additions to Lines, Stations, Buildings, etc.				2,186,809	0	0
Duplication and Deviation of Lines				2,770,071	0	0
Construction of new goods relief line between Flemington and Glebe Island				670,762	0	0
Total				£9,579,623	0	0

The Main Line through-passenger trains are equipped with modern lavatory compartment and corridor carriages, and in addition, sleeping-cars of the most up-to-date type are provided on the express and mail trains. All trains are fully equipped with the Westinghouse brake.

Owing principally to the heavy grades on the main trunk lines and the long stretches of single line on which crossings have to be effected with other trains, very high journey speeds are not attained.

To provide for the ever-increasing traffic, contracts for the supply of a large number of additional engines, carriages and waggons have been entered into.

Duplications and Deviations of Lines.

The railways in many cases pass through heavy and mountainous country, involving steep grades, some of the heaviest of which are situated on the trunk lines. On the Main Southern Line the summit is at Cullerin (2,395 feet); on the Western Line, as already stated, at Newnes Junction, on the Blue Mountains, where a height of 3,503 feet is attained; and on the Main Northern Line the greatest elevation, 4,473 feet, is reached at Ben Lomond.

Of the deviations made in late years to improve the grades one of the most important has been carried out on the Western Line to avoid the great Zig-zag. This work was completed in 1910.

To provide for the continued increase in the traffic the main trunk lines are being duplicated as rapidly as possible, the scope of the present scheme being to duplicate the Northern Line as far as Werris Creek (255 miles from Sydney), the Western Line to Orange (196 miles from Sydney), the Southern Line to Harden (230 miles from Sydney), and the South Coast Line to Wollongong (48 miles from Sydney).

Forty-nine miles eighteen chains of duplications and deviations were completed during the year ended 30th June, 1913, and an additional 74 miles 30 chains are in hand.

Carriage of Traffic.

The policy is to encourage development in the interior by reduction of fares and freights for long distances, and with that object in view the rates are based on tapering scales of charges, which decrease as the distance increases.

Return tickets are not issued except to suburban passengers travelling within a radius of 34 miles of Sydney and Newcastle, and to travellers by cheap excursion trains.

In regard to goods traffic the average receipts per ton per mile during the year ended 30th June, 1913, and the average length of haul were as follows:—

	Per Ton per Mile. d.	Average Length of Haulage. Miles.
Coal, Coke and Shale	0.47 ..	28.12
Grain, Flour, etc.	0.39 ..	239.74
Hay, Straw and Chaff	0.37 ..	199.89
General Goods in Truck Loads	2.57 ..	354.42
Wool	1.93 ..	304.80
Live Stock	0.98 ..	266.63

Wheat Traffic.

The production of wheat in New South Wales is steadily increasing each year, and during the 1913-14 season the prospects point to a crop of about 40,000,000 bushels.

To encourage the production of wheat and other agricultural produce, specially low rates are in operation. For instance, agricultural machinery carried in truck loads for a distance of 300 miles is charged 48s. 3d. per ton, or equal to 1.9d. per ton per mile; and for wheat in truck loads carried to the seaboard over a similar distance, the rate is 10s. 6d. per ton, or equal to the very low charge of .42d. per ton per mile.

To facilitate dealing with the wheat traffic the Railway Department provides grain storage sheds of a standard type with concrete floors and open sides (in some instances movable sides are provided). The sheds are erected at stations where the annual quantity of grain trucked warrants their provision, and they are leased to the local farmers at a very low rental, equal to about 3½ per cent. on cost. Up to the present the Department has provided 83 of these sheds, having a total storage capacity of 4,770,000 bushels. In addition, at stations at which there is room, spaces are let at low rentals for the erection of private grain sheds, whilst grain stacking sites, with old sleepers (free of charge) on which to stack the grain, are also provided.

At the Darling Island shipment depot commodious sheds equipped with electric elevators and conveyors are provided for dealing with export wheat.

The question of the adoption of a system of dealing with grain in bulk is at present under consideration.

Coal Traffic.

The principal coal shipment depot is at Newcastle (104 miles north of Sydney). The coal-shipping appliances there are under the control of the Chief Commissioner and consist of a McMyler Hoist, 16 hydraulic cranes, and two steam cranes, which are capable of dealing with up to 7,500,000 tons of coal per annum. The provision of additional wharfage and coal-shipping accommodation at Newcastle and additional lines for the more expeditious working of the coal traffic between Maitland and Newcastle is now in hand.

Coal-shipping appliances under the control of the Chief Commissioner are also provided at Sydney (Darling Harbour).

The total quantity of coal and coke carried by rail from collieries on all lines during the year ended 30th June, 1913, amounted to 7,090,107 tons, an increase of 825,571 tons on the quantity carried during the year ended 30th June, 1912. 5,119,704 tons of coal were exported from Newcastle to Interstate and foreign ports during the year ended 30th June, 1913, an increase of 685,955 tons on the quantity exported from Newcastle during the preceding year.

The State Tramways.

Although a portion of the passenger traffic of Sydney and Suburbs is dealt with by the suburban railway lines and the Sydney Harbour ferries, a very considerable proportion is conducted by the Sydney and suburban electric tramways, which comprise a total length of 141 miles 36 chains, and are under the control of the Chief Commissioner.

There are also steam tramways under the control of the Chief Commissioner serving the City of Newcastle and suburbs (total length, 29 miles 41 chains), between East and West Maitland (4 miles 47 chains), Parramatta to Castle Hill (6 miles 55 chains), Sutherland to Cronulla Beach (7 miles 32 chains), Arncliffe to Bexley (2 miles 50 chains), Kogarah to Sans Souci (5 miles 45 chains), and the Broken Hill tramways (10 miles 4 chains). These lines are all 4 feet 8½ inches gauge.

On the 30th June, 1913, the total length of tramways open for traffic was 207¾ miles, the capital cost of which for construction and equipment amounted to £6,699,305. The earnings from the tramways during the year ended 30th June, 1913, amounted to £1,754,566, the working expenses to £1,572,190, and allowing for interest on capital and working expenses the tramways showed a loss of £32,456 on the year's working, due largely to the increased wages allowed to the staff owing to the operation of wages board awards, and the Industrial Arbitration Act. The number of passengers carried during the year was 294,455,452, an increase of 27,665,906 on the number carried during the preceding year.

In 1909 a Royal Commission on the Improvement of the City of Sydney and its suburbs recommended the introduction of a system of underground electric railways and the connection of Sydney with North Sydney by means of a harbour bridge or a tunnel.

The design for the harbour bridge has been approved by the Public Works Committee, and the preliminary work in connection with the first section of the City Railway from the Central Station to Wynyard Square is in hand.

Administration.

Prior to 1888 the control of the New South Wales State Railways and Tramways was vested in the Minister for Works under the provisions of the Railway Act of 1852, the actual management being in the hands of a Commissioner. In 1888, however, an amended Act was introduced, the object of which was to improve the administration and remove it from direct political control. Under this Act three Commissioners were appointed, the term of office being seven years.

In 1906 an amending Act was passed, which provided for the appointment of a Chief Commissioner with enlarged powers, to be assisted by two Assistant Commissioners, one for the Railways and the other for the Tramways.

The initiation and construction of new lines is a matter not controlled by the Chief Commissioner. Such work is carried out by the Railway and Tramway Construction Branch of the Public Works Department, the new lines being handed over to the control of the Chief Commissioner on completion.

Duplications and deviations of the existing lines, when such are within the railway property, are carried out by the Chief Commissioner, and in cases where such works have been outside the railway boundaries, special approval has been given by Parliament for the work to be carried out by him, as constructing authority.

Staff.

The Railway and Tramway Staff are appointed under certain conditions and subject to the approval of the Chief Commissioner, and, in addition to enjoying the privileges of the Workmen's Compensation Act and Industrial Arbitration Act, are provided with the right of appeal against punishment imposed for dereliction of duty by the Officer at the head of the Branch to a board consisting of Officers of the Department and their own elected representative. The employees may appeal from a decision of this Board to a final court of appeal consisting of the Chief Commissioner and one of the Assistant Commissioners.

They are also provided with a Superannuation Fund to which they contribute at the rate of $1\frac{1}{2}$ per cent. of their salaries and emoluments, which entitles an employee on retirement to a pension amounting to one-sixtieth of an average of his annual salary and emoluments during his term of service, multiplied by the number of complete years of his service, but not exceeding two-thirds of the average annual salary and emoluments during the whole period of service. For superannuation purposes the limit of salary and allowances is fixed at £800 per annum, and no Officer is liable to a deduction from so much of his salary and emoluments as is in excess of that amount. Provision is also made for the payment of gratuities to Officers incapacitated from the further discharge of their duties by reason of bodily injuries received in the course of their duties, also to employees who are under 60 years of age and with less than 10 years' service who have been compelled to retire through infirmity of body or mind not caused by intemperate habits, or whose services have been dispensed with otherwise than for an offence and who are not entitled to a superannuation allowance. The contributions of Officers are placed to the credit of a special account from which superannuation claims and allowances are paid, but provision is made that, on appropriation by Parliament, there shall annually be placed to the credit of the account such moneys as may be required to meet claims, etc.

The total staff employed on the Railways and Tramways on the 30th June, 1913, numbered 41,322—27,805 employed permanently and 13,517 temporarily.

First-aid and Ambulance Appliances.

Appliances for rendering first-aid have been provided at all depots and important stations throughout the lines and are carried in the brake-vans of all main-line and through trains; and equipment for Surgeons' first-aid use is provided at Sydney, Newcastle, and the more important country stations.

The total strength of the Departmental Ambulance Corps is now 7,014. Ambulance instruction classes have been established at 175 places throughout the State for the instruction of the Railway Staff, and a high standard of efficiency in first-aid work is maintained.

Other Railway Systems of New South Wales.

There are a number of other railway lines publicly and privately controlled, the principal being as follows:—

Deniliquin-Moama Railway Company's Line.—This line is of 5 feet 3 inches gauge, 45 miles in length, connecting Deniliquin in New South Wales with Moama on the River Murray, where it connects with the Victorian State Railways.

Silverton Tramway Company's Line.—This is a 3 feet 6 inches gauge line, about 36 miles in length, running from Silvertown and Broken Hill to Cockburn, on the South Australian border, where it junctions with the South Australian State Railways. A considerable passenger and goods traffic is conducted.

Commonwealth Oil Corporation's Line.—This is a 4 feet 8½ inches gauge railway junctioning with the Main Western Line at Newnes Junction (87 miles from Sydney) and running to Newnes, a distance of 32 miles. The grades on the line are heavy, with sharp curves, and engines of a special type (Shay) are used. The line was constructed to deal with the shale deposits in the Wolgan Valley. Passengers as well as goods for the general public are carried.

Colliery Lines.—There are, in addition, a number of privately owned lines in the Newcastle, Maitland and South Coast coal districts used for the conveyance of coal and coke, and, in some cases, passengers and general goods traffic.

Chapter IX.

THE UNIVERSITY OF SYDNEY.

Constitution and Government.

The University of Sydney was incorporated by an Act of the Legislature of New South Wales, which received the Royal Assent on the 1st of October, 1850. This Act was amended by subsequent Acts, enlarging the scope of the University, and the whole were consolidated in the University and University Colleges Act, 1900.

By a Royal Charter issued in February, 1858, the same rank, style and precedence are granted to graduates of the University of Sydney as are enjoyed by graduates of Universities within the United Kingdom.

By the University and University Colleges Act the University of Sydney is declared to be a body politic and corporate, consisting of a Senate constituted by sixteen elective Fellows, and not fewer than three nor more than six *ex officio* members, who shall be Professors of the University, in such branches of learning as the Senate shall by by-law select.

In 1912 an amending act was passed by the legislature making radical changes in the governing body of the University. Under the provisions of that Act, the Senate consists of four Fellows appointed by the Governor, one each by the Members of the Legislative Council and Legislative Assembly respectively, five Fellows representing the teaching staff, *viz.*, the Chairman of the Professorial Board elected by the Board, and four Fellows elected one by each of four faculties, ten Fellows elected by the graduates of the University, and three elected by the remaining Fellows, together with the present Chancellor (the Hon. Sir Normand MacLaurin, M.A., M.D., LL.D.) and Vice-Chancellor (His Honour Judge Backhouse, M.A.) who were given a life tenure. All the Fellows hold office for five years except the representatives of the teaching staff, who hold office for two years. All are eligible for re-appointment or re-election. Voting at elections of the Fellows elected by the graduates is conducted by ballot and by voting papers transmitted through the post. The electors consist of all graduates of the full age of twenty-one years, together with the Fellows of the

Senate, Professors, Public Teachers and Examiners in the schools of the University, Principals of Incorporated Colleges within the University, and Superior Officers declared to be such by by-law. The Senate has power to appoint all Professors and other officers, and has the entire management and superintendence over the affairs of the University, with power to make by-laws governing the discipline and curriculum and other matters, which by-laws, however, must be submitted for the approval of the Governor.

The Senate is empowered to give such instruction and to grant such certificates in the nature of degrees as it thinks fit, in all branches of knowledge except Theology or Divinity. Women were admitted to all University privileges equally with men in 1884.

The Chancellor and Vice-Chancellor are elected by the Senate from their own body, the former for a period of three year, and the latter for one year. Both are eligible for re-election. The Chancellor, or in his absence the Vice-Chancellor, presides at all meetings of the Senate, and is its chief executive officer. The present Chancellor, the Hon. Sir Normand MacLaurin, M.A., M.D., LL.D., has occupied the office continuously since 1896. The Chancellor and Vice-Chancellor are *ex officio* members of all Boards and Faculties.

The Professorial Board consists of the Chancellor, the Vice-Chancellor, the Professors in the several Faculties and departments, and the present Registrar. It reports to the Senate upon all matters referred to it by the Senate, and has power to determine all matters concerning the studies and examinations which affect the students of more than one Faculty. It is also charged with the maintenance of discipline, its powers in this regard being committed in the first instance to a Proctorial Board consisting of the Chairman, the Deans of the Faculties and the Registrar.

There are four Faculties in the University, viz., Arts, Law, Medicine, and Science.

The Boards of the Faculties generally consist of the Professors and principal Lecturers in the various subjects included in the faculty, together with the Registrar.

The Faculty of Science includes four separate departments, in each of which there is a Board of Studies which reports to the Faculty, viz., (*a*) Pure Science, (*b*) Engineering, (*c*) Veterinary Science, and (*d*) Agriculture.

Other Boards are the Boards of Studies for Economics, Dentistry and Military Science, the Board for Conducting

Public Examinations, the Library Committee, and the University Extension Board.

Colleges.

By the Act 18 Vic. No. 37, superseded by Act Vic. 64 No. 22, provision is made for the foundation of Colleges within the University in connection with the various religious denominations, in which students of the University may enjoy the advantages of residence, instruction in the doctrine and discipline of their respective Churches and tuition supplementary to that of the University Professors. No student may be admitted to any such college unless he immediately matriculates in the University, submits to its discipline and attends the statutory lectures; nor can he continue a member of the College longer than his name remains upon the University books.

Provision was made by law for a payment from the State in aid of the building fund of every College so established, of a sum not exceeding £20,000 nor more than had been from time to time actually expended by the College out of its subscribed funds for the purpose of building, and also for an annual endowment of £500 towards the salary of a Principal.

Three such Colleges have been established and incorporated by Act of Parliament, viz., St. Paul's College, in connection with the Church of England, with accommodation for 40 students; St. John's College, in connection with the Roman Catholic Church, with accommodation for 35 students, and St. Andrew's College, in connection with the Presbyterian Church, with accommodation for 70 students.

A Women's College has been established, incorporated and built on the University Grounds. It is not attached to any religious denomination. The Act of Incorporation describes it as a College within the University of Sydney wherein may be afforded residence and domestic supervision for women students of the University with efficient tutorial assistance in their preparation for University lectures and examinations. It provides also "that no religious catechism or formulary which is distinctive of any particular denomination shall be taught, and no attempt shall be made to attach students to any particular denomination, and that any student shall be excused from attendance upon religious instruction or religious observances on express declaration that she has conscientious objections thereto." It has accommodation for 28 students.

The Royal Prince Alfred Hospital has been erected on the University grounds as a general hospital and medical school for the instruction of students attending the Sydney University and for the training of nurses for the sick. It is managed by a Board of fifteen Directors, of which the Chancellor of the University and the Dean of the Faculty of Medicine are members *ex officio*. All appointments of medical officers are made by a conjoint board consisting of the Senate of the University and the Directors of the Hospital.

Teaching Staff.

The members of the teaching staff in 1913 numbered 127, of whom 23 were Professors, nine Assistant-Professors, 49 independent Lecturers in various branches, 23 Assistant-Lecturers and Demonstrators of Senior Grade, and 23 Junior Demonstrators and Tutors. In addition there were four honorary Lecturers and three honorary Demonstrators.

The number of students attending in 1913 was 1,631 (254 women), of whom 1,277 were proceeding to degrees (Arts 465, Economics and Commerce 11, Law 103, Medicine 478, Dentistry 25, Science 65, Engineering 102, Veterinary Science 15, Agriculture 13). This includes 82 research students and graduates attending post-graduate courses for higher degrees. For the diploma in Education 16 attended; for that in Economics and Commerce, 174, and for that in Military Science, 82. There were 41 Pharmacy students. 71 attended in individual subjects.

Endowment and Finance.

The original Act of Incorporation passed in 1850 provided for a Statutory Endowment of £5,000 a year, and this was practically the sole resource of the University until the year 1880, from which date the University has received increasing annual grants from the Legislature.

By means of these and of the bequest of John Henry Challis for general purposes, amounting to more than a quarter of a million, the University was enabled to expand from the original Faculty of Arts by the creation of teaching faculties in Law, Medicine and Science, and the foundation of additional Chairs and Lectureships. Further assistance was given by the gift of £100,000 from Sir Peter Nicol Russell for the maintenance of a Department of Engineering and a handsome bequest from Thomas Fisher for the maintenance of the library.

In an Amending Act passed in 1902, the Statutory Endowment was increased from £5,000 to £10,000 per annum, the Parliament still providing annual votes for special purposes, including the expenses of evening lectures, the repairs of the buildings and the provision of scientific apparatus. The University Amendment Act of 1912 advanced the Statutory Endowment from £10,000 to £20,000 per annum, at the same time conferring upon the University the obligation of awarding annually a number of exhibitions giving free tuition at the University to candidates from Government High Schools and Registered Schools. The number of these is limited for the year 1914 to one hundred, and in future years to an entry of about two hundred, with a provision for an automatic increase of the number according to the population of the State. The Government has intimated its intention of still further increasing the Statutory Endowment to meet the expenses of these exhibitions when the need arises.

In 1912 the Government also provided additional votes on a liberal scale for the establishment of several new departments in the University, including Economics and Commerce, Botany and Organic and Applied Chemistry, as well as for special equipment for the Faculty of Medicine and the Department of Engineering, assistance in the purchase of books for the Library and provision for superannuation.

The income of the University in 1912 was derived approximately from the following sources:—

Statutory Endowment	£20,000
Additional Government Votes	27,500
Fees from Students	18,500
Income from Private Funds for General and Special Educational Purposes ..	20,000
Income from Private funds for Endowment of Scholarships, Bursaries, etc.	3,500
	£89,500

Facilities for Students.

The fees payable by students for tuition in the various departments vary from fifteen guineas in the Faculty of Arts to twenty-seven guineas per annum in the professional schools. In addition there are matriculation and degree fees and small laboratory expenses and hospital fees in Medicine and Dentistry.

Scholarships, generally of the value of £50 per annum, are awarded upon competition to students entering the University and in various stages in their University course. They are, as a rule, tenable for one year. The amount awarded in Scholarships, all derived from private benefactions, is about £1,200. In addition, Bursaries varying in value from £25 to £50 per annum, tenable for three years, and amounting annually to £885, are awarded after inquiry into the financial means of applicants. These carry with them a remission of fees in the Faculty of Arts or that of Pure Science, but not in the professional schools. In addition, remissions of fees are granted annually to the number of about twenty for the Faculty of Arts or the Faculty of Science.

The University Amendment Act, as previously stated, provides for the annual award by the University of a number of Exhibitions entitling the holders to free tuition at the University during the period necessary for graduation. These are awarded on the results of the Leaving Certificate Examination of the Department of Public Instruction to pupils who have been in attendance at Government High Schools or Registered Schools for a period of four years, but five per cent. annually may be awarded to other persons—residents of New South Wales—who have the privilege of competing at the Leaving Certificate Examination. The number of such Exhibitions for those entering the University in 1914 is one hundred, and in future years, "one for every five hundred of the persons within New South Wales who are between the ages of seventeen and twenty," or such ratio as may be determined by resolution of both Houses of Parliament. The number for 1915 will be approximately two hundred. In addition, twenty Bursaries from public funds are awarded annually by the "Bursaries Board," established by Act of Parliament, to pupils of Government and Registered Schools upon entering the University. These provide an allowance for living expenses varying from £20 to £50 per annum, according to the applicant's place of residence.

Students of the Government Teachers' College and Teachers in Government Schools nominated by the Minister for Public Instruction may attend the University lectures without the payment of fees provided they pass the matriculation examination.

Matriculation Examination.

All candidates for degrees are required to pass the matriculation examination before commencing their course, but except in the Faculty of Medicine the classes are open to any non-matriculated students who are competent to attend, and such students may receive certificates of attendance and examination in special subjects. For matriculation candidates are required to pass an examination in the following subjects:—(1) English, (2) Mathematics, (3) Latin, Greek, French or German, and (4) one or more additional subjects taken from a somewhat comprehensive list in accordance with specific regulations for the various departments.

A school's Leaving Certificate of the Department of Public Instruction is accepted by the University as qualifying for matriculation provided that it includes all the necessary subjects at the standards laid down by the Senate. The Leaving Certificate is granted by the Department of Public Instruction on the recommendation of a Board of Examiners consisting of four officers of the Department of Public Instruction, and not less than four Professors, or other teachers of the University nominated by the Senate. It implies attendance at a Government High School or Registered Private School for a period of four years, and proficiency as shown by examination.

List of Degrees and Diplomas.

1. *Faculty of Arts.*

Entrance Examination.—The compulsory subjects are:—(i.) English, (ii.) Mathematics, (iii.) Latin or Greek, and (iv.) one other subject; Latin or Greek and a second subject must be taken at the higher standard.

(*a*) Bachelor of Arts (B.A.).—The curriculum covers a period of at least three years during which students are required to attend ten courses of instruction, each covering a period of one year, and consisting of ninety lectures or their equivalent, with class or laboratory work. Not more than four courses may be taken in any one year. The subjects are divided into four groups:—(1) Ancient Language and Literature, (2) Modern Language and Literature, (3) Historical, Mental and Social Science, including Roman and Constitutional Law and Jurisprudence, and (4) Mathematics and Science.

The ten qualifying courses must be selected from at least three groups, three must be language subjects, and one must be a science subject. One subject must be studied during three consecutive courses, and two other subjects in two consecutive courses, or the student is at liberty to study two subjects each in three consecutive courses. Honours at graduation are awarded to those students who have gained distinction at the yearly examinations in their subjects and have attended in such cognate subjects as the Faculty may by regulation determine. Special honours classes are conducted, and additional work is required from candidates competing for honours and distinctions.

A full curriculum for the degree of Bachelor of Arts is provided by a system of evening lectures, but with limited options. The subjects provided are:—English, Latin, French, Mathematics, History, Philosophy, Economics and Science. The majority of evening students are teachers in State Schools, others are private teachers, clerks in Government and commercial offices, and theological students.

(*b*) Master of Arts (M.A.).—The candidate must be a Bachelor of Arts of two years' standing. The degree is conferred after examination, and thesis in some subjects. In the case of a Bachelor who has graduated with first-class honours, the degree may be awarded on thesis only.

(*c*) Bachelor of Economics (B.Ec.).—Entrance Examination.—The compulsory subjects are:—(1) English, (2) Mathematics, (3) Latin, Greek, French or German, and (4) one other subject. Two subjects must be taken at the higher standard, one of which must be Latin, Greek, French or German.

The regulations governing the curriculum for the degree of Bachelor of Economics are similar to those for the degree of Bachelor of Arts, each student being required to take ten qualifying courses.

All students must take three complete courses in Economics and three other courses from those prescribed for students in the Faculty of Arts, one being French or German. They also take Commercial and Industrial Law, Economic Geography, Accountancy I., and Business Principles and Practice, and the remaining two full courses may be made up from half-courses on the following subjects:—Accountancy, Technology of Commercial Products, Principles and Practice of Banking, Methods and Applications of Statistics, Public Administration, including Local Government, Business Technique and Organisation, and the principal Australian Industries, Principles of Company and Industrial Organisation and Management.

(*d*) Diploma in Education.—Awarded to a graduate in Arts or in Science after one year of further study, including classes at the University and observation and practice in teaching.

2. *Faculty of Law.*

Entrance Examination.—Compulsory subjects:—(i.) English, (ii.) Mathematics, (iii.) Latin, (iv.) Greek, or French, or German. Latin and two other subjects must be taken at the higher standard.

(*a*) Bachelor of Laws (LL.B.).—The curriculum covers a period of four years. Students are required to pass an intermediate examination and a final examination. Both are divided into two sections, which may be taken separately. The usual practice is for the student to take the degree of Bachelor of Arts, selecting the theoretical law subjects in his third year, and subsequently proceeding to the degree of LL.B. in five or six years from his matriculation.

The law lectures are delivered in premises in the city, situated near the Law Courts, and the law library is housed in the same building. The lectures are delivered in the early morning and late afternoon to facilitate the attendance of solicitors' articled clerks and students reading in chambers for the Bar.

(*b*) Doctor of Laws (LL.D.).—The candidate must be a Bachelor of Laws of two years' standing. He must pass an examination in Legal History, Roman Law, International Law (public and private), and a special professional subject.

3. *Faculty of Medicine.*

Entrance Examination.—(i.) English, (ii.) Mathematics, (iii.) Latin, (iv.) Greek or French or German. Three subjects must be passed at the higher standard, one of which must be Latin, Greek, French or German.

(*a*) Bachelor of Medicine (M.B.) and Master of Surgery (Ch.M.).

The curriculum covers a period of five years, during which the student is required to attend the University classes. He must also attend the practice of a recognised hospital for two years and a-half.

He must pass the following examinations:—(i.) a first degree examination at the end of the first year in Physics, Chemistry and Biology; (ii.) a second degree examination at the end of the second term of the second year in Anatomy and Physiology; (iii.) a third degree examination at the end of the second term of the third year in the entire subjects of

Anatomy and Physiology; (iv.) a fourth degree examination at the end of the second term of the fourth year in Pathology, Surgical Anatomy and Operative Surgery, and Materia Medica and Therapeutics; (v.) a fifth degree examination in Medical Jurisprudence and Public Health at the end of the second term of the fifth year; (vi.) a final degree examination in Medicine, Surgery, Midwifery and Gynæcology at the end of five calendar years of study.

(*b*) Doctor of Medicine (M.D.).

The candidate must be a Bachelor of Medicine of at least two years' standing. He is required to pass a written and practical examination and to present and defend a thesis.

(*c*) Diploma in Public Health.

This may be conferred upon a qualified medical practitioner of not less than one year's standing, who has attended certain special prescribed courses in the University of Sydney, has acquired a practical knowledge of Public Health Administration, and has passed the prescribed examinations.

(*d*) The Australian Diploma in Tropical Medicine.

Arrangements have been made for the award of an Australian Diploma in Tropical Medicine. The candidate must be a duly qualified medical practitioner, must attend a special course of laboratory work in one of the Universities of Sydney, Melbourne, or Adelaide, a further laboratory and clinical course at the Australian Institute of Tropical Medicine at Townsville, Queensland, and pass the prescribed examinations.

(*d*) Bachelor of Dentistry (B.D.S.).

Entrance Examination.—The same as for the Faculty of Medicine. The curriculum covers a period of four years, during which the student is required to attend courses of instruction at the University, the practice of a dental hospital, and to attend specially selected cliniques in a general hospital.

4. *Faculty of Science.*

(*a*) Bachelor of Science (B.Sc.).

Entrance Examination.—Compulsory subjects: (i.) English, (ii.) Mathematics, (iii.) Latin, Greek, French or German, (iv.) another subject. Three subjects must be passed at the higher standard, one of which must be Latin, Greek, French or German.

The curriculum covers a period of three years, during which the student is required to attend courses of instruction at the University and to pass annual examinations—in the first year four courses, in the second year three courses, and in the third year two courses.

(*b*) Doctor of Science (D.Sc.).

The candidate must be a Bachelor of Science of at least three years' standing. He is required to pass an examination and to present and defend a thesis.

(*c*) Bachelor of Engineering (B.E.).

Entrance Examination.—Compulsory subjects:—(i.) English, including Geography, (ii.) Mathematics, (iii.) Latin, Greek, French or German. (iv.) Mechanics. Mathematics, Mechanics, and Latin, Greek, French or German must be passed at the higher standard.

There are three sub-departments of the Department of Engineering, viz.:—(*a*) Civil Engineering, (*b*) Mining and Metallurgy, (*c*) Mechanical and Electrical Engineering. In each sub-department the curriculum covers a period of four years. The subjects of the first two years are mainly common to all. In the sub-departments of Civil Engineering and Mechanical and Electrical Engineering during the third term of the third year and the succeeding long vacation, students are required to obtain six months' practical experience before proceeding with the fourth year.

(*d*) Master of Engineering (M.E.).

The candidate must be a Bachelor of at least three years' standing. He must produce evidence that he has been engaged for that period in engineering study or practice, and must pass an examination in some branch of engineering and present a thesis. If he has obtained honours at his Bachelor's degree he may be examined by thesis only.

(*e*) Bachelor of Veterinary Science (B.V.Sc.).

Entrance Examination.—Compulsory subjects:—(i.) English, (ii.) Mathematics, (iii.) Latin, Greek, French or German, (iv.) another subject. Two subjects must be passed at the higher standard, one of which must be Latin, French, Greek or German.

The curriculum covers a period of four years, during which the students are required to attend courses of instruction at the University and hospital practice; meat inspection, etc.

(*f*) Bachelor of Science in Agriculture.

Entrance Examination.—The same as for the degree of Bachelor of Science. The curriculum covers a period of four years. The first year is similar to the first year of the course for the degree of Bachelor of Science. Before admission to the degree, each candidate is required to produce evidence of having spent a period of not less than twelve months, which need not be continuous, at an agricultural college or approved farm where he has been engaged in practical field operations.

Diplomas.

The following diplomas are granted to students who attend the appropriate courses of lectures and pass the concluding examinations. No entrance examination is necessary.

(*a*) Diploma in Military Science.—Courses: Military History, Strategy, Tactics, Imperial Defence, Military Topography, Military Engineering, Military Administration and Law.

(*b*) Diploma in Economics and Commerce.—This diploma is granted after attendance upon three courses of evening lectures, each course consisting of 90 hours' instruction. The subjects included in the course are Economics, Accountancy, Business Methods, Organisation and Enterprise, Technology of Commercial Products, Banking, Insurance and Exchange, Commercial Law, and Commercial Geography.

(*c*) Pharmacy.—The University gives no degree or diploma in Pharmacy, but those who wish to become pharmaceutical chemists are required by the Pharmacy Board to attend courses of instruction at the University in Chemistry (theoretical and practical), Botany, and Materia Medica and Therapeutics. The University examinations in these subjects qualify, *pro tanto*, for the diploma of the Pharmacy Board.

Post Graduate Study and Research Work.

The facilities for post graduate and research work on the part of graduates are the following:—Six science research scholarships of £150 per annum, established from an annual Government grant for the purpose. Five post graduate scholarships, founded by private benefaction—one of £70 and four of £50—for study and research in the University. Four Macleay Fellowships of £400 a year each, founded by the late Sir William Macleay and awarded by the Linnean Society of New South Wales to graduates holding the degree of Bachelor of Science "to encourage and advance research in Natural Science." In addition, two post graduate scholarships of £150 per annum, tenable for two years, are awarded annually for further study and research in Europe, and the University has the privilege of nominating a science graduate annually to one of the Science Research Scholarships awarded by the Royal Commissioners of the Exhibition of 1851.

THE MEDICAL SCHOOL

The University Buildings.

The University buildings have, with some small exception, all been erected from public grants, at a cost of more than £350,000.

The University main building, erected in 1858, is built of brown sandstone, in the Tudor perpendicular style. It faces the east and has a frontage of 410 feet, the Great Hall being at the northern end, with a tower 90 feet high in the centre. It forms the front of a proposed quadrangle, of which the Fisher Library and its extensions, now in progress, constitute the southern side. Its chief feature is the Great Hall, used for examinations and meetings, a noble chamber of elegant proportions, designed by Mr. Edmund Blacket. Besides the Senate Room and administrative offices, the main building contains ten lecture rooms for the Faculty of Arts, the largest having a seating capacity of 200, and private rooms for the professors and lecturers.

The Medical School is a separate building, also of brown sandstone, erected to the south of the main building. It was built in 1887 and has been twice enlarged within the past five years. It comprises accommodation for all the medical subjects usually taught in the medical curriculum, apart from the preliminary sciences, each of which has a separate building. There are five large theatres with a capacity of 200, as well as smaller apartments for tutorial and other teaching. There is a large collection of normal and morbid preparations, and generally the different departments are well equipped with all necessary appliances and apparatus for teaching and research. The Royal Prince Alfred Hospital with four hundred beds, situated on the University grounds, and the Sydney Hospital in the city furnish complete arrangements for clinical study.

The Science Schools are situated to the west of the main building, where there are separate detached buildings for the several departments of Chemistry, Physics, Geology and Biology. A building is about to be erected for the new department of Organic and Applied Chemistry as part of a general scheme for the extension of the University buildings, which will ultimately include enlarged departments of general Chemistry and Physics, and another for the new department of Botany is to be placed in the Botanical Gardens. The Geological collections are housed chiefly in the Macleay Museum, to which the Geological Department is connected by an over-bridge.

The Peter Nicol Russell School of Engineering was erected in 1909, to replace an older building, by the Government of New South Wales as a recognition of the munificent gift of Sir Peter Nicol Russell of £100,000 to endow the Engineering Department. Besides the usual lecture rooms it is well equipped for the testing of materials as well as for teaching and research in the Departments of Electrical and Mechanical Engineering.

A building for the Department of Agriculture is in course of erection, containing all necessary lecture rooms and laboratory rooms for research work in the different branches of Agricultural Science.

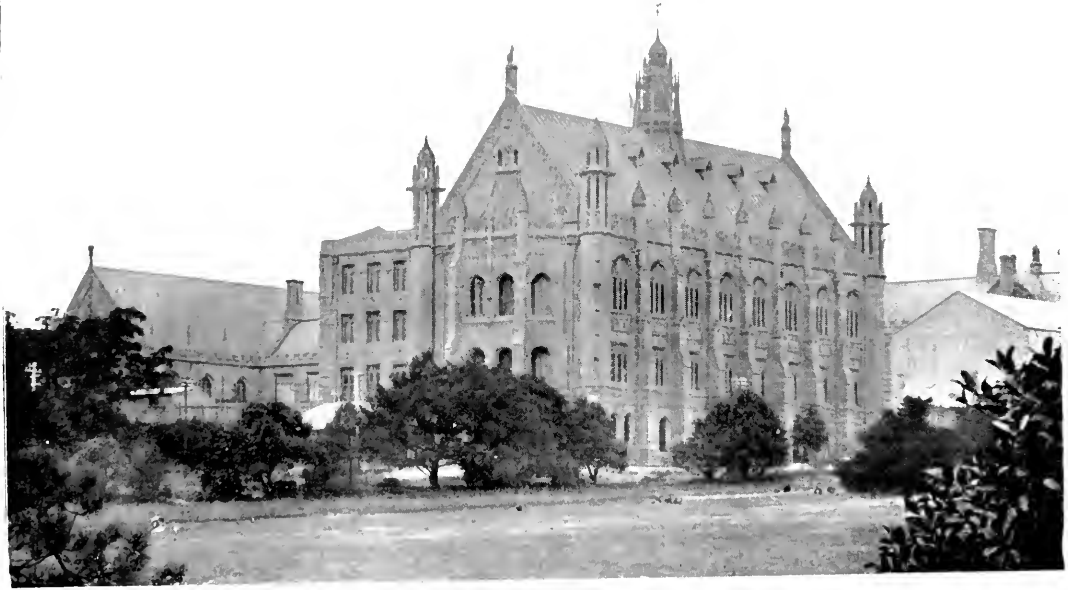
The Department of Veterinary Science was completed in 1912 sufficiently to permit of the regular University classes to be conducted in the new building, and arrangements are being made for the erection of a Veterinary Hospital on an adjoining site.

In all the scientific departments the equipment is fairly adequate, but the rapid increase in the number of students is creating difficulties in regard to accommodation, which must be met by the erection of additional buildings in the near future. This is chiefly felt in the Department of Chemistry, Physics and Geology.

THE FISHER LIBRARY.

There are at present in the University Library upwards of 100,000 volumes. The number of serial publications taken is a little over 700; but the increase is as rapid as funds will permit, for in a library which is mainly scientific the living interest is largely concentrated upon the periodical literature.

The reading-room is 122 feet long and 50 feet wide, and has seating accommodation for 150 readers. A number of works of reference are shelved in this room, but the rest of the books are kept in a separate stack of seven floors, which stands at right angles to the reading-room. Readers obtain the books they require on applying at a counter opposite the stack door and leaving with an attendant a signed slip bearing the date and title of the issued work. Free access to the books is not permitted, but any reader who asks permission to inspect the shelves is allowed to do so under supervision, and many students are personally advised to use the stack in this way. All members of the University have the right to use the library, but, except in the case of Fellows of the Senate and officers of the University, those



THE FISHER LIBRARY.

who wish to borrow books and remove them from the library premises are required to make a deposit of one pound. Borrowers, with the exception of the teaching staff, are permitted to hold only three volumes at a time. Strangers are allowed to use the library, even to the extent of borrowing, if they are able to satisfy the Library Committee that they can use it with advantage. Borrowed books are returnable on the demand of the librarian, or, without such demand, on or before the last day of Lent and Michaelmas terms respectively. On ordinary week-days the library is open for 10½ hours, and on Saturdays 3 hours. It is closed on Sundays and public holidays, and for one clear fortnight in the long vacation. The books are classified according to the Dewey decimal system, fully carried out.

MUSEUMS.

The Nicholson Museum of Antiquities owes its existence to the liberality of Sir Charles Nicholson, who presented to the University a considerable collection of Egyptian, Etruscan, Greek and Roman objects. The nucleus of this collection (about 400 objects) was acquired by him in Egypt and Italy in 1856-7. Large additions were subsequently made to it by the founder himself and by Sir John Young and other donors. In recent years gifts on the part of the Egypt Exploration Fund Committee have been the main source of supply. The collection, which now numbers more than 4,000 objects, has outgrown the capacity of the two large rooms which have been its home for half-a-century. Provision has accordingly been made on the ground floor of the Fisher Library building for the adequate display of the antiquities in three rooms as follows: Egyptian antiquities (75 feet x 50 feet), classical antiquities (45 feet x 23 feet), mediæval antiquities (45 feet x 23 feet). The vase collection has been catalogued and described by Miss Louisa Macdonald, M.A. The old general catalogue, published in 1870, is now obsolete, and a new catalogue will be undertaken upon the reorganisation of the collection. The collection has also been augmented by the purchase of about 150 casts of Greek and Roman sculptures. I' is intended that these shall be used to illustrate systematic courses of lectures on the history of ancient sculpture.

The Macleay Museum was built to house the Natural History collections of the late Sir William Macleay, which he presented to the University during his lifetime. The building is constructed of brick and iron, and is 210 feet long by 61 feet wide. The greater part of the space is occupied by the museum-hall, with bays along the sides and a gallery above. Rooms are partitioned off for the Curator and for the entomological collection, etc. A part of the space is utilised for special purposes by the Department of Geology, the main building of which, immediately adjoining, is connected with the Macleay Museum by a bridge-corridor. The Macleay Museum is open to the general public, and facilities are afforded to special students, more especially students of entomology.

The University Union.

The main provision for the comfort of students in attendance at lectures is found in the Union. It is intended as the universal centre of their community life for men under-graduates. The Union building is large, handsome and conveniently situated. It contains recreation and common rooms, a board room and other rooms suitable for committee meetings, with a hall for debates and other business gatherings, as well as for social uses. The plan allows for extension of the building as required.

The cost of the building and its equipment is estimated at £10,000, of which £7,000 have already been spent. This is borne by the Senate. Maintenance is provided by a general subscription of 5s. per term or 10s. per year (three terms). A life-membership fee of £5 is payable only to capital account, which may be used only for specified purposes, *e.g.*, purchase of furniture.

University Extension.

The University Extension Board offers Tutorial Classes and courses of Lectures from three upwards to local committees and institutions throughout the State. It also provides instruction, by both methods, at the University and elsewhere in the city, as required.

By far the greatest part of this extension work consists of short courses of lectures—in England sometimes called "pioneer courses"—in small country towns scattered over the length and breadth of New South Wales, at distances varying from a few miles to over five hundred miles from Sydney. The Board's lecturers are mainly the regular members of the University staff. These can reach remoter centres only by giving up several successive weeks of their vacations to extension duty. The same condition prevents their offering long and systematic courses of instruction, which would necessitate their absence from the University for months at a time. The need for such systematic instruction in Sydney itself is met, practically as much as is now required, by the University system of evening lectures which cover the whole course of study for a degree in Arts, and are open to unmatriculated as well as regular students. But groups of unattached students can also apply for Tutorial Classes under the extension scheme.

SECONDARY EDUCATION.

The Primary Schools of New South Wales are known as Public Schools, while Secondary education is provided for by Public High Schools and Superior Public Schools. The Public High School provides a four-years' course of instruction, leading to a standard equivalent to what is required for matriculation at the University. The Superior Public School has a two-years' course, and the instruction given is distinctly vocational in character. The Public High School is conducted as a separate school in separate premises. The Superior Public School, on the other hand, is organised as a "top" to a Primary School. Both Public High Schools and Superior Public Schools are controlled by the Department of Public Instruction.

Only those pupils enter upon secondary education who have gained the Qualifying Certificate—that is, a certificate gained after examination, as an evidence that the course of instruction provided in the Primary Schools of the State has been satisfactorily completed. Before any pupil enters a High School, his parents are required to give an undertaking that he will be kept at school to complete the four-years' course.

In Sydney and the larger towns, the accommodation in High Schools is limited, so that all the pupils whose parents might wish to send them to High Schools cannot find places. This enables the Department of Public Instruction to make the conditions of admission to High Schools competitive. It further takes the results of the Qualifying Certificate examination, and the reports of the headmasters of the schools from which candidates have come, and uses these as a means for selecting those pupils who are most likely to benefit by High School instruction. Those so selected are given priority of admission to High Schools, this priority being called a scholarship, and carrying with it an annual gift of the text-books required. It will thus be seen that the High School is selective, in that, first of all, a Qualifying Certificate has to be gained; secondly, all pupils who enter must give an undertaking to attend for four years; and thirdly, the most fit are given priority of admission to vacant places. For those pupils who gain the certificate, but do not gain admission under these conditions to the High School, the Superior Public Schools, with their two-years' course and their more definitely vocational basis, are available.

The average age at which pupils are able to enter the High Schools is about 13 years, though many enter at the age of 12, the standard being so fixed that pupils may complete their secondary education and be prepared, either to enter the University or to take up a career at between 17 and 18 years of age.

The High School.

The High Schools are distributed among the important centres of population throughout the State. As a rule, the prospect of a regular attendance of about 100 children prepared to attend the High School for the whole period of four years, is required before any such school is established. The High Schools so far established range from 100 to about 600 pupils in attendance, and all are organised in the same way carrying out courses of work, which, though not always identical, are yet equivalent in standard. Each High School is organised into classes known as First Year, Second Year, Third Year, and Fourth Year Classes, admission to each class taking place only at the beginning of each year.

Two external examinations take place during the four years, one at the end of the second year leading to an Intermediate Certificate, the other at the end of the fourth year leading to a Leaving Certificate. The gaining of an Intermediate Certificate is a condition for promotion from Second to Third Year. The gaining of the Leaving Certificate, if obtained in the subjects which the University requires for matriculation, entitles the holder to admission to the University.

All High Schools are inspected annually by an Inspector of Secondary Schools under the Department. At these inspections the Inspector brings under review the suitability of the school premises, the material, organisation and equipment of the school, the methods of instruction, the efficiency of the teaching staff, and the general conduct of the school as a whole, and this inspection has an important bearing upon the issue of certificates which follow upon the Intermediate and Leaving examinations. These examinations are conducted by a Board of Examiners representative of the Department and the Sydney University, and though they are external in character, the endeavour has been made to protect the work of the school from some of the evils which follow upon purely external examinations. This is provided for by the conditions under which the two certificates are awarded. These conditions are (1) that the pupil has graduated through the four-years' course (or the two-years', according to the certificate) of a High School; (2) that he is reported by the principal of the school as satisfactory in conduct and personal character; (3) that he passes the examination in not less than four subjects; (4) that the Inspector of Secondary Schools, after the inspection of the school and consultation with the principal, certifies that he has satisfactorily followed the subjects of his course of study other than those in which his examination has been passed. It will thus be seen that the certificate is not entirely dependent upon the result of the examination. The first condition prevents the crowding into a limited time a study which demands continuous and steady progress throughout a lengthened period, and the certificate is not awarded unless either the two or four years' course of school work has been followed. The second condition demands satisfactory school conduct, the third condition depends upon the examination. The fourth condition—and this, perhaps, is the most important—prevents the narrowing down of a course of study to the limited number of subjects, which are necessary for an examination pass, and requires that whether seven or eight subjects, as is usually the case, constitute the normal course of study, the pupil must not only pass his examination in a minimum number of subjects, but must give evidence that the remaining subjects have been diligently followed, even though he has not reached the pass standard in them. It is with regard to this latter condition that the report of the principal upon the general school work of the pupil has an important bearing. Under this scheme emphasis is laid not upon the standard of external examination, but upon the proper completion of a systematic course of study, and the attention of the teacher is directed to the course of instruction rather than to the special characteristics of a set of examination papers. The Board of Examiners is constituted with four professors of the University and four officers of the Department of Public Instruction, under the chairmanship of the Director of Education.

A course of study has been issued by the Department for the guidance of High Schools. In the construction of this syllabus of work an endeavour has been made to secure a satisfactory standard, and at the same time to leave the teacher as much freedom as possible. This Syllabus for High Schools provides various types of courses, known as the General course, the Commercial, the Industrial, the Agricultural, and the Domestic. To all these courses certain subjects are common. English, History, Geography, Mathematics, and one foreign language enter into them all; while they are differentiated from one another by the options allowed in science, additional languages, drawing and manual work, economics, business principles and practice; and in the Domestic course in sanitary science, cooking and laundry work, and needlework. Whether only one, or more than one, of these courses is taken in any one school, is determined by the size of the school and the special conditions under which the school is established. Specialisation is provided for after the Intermediate Certificate is gained—that is, in the third and fourth years of the course. For example, the pupil who is specialising in languages may drop part of his mathematical course and the science course for those years. The pupil who takes the industrial course takes only one language, and gives additional time to science and practical work.

An attempt has been made in the arrangement of the curriculum in this way to provide a balanced course of instruction for boys who complete their education with the High School. While those whose aim is to enter the University ultimately have the opportunity provided for them to qualify for a University career, the majority, who do not aim at the University, may get the kind of education which is likely to fit them for those careers in which high academic qualifications are not so essential.

Religious instruction does not enter into the regular and ordinary work of the High Schools under the State, but provision is made by which a clergyman of any religious denomination may give religious instruction to pupils belonging to his denomination for one period a week of regular school time. This opportunity is availed of by clergymen of various denominations.

Provision is made for instruction in Latin, Greek, French or German, but, as a rule, only two of these languages are taught in any one school, Latin and French being the most common. Pupils are allowed to take up two of these languages immediately upon entering the high schools, and they are followed throughout the four years of the course. Those taking a third language do so in the third year. In the teaching of modern languages the use of the direct method is encouraged. This is, however, governed by the qualifications of the teachers. Situated as this State is, remote from Europe and from the opportunities which residence in France or Germany affords to modern language teachers, the number of teachers who have such a fluent command of spoken French and German as will qualify them to follow the direct method is comparatively limited. The Department, however, has secured the services of a number of teachers who have had the necessary training, and the direct method is effectively used by them. Other teachers who have a thorough knowledge of the foreign language as far as reading and writing it are concerned, but have not the power of fluent speech in the language, are not encouraged to adopt the direct method.

In English, the authors to be studied are specified in the official syllabus, a certain number being set down for each year of the course. The principle is adopted that in each year one or two books shall be studied intensively, while others have to be read in a more general way. The object is to give, by the detailed study of at least one book a year, a training in language and in such literary analysis as will enable the pupil to gain as complete a mastery as possible of the ideas and style of the author. On the other hand the books prescribed for general reading are intended to introduce pupils to some of the best literature of the language and induce a desire for reading it.

The courses in both ancient and modern languages are governed by the same principles as are indicated in the course of English as far as the extent of reading matter is concerned. Three or four authors are specified for each year.

In mathematics, the ordinary course includes arithmetic, geometry, algebra, and trigonometry.

Provision is made for the teaching of science throughout the four years of the course; all pupils take an elementary course in the first two years covering the elementary study of chemistry or physics or botany, while in the third and fourth years, any one of the subjects, physics, chemistry, biology, or geology, may be taken. In most of the High Schools provision is made for laboratory work in chemistry and physics and every student is required to keep a notebook record of all practical work done. In one High School the course is directed to a study of agriculture in the first two years, qualifying the boys for admission upon the intermediate certificate to an Agricultural College. In one other High School the instruction is directed specially for those who are qualifying for engineering. Provision is also made for a course in domestic science for girls.

The parts of history studied are as follows:—

First and Second Years:—(1) History of England from the Roman invasion to the present time. (In outline only.) (2) History of Australia from 1851 to the present time.

Third and Fourth Years:—(*a*) History of Western Europe.

(*b*) *Either* (1) History of Australia, with special reference to industry and commerce; or (2) social and industrial history of England from 1776.

Classical pupils take Roman and Greek history instead of (*a*) and (*b*). Pupils taking Latin only take (*a*) and Roman History.

No definite instruction is given to pupils taking modern languages in the history of the countries concerned, but historical books are included in the books set out for reading in the languages.

Geography:—(1) The geography of the world in outline, following the Oxford preliminary and junior geographies in the lower years and the senior geography in the fourth year.

(2) The geography of New South Wales in detail and of other Australian States and New Zealand in less detail.

(3) Physical geography.

(4) A course of practical geography.

At the close of 1913, fifteen High Schools were in operation and five Intermediate High Schools. The Intermediate High School is a temporary expedient pending the erection of necessary buildings for additional High Schools. These schools are established in connection with the Primary Schools and undertake the first and second years High School course, pupils being subsequently transferred to a High School. In addition to the High School and Intermediate High Schools a number of pupils take the secondary course of instruction at what are known as "District" Schools. These District Schools in the country are identical with the Intermediate High School in Sydney. On 31st December, 1913, —— pupils were engaged in Secondary Education at High Schools, Intermediate High Schools or District Schools.

High School teachers are paid definite salaries prescribed by regulation. The schools are divided into three classes: first, second and third, according to attendance. The Head master of a First-class High School receives a salary ranging to £600, and the Head Mistress a salary ranging to £450, while the Deputy Head Master receives £440, and the Deputy Head Mistress £330. The salary of Masters range to £400, Assistant Masters to £300, Mistresses to £300, and Assistant Mistresses to £250. By far the majority of High School teachers are University graduates.

Superior Public Schools.

The course of instruction in these schools is governed by the prospect that the pupils will enter into some employment at about the age of 15. The boys' schools are therefore organised either as commercial or as junior technical schools, while for girls the course is largely devoted to subjects of domestic interest. Under this broad classification, the instruction is general in character in so far that the idea that the school prepares for any one form of business undertaking or any one trade is carefully excluded. The Junior Technical School is intended to give the fundamental preparation necessary and desirable for the boy's entry at a later period into the work of any particular skilled trade he may choose. Similarly, the commercial school gives a range of instruction necessary in whatever business the boy may afterwards enter. These schools are, therefore, preparatory to the trade school or the more advanced commercial school which the boy may attend when he has left the day school and definitely entered on his chosen occupation.

The special character of these schools has made necessary not only a special course of study, but also an attitude on the part of the teacher towards his work that will secure the right spirit in the instruction he gives. It is, therefore, made clear that the teacher is no longer engaged in teaching Primary School subjects. It is not arithmetic, geography, and history as understood in the primary school course that he has to teach, but rather certain subjects that bring the pupil into direct intimate relation with the work-a-day world outside.

The subjects of the commercial schools are (1) English, (2) commercial arithmetic, (3) trade and transportation, (4) business principles and elementary economics, (5) commercial drawing. Under the title, trade and transportation, for example, the lessons will treat of the physical conditions of the

State which directly or indirectly influence its trade, the production and distribution of raw materials, the forces of nature as agents in the production of the materials of commerce, the location of manufacturing industries, the means of transportation of products and for communication between different parts of the world.

The Junior Technical Schools have as the subjects of their curriculum (1) English, (2) trade arithmetic, (3) industries, (4) drawing and brush-work, (5) elementary science. In the course in "industries," for example, the teacher gives a number of preliminary lessons on primitive man and his needs, the evolution of the various tools of industry, and the growth from home industries through the period of handicrafts to the age of machinery and the factory. The course follows on with lessons on the raw materials in the pastoral, agricultural, mining, and timber industries of the State, concluding with an outline of the chief manufactures.

The Domestic Superior Public Schools for girls have as their curriculum, (1) English, (2) household accounts, (3) geography, (4) cookery and laundry, (5) simple dressmaking, (6) home management, hygiene, and the care of infants, (7) botany and gardening.

In addition to the special subjects above-mentioned, schools of all three types set apart a definite time weekly to lessons on morals and civics, music, and physical training.

The specialised character of these schools has demanded the training of teachers for their work, and those so trained are employed as visiting teachers for those subjects for which the ordinary teaching staffs could not be adapted.

TECHNICAL EDUCATION.

Technical Education was started in Sydney about 48 years ago by a Committee of the Sydney Mechanics School of Arts. The scope of instruction increased until in 1883 the Board of Technical Education, consisting of men eminent in the professional and industrial life of the community, was established to control Technical Education. During the latter part of 1889 the Board was dissolved, and the work of Technical Education was placed completely under State control as a branch of the Department of Public Instruction. In 1912, 16,500 students received instruction in the various Technical Colleges and Schools.

In addition to the central college at Ultimo (Sydney), branch colleges have been established in important country towns, such as Newcastle, Broken Hill, Goulburn, Bathurst, etc., while during 1912, 114 classes were conducted in the suburbs, 413 in the country, and 61 in connection with Public Schools. Technical subjects are taught in connection with agriculture, architecture and industrial art, biology, chemistry and metallurgy, commerce, domestic science, electrical engineering, mechanical engineering, geology, mathematics, printing, sanitation, woolclassing, women's handicrafts, etc., etc. Students are charged a small fee, a distinction being made between juniors and seniors.

During 1913 the whole question of Technical Education was reviewed. It was recognised that the true aim of Technical Education should lie in the direction of helping in the training of efficient tradesmen. This objective had not hitherto been sufficiently kept in view, with the result that many classes had been established which had no definite place in the scheme—students being allowed to enter any class without preparation, and without any attempt to study subjects in proper sequence. In the plan of reorganisation the following facts were taken as a basis:—

Apprentices indentured under the provisions of the Industrial Act have opportunities of gaining practical experience of a certain kind during the day, but this experience is limited and apprentices have no opportunity whatever of learning the theory of their trade in the workshop. The training to be provided, therefore, had to be supplementary to workshop experience, and should be strictly limited to what was required to complete the education required to make a tradesman. In other words the instruction might properly be called supplementary trade courses. Provision, however, had to be made for the training of foremen or managers or those who wished to gain a higher knowledge of the trades and manufactures.

The co-operation of both employers and employees was secured, and a series of conferences was held in connection with building trades, engineering trades, artistic trades, printing and allied trades, tanning trade, boot trade, baking trade, tailors' cutting and coal mining. These committees drew up different courses of instruction. As a result, the whole scheme of technical education was altered from the beginning of 1914. Trades Schools requiring an entrance qualification were established in various suburbs, such qualification being the standard reached at the termination of the two years' course of the Junior Technical Evening Continuation School. The Trades Schools provided the first three years of the Trade Courses, and the Technical Colleges the latter portions of the Trade Course and the whole of the Diploma Course. Entry to the Technical College was made conditional on having finished the early part of the Trades Course in a Trades School, or the possession of the equivalent knowledge and skill.

In some of the trades mentioned it was arranged with the employers that apprentices should be allowed to attend a Trades School during working hours.

The essence of the reorganised scheme is that both the workshop and the Trades Schools each have a definite share in the making of a tradesman, and that the certificates of competency which the tradesman will hold will depend upon the record of the work accomplished in both the workshop and Trades School.

The work of Technical Education has been grouped under six main Departments:—Engineering and Iron Trades, Building Trades, Science, Applied Art, Manufacturing Trades, and Women's Industries.

It is expected that the total number of students will diminish temporarily, owing to the condition that the Trades Schools cater only for apprentices, that an entrance qualification is required, and that groups of subjects necessary for a trade must be taken up rather than individual subjects. As the scheme is worked out, however, the numbers may be expected to again increase.

At the time of writing the new conditions had not been in operation long enough to warrant any criticism of their probable effects, but the scheme projected has the merit of co-ordination. Manual training, begun in the Kindergarten, is continued throughout the Primary Schools. At the completion of the Primary School course, boys who wish to enter upon a trade are encouraged to attend either the Junior Technical Superior Public School or the Junior Technical Evening Continuation School for a two years' course in which drawing and manual training are leading features. At the conclusion of this continuation course the boy enters the Trade School, passes on to the Technical College, and it is hoped that shortly the higher work of the Diploma Course will be accepted by the University authorities as part of the graduation course in Engineering and Science.

PRIMARY EDUCATION IN NEW SOUTH WALES.

New South Wales probably furnishes the most complete system of centralised educational administration that can be found. A Public Instruction Act passed in 1880 vested all schools previously controlled by a "Council of Education," under the administration of a responsible Minister. The Department of Public Instruction has complete control of all matters relating to State Schools, although the appointment suspension or dismissal of teachers finally rests, as with all other members of the Public Service, with a "Public Service Board." The whole cost of education is paid out of consolidated revenue, and there is absolutely no educational tax or local rate. While the Public Instruction Department controls all State education, there is nothing to prohibit a school being opened by any private person or religious denomination that so desires. Such schools, however, are wholly self-supporting. With a total population of 1,800,000, the average quarterly enrolment during 1913 was: Secondary pupils at High Schools and District Schools, 4,605; Primary Schools, 232,597; Evening Continuation Schools, 3,614; Subsidised Schools, 4,302; a total average quarterly enrolment of 245,118. There has been a remarkable increase in population during the present year, and the year's figures show an increase of 9,315 over the previous year. In addition to children attending the Public Schools, about 60,000 children attend Private Schools, many of which are denominational.

The scattered population of New South Wales, together with its large area of 310,000 square miles, makes the provision of education a matter of considerable difficutly in remote parts of the State. It has to be remembered that approximately 40 per cent. of the total population is centralised in Sydney and suburbs. A number of interesting expedients have been adopted in order to provide means of education to children in the bush. A Public School is established wherever an average attendance of 20 children can be guaranteed. The Department pays the whole cost of the school building and equipment, and appoints a teacher to the charge of such school. Where an attendance of from

12 to 20 can be maintained, a school is established provisionally, and called a "Provisional School." Exactly the same conditions obtain as for Public Schools, and at the end of 1912, 485 of these Provisional Schools were in operation. In many instances, however, even this attendance cannot be maintained, but it is frequently found that two centres distant, say, from five to ten miles apart would if combined maintain the required attendance. Under these circumstances the Department establishes what are called "Half-time Schools," the teacher dividing his time equally between the two centres. The course of instruction is identical with that of the Public Schools, but, of course, pupils are not expected to attain the same proficiency as pupils who attend a full-time school. There are no "Part-time" Schools in New South Wales as such schools are understood in England.

While the Department establishes schools as shown, of late years the policy is directed wherever possible towards the establishment of "Central Schools," to which pupils are conveyed by means of coach—or in the coastal districts, by launch—to a Central School, the Department defraying the cost of conveyance. For the year ending 30th June, 1913, an average of 1,486 children were conveyed every day to 103 Central Schools, the cost to the Department being a little over £6,000 for the year. No fixed rates are paid, the rate being determined by the circumstances.

In remote places where a sufficient attendance cannot be maintained for any of the foregoing types of schools, the Department subsidises single families or groups of families, towards paying the salary of a governess or tutor. Such governesses or tutors are then known as "subsidised teachers," the subsidy paid being £5 per head for pupils in average attendance up to a maximum of £50, or in the far western districts a subsidy of £6 per head, with a maximum of £60. Where it is found impracticable to employ a subsidised teacher a boarding allowance equal to the subsidy is paid to parents to assist them in maintaining their children at a school away from home. During 1913 subsidy was paid to 669 schools, the average quarterly enrolment of the pupils for whom subsidy was paid being 4,302. An experiment has been in progress for some time with what might be called a "Caravan" School, and the success achieved has been such as to justify an extension of the system. These Caravan Schools are equipped with a covered waggonette, a tent and school material. Specially selected teachers are placed in charge, and the teacher moves from family to family, spending a few days with each, instructing and otherwise directing the studies of the pupils and returning in regular circuit to give further instruction.

Another type of school is the "Flying-Camp" School, which is established in connection with railway extension. The school is portable, and, as the railway camp moves on, the school is shifted bodily to the new location, thus maintaining the continuity both of teacher and pupils.

At the end of 1913, including Subsidised Schools, there were 3,247 schools in operation under the control of the Education Department.

Teachers.

Until six or seven years ago the Pupil-teacher system was an essential feature of the Education system of New South Wales. Pupil teachers, however, have now been abolished, and all teachers undergo a period of training at the expense of the State before appointment. Adults seeking appointment as teachers of small Bush Schools are subjected to an Entrance Examination, and if successful attend the Sydney Teachers' College for a period of six months' training. The teaching supply, however, is largely recruited from High School pupils, who are assisted by means of scholarships to obtain a four years' High School education with a view to entering the Teachers' College. They then undergo a course of training of either one, two or three years duration. As a general rule students elect to remain two years, only specially qualified teachers being selected for a third years' course. The best of these students are further assisted in graduating either in the Arts or Science Schools of the University. There is a larger proportion of men teachers than women teachers, but of late years this proportion has been materially lessened. Of 6,123 teachers employed on 31st December, 1912, 3,289 were men and 2,834 were women. Women teachers may be placed in charge of small country schools, but by far the great majority of women, however, are employed as assistants. The large city schools are divided into three departments: Boys, Girls, and Infants. The principal teacher exercises a general supervision over all departments, but in practice the Mistresses of the Girls' Departments and the Mistresses of the Infants' Departments are practically in charge of their own sections.

A minimum salary of £110 is paid to all adult teachers. Salaries are determined (1) by the classification of the teacher, and (2) by the class of school. The classification of the teacher is determined by a series of examinations, supplemented by the reports of inspectors upon the efficiency of the teacher. The classification of the school is determined by the attendance. The classification scheme is somewhat complex, but it may be said that the teacher of a small country school who starts on £110 a year may reach to £156 within two years, while if his wife teaches sewing to the senior girls, an allowance is made of £24 a year, making in all a salary of £180. The salaries of Head Masters range from £110 to £450, Mistresses of Girls' Schools from £204 to £288; Mistresses of Infants' Departments, from £192 to £252; First Assistant Teachers (Men), £198 to £312; Women First Assistants, £150 to £222. The salaries of ordinary classified assistants range from (Men) £156 to £228, (Women), £120 to £162. The amount paid in salaries during 1912 was £1,044,946.

Types of Schools.

The State system of education comprises separate Infant or Kindergarten Schools, Primary Public Schools, Public High Schools, Superior Public Schools, and Evening Continuation Schools. The Primary School course extends over a period of six to seven years. Attendance is compulsory for all pupils between the ages of 6 and 14 who live within two miles of a Public School, unless satisfactory proof is given that the child is being otherwise educated or has reached a definite standard of education. The High School course extends over four years and is designed for pupils of from 13 to 17 or 18 years of age. In practice, however, it is found that these ages vary considerably, and it is not uncommon to find boys and girls of 11 years of age in High Schools. The Superior Public Schools are in effect Day Continuation Schools, the course extending over two years and being vocational in character. These schools are designed for boys and girls who are required to leave school at or about the age of 15 and 16. The Evening Continuation Schools are also vocational in character, being divided into Commercial, Junior Technical, and Domestic, and while intended primarily for pupils who leave school after completing the primary course, the majority of these schools have a preparatory class at which pupils may attend whose education has been neglected. A reference to the diagram at the end will show the relation of the various types of schools to one another.

Certificated Scheme of Examination.

Within the last three years the Education Department has instituted a system of examinations for certificates. All pupils who have completed 18 months in a Fifth Class of a Primary School are required to submit to a written examination called the Qualifying Certificate Examination. There is no limit to age, and any pupil, whether attending a Public School or a Private School, may present himself for this examination. Successful candidates are awarded a Qualifying Certificate, which gives the right of admission to a High School or to a Superior Public School. Under a special Act of Parliament, known as the Bursary Endowment Act of 1912, State Bursaries are awarded to pupils showing the most ability in the Qualifying Certificate Examination to enable them to attend High Schools. During 1912, 300 of these bursaries were awarded, each carrying a monetary grant of £30 a year for four years, if the pupil has to board away from home; and £10 for each of the first and second years, £15 for the third year, and £20 for the fourth year, if the pupil lives sufficiently near to the High School to be able to board at home. Free text-books are also given and a free railway pass to and from school. In addition to these bursaries 514 scholarships were awarded during 1912. The scholarship carries no monetary grant, but it gives priority of right of admission to a High School where accommodation is limited, free text-books and a railway pass. As the bursaries are intended to assist pupils of comparatively poor parents, an income limit is fixed, a quota of £50 income being allowed for each member of the family, including the parents, but excluding children in receipt of more than 10s. a week. There is no restriction of any kind upon scholarships. Both in the case of bursaries and scholarships, the parents are required to sign a guarantee that they will permit the child to attend the High School for the full four-years' course.

In addition to the Qualifying Certificate, the Department also issues an Intermediate Certificate and a Leaving Certificate. The Intermediate Certificate is given to pupils who satisfactorily complete the first and second years' High School course, and as a rule the gaining of this certificate is a condition to entering upon the third-year course. The Leaving Certificate marks the satisfactory completion of a four years' High School course, and is awarded as a result of an examination controlled by a board consisting of officers of the Education Department and professors of the Sydney University. The examination is a written one, but it is a condition of the award of the Leaving Certificate that the candidate must have completed a full four-years' course, and must have satisfied the examiners that satisfactory work has been done in all subjects of a course as well as the particular subjects taken at the written examination.

The Sydney University has accepted the Leaving Certificate when awarded for specified subjects as the equivalent of matriculation, and possession of the certificate thus gives the holder the right to enter the University. Under the University Amendment Act of 1912, the State endowment of the University was considerably increased, and a system of Exhibitions instituted which will make the University free to a large number of its students. This Act provides that there shall be one Exhibition awarded for every five hundred persons in the State between the ages of 17 and 20. On basis of present population this provides for 200 Exhibitions carrying exemption from tuition fees at the University and tenable in any of its departments.

The Intermediate and Leaving Certificates are not awarded wholly on the results of the examination. Attendance at a Secondary School for at least two years for one and four years for the other is a condition of the award. Moreover, while the examination may be passed in a minimum of four subjects, courses involving the study of at least six subjects are set out for these Schools, and a pupil must give evidence that all the subjects of the course have been satisfactorily followed in order that a certificate may be issued to him covering the subjects in which he passes the examination. This feature has been introduced to prevent the pupils confining their studies to too limited a range of subjects.

The Primary School.

Except in what are called first and second class schools, co-education is in operation throughout all the Primary Schools. A first-class school has an attendance of 600 and over, and a second-class school an attendance ranging from 400 to 600. In these schools there are separate departments for boys and girls, although in the Infants' Department the boys and girls are taught together, being transferred to the primary department after completing a two-years' course of instruction in the Infants' Department. The Girls' Department and the Infants' Department are each in charge of a Mistress who, however, is under the direction of the Principal Teacher in matters affecting the whole school. As a general rule the number of pupils in a class is about 40. In the smaller schools, however, it is the practice to grant an assistant teacher when the average attendance exceeds 45. In one-teacher schools the Syllabus of Instruction provides that the pupils shall be arranged into two divisions—Higher and Lower—instead of into classes as is the case with the larger schools. The same course of instruction is carried out in all schools, but the same degree of efficiency is not required in small schools. The course of instruction in Primary Schools includes: English, Mathematics (including Arithmetic, Mensuration, Algebra and Geometry), Nature Knowledge (Geography and Elementary Science), Civics and Morals (History, Scripture, Moral Duties and Citizenship), Art and Manual Work (Music and Physical Education). As stated the Qualifying Certificate Examination marks the completion of the Primary course.

Continuation Schools.

There are two types of Continuation Schools in existence in New South Wales: Day Continuation Schools, called Superior Public Schools and Evening Continuation Schools. In both types of schools the course of instruction is vocational in character. They are divided into Commercial, Junior Technical, and Domestic Schools. Practically the same subjects are taught in the Superior Schools as in the Evening Continuation Schools, but since the latter are only in operation two hours for each of three evenings during 33 weeks in the year, the same degree of efficiency is not required as in the Superior Schools, which are in operation throughout the whole day. In the Commercial Schools the subjects include Trade Arithmetic, Trade Geography, Business Principles, Book-keeping, Shorthand, in addition to the ordinary subjects, English, History and Morals. The Junior Technical Schools specialise in Drawing, Manual Work and Elementary Science, in addition to ordinary educational subjects. In the Domestic Schools the girls are taught Home Management, Cookery, Dressmaking, Care of the Sick, Care of Infants, in addition to English, Music, Art Work and Social Exercises. The Evening Continuation Schools were only established in 1911, but at the present time there are 48 of these schools in operation, the enrolment for the term ending 31st December, 1913, being 3,221. The Superior Schools were reorganised at the beginning of 1913, and at the present time there are 32 Commercial Superior, 20 Junior Technical Superior and 52 Domestic Superior Public Schools in operation; the enrolment for December being 1,340 boys and 837 girls.

A fee of 6d. per week is charged pupils attending the Evening Continuation Schools, but the whole amount is refunded if attendance and conduct is satisfactory. In all other schools under the Department education is free.

Special Religious Instruction.

The Public Instruction Act of 1880 provides that "teaching in all Public Schools shall be strictly non-sectarian, but the words secular instruction shall be held to include general religious teaching as distinguished from dogmatical or polemical theology."

This "general religious teaching" forms part of the ordinary school course. In the Junior classes when children are unable to read, lessons are given in the form of Bible stories, and cover a complete course of the old and new Testament History. In classes above the second, the Irish National Board Scripture lesson books are regularly read. The Old Testament No. 1 deals with the Book of Genesis; Old Testament No. 2 ranges from Exodus to Deuteronomy; New Testament No. 1 deals with the Gospel of St. Luke; New Testament No. 2 deals with the Acts of the Apostles, and contains extracts from other parts of the New Testament.

Teachers in the State Public Schools are not required to furnish their religious denomination, and there is no record of the number of teachers belonging to the several denominations. All teachers, however, irrespective of creed, are required to give these Scripture lessons, and in no case has any refusal to do so taken place—the teachers accepting the subject exactly on the same footing as Geography or Grammar. At the same time pupils are not compelled to remain in the class while such lessons are being given—a written request from the parent giving exemption to any pupil from the Scripture lesson.

In addition to this general religious teaching, the Public Instruction Act has the following provision:—

> Section 17.—In every Public School four hours during each day shall be devoted to secular instruction exclusively and a portion of each day not more than one hour shall be set apart when the children of any one religious persuasion may be instructed by the clergyman or other religious teacher of such persuasion but

> in all cases the pupils receiving such religious instruction shall be separated from the other pupils of the school. And the hour during which shall be fixed by mutual agreement between the Public School Board in consultation with the teacher of such school and the clergyman of the district or such other person as may be duly authorised to act in his stead and any class-room of any Public School may be used for such religious instruction by like agreement. Provided that if two or more clergymen of different persuasions desire to give religious instruction at any school the children of each such different persuasion shall be so instructed on different days. Provided also that the religious instruction to be so given shall in every case be the religious instruction authorised by the Church to which the clergyman or other religious teacher may belong. Provided further that in the case of the non-attendance of any clergyman or religious teacher during any portion of the period agreed to be set apart for religious instruction such period shall be devoted to the ordinary secular instruction in such school.

SECTION 18, however, reads:—

> Notwithstanding anything to the contrary in the last preceding section no pupil in a Public School shall be required to receive any general or special religious instruction if the parents or guardians of such pupil object to such religious instruction being given.

While provision is made for one hour's special religious teaching daily, in practice it is found that clergymen or other authorised religious teachers attend at such schools as they desire, one morning in each week for one lesson period. The instruction may consist of worship and purely sectarian teaching. It is given during the ordinary school hours in a separate room, and where two or more clergymen of different denominations attend the same school, the teacher and clergymen find no difficulty in making arrangements to suit all concerned.

No sectarian difficulties have arisen in the clauses providing for such religious instruction. The system has formed a part of the school routine since the passing of the Act in 1880.

THE MEDICAL WORK OF THE DEPARTMENT OF PUBLIC INSTRUCTION, NEW SOUTH WALES.

By C. S. Willis, M.B., D.P.H., Etc.,
Principal Medical Officer.

The Medical work of the Department of Public Instruction, New South Wales, has been completely reorganised and considerably extended during 1913. The extension was most pronounced with regard to the Medical Inspection of school children. Previous to this year only children attending the State's schools in two populous areas, viz., the Metropolitan area of Sydney, and the Newcastle and Maitland districts, were liable to medical inspection.

In July, 1913, it was decided that every child attending the State's schools should be medically inspected. A few months later (October) free medical inspection of the children attending their schools was offered to the principals of all non-State schools in New South Wales. The offer was accepted by the Roman Catholic authorities for all the schools under their jurisdiction, and also by a large proportion of the Private Schools. New South Wales, therefore, is in what I believe to be the unique position of providing for the medical inspection of practically the whole of the school children of the State, by one Medical Staff, paid by the Government. Uniformity is thus assured.

The number of children attending schools in New South Wales at the end of 1912 was as follows:—

Attending the State's Schools	228,543
,, Roman Catholic Schools (Approx.) ..	50,000
,, All other Schools (Approx.)	17,000
Total	295,543

Allowing for (*a*) the increased enrolment, and (*b*) those Private Schools not desiring medical inspection, there are about three hundred thousand school children to be medically inspected by this Department. The work entailed in the Medical Inspection, however, cannot be estimated by merely considering the number of children to be examined. With this has to be taken into consideration the vast distances to be travelled to get to these children. The Medical

Officers have to cover an area of about 310,000 square miles and examine at some four thousand schools. In several cases a distance of over one hundred miles has to be traversed getting from one school to another, and this without the aid of a railway. The annexed graph of a group of some of our most remote schools, illustrate the large amount of ground to be covered by the School Medical Officers.

In this country school attendance is compulsory between the ages of 6 and 14 years. A medical examination of all children present at each school is to be made every four years. In other words, every school child will be medically examined at least twice during his or her school life. The examination will be fairly thorough: eyes, ears, throat, nose, speech, mental condition, deformities, etc., etc., being examined. With the exception of weighing and measuring the height, the whole examination will be conducted by the Medical Officer. In connection with the Medical Inspection a large amount of information concerning the child is obtained by means of a card on which is printed a set of questions to be answered by the parents or guardians. Included in this information is the past history of the child relating to infectious diseases. Thus, in a few years, the Department will have a very fair idea of the number of children in any school who have had a particular infectious disease, and should an outbreak of this disease occur in the school the possibilities of spread can be estimated.

The notifications to parents, informing them of the defects found in their children, are accompanied by printed circulars describing the defect and pointing out the danger of allowing it to go untreated, and describing how to set about having it treated.

Those children found physically defective are "followed up" thus:—The Head Teacher is first asked to find out by inquiry which children have been treated, and then in the larger towns, a school nurse visits the parents of the children who have not been treated, and endeavours to persuade them to obtain the necessary treatment, and in many cases takes the children to a General or Dental Hospital herself. In the smaller back-country towns, where there are no school nurses available, second, third, or more, urgent notices are sent to the parents until some finality is reached.

In some of the back-country districts the contagious disease, Ophthalmia, is prevalent, and has in the past caused a great permanent damage to the eye-sight of children. In these districts the School Medical Officer gives first treatment to the affected eyes and instructs the parents or children how to continue this treatment, and supplies free drugs for that purpose. In addition, each child is supplied with a pamphlet containing a description of the disease and instructions about its prevention and treatment.

At every school inspected arrangements are made for a meeting of parents, at which they receive instruction from the Medical Officer on the defects of school children, on personal and home hygiene, and on the nature, cause or prevention of consumption.

One of the greatest problems to be faced in the near future is how to get the school children living in the back-country treated. The Medical Inspection will be made, but as the nearest practising doctor may be 30 or more miles away, very few of the children will receive treatment. The establishment of a travelling hospital and dentist will need to be considered.

Other Medical Work Carried Out by the Department of Public Instruction.

The Medical Inspection of School Children, although the most important, is by no means the only medical work carried on by this Department. The following may be mentioned as the more important of the remaining medical work done by us:—

1. Inspection of school buildings.
2. Investigation of epidemics of infectious diseases affecting school children.
3. Systematic course of instruction in hygiene, first-aid, etc., given to men and women in training to become teachers.
4. Instruction to the senior girls in all the Metropolitan Schools on the care of babies, personal cleanliness, home hygiene, etc., etc.

Inspection of School Buildings.—The sanitary condition, lighting, and ventilation of every school are reported on by the Medical Officers. Their reports are then forwarded to the Department's Building Branch, where steps are taken to remedy the defects.

Investigation of Epidemics of Infectious Diseases in the School.—All teachers are instructed under what conditions and for what period children and contacts are to be excluded from school attendance in cases of infectious diseases, contagious skin conditions, pediculosis, etc., etc. They are also instructed in that part of the Public Health Act relating to infectious diseases in so far as it affects schools.

When a number of cases of an infectious disease occur among the children of a school a Medical Officer visits the school and inquires into the whole circumstances of the outbreak, and searches for "carriers." Swabbings are taken in the case of diphtheria, discharges collected when typhoid fever is the trouble, etc. The specimens thus obtained are forwarded for examination in the Department's own laboratory. By this means much success has been achieved during the last year in preventing the spread of infectious diseases, not only in the school itself, but also in the surrounding district.

Courses of Instruction in hygiene, first-aid, etc., to Men and Women Training to Become Teachers.—All those in training to become teachers, under the Department of Public Instruction, receive systematic instruction at the hands of the Medical Officers on school, home and personal hygiene, infectious diseases, first-aid, etc., etc. A special feature is made of the first-aid instruction as it is recognised that many of the students will later be sent to schools situated many miles from a doctor. The course of instruction is followed by an examination which all students must pass.

Instructions to Senior Girls on the Care of Babies, Etc.—Every girl attending the State's schools in the Metropolitan area before leaving school receives a course of instruction in the care of babies, home and personal hygiene, cause and prevention of consumption and allied subjects. These courses are aided by illustrated pamphlets and are followed by written examinations. Each girl is supplied with a set of pamphlets to take home. The idea of distributing pamphlets is not only to afford more lasting instruction to the child, but also to educate the parents on these subjects.

The Department is at present engaged in collecting statistics with a view to the establishment of a school or schools for those children who are mentally defective.

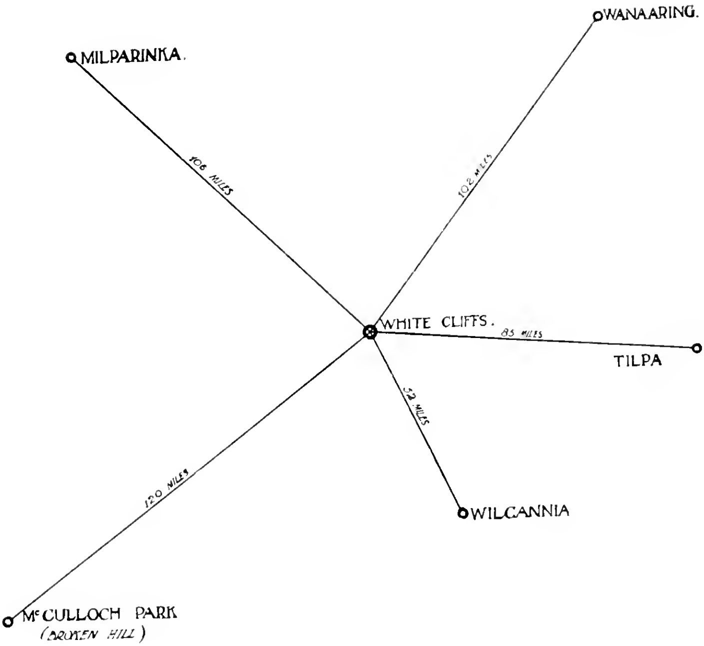


DIAGRAM SHOWING INSPECTIONAL AREA OF MEDICAL OFFICER IN WESTERN DISTRICT.

Chapter X.

AGRICULTURE.

By Professor R. D. Watt.

I.—Historical and General.

It was no light or common task which confronted Captain Phillip when, on the 26th of January, 1788, he arrived in Port Jackson with his 720 convicts and 443 free men to found a penal Colony in a distant, unknown land. For he brought with him only sufficient provisions to supply his little band with the necessaries of life for two years from the time of leaving England, after which it was supposed that, with the aid of an occasional supply of stores from the Home country, he would be able to support his followers from the products of the soil. With that end in view he had brought with him from Home or taken on board at Rio or the Cape a considerable equipment in the form of live-stock, seeds and agricultural implements. Unfortunately some of the invaluable live-stock had died on the voyage, whilst others were killed by the convicts or wandered off into the bush; many of the seeds failed to germinate, and the agricultural implements which consisted chiefly of axes, mattocks and hoes were of the most primitive description. An even more serious circumstance was the fact that there was no one amongst the freemen who could lay any claim to agricultural knowledge. The first transport sent to his relief was wrecked on an iceberg off the Cape; so that it is scarcely surprising that the young Colony was again and again on the verge of starvation. The first land to be cleared and cultivated was an area of about nine acres on the banks of a little stream which flows into Farm Cove through the present Sydney Botanic Gardens. As the land here was not very promising the centre of agricultural operations was transferred before the end of the first year to a much better site in the vicinity of the present town of Parramatta, about 15 miles to the west of Sydney. It was in this neighbourhood that James Ruse, the first ex-convict to take up land, grew his wheat and maize, and that Captain John MacArthur—the pioneer pastoralist of Australia—started his agricultural operations. Slowly, but surely, settlement extended in every direction from this centre, as military officers, ex-convicts and free settlers obtained grants of land. Though MacArthur introduced a plough about 1795, practically all the cultivation for many years after the establishment of the Colony was done with hand implements by convict labour, and wheat and maize were the only crops grown to any extent. The land in the neighbourhood of Parramatta was fairly satisfactory for agricultural purposes; but with the primitive methods adopted the yields obtained were small, and venturesome settlers, encouraged by the Governor, were continually on the outlook for richer and kindlier land. This was soon discovered on the banks of the Hawkesbury in the neighbourhood of the present towns of Windsor and Richmond. For many years the alluvial flats in this vicinity were the chief centres of agricultural progress, excellent crops of maize especially being obtained. Floods, however, occasionally caused disaster, and the distance from the main settlements at Sydney and Parramatta rendered transport expensive. As population and stock increased it became necessary to open up new districts, and expansion took place both to the north and the south, but the areas of land which were both reasonably fertile and free from dense scrub or forest growth were relatively small. Directly to the west, at a distance of 40 miles or so, the Blue Mountains stood like a huge wall, preventing expansion in that direction. Frequent attempts were made to find a crossing, but without success until in 1813 three dauntless men—Blaxland, Wentworth and Lawson—penetrated the barrier and were rewarded by seeing fertile slopes and plains stretching away to the setting sun as far as the eye could reach. A rough road was soon constructed and the pent-up sheep and cattle had an unknown and indefinite area in which to expand. Owing to the cost of transport, agriculture proper was out of the question there except for local requirements, and the bulk of the cereals for human consumption continued for many years to be grown in the coastal regions. From the pastoral point of view, however, it is difficult to exaggerate the importance of gaining access to the enormous extent of good grazing land. For several decades hardy pioneers with their flocks and herds, their axes and their rifles, their brave-hearted women-folk and sturdy children continued to spread farther and farther out into the unknown and to found homes in the silent forest or on the lonely plain. Though there were no beasts of prey except the dingoes, which sometimes played havoc with the sheep, the natives were a very uncertain quality, and later on the bushrangers caused trouble.

Owing to the great distances and the difficulties of transport it was necessary to produce a marketable commodity of high value, and fortunate it was for Australia that, through the agency of Captain MacArthur, the merino sheep, with its capacity for searching far and wide for its food, resisting drought and producing wool of the highest quality had been introduced. Years of plenty succeeded years of drought and the flocks rapidly increased in numbers. When the limit of expansion had been reached the question of the surplus stock became a serious one as the demand for mutton was strictly limited. The boiling down of the sheep for their tallow and, later on, the development of the frozen mutton trade which enabled the surplus to be sent to England, again relieved the tension. But a new difficulty arose. All of the land that had been surveyed (and a good deal that had not) and was worthy of being occupied had been taken up either in the form of a grant, a purchase or a lease, and there was very little available for the new settlers who continued to arrive and for those who had met with disappointment in their search for gold. This state of affairs necessitated, in 1861, the famous "free selection" Act, and ever since that time politicians have been trying to devise schemes for closer settlement. Small holdings, of course, could only be profitable where agriculture was practicable, and this necessitated the building of railways to convey the products to the seaboard.

The coastal districts had proved admirably suited for dairying and for the growth of maize and (in the north) of sugar cane, but the combination of heat and moisture caused the wheat crop to fail in many years owing to rust. Though wheat had been grown to some extent west of the mountains previously it was not until about 20 years ago that it began to be produced on anything like a large scale. All the factors mentioned were contributory causes to the westward expansion of agriculture—the failure of wheat in the coastal districts, the dawning of closer settlement and the construction of Government railways—but there were others almost as important. The invention by a South Australian of the "stripper," which greatly minimises the labour required to harvest the crop, the establishment of the system of share-farming, the evolution of the stump-jump plough and the influx of farmers from South Australia and Victoria, in which States the climatic conditions closely resemble the present wheat districts of this State, were all factors in starting that great agricultural advance which has been one of the most notable features in the recent history of New South Wales.

The progress of the agricultural industry is well shown by a consideration of the area under crop at ten-year intervals, the actual figures being as follow:—

Season.	Area under Crop in N.S.W.
1860-1	260,798 acres
1870-1	426,976 ,,
1880-1	629,180 ,,
1890-1	852,704 ,,
1900-1	2,445,564 ,,
1910-11	3,386,017 ,,

During the season 1911-12 the acreage increased to 3,737,268, while for 1912-13 the area under *wheat alone* is estimated at 3,730,990 acres, or an increase of 25 per cent. on the previous year.

In addition to the cultivated land a considerable area is devoted to artificially-sown grasses, which are generally sown on unploughed land after burning off the timber. The quantity of land devoted to this purpose in New South Wales increased from 467,839 acres in 1901-2 to 1,119,738 acres in 1911-12, coincident with a great development of the dairying industry.

The area devoted to agriculture, of course, represents a very small percentage of the total area of the State, and an unknown but still small proportion of the land which could be profitably cultivated. In 1911-12, the latest year for which statistics are available, only 1.832 per cent. of the total area of New South Wales was devoted to agriculture, or about one acre in every 55.

Wheat is by far the most important crop, as will be seen from the following table showing the area under the chief crops in 1911-12*:—

* Since this article was written the figures for the year 1912-13 have become available, but the proportions are not materially altered.

	Per Cent.
Wheat	65.59
Hay	17.97
Green Forage	5.83
Maize	4.62
Oats	1.96
Orchards	1.33
Potatoes	1.19
Sugar Cane	0.38
Barley	0.30
Vineyards	0.23
Other Crops	0.60
Total	100.00

The pre-eminence of wheat is even greater than is apparent from the table, for nearly seventy per cent. of the hay and a considerable proportion of the green forage consists of wheat grown for these purposes. The remainder of the hay crop is chiefly derived from oats and lucerne, whilst for green forage a great variety of plants are grown, including oats, barley, maize, sorghum, rape, vetches and cow-peas.

The other crops include pumpkins and melons, tobacco, tomatoes, sweet potatoes, beans and peas, turnips and onions in that order.

The State of New South Wales can be divided roughly into five main agricultural divisions, each running from north to south in strips more or less parallel with the coastline, viz., the Coastal Division, the Tablelands, the Western Slopes, the Western Plains and Riverina, and the Western Division.

The Coastal Division has a great variety of soils, including rich alluvial flats as on the Hunter and the Clarence, deep-red loams derived from basalt and similar rocks, as in the Richmond River district, and poor sandy soils derived from the Hawkesbury sandstone in the neighbourhood of Sydney, as well as many of an intermediate nature. Dairying is the staple industry and, as the climate is genial throughout the year and the rainfall reliable, the cows are never housed and require very little hand-feeding. Agriculture is chiefly confined to the alluvial soils where maize, sugar-cane, lucerne and potatoes form the principal field crops.

The Tablelands include a large area of rough, mountainous country as well as much good grazing land where the finest merino wool is produced. Isolated areas near the railways are devoted to agriculture and fruit-growing, the principal products being apples, pears, cherries, potatoes, wheat, oats and maize. Dairying is also practised to a considerable extent and farming methods generally approach much more closely to those of England than in any other district of the State, the rainfall being similar in amount.

The Western Slopes consist of gently undulating country varying in altitude from 800 to 2,000 feet above sea-level. The predominating soils are red in colour, varying in texture from sandy loams to clay loams, with a clay sub-soil. As the rainfall varies from 18 to 30 inches they are admirably adapted to the growth of wheat, which is the staple industry. Along the rivers isolated areas of rich alluvial soils are found where lucerne grows luxuriantly in the hottest weather as its deep-rooting habit enables it to tap underground supplies of moisture. Some of the lucerne hay is sent to market, but where the distance from the railway is prohibitive it is fed to dairy cows, sheep and pigs on the farm. Much of the land at present devoted to grazing in this important division will ultimately be cultivated, as there is no comparison between the financial results of the two ways of utilising the land.

The Western Plains for the most part consist of flat or very gently undulating land only a few hundred feet above sea-level, broken here and there by chains of hills or isolated peaks. Much of the soil, especially of the northern part of this division consists of a stiff black clay at present considered too difficult and expensive to cultivate. There are large areas, however, of a deep, friable, reddish soil where agriculture, especially wheat-growing, is practised to a considerable extent and is gradually spreading. The rainfall varies from 13 to 22 inches and when it falls much below the average its sheep population is apt to become considerably reduced, especially on those holdings where overstocking is practised. In normal seasons it is, however, excellent grazing country where the merino thrives to perfection. The Riverina, which is situated in the south of the State between the Murray and Murrumbidgee Rivers, has a much larger area of soil suitable for agriculture and a more reliable winter and spring rainfall, especially in the eastern half, which is rapidly being transformed from a second-rate grazing district into a succession of wheat farms. The

Western District can hardly be called an agricultural division as it is entirely devoted to grazing.

Although less than two per cent. of the land in the State is under cultivation, over 92 per cent is occupied, the remaining 8 per cent. being reserved by the Crown or unoccupied. In 1912, 19.75 per cent. of the land had been alienated, 8.75 per cent. was in process of alienation, and 63.65 per cent. held under lease or license.

The various sizes of the holdings alienated or in process of alienation in 1912 may be seen at a glance from the following table:—

Size of Holding. Acres.	Number of Holdings.	Area. Acres.
1 to 50	38,211	503,060
51 to 100	9,027	714,130
101 to 500	25,964	6,578,002
501 to 1,000	8,329	5,822,517
1,001 to 5,000	6,934	13,743,189
5,001 to 10,000	825	5,715,461
10,001 to 20,000	371	5,174,155
20,001 to 50,000	247	7,249,093
50,001 and over	84	7,611,345
Total	89,992	53,111,132

The most frequent class of holding met with is the small one under 50 acres, chiefly occupied by orchards, market gardeners and small dairy farms, though the percentage of such holdings is very much smaller than in the older settled countries. The next most popular size is between 100 and 500 acres, in which category would be included the larger dairy farms and the smaller wheat farms. The holdings, over 5,000 acres, are chiefly devoted to grazing, though dairying and wheat-farming on the "shares" system are largely practised, even on the larger estates.

There is room for an immense amount of closer settlement in the coastal district and this is going on steadily as means of communication improve. Indeed, it has been estimated that the whole of the present population of New South Wales could find a livelihood in the narrow coastal fringe. The Tablelands, too, offer many opportunities for smaller holdings and more intense culture, especially in the growing of cool-climate fruits; but it is in the regions west of the Blue Mountains—the Western Slopes, the Central Western Plain and the Riverina—that the great bulk of the land suitable for agriculture exists. How much of this lies within the limits of sufficient rainfall can hardly even be guessed at, as our ideas of what constitutes an adequate precipitation for the growth of such a crop as wheat are constantly changing in the light of scientific knowledge. The following considerations should help the visitor to form some idea of the enormous possibilities in this direction.

The area of land which lies within the various rainfall regions is shown in the following table:—

Average Annual Rainfall.	Area in Square Miles.
Under 10 inches	79,629
10 inches to 20 inches	118,685
20 ,, to 30 ,, ...	76,219
30 ,, to 40 ,, ...	24,685
Over 40 inches	11,156

The bulk of the area, with a rainfall of over 30 inches, occurs on the coast or on the Tablelands where wheat is not likely to be grown on a very large scale for reasons already indicated.

There are, however, 76,219 square miles or 48,780,160 acres situated chiefly on the Western Slopes, with a rainfall of between 20 and 30 inches, where a very large proportion of the soil is well adapted for wheat-growing and mixed farming. But that is not all; for at least one-third of the total area under wheat at present has a rainfall of less than 20 inches, and there the industry is proving very profitable where up-to-date methods are used. The inadequacy of the total precipitation is, of course, not the only limiting factor in the growth of wheat, though it is a very important one. The incidence of the rainfall and the freedom of a district from hot, drying winds in the late spring and early summer, also require consideration. In most districts April is the earliest month for sowing and by the end of October the wheat crop has usually passed the critical stage. It was formerly considered that an average precipitation of ten inches during the growth of the crop was essential, and in 1904 the "wheat experience line" was well within the limit, but by 1912 wheat was grown successfully in several districts to the west of this. The problems of pushing the western limit of the wheat-belt farther and farther backwards is one of the most fascinating problems ever placed before an agricultural community. How much success has been achieved may be understood from the fact that the area between the wheat experience line in 1904 and that of 1912 is no less than 13,430,000 acres; in other words it has been demonstrated that, when the soil conditions are suitable over these 13,000,000 acres, wheat can now be grown successfully, though only eight years ago this was thought to be impossible. For every ten miles that the wheat-line is pushed westwards an area of nearly 3,000,000 acres is added to the wheat-belt. The main factors which are bringing about this important change are (1) the monumental work of the late William Farrer in breeding varieties of wheat specially suited to our climatic conditions; (2) the practice of fallowing combined with summer culture, resulting in the conservation of a good deal of the rain which falls outside the growing period and enabling farmers to sow each variety at the most suitable time; (3) the use of superphosphate, which gives the young plant a good start and encourages root-development to such an extent that it can make better use of the conserved moisture; (4) the use of the seed-drill, which necessitates a carefully prepared seed-bed and ensures uniform germination; and (5) the educational work done by good farmers and by the State Department of Agriculture in bringing these improved methods prominently before the notice of the general farming community.

The operations of the State Department of Agriculture are many-sided and far-reaching in their effects. The Hawkesbury Agricultural College, situated 38 miles from Sydney, gives a three years' course in the science and practice of agriculture, leading to a diploma. In addition to this the Department controls fifteen experimental and demonstration farms and stations, at most of which pupils are received, and the agricultural districts are covered by a net-work of experiments on private farms, superintended by district inspectors. Chemical, entomological, botanical, veterinary and dairying problems are studied by experts who spend part of their time in Sydney and part travelling round the country giving the farmers the benefit of their researches. Some difficulty has been experienced in getting properly trained men to take up this highly important work, but the supply should be more plentiful in future owing to the establishment of Chairs of Agriculture and Veterinary Science in the University of Sydney.

From this necessarily brief general outline it is to be hoped that the visitor will have gleaned something of the agricultural history and capabilities of the State. It will be seen that while the first century of the white occupation of this great island continent and especially of the Mother State has been one of remarkable pastoral development, it seems not improbable that the second century will be equally notable for the progress of its agricultural and dairying industries.

In the pages which follow a fuller account will be given of some of the more important aspects of the agricultural situation.

WHEAT.

By H. Ross, Chief Inspector, Department of Agriculture, New South Wales.

Glancing at the history of wheat-growing in New South Wales, the gigantic strides this industry has made during the last ten years stand out as a prominent feature. The following figures, giving some idea of the expansion of wheat-growing, are worthy of close investigation:—

Year.	Area under Wheat for Grain. Acres.
1890-01	333,233
1895-96	596,664
1900-01	1,530,609
1905-06	1,939,447
1906-07	1,866,253
1907-08	1,390,171
1908-09	1,394,056
1909-10	1,990,180
1910-11	2,128,826
1911-12	2,380,710
1912-13	2,231,514

The average yield for the last ten years, exclusive of 1912-13, has been 11 bushels per acre; in the season 1912-13 the average was 14.6 bushels, resulting in a total yield of 32,486,050 bushels, worth over £5,700,000.

Where Wheat can be Grown Profitably.

The wheat belt of New South Wales, that is to say, the area in which it is considered safe to grow wheat profitably, extends from the furthest northern point at Tenterfield to the furthest southern point at Albury, stretching out west as far as Nyngan, Coonamble, Condobolin, Dubbo, Parkes, and Forbes, and south-west as far as Wyalong and Barellan. The coastal districts, that is, the South and North Coast, are not adapted for wheat-growing for grain.

For purposes of classification and easy recognition, the principal wheat-growing areas have been grouped in the following districts:—

Northern Tablelands, of which Glen Innes is representative;
Central Tablelands, of which Bathurst is representative;
South-Western Slopes and Riverina, of which Wagga is representative;

Central Western Slopes (which includes Narromine, Dubbo, Gilgandra, Wellington, Cowra, Grenfell, Forbes and Parkes);

North-Western Slopes (including Tamworth, Gunnedah and Inverell districts);

Western Plains, of which Nyngan is representative.

It must not be thought that, when mention is made of "profitable wheat-growing," wheat cannot be grown outside of these districts; as a matter of fact, as much, if not more, land than is at present under cultivation and eminently suited for wheat-growing is at present not cultivated on account of having no railway communication. The furthest distance from the nearest railway station to make wheat-growing profitable should not exceed 18 or 20 miles.

Clearing the Land.

The timber usually associated with wheat-growing country is Grey Box, Yellow Box, Pine, Apple-tree, Bull Oak, Belah, Ginn, Yarran and in some cases, Mallee.

The new settler has the choice of two methods of clearing; firstly, to grub out all the trees, roots and stumps, to a depth of nine inches, and so make the land ready and fit for the set plough; or secondly, to burn off the timber to a depth a little below the surface of the soil. This latter method is known as "Yankee" grubbing, and land so cleared cannot be ploughed with the ordinary set plough on account of the stumps and roots left in the ground, therefore, recourse is had in this case to the stump-jump plough, an apt name for the implement, as it actually jumps over the obstructions in the shape of roots, etc.

Yankee grubbing is largely practised in New South Wales, especially in the South-western Slopes and Riverina, the two districts which produce no less than 85 per cent. of the total wheat yield of the State. Most settlers are anxious to get in as much crop as possible the first year, so they prefer the easier and cheaper method of Yankee grubbing to the more tedious and expensive one of thoroughly clearing it. The cost of Yankee grubbing varies according to locality and variety of timber, from 6s. to 12s. per acre; clearing land thoroughly costs from 12s. to 25s. per acre.

Cultivation.

It has long been a matter of controversy amongst wheat-farmers which of the two implements is the better to use, the mouldboard or the disc plough. The usual practice is to use the mouldboard plough when long grass or much rubbish has to be turned under, whereas the disc plough is extensively used if the land is fairly clean. Experiments carried out at various times by the Department, and the consensus of opinion of large wheat-growers in this State, point to the fact that under average conditions the yield is not influenced to any appreciable extent more by the use of one implement than it is by the other. The selection of either implement is largely a matter of choice with the farmer, although in some instances local conditions are the determining factor.

What is of more importance than the implement itself, is the actual operation of ploughing. The practice advocated by the Department of Agriculture is to plough the land in July or August to a depth of from $4\frac{1}{2}$ to 5 inches, and then to let it lie in the comb for a period of six weeks, when it is broken down with the harrows; subsequently the land, or fallow, as it is now called, receives frequent workings with cultivator or harrows to a depth of about three inches, so as to form and preserve a loose mulch on the surface of the soil, in order to check evaporation of soil-moisture. This operation is repeated until sowing-time in April or May, whenever a hard crust is formed on the soil-surface, usually caused by rain. Usually, however, three harrowings and twice cultivating with cultivator is all that is needed between the period of ploughing and sowing. It is thus seen that it is not advocated to sow the seed the same year as the land is ploughed. The reason for this is not hard to find. The large majority of New South Wales districts enjoy an annual rainfall of 20 inches or less, and it not infrequently happens that only from 6 to 8 inches of this falls during the growing period, which, of course, is quite inadequate to produce a crop of wheat of, say, 20 bushels. It is, therefore, essential that the previous year's rainfall should be stored in the soil and retained there by the methods previously described when the land is lying fallow to be augmented by the second year's rainfall when the wheat is sown. This means storing in the soil two year's rainfall to produce one crop. This is the theory advanced and invariably preached by the Department, a theory which in practice has borne golden fruit. Unfortunately, not every wheat-farmer in the State follows these methods, otherwise the average yield would be considerably higher than it is.

Amount of Rainfall for a Payable Crop of Wheat.
Results of Farmers' Experiment Plots.

What can be achieved in dry districts with a limited and intermittent rainfall in connection with wheat-growing is yearly forcibly brought to light through the medium of the Farmers' Experiment Plots. These plots comprise areas of ten acres each, and are situated in the main wheat-growing centres of the State. The work on these plots is carried out by the farmers who own the land, under the personal direction and supervision of an Inspector from the Department.

If anyone not familiar with New South Wales wheat-growing conditions in dry districts were told that a 24-bushel crop was produced on 668 points of rain the idea would be ridiculed, for we know thoroughly well that such a crop must of necessity make use of a much larger quantity of water to return such a yield. Yet such results have been obtained frequently on the Farmers' Experiment Plots. How is this possible? The explanation is simple; the crop during the growing period received 668 points of rain, but in the land on which it was sown and which was fallowed and properly worked, a large quantity of moisture was stored from the previous year; on this reserve the growing crop made successful demands, so that with the addition of the 668 points which fell during the growing period, sufficient moisture was available to produce a yield of 24 bushels per acre. This experiment was carried out at Messrs. Gagie Brothers' farm, Spy Hill, West Wyalong, in 1911-12.

Still more remarkable are the results obtained in the same year from the experiment plots situated at the farm of Mr. M. Carew, Deniliquin. In this case the seed was sown in May on well-worked fallow in which a good amount of the previous year's rainfall had been conserved. The rainfall during the growing period, *i.e.*, May to end of November, was as follows:—

May	210	points
June	60	,,
July	12	,,
August	nil	
September	37	,,
October	3	,,
November	nil	
Total	322	,,

The result was 14 bushels per acre. It should be noted here that in October, the most critical month, only three points were recorded.

Again, at Jindera (Albury), on Mr. G. Laidlaw's farm, "Elm Park," 28 bushels 56 lbs. were obtained on fallowed land with a rainfall of 752 points.

Encouraged and guided by such results, we now find that the more progressive wheat-farmers gradually adopt a rigorous system of fallowing, with the result that the area under wheat cultivation in New South Wales is increasing from year to year, and wheat-growing in dry districts is placed on a sure and profitable basis.

Varieties of Wheat.

However well the land has been prepared for sowing, the best results can only be looked forward to if those varieties are sown which are eminently suited for certain districts. The experience gained by the farm managers from experiments on the Government Farms and by the Inspectors from the Farmers' Experiment Plots, combined with the advice of other Experts of the Department, has resulted in recommendations being made to farmers as to which varieties to sow in certain districts. These recommendations are the result of a conference held annually by these officers immediately after harvest is over, and are published in time to allow farmers to decide upon the varieties for the coming season.

Classification of Varieties of Wheat.—1914.

In respect of time of maturity, the varieties of wheat recommended were classified as follows:—

Very early: Sunset, Bunyip, Florence, Firbank.

Early: Comeback, Thew, Steinwedel.

[These should usually be sown late.]

Mid-season: Bobs, John Brown, Cedar, Warren, Bomen, Federation.

[These should usually be sown in mid-season.]

Late: Rymer, Marshall's No. 3, Zealand, Yandilla King, Cleveland, Huguenot.

Very late: Haynes' Blue Stem.

[These should usually be sown early.]

Varieties Recommended.

It was decided that the following varieties of wheat should be recommended for cultivation during the year 1914:—

A.—*Dual-Purpose Wheats* (recommended for both Grain and Hay).

Variety.	Period of Sowing.	Districts.
Bobs	Mid-season and late	Central Tableland; Central-western Plains.
Cleveland	Early and mid-season	Central Tableland; cooler portions of North-western Slopes, Central Western Slopes, and South-western Slopes.
Comeback	Late	South-western Slopes and Riverina.
	Mid-season and late	Central-western Slopes; North-western Slopes; Western Plains.
Firbank	Mid-season and late	Central-western Slopes; Western Plains.
Florence	Mid-season and late	Central-western Slopes; South-western Slopes and Riverina; North-western Slopes; Central Tableland; Northern Tableland; Western Plains.
Haynes' Blue-stem	Very early	Northern Tableland.
Marshall's No. 3	Early	South-western Slopes and Riverina.
	Early and mid-season	Central Tableland; Central-western Slopes; North-western Slopes.
Rymer	Mid-season	Central Tableland.
	Early and mid-season	South-western Slopes and Riverina; Central-western Slopes; North-western Slopes.
Thew	Mid-season and late	Northern Tableland; Central-western Slopes.
Warren	Early, mid-season and late	Coastal.
	Mid-season	Northern Tableland; Central-western Slopes; North-western Slopes; Western Plains.
Yandilla King	Early	South-western Slopes and Riverina.
	Early and mid-season	Central Tableland; North-western Slopes; Central-western Slopes.

B.—*Wheats for Grain Only* (not recommended for Hay).

Variety.	Period of Sowing.	Districts.
Bunyip	Mid-season and late	South-western Slopes and Riverina; Central-western Slopes.
	Late	North-western Slopes; Western Plains.
Federation	Mid-season	Central Tableland; South-western Slopes and Riverina; Central-western Slopes; North-western Slopes.

C.—*Wheats for Hay Only* (not recommended for Grain).

Variety.	Period of Sowing.	Districts.
Firbank	Mid-season and late	South-western Slopes and Riverina; North-western Slopes.
Huguenot	Early, mid-season and late	Coastal.
John Brown	Early, mid-season and late	Coastal.
Steinwedel	Early and mid-season	Western Plains; Central-western Slopes and drier portions of South-western Slopes and Riverina.
Thew	Mid-season and late	Coastal; South-western Slopes and Riverina; North-western Slopes.
Zealand	Early	Central Tableland; South-western Slopes and Riverina; Central-western Slopes.

D.—*Wheats Suitable for Green Feed and Soiling.*

Variety.	Period of Sowing.	Districts.
John Brown	Early and mid-season	Coastal.
Hugnenot	Early and mid-season	Coastal.
Thew	Early, mid-season and late	Coastal; Northern Tableland; North-western Slopes.
Florence	Early, mid-season and late	Coastal.

E.—*Wheats for Further Trial.*

The following varieties were selected as being suitable for continued experiment at the Experiment Farms and in the Farmers' Experiment Plots:—

Variety.	Period of Sowing.	Districts.
Cedar	Early and mid-season	North-western Slopes.
Sunset	Late	Western Plains.
Bomen	Mid-season	Central-western Slopes; South-western Slopes and Riverina; North-western Slopes.
Genoa	Early and mid-season	Northern Tableland.
Canberra	Mid-season and late	Central-western Slopes; South-western Slopes and Riverina.
Nardoo	Mid-season	Central Tableland; Northern Tableland; North-western Slopes.

F.—*Wheats to be Grown under Irrigation.*

In the experiments carried out by the Department, the following wheats have given the best results when grown under irrigation for hay and green fodder:—

(1) Zealand.
(2) Marshall's No. 3.
(3) Florence (late sowing).

These experiments are being continued in several districts.

With such a comprehensive system it will be seen at a glance, that little difficulty is experienced in recommending the most suitable variety for any district.

It is worthy of note that all of these varieties except three are new crossbreds produced by the late Mr. William Farrar, to whose great work in connection with wheat-improvement reference is made elsewhere.

A revolution in wheat-growing may be said to have taken place with the advent of these new varieties. Such an extensive range is provided that farmers can now begin their sowing in the principal areas with one kind of wheat the end of March, continue sowing through April, May, June, and finish with certain varieties at the end of July. Not only is the sowing period thus considerably prolonged, but the harvest period is extended accordingly, for the late varieties sown early, mature late, those sown in mid-season are harvested in mid-season, and the early varieties which have been sown late, mature and are harvested early. Thus, instead of the whole crop becoming ripe at the one time, it ripens in stages and is harvested accordingly. The immense advantages of such a system are in striking contrast with the methods practised before the introduction of these varieties, when practically the whole crop became ripe at the one time.

Foremost of the varieties bred by Mr. Farrer is "Federation." Ever since its introduction it has become a general favourite, not only with farmers in this State, but also in Victoria and South Australia.

Some six years ago the then Director of Agriculture in Victoria, Dr. Cherry, estimated the *increased* value in wheat-production in Victoria due to "Federation" annually at £250,000. The *increased* value in New South Wales I estimate to be considerably more. In the South-western Slopes, Riverina, and a slight portion of the Western Slopes, 1,800,000 acres are under wheat-cultivation, and it can quite safely be said that half of this area is sown with "Federation;" estimating the yield of "Federation" to be three bushels per acre more than the next best yielding variety (truly a moderate estimate) we find that at 3s. per bushel, the increased yield amounts to no less than £350,000 for this State, and this is due to one variety only. "Federation" is such a favourite, not only on account of its fine yielding and drought-resistant qualities, but also because it withstands wind and weather so well that it may be said to be almost storm proof; it would require a storm of exceptional violence to either cause the crop to lodge or cause the ear to shed its grain.

During the seasons 1910-11 and 1911-12, individual yields of 47, 42, 41, 39, 37 and 36 bushels were obtained in the Farmers' Experiment Plots; in fact, the average for all varieties recommended by the Department is considerably over 20 bushels per acre. "Federation" tested in the plots against what the farmer considers to be his best variety, has given some interesting results:—

District.	Departmental Wheat.	Yield per acre. bus. lbs.		Farmer's Variety.	Yield per acre bus. lbs	
Harden ..	.. Federation	.. 37	48	.. Lotz	.. 34	8
Ringwood ..	,,	.. 29	30	.. College Purple	.. 22	49
Ganmain ..	,,	.. 26	2	.. Turvey's Experimental	.. 23	22
Deniliquin ..	,,	.. 16	58	.. Dart's Imperial	.. 8	10
Lockhart ..	,,	.. 16	46	.. Farmer's Friend ..	.. 11	48

It will thus be easily seen that the choice of varieties particularly suited for certain districts is a big factor in increasing the yield.

Sowing.

The seeding period extends according to districts and variety sown from end of March until beginning of August, and sowing is almost invariably performed with a seed-drill with a fertiliser distributing attachment.

Late-maturing varieties, which are mostly good stoolers, are sown early, at the rate of from 35-45 lbs. seed per acre; mid-season wheats are sown in mid-season, at rate of from 45-50 lbs. per acre; and early-ripening varieties, usually poor stoolers, require to be sown late, at the rate of from 50-60 lbs. per acre. Much, however, depends upon local conditions, and no hard-and-fast rule can be laid down in this direction. Extensive experiments in thin and thick seeding with early, mid-season and late-maturing varieties are now being conducted at the various Government Experiment Farms and Farmers' Experiment Plots, and results will be available after next harvest.

Manuring.

The question of manuring is one which is of the greatest importance to the wheat-farmer. It is a factor vitally influencing the yield in the principal wheat areas. When the term manuring is used it refers to phosphatic manuring only. Fortunately, our wheat-growing soils possess an abundance of nitrogen and a sufficiency of potash, at least for present requirements, but are mostly deficient in available phosphoric acid. This is especially noticeable in the South-western Slopes, Riverina, and most of the western districts. Soils in the north-western and northern districts do not appear to lack phosphoric acid to such an extent as those previously mentioned. This is most likely due to the fact that the geological formation of the north and north-west is largely basaltic, whereas the west, south-west and Riverina is mostly of granitic formation.

Whatever may be the cause, it has been proved by practical experiments, extending over a number of years, that the southern and western soils respond more to phosphatic manuring than do those of the north and north-west.

Practically the only manure now used in the State in connection with wheat-growing is superphosphate; this practice is the result of years of experimental work with nitrogenous, potassic and phosphatic manures, singly and in combination. Superphosphate has proved superior to bone-dust or basic slag; sulphate of potash has not increased the yield, while nitrogenous fertilisers, such as dried blood or sulphate of ammonia, have proved either useless or harmful.

The quantity of superphosphate used is usually 56 lbs. per acre. Experiments carried out here clearly proved that larger quantities, say, 84 lbs. to 112 lbs. per acre, do not result in bigger yields being obtained, and still larger quantities, say 1½ to 2 cwt. per acre, actually result in poorer yields. In most wheat areas an application of a small quantity of superphosphate is almost as essential as fallowing.

RESULTS OF MANURIAL EXPERIMENTS.

South-western Slopes and Riverina (Farmers' Experiment Plot, 1912).

District.	No Manure. Bus.	lbs.	Manured with 56 lbs. Superphosphate per Acre. bus.	lbs.
Nubba	31	18	36	29
Germanton	28	49	40	5
Harden	26	45	30	2
Gininderra	25	24	30	2
Young	14	41	19	4
Ganmain	18	10	26	2
Ringwood	25	30	29	30
Grong Grong	22	15	24	32
Wyalong	19	33	25	45
Deniliquin	18	17	16	58
Henty	5	50	12	54
Lockhart	9	25	16	46
Average	20	32	25	40

While in some instances the outlay of 2s. 6d. per acre in 56 lbs. of superphosphate has resulted in substantial increases; in other cases, it has meant the difference between success and failure. In the western portion of the State the figures show that the unmanured section of the experiment plots gave an average of 16 bushels 49 lbs. per acre, whereas manured sections returned 20 bushels 14 lbs., so we see that in the districts where 95 per cent. of the wheat of the State is grown, *i.e.*, South-western Slopes, Riverina and Western Slopes, an average increase of 5 bushels per acre has been the result of ½ cwt. of superphosphate, a return of 17s. 6d. per acre for an outlay of 2s. 6d.

Harvesting.

Right throughout the State either strippers or harvesters are now used for harvesting the wheat crop.

The stripper is an implement which strips the heads of wheat by means of a 4½-foot or 6-foot comb and deposits the grain and chaff in a big drum attached to the rear of the comb, and is emptied whenever it is full. The "beeswing" and wheat being mixed, it now has to go through a winnower to be cleaned. The complete harvester, on the other hand, is an implement that strips similarly to a stripper, but by means of elevators, fans and riddle plates, not only at the one operation separates the wheat from the chaff, but also shoots the cleaned wheat into bags ready for sewing up.

This latter method is the one now almost universally adopted throughout the State, as by its means the work can be done expeditiously and cheaply.

To sum up the principal factors governing wheat-growing in this State, we find that farmers must pay close attention to:—

1. The conservation of soil-moisture by means of fallowing the land.

2. The sowing of only those varieties which are pre-eminently suited to certain districts.

3. The judicious use of fertilisers.

Maize.

Maize ranks second in importance amongst the crops of New South Wales, but its cultivation is small in contrast with that of wheat, although thirty-five years ago there was very little difference in the areas under each cereal. For the year ending March, 1913, 177,615 acres were under maize. This was an improvement on the preceding year, but still a considerable reduction on some of the previous years, when as much as 226,000 acres were planted.

The reason for this decrease is not far to seek. Maize is cultivated chiefly in the valleys of the coastal rivers, where both soil and climate are peculiarly adapted for its growth. Roughly, two-thirds of the total is grown under such conditions, and these are the particular localities where dairying has made such headway during the past few years. Milk, with its regular returns, has proved more profitable than the growing of a seasonal crop, with a big risk of failure, owing to unsuitable weather at a critical stage of growth.

The average yield for the coastal districts for 1912 was 34 bushels per acre, but the low returns from the Tablelands (averaging 15.8) and the Western Slopes, etc. (ranging from 10.4 to 7.4 bushels per acre) reduced the yield for the State to 26.9 per acre.

Successful efforts have of late years been made by the Department of Agriculture to introduce more suitable varieties than those hitherto grown, both for grain and greenfeed production.

Owing to the present custom of growing half-a-dozen or more varieties of yellow, red or white maize in a district, it is impossible to keep varieties pure, and cross-fertilisation occurs, thus tending towards deterioration. The Department has made arrangements by which pure pedigreed seed will be grown on the Government Farms and be available to farmers.

The best varieties at present grown in the State are: Funk's Yellow Dent, Boone County Special, Early Yellow Dent, Red Hogan, Early Leaming, Improved Yellow Dent, and Hickory King. In variety trials conducted by the Department on the Farmers' Experiment Plots, yields of 68 bushels of some of these have been obtained.

In maize-growing, as with most other crops, it is found that the crop requires to be manured.

Superphosphate, in combination with dried blood or sulphate of ammonia and sulphate of potash, or superphosphate combined with sulphate of potash, does not give better returns than superphosphate alone, and this fertiliser, used in quantities ranging from 1 to 2 cwt. per acre, appears to be the most profitable and economical manure for maize.

Increases up to 14 bushels per acre have resulted in some of the Farmers' Experiment Plots as the result of applying such fertilisers.

Oats.

The area under cultivation for oats for grain amounted in 1912-13 to 85,375 acres, yielding an average of 19.6 bushels per acre. The average yield for the last ten years has been 19.02 bushels per acre. This is not a profitable yield and, therefore, it is not astonishing to find such a comparatively small area under cultivation. Oats grow in almost any district in which wheat-growing flourishes, but to obtain best results districts with a 25-inch rainfall and over are preferred.

While for wheat-growing a shallow system of ploughing is advocated, the reverse is the case with cultivation for oats, and the land can with advantage be ploughed to a depth of 6-7 inches and deeper if the top soil permits it, otherwise the cultivation and harvesting methods are similar to those for wheat-growing, but the curious fact remains that while the manurial requirements for wheat consist of phosphoric acid only, the addition of a small quantity of nitrogenous manure in combination with phosphatic fertilisers usually gives the best results for oats. Of all the varieties tested for several years it can be safely said that Algerian oats have given the best all-round results for both hay and grain.

Potatoes.

The area under cultivation season 1911-12 was 43,079 acres.

Thanks to the good prices prevailing in New South Wales during the last few years the area under potato cultivation has increased steadily, and with more suitable varieties available and a more intimate knowledge of manurial requirements the farmers find potato-growing more profitable now than they did some years ago. The chief feature during the past few years has been the notable increase in yield due to artificial fertilisers. In this respect it appears that potatoes require heavier manuring than perhaps any other crops. The experiments carried out for a number of years in the Farmers' Experiment Plots throw a good deal of light on manurial requirements for potatoes.

A complete manure, consisting of superphosphate, dried blood and sulphate of potash, was tested against a complete manure consisting of superphosphate, sulphate of ammonia and sulphate of potash. The results were for several years so much in favour of sulphate of ammonia that now the Department has eliminated dried blood as a nitrogenous fertiliser, and the complete manure now recommended consists of:—

13	cwt.	Superphosphate
4	,,	Sulphate of Ammonia
3	,,	Sulphate of Potash
20	,,	

Of this mixture 4 cwt. is applied at time of sowing in the furrows in which the potatoes are planted, at a cost of 32s. per acre. In most cases the application of this manure results in payable returns, but from the results of some of the experiments it is quite evident that nitrogenous manuring is not so much required as phosphatic and potassic manuring. This conclusion is arrived at by comparing the results from the above mixture with a mixture consisting of—

16	cwt.	Superphosphate
4	,,	Sulphate of Potash
20	,,	

of which also 4 cwt. per acre was applied.

RESULTS OF FARMERS' EXPERIMENT PLOTS.

District.	Manured with 291 lbs. Super. 89 lbs. Sul. Am. 67 lbs. Sulp. Pot. per acre.			Manured with 358 lbs. Super. 89 lbs. Sulp. Pot. per acre.			Unmanured.		
	tons	cwt.	qrs.	tons	cwt.	qrs.	tons	cwt.	qrs.
Batlow	3	14	0	3	6	0	2	0	1
Chatsbury	3	2	2	3	13	2	2	10	3
Wolseley Park	7	8	0	7	19	0	5	7	1
Crookwell	5	10	3	4	18	2	4	0	2
Kangaroo Valley	2	13	2	2	18	1	2	10	1
Albion Park	1	13	3	1	17	2	1	1	1
Mittagong	2	9	1	1	16	3	1	5	2
Tenterfield	6	14	0	6	6	2	5	4	2
Black Mountain	6	3	0	5	6	1	4	8	1
Red Range	5	17	1	6	0	1	4	10	1
Guyra	7	10	1	7	2	2	7	15	3
Millthorpe	5	10	3	5	19	2	4	4	2

From the above figures it will be readily seen that manuring in nearly all instances gave substantial increases, with the exception of the experiment at Guyra, where the soil is of a particularly rich basaltic formation.

Nitrogenous manuring does not appear to be necessary for potatoes, as the yields obtained from superphosphate and sulphate of potash show.

The varieties which have given the best results are Queen of the Valley (late), Coronation (late), Surprise (late), and Manhattan (mid-season).

WHEAT-BREEDING.

By J. T. Pridham, Plant-breeder, Department of Agriculture, New South Wales.

Wheat-breeding in this State dates back twenty-eight years to the time when William Farrer took up the work which he since carried on enthusiastically at Lambrigg, near Queanbeyan, until his death in 1906. It was the ravages of rust in wheat (*Puccinia granuinis*), grown in coastal districts and to some extent inland, that led him to undertake the task of wheat improvement.

Farrer's objective differed from that of most experimenters in this field, in that his attention was not devoted to mere increase in yield. His aim was to produce wheats which should be able to resist rust and to thrive in the dry soils typical of our Wheat Belt. For this it was observed that varieties require to have stiff, narrow, glaucous leaves, to ripen early and to stool moderately. It was thus early recognised that ability to stool profusely, although desirable in countries of abundant rainfall, is a drawback in our hot wheat-growing country, where the plant is not able to fill with grain more than a limited number of ears.

In 1894 the nutritive and baking qualities of wheat received attention, and milling tests began to be made of the varieties produced: these were of immense assistance in determining the value of the material in hand and much time was saved which might have been spent upon breeding undesirable sorts.

In 1901 experiments were begun at Lambrigg with the object of securing a wheat immune to the attack of bunt (*Tilletia tritici*). It was hoped that the work and expense involved in pickling seed-grain before sowing might be saved if varieties could be bred to resist the disease. It has been found, however, that the degree of resistance secured, though high, is not sufficient to justify the farmer in omitting to treat his seed-wheat. Certain varieties are highly resistant, but in nearly all cases this attribute has been gained at the expense of some useful field quality. The experiment consisted in heavily bunt-infecting seed continuously year by year and saving each season the healthy individuals, the seed from which was used for the next year's plots.

Working Principles.

Crossing was employed from the first and the principles found in Darwin's "Variation of Animals and Plants under Domestication" formed the basis of the work of selection which followed. Although the system started by Farrer has in the main been continued ever since, our conception of the laws of breeding has been materially altered since the rediscovery of Mendel's laws of inheritance. It had been thought that the effect of crossing was to greatly stimulate variation in plants and even create new forms. Now, however, we have come to recognise that the characters of plants are units found in pairs—negative and positive—and are inherited in a pure state. The act of crossing causes the various characters to re-combine, and the great number of composite unions thus effected results in the well-known variation of form developed in the progeny of a cross. It will be seen that nothing new is evolved, but what is of value to the breeder is that the characters divide in a regular numerical proportion and certain characters can be depended upon to breed true, while others continue to segregate in the same proportion as before. Where a number of characters are involved in the cross it is difficult to secure a given character in a pure state. It is therefore necessary to employ large numbers in breeding in order to isolate the constant forms. The importance of handling large numbers was early realised and a great many crosses were made each year, by far the greater number of which would be eventually rejected.

Continuous selection is practised with fixed varieties, not with the hope of effecting any permanent cumulative improvement, but merely with the object of keeping the type pure and up to the original standard. Although improvement is certainly effected, both in yield and quality by this method, the amelioration is only of a temporary character, and if selection methods be relaxed the variety falls back to mediocrity.

Breeding Methods.

In 1906 the Cowra Experiment Farm was selected as the site for the central breeding station, the district being considered a safe one for the wheat crop and in a central position with respect to the other wheat-growing areas of the State. While the crossing is done at Cowra, it is recognised that the breeding of improved or new varieties must be accomplished by growing the unfixed progeny in other representative districts also in order that they may become adapted to the special local needs of soil and climate. Wheats fixed at Cowra are suited best to the conditions of that district only: one which thrives there is not necessarily the best wheat for the Wagga district, and a variety bred at Wagga would not be suitable for Bathurst. Breeding plots have been established at the following Government Farms: Wagga, Bathurst, Glen Innes, Richmond (Hawkesbury Agricultural College), and Nyngan. These plots are in the charge of the experimentalist at the respective farms and are visited from time to time by the Plant-breeder. The size and arrangement of plots is much the same at each station; they are in the form of drills or rows, each about 22 yards long, with a space of 16 inches between each plot. Paths are provided at convenient intervals and check or buffer rows adjoining paths or vacant spaces. The seeds are sown singly at five or six inches apart so that the individual plants can be easily distinguished and weeding facilitated. Check plots of the standard variety for the district are sown at regular intervals for purposes of comparison. Introduced varieties are grown for trial and acclimatisation, also samples forwarded by growers for identification or milling analysis. A good deal of space is occupied by stud plots of varieties commonly grown for supplying seed to farmers. The varieties are thus kept under observation; strange plants can be removed; the standards of yield and quality maintained and a supply of pure pedigreed seed, free from disease, provided for the Farm Manager's field sowings.

RECORDS.

Field notes are made at successive stages of growth, the most important of these are: description of the young plant, time of coming into ear, degree of stooling, height and character of straw, diseases, defects or peculiarities noticed, the suitability of the variety to the district and the date of ripening. The Experimentalist does not select a preconceived type of plant but marks the earliest heading individuals in the plot with a strip of black print tied just below the head. The five or six plants that appear best are cut with a good length of straw at harvest time and each plant is tied separately. The plants are then tied in a bundle to which is affixed a label bearing the number of the plot, name of wheat and date harvested. The balance of the plot is rejected unless the bulk of seed is wanted for sowing or milling purposes. In the case of unfixed crossbreds or wheats sent for identification, only selected individual plants are kept: in the former case all early ripening plants which appeared promising would be harvested. Before the straw turns yellow the rows are examined for the plants which ripen early: these are marked just beneath the ear with a strip of coloured print. It does not always follow that plants first in ear also ripen first.

At threshing-time a description of the ear and the strength and character of the straw is entered upon the records with a full description of the grain, the best milling type having usually a horny or transparent appearance. At this time an opportunity is afforded of examining the plants more closely than is possible in the field, and their capacity to hold the grain firmly as well as stoutness of straw can be well gauged when threshing. The heads of each plant are enclosed in a calico bag and the grain beaten out on a block. The contents are emptied into a shallow basin and the chaff blown away. The samples of grain from the various plants of a given plot are then compared with respect to their quality before enclosing in seed packets. Full descriptive notes are only made in the case of fixed varieties or cross-breds nearly constant.

When a wheat becomes fixed it receives a number, is sown in larger plots and tested in the Farm Variety Trial. If satisfactory here it is given a name and next season grown in Farmers' Experiment Plots or if enough seed is available sold to private growers. Besides the descriptive data noted at the stations where they have been grown, the behaviour of wheats in the mill is recorded and any information regarding them received from other sources is arranged alphabetically in drawers on the card system. Another set of records gives the locality in which any wheat was grown in a given year, the particular strain grown and its source. The history of a variety can be traced back by this means to the date when it first received a place in our plots.

District Requirements.

At the Wagga Experiment Farm wheats are grown to suit the warm Riverina climate. The varieties accepted here need to have good straw and to hold their grain when ripe. It sometimes happens that a variety which may have strong enough straw at Cowra or Bathurst will be found to be defective in this respect at Wagga; and a wheat which is not found to shake out its grain at Bathurst is condemned for this fault at Wagga.

At Glen Innes we have severe frosts to contend with and rather late-ripening wheats suit the district best.

At the Agricultural College the rust pest is always to be reckoned with, and quickly-maturing varieties give better results than sorts which offer resistance to the parasite by means of a tough, waxy cuticle, and which mature their grain comparatively late in the season. As the attack of rust is more severe usually towards harvest-time, the varieties which escape the disease by ripening their grain early are to be preferred to those which, though resistant, mature shrivelled grain on account of their protracted growing period.

At Nyngan the problem before us is to determine how far into the dry interior it is possible to profitably grow wheat for grain and when it becomes advisable to grow only for hay purposes. Here, more than at the other stations, early maturity is essential if wheats are to survive the hot winds which usually set in early in the season and cause the crop to dry off quickly.

WHEAT IMPROVEMENT AND WHEAT AND FLOUR INVESTIGATIONS.

By F. B. GUTHRIE, F.I.C., Chemist, Department of Agriculture.

THE history of the improvement of wheat in New South Wales possesses several features of peculiar interest. In the first place, wheat-growing is carried out under conditions which differ considerably from those which prevail in other countries, and as a consequence the problems presented are in many cases of an unusual kind. In the second place, the work has been done by a comparatively small body of investigators, and has been largely of a pioneer nature, involving many lines of work which had not hitherto been attempted.

In the earlier days, wheat-growing, like all other agricultural occupations, was confined to the coastal districts, which are not suited to the growth of this cereal owing to the liability to rust. It was not until cultivation had extended westwards beyond the Blue Mountains that New South Wales could become a wheat-producing country. The first extensive areas of wheat country were on the tablelands and western slopes. To-day, Riverina, in the south-western part of the State, is the principal wheat-producing region, and the cultivation of this cereal is extending westwards and northwards into the semi-arid and arid districts.

Here the danger from rust is very slight, but we are faced instead with the risk of droughts, particularly in those districts where the rainfall is below 16 inches. In these districts it frequently happens that the greater part of the rain falls when the land is unoccupied, and the quantity received by the growing crop is only 5 or 6 inches, or even less. At one of the Government farms in the west of the State a good crop of wheat has been grown with a rainfall of 2½ inches during the period of growth. So that the most important problem to be solved, if New South Wales is ever to become a great wheat-exporting country is the production of varieties capable of resisting droughty conditions.

In the following short account of the work carried out in the laboratory of the Department of Agriculture, only the general results have been considered. A bibliography is appended, giving references to the original papers, which are to be consulted for details.

Rust in Wheat Conferences.

The first official steps taken in Australia towards a systematic improvement of the wheats locally grown were made by the Victorian Minister for Agriculture, who in 1890 convened a meeting in Melbourne of the officers connected with the Agricultural Departments of the different States. The primary object of these conferences was to devise means of combating the rust pest, which had done very considerable damage in all the States during the years immediately preceding 1890. These conferences met subsequently in Sydney, Adelaide, Brisbane and Melbourne until 1895, when they were discontinued.

A great deal of good work was done by these meetings in the direction of studying the disease, testing different remedies, and bringing the confused nomenclature then prevalent into something like systematic order; but unquestionably the most valuable work performed by them was in drawing attention to the existence of an indefatigable, patient and intelligent worker—Mr. William Farrer, of New South Wales—who had for some ten years previously been engaged in the production, by cross-breeding and selection, of improved varieties of wheat.

At the last of the conferences it was fully recognised that the combating of rust was only one of the many problems which confronted the wheat-improver; and, although it cannot be said that these conferences advanced the solution of the particular problem with which they were concerned to any great extent, they were undoubtedly instrumental in drawing attention to other and more important factors, and it may be said that the advance in the production of improved varieties of grain along definite and scientifically thought-out lines was made possible by their labours.

The Work of William Farrer.

Mr. Farrer, who had at that time been working for ten years on the subject to which he devoted the remainder of his life, had been directing his attention particularly to the improvement of wheat, by cross-breeding and selection, along certain definite lines, namely, for rust-resistance, bunt or smut-resistance, prolificness, drought-resistance, facility of stooling, power of holding the grain, etc.

The question of attempting to produce grain which should be more acceptable to the millers had been mooted at some of the later conferences, but it had not been possible to suggest any definite scheme. In the first place, Australian millers were accustomed to handle a particular class of grain, namely, the soft white-flour wheat, and were not favourably disposed towards any new varieties, the milling of which would entail a modification of the methods then in use. The public and the bakers also had become accustomed to a loaf of extreme whiteness, and were inclined to regard any tinge of colour as indicative of dirt. Secondly, our wheat met a certain demand upon the English market for a white flour with which to blend the stronger, but yellower, flours obtained from America and other places; and, what was still more important, there was no means of reducing small quantities of grain (such as would be the result of the first few years' cultivation of a newly-created variety) to a flour comparable with that obtained by the miller. Consequently, it would take many years before the wheat experimenter could produce a sufficient quantity of any new variety to enable its merits as a milling wheat to be tested.

Milling Qualities of Wheat.

The first batch of results giving the milling qualities of a number of standard varieties and new crosses, tested on a small mill devised and constructed for that purpose, was published in March, 1895. (*See Bibl. A1.*) This mill consisted merely of two small pairs of rollers—rough and smooth—and was worked by hand, the bolting being done by means of hand-sieves. In spite of the primitiveness of the apparatus, we were able to turn out a very creditable flour, similar to that obtained by the miller in all respects, perhaps except in colour, and were able to state with some degree of accuracy how any particular wheat would behave when treated on a large scale—and this on small parcels of 10 to 12 oz. of grain. (*See Bibl. A11.*) The work that had been done by the nomenclature committee appointed by the Rust in Wheat Conferences enabled us to compare, with some accuracy, the milling qualities of the different types of wheat then in cultivation with foreign types, and with some of Mr. Farrer's new crosses.

A point of special interest was that the cross-bred wheat was found to inherit the milling characters of both its parents (the Mendelian law was not then generally known), so that it was henceforward possible to breed for milling quality, as well as for other desirable characteristics. From this time on it was possible for Mr. Farrer to reject an enormous number of his crosses as soon as they were fixed, without being put to the trouble of growing them for many years until he should have enough of the pure seed to enable a miller's judgment to be passed on them. He was thus able to lessen his labours considerably, and at the same time to prevent the propagation of grain of inferior milling quality. In two or three years' time he was able to put into distribution four or five varieties, which, while they met certain requirements, such as drought or rust resistance, were good milling wheats; and at the present time the Farrer wheats are all such as to be preferred by the local millers to those previously grown.

Mr. Farrer's work has been ably continued since his death by his successors, Mr. G. L. Sutton and Mr. J. Pridham, and the Agricultural Department is now in a position to recommend with confidence improved varieties of grain suitable for different purposes and for different districts of the State, and, what is of more importance, is able to provide farmers with pure seed-wheat true to name.

Strong-flour Wheats.

Flour-strength was also found to be an inherited characteristic, so that it was possible to improve the flour-strength of a soft wheat by inter-breeding with a strong-flour variety, and this without impairing the other properties of the flour, such as colour or gluten-content.

A great number of Mr. Farrer's earliest successes were varieties produced by crossing the ordinary soft, weak-flour wheats with those of the Fife family. Among the most important of these was Federation, which is also of special value as a dry-climate wheat. At that time considerable doubt was expressed as to the possibility of maintaining the strong-flour characteristics when grown in New South Wales, the opinion being generally held that such wheats would tend to become soft when grown in our climate, the absence of long-continued and heavy frosts being considered detrimental to the production of a strong flour. The possession of the small testing mill enabled us to investigate this question, and we were able to state definitely that certainly in some districts the seed imported from Duluth or Manitoba could be grown satisfactorily for several years in succession, yielding as well as most of the other varieties, and not deteriorating to any perceptible degree in flour-strength. *(See Bibl. B4.)*

In other warmer districts the imported grain showed signs of deterioration after a few seasons. Here Mr. Farrer's crosses showed their superiority, and, thanks to his work, New South Wales can to-day grow wheats yielding as strong flour as that produced in any country in the world.

Flour Strength and Baking Quality.

In close connection with the problem of maintaining and increasing the strength or baking quality is the question of what constitutes "strength." It had been found in examining the flour produced by the first batch examined (*loc. cit.*) that the largest and best loaves were always obtainable from the flours having the highest water-absorbing capacity. It seemed, therefore, quite justifiable to continue to regard the power of absorbing water as an indication of the "strength" of the flour. This practice was continued, and—for want of any more accurate method of determining strength, otherwise than by baking tests, which are by no means reliable—is continued by us to the present day. In justification of this procedure, I may draw attention to the fact that all the new strong-flour wheats created by Farrer were selected by him because of their possessing this power of absorbing water when made into flour in an eminent degree. Nor have we met with a case in which this characteristic was not associated with good baking quality.

Although, therefore, this property does not constitute flour-strength, it may quite safely be regarded as a measure of that quality. It has, moreover, the advantage that it is a test which can be applied readily and which can be relied upon to give concordant results, which cannot be said of a baker's test.

The question of what is the cause of strength in flour has not been overlooked, and a good deal of work has been done in this direction. At one time the opinion was generally held that gluten-content and strength of flour were synonymous. This had been shown to be untenable, as the wheats giving the highest gluten contents, namely, the Durums, produced the weakest flours of any examined, and in no case was there any regularity to be noted between the gluten-contents and the strength of flour. We must look for some characteristic property, or combination of properties, either in the flour itself or in the gluten, to supply the answer.

The first investigation published related to the connection between the strength of a flour and the proportions of glutenin and gliadin in the gluten, which Osborne and Voorhees* had recently shown to be the proteids present in gluten. This investigation was published in June, 1896 (*Bibl. B1*), and constitutes the first suggestion that flour-strength depends upon the relative proportion of glutenin and gliadin in the gluten, those flours being the strongest in which the glutenin preponderated. Shortly after this paper appeared, a communication was published by M. Fleurent† in the *Comptes Rendus*, drawing attention to the same fact, and in a subsequent paper‡ M. Fleurent applied this method in appraising the baking qualities of a flour.

Further work on this subject (*Bibl. B3*) has convinced me that the relationship is not as simple as I at first thought; nor is the separation and accurate determination of the two proteids quite satisfactory. This method has, therefore, been abandoned in this laboratory, and is not, I believe, any longer recognised. The question—what is the cause of strength—still remains to be solved.

Relative Strength of Flour of Different Grades and Blends.

(*See Bibl. B6.*)

The results of some recent experiments into the causes determining strength in flour were published in 1909. The water-absorbing powers of flours of different grades of fineness were examined.

It was found that the finest flours always possessed the highest water-absorbing power. If this were alone considered, it would appear that the water-absorbing power of the flour obtained from the same wheat depended upon the fineness of division of the flour; but the further peculiarity was noted that when these different grades of flour were reduced to flour of a uniform grade the flour derived from the finer and more water-absorptive grades was invariably itself more water-absorptive than that derived from the coarser grades.

It was also found that when a strong and a weak flour wheat were blended before milling the resulting flour was always stronger (more water-absorptive) than one would have

* "The Proteids of the Wheat Kernel;" *American Chemical Journal*, vol. xv, No. 6. † *Comptes Rendus*, 3rd August, 1896. ‡ *Comptes Rendus*, 9th November, 1896.

anticipated. For instance, a blend of three-quarters of a strong-flour wheat with one quarter of a weak-flour wheat produced a flour of exactly the same strength as that obtained from the strong-flour wheat alone.

This peculiarity was even more strikingly shown in the case of flour blends. In these cases the blend of three-quarter strong flour with one-quarter weak flour had a higher water-absorptive power, and produced a loaf of greater volume, than did the original strong flour.

It would therefore appear more profitable to the baker to blend his flour than to use flour of one quality from a mixture of wheats, and that the addition of a small proportion of weak flour to his strong flour, so far from reducing the water-absorptive power of the latter and the volume of the resulting loaf, actually increases them.

Other Uses of the Mill.

In addition to the assistance afforded to the wheat experimenter in enabling him to maintain a high standard of milling excellence in his new varieties of wheat—for which purpose it was originally devised—the wheat-testing mill has been of service in a variety of other ways for the benefit of the wheat-grower, miller and dealer. After the value of small testing machines of this description had become recognised, small mills of this kind were made by several firms of milling engineers, and our original hand-mill has long ago been superseded—first by having the original rolls run by power, and attached to a bolting box (*Bibl. A11*), which enabled the different products to be more expeditiously and satisfactorily separated; and later by a small model mill constructed in Europe, all the recent work having been carried out on this improved model.

In addition to the information afforded to the wheat-experimentalist, we are able to test for the miller small parcels of grain, and report upon their milling quality, and thus often save him from purchasing a wheat which, though attractive in appearance, might not give good results in his mill. The farmer is able to get an opinion as to the milling quality of his seed-wheat, and the value that is likely to be put upon it by the miller. The wheat-buyers and shippers also make frequent use of the mill in having samples tested. It is further of value in adjudicating upon the wheats entered for prizes at agricultural shows. In Sydney, for many years past the wheats competing for prizes at the Royal Agricultural Society's Show have been submitted to the Agricultural Department for judgment, and the prizes have been awarded according to the actual behaviour of the wheat in the mill, marks being assigned for such qualities as weight per bushel, ease of milling, percentage of flour, and colour, strength and gluten of the flour. (*See Bibl. A6 and A7.*)

It will be seen, therefore, that the possession of such a mill for testing small samples is a matter of necessity to any person or institution concerned in the improvement of wheat. It is not too much to say that the great success that attended Mr. Farrer's labours was due to the fact that he was able to ascertain the milling qualities of any variety as soon as it was established, and to utilise as parents strains of milling excellence. He was thus saved from the risk of spending many years in establishing and growing a new variety, only to find that, though it was excellent in other respects, it was of no use to the miller, and consequently worthless—an experience that every wheat-breeder has had. It is true that he might by accident have produced one or two strains of good milling quality, but he could not have systematically bred for other qualities with the certainty that the result would be an improvement on the old variety as regards milling excellence; and it is in this respect that Mr. Farrer's work since 1896 (he had been at work since 1882) differed from that of his predecessors, and was so prolific and speedy in its results.

Nature of Flour Produced at Different Stages of Milling.

(*See Bibl. A9.*)

Examination of the flour produced at different stages in the mill has given some rather interesting results, which are here summarised from the original papers.

The flour from the breaks is stronger than that obtained from the reduction of the semolinas, and on the whole of somewhat better colour.

The break-flour is notably richer in gluten, the proportion of gluten being particularly high in the last break. As the gradual reduction of wheat involves the gradual scraping of the flour by the rough rolls until the bran is clean, this means that the layer nearest to the bran (the so-called aleurone layer) is the richest in gluten. This richness in gluten is unfortunately not accompanied by the other characteristics which go to make a good flour, and the flour from the last break is of little value to the baker.

In other words, though the flour won from the neighbourhood of the bran is remarkably rich in gluten, the gluten is not of the quality to form a good dough. This fact is taken advantage of by millers in the production of "patent" and "baker's" grades.

Manure Experiments with Wheat.

(See Bibl. C1 and C3.)

Experiments to determine the most suitable manuring for wheat were initiated at the Experiment Farms at Bathurst and Wagga in 1900, and were continued at Wagga for five seasons. The great difficulty experienced in controlling such experimental work at so great a distance from Sydney led to their abandonment.

The general results of these experiments may be summarised as follows, and refer to the Riverina district of the State, which is typical, in regard to climate, of the greater part of the wheat-growing area of New South Wales. The rainfall varies from 11 to 26 inches, the actual amount received by the crop being seldom much more than 12 inches, and often as little as 8, excluding droughty seasons:—

1. On new or fairly good land the addition of small quantities of superphosphate ($\frac{1}{2}$ cwt. to $\frac{3}{4}$ cwt. per acre) alone gives better results for the first few years than mixtures of complete manures. This initial advantage disappears, however, after the first two or three years, and a complete manure is necessary to obtain the best results.
2. The use of nitrate of soda, or of sulphate of ammonia, alone, has no influence on the yield, and it would appear that superphosphate occupies the same position as a manure for wheat that nitrate of soda does in Europe. *(See Bibl. C3.)*
3. Basic slag is just as effective as superphosphate, and has the advantage that the beneficial effects persist for a longer period of time.
4. Potash salts, though apparently without influence on the yield when used alone, are a necessary ingredient when wheat-growing is carried on continuously, and should not be omitted from the mixture.
5. Light manuring is more economical than heavy. Excessive proportions of the ingredients are not only uneconomical, but actually less productive of high yields of grain than small quantities.

6. The results obtained by the addition of part of the manure as a top-dressing at a later stage of the plants' growth are not commensurate with the labour and time expended. Manuring is best done when the seed is sown.

Tolerance of Wheat for Injurious Substances in the Soil.

(*See Bibl. C2.*)

A series of pot experiments was carried out to determine the proportions of certain toxic saline matters which could be tolerated by different farm crops.

The substances particularly examined were common salt and carbonate of soda, both of which occur in the water obtained from artesian bores which is used for irrigating purposes. In addition, certain substances which may occasionally occur in the manures used for fertilising the crop, such as chlorate of potash, ammonium sulpho-cyanide and arsenic, were also tested.

The following summarises the results obtained in the case of wheat:—

Effect upon germination and subsequent growth of the wheat plant of different percentages of injurious substances in the soil.

	Germination Affected.	Germination Prevented.	Growth Affected.	Growth Prevented.
$NaCl$	.05	.20	.05 to .15 (recov.)	.20
Na_2CO_3	.30	.5 to 1.0	.10	.40
NH_4CNS	.005	.01	.001	.005
$NaClO_3$	above .01	.05	.001	.003
As_2O_3	.05	above .05	.05	.10

Variations in the Strength and Gluten-content of Local Wheats over a Series of Years.

(*See Bibl. D6.*)

Doubt is frequently expressed as to the ability of any fixed variety of wheat to maintain its characteristics over a series of years. This is more particularly the case with regard to the strong-flour varieties created by the late Mr. Wm. Farrer, with special reference to local requirements. Some prominence has been given lately to a statement to the effect that these wheats were deteriorating, more particularly in respect to their gluten-content.

In order to ascertain if any such alteration could be traced, the records of the work done in the testing of wheats and flours in the laboratory of the Department of Agriculture during the last thirteen years have been carefully collated.

The wheats and flours tested cover a fairly large field, and include typical farmers' wheats, as well as the cross-breds made and in process of making by this Department.

An examination of the table published with the article referred to shows that there is no falling-off in either strength or gluten-content of the Farrer wheats during the period covered; nor, for that matter, in any other class of wheat. There are seasonal variations, and in this respect the years 1908, 1909, and 1910 have been exceptionally high in both strength and gluten, and have inflated the averages in all cases.

As far as the Farrer wheats are concerned, there is no regular deterioration such as is suggested, but on the contrary the figures for the present season are close up to the average. The millers' flours show the least variation of any, as might be expected, since variations in quality due to the seasons are largely counteracted by blending. They nevertheless reflect the high flour strength and high gluten characteristic of 1908-1909. The local soft-wheat class (non-Farrer) are the only ones of which it can be said that there is any indication of a downward tendency in this respect. If we neglect the two years of exceptional flour-strength, 1909-10, and the three years of exceptionally high gluten, there is a slight reduction apparent in both these figures; but such reduction is probably more apparent than real, and the conclusion may be drawn that, when dealing with considerable numbers of typical wheats of fixed types, any alterations noticeable are seasonal ones, and not due to alterations in the characteristics of the grain.

Effect of Weathering on Wheat.

(See Bibl. D7.)

In order to test the nature of the damage done to grain from the milling point of view by bleaching, samples of bleached and unbleached wheats harvested in 1912 were examined.

Apart from the colour and appearance of the grain, the difference in which is very marked, and to the disadvantage of the bleached grain, the chief difference is in the bushel weight, which is lower in the case of the bleached sample of Federation by 5 lb. per bushel, and in the case of Jade by $3\frac{3}{4}$ lb. This is a very serious deficiency, and affects the commercial value of the sample considerably.

Summing up, the effects of bleaching (by weathering) are to affect the appearance and colour of the grain, to lower the bushel-weight considerably, and to diminish the gluten-content of the flour. The most serious of these results, from the miller's point of view, is the lowering of the weight per bushel, and this is a defect that seriously reduces the market value of the bleached grain.

Some time ago, in order to test the effect of bleaching on grain, we exposed a sample of Bobs wheat during a showery week to the alternate action of sun and rain for six days. The original sample had a bushel-weight of $64\frac{1}{2}$ lb. The same sample, after bleaching, weighed only $54\frac{3}{4}$ lb. per bushel, having suffered a loss in weight of $9\frac{3}{4}$ lb. This is, of course, an exceptional case, as the conditions were purposely made very severe.

Effect on Milling Quality of Cutting at Different Stages.

(See Bibl. D8.)

Since weather conditions at the time of harvest may have such serious consequences on the value of the crop, it is important to ascertain whether harvesting at an earlier stage than is customary would have any bad effects on the quality of the grain. If the grain can be cut before it is dead ripe and allowed to ripen under cover without lowering its value, it would often be possible to save a crop from the bleaching action of sun and rain, by cutting it at a more favourable time.

Samples have been taken over a number of years (1907-1912) from different varieties of wheats (mostly strong-flour wheats), and from farms in various localities of the State. Plots were selected, and the grain from the one crop harvested at different stages of ripening—when the grain was in the milk-stage, soft dough and hard dough stages, and when dead ripe; and the behaviour of the different samples compared in the mill.

The figures for bushel-weight, colour of flour, gluten-content and absorptive power for water are very irregular, and it is not possible to say that any particular quality is affected by the time at which the grain is cut. When the wheat has been allowed to become dead ripe before harvesting and has become bleached, there is the usual lowering of bushel-weight; but in cases where the grain has ripened normally in the ear there is very little difference in the milling quality of the grain when cut at different stages, and no regular difference such as would justify us in saying that any particular stage of ripeness was the best.

On the whole, the advantage seems to lie with the grain when cut in the hard-dough stage, and the conclusion is justified that, when weather conditions threaten to be unfavourable, it will be advantageous to harvest the grain before it is ripe. This procedure has the advantage, not only of saving the crop from being bleached, but also of avoiding loss from shelling of the grain.

With the stripper, of course, this cannot be done, and it is stated by many observers that bleached wheat was unknown in this State until the advent of the stripper.

Tests made by baking flours made from wheat cut at different stages (*Bibl. D8*) also showed that the wheat cut in the hard-dough stage gave an even better loaf, lighter and of greater volume than did the dead-ripe grain.

Daily Variation in Moisture-content of Flour.

(*See Bibl. D9.*)

The determinations were made fairly regularly from 26th October, 1910, to 31st October, 1911, with the exception of a break of three weeks in April, 1911. The flours were kept in ordinary flour-bags, and were placed in a vestibule outside the laboratory, so that they were unaffected by the variations in temperature or by the air of the laboratory, and were in a well ventilated but not draughty place where the outer air had free access to them. A sample was taken each day from the mouth of the bag, which was then loosely closed.

A graph was prepared in order to see whether any close connection existed between the humidity of the air and the moisture in the flour at the same time. The air-humidity graph and the flour graphs coincide fairly well, any exceptional rise or fall in the one being reproduced in the other. At the same time, there are some remarkable deviations.

The flour-moisture graphs run very closely together. On the whole, the Manitoba flour shows a slightly higher moisture-content, the average being about 11.2 per cent., as against 10.8 in the case of the ordinary flour. The mean for both is about 11 per cent.

The chief interest lies in showing how the moisture-content in the same flour may vary from day to day, and within what limits it may vary. The lowest percentage of moisture in the case of the ordinary flour is 8.1, the highest 13.4. In the case of the Manitoba flour, these figures are 8.6 and 13.6, respectively.

The figures may also be of interest in connection with the question of the amount of moisture permissible in flour, especially as many people think that the millers add water to their flour in order to increase its weight.

The amount of moisture in the finished flour depends more upon the atmospheric conditions prevailing in the mill than upon any conditioning or spraying to which it has been subjected, since unless it contains the proper proportions of moisture, it will not pass satisfactorily between the rolls or through the sieves and purifiers.

These experiments show that the proportion of moisture in flour may vary considerably from day to day within the limits indicated.

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DAIRYING IN NEW SOUTH WALES.

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Australian dairying was cradled in New South Wales, the districts known as Illawarra and Shoalhaven, lying on the coast-line from 50 to 90 miles to the south of Sydney, being responsible for the initiation of dairying on a commercial basis. The early pioneers of the movement were mainly Irishmen and Scotchmen, and great were the difficulties they had to contend with in the way of manufacturing and marketing their produce. In the summer time the temperature frequently exceeds the point at which butter becomes semi-liquid, and, as transit facilities were primitive, the butter consigned to Sydney from these districts frequently arrived in a melted condition. In winter very high prices were obtained, and this partly compensated for the summer losses.

Introduction of Refrigeration and of the Separator.

It was not, however, until lower temperatures could be produced on a commercial basis by refrigerating machinery that it became possible for Australian dairying to develop to a standard worthy of comparison with the state of the industry in colder climates, and it is to the credit of such men as Messrs. James Harrison, T. S. Mort, and E. D. Nicolle, that it was made possible for following generations to not only produce butter in an atmosphere artificially cooled, but to export it to England in chambers made so cold by machinery that it does not deteriorate to any material degree.

Following improvements in methods of refrigeration, came the invention of the centrifugal separator, and its general application in the dairying districts of the State was only a question of a very short time. Mr. David Lindsay Dymock, late of Jamberoo, New South Wales, was mainly instrumental in introducing the centrifugal separator into Australia, and to his enthusiasm was due its almost immediate adoption.

Factory Dairying.

The introduction of the separator made possible the factory system, and the first Australian factory was erected in the Illawarra district, near Kiama, New South Wales, in 1884. To-day there are in the State 160 butter factories, all being worked on up-to-date lines, and deriving the raw product from the farmers in the shape of cream. In 1911 there were 101 butter factories worked on co-operative lines, and 50 proprietary concerns. There were also 20 proprietary cheese factories, and eight co-operative undertakings.

From Milk to Cream.

As in all other countries, factory dairying in New South Wales began with the supply of milk to a central manufacturing institution, where the cream was separated from the milk and manufactured into butter. Owing, however, to a number of factors—to principally the difficulty of keeping milk sweet for any length of time during the summer months, to inferior roads, as well as to the distance of some farmers from central factories—the question of separating milk at farmers' homes and supplying cream to the butter factory became a problem in dairy economics, and our dairy farmers adopted the home separator principle unanimously within a period of four or five years. To-day there is not a butter factory in New South Wales that draws its supply solely from milk; in fact, it is rare to find one receiving milk, farmers preferring to separate the milk at their own homes, and feed the freshly separated milk to their own pigs and calves, rather than send large quantities of milk to the factory and draw back heavy loads of separated milk.

Some of the butter factories make as much as 60 tons of butter per week during the summer months, and their cost of erection has been anything from £10,000 downwards. Probably the best factories in the State are situated in what is known as the Richmond River district on the North Coast. There is also a very modern butter factory on the Yanco Irrigation Area, probably as complete as any in Australia.

The largest co-operative concern in the State is that which has its headquarters at Byron Bay, and is known as the North Coast Co-operative Company. The turnover last year was £879,402, an increase of £127,129 on that of the previous year.

Our Dairy Herds.

To-day excellent representatives of all the British breeds of dairy cattle may be found in the State; in fact, New South Wales is, and promises to continue to be, a leading stud stock State of Australia, both in cattle and horses. The greater number of our dairy cattle are, however, of the Shorthorn type, and there is a strain of Shorthorn, known as the Illawarra type, in existence to-day, which has no superior in any part of the world as a dairy cow suitable for good country. This strain of Shorthorn can be traced back to early importations, but it has not been kept absolutely pure, and there is no doubt that in many cases Holstein and Ayrshire blood has been introduced, but in the stud book representing the breed only animals of the Shorthorn type that have passed a severe inspection, and whose descent is traceable for some generations to milking Shorthorn blood, are admitted. To the early pioneers of Australian dairying in the districts of Illawarra and Shoalhaven must be credited the development of the milking qualities of this breed. The early representatives of this breed were brought to Australia before the Shorthorn was converted into a beef breed in England; and the New South Wales dairymen, with some exceptions, having declined later on to use beefy bulls in their herd, preserved the deep milking qualities for which the old Teeswater cattle were famous. As showing the milking capacity of some of these animals, the following yields, which were obtained on the Darbalara Estate by officials of the Dairy Branch of the Department of Agriculture, are given:—

RESULTS FOR A NINE-MONTHS' MILKING PERIOD.

Name of Cow.	Yield of Milk.	Yield of Butter.
"Lily"	14,347 lbs.	571 lbs.
"Melba II."	12,981 ,,	561 ,,
"Champion III."	10,213 ,,	558 ,,
"Sybil"	9,788 ,,	456 ,,
"Camelia II."	9,303 ,,	432 ,,
"Lily II."	9,116 ,,	402 ,,

GOVERNMENT IMPORTATIONS OF STUD DAIRY STOCK.

In the year 1897 the New South Wales Government engaged the writer as Dairy Expert, and, after a careful survey of the conditions, certain recommendations were made, the principal being the importation of stud dairy stock, and the establishment of a State stud farm, so that a stimulus could be given to the breeding of approved types of dairy cattle. As a result, the Government of the State imported 24 bulls and 38 cows representing Shorthorns, Guernseys, Jerseys, Ayrshires, Kerrys, Holsteins and Red Polls. The bulls were to be used for the double purpose of being mated with the imported cows on the State farm, and being leased to dairy farmers with a view to improving the ordinary dairy cattle. Prior to this date important importations, mostly Jerseys and Ayrshires, had been made by private breeders, but, following on the lead given by the Department, quite a large number of importations for private studs followed soon afterwards, more especially in Guernseys and Jerseys, and to-day there are in the State of New South Wales as good representatives of the three breeds mentioned as can be met with anywhere. The winners of champion honours in English shows, both in Jerseys and Guernseys, have been imported into the State for private stud purposes.

Numbers of Dairy Cattle.

At the end of the year 1912 there were in New South Wales 822,646 dairy cows, together with about 30,000 two-year-old heifers who were within three months of calving. In 1907 there were 713,223 dairy cows; thus there was an increase of 109,423, or over 15% milking cattle in five years.

Total Dairy Production.

The year 1911 was our largest in the way of dairy production, as, owing to an unfavourable season in 1912, there was a material decrease. During the year 1911, 83,204,568 lbs. of butter were manufactured; in addition to this, 5,640,652 lbs. of cheese were produced. There were also 3,058,497 lbs. condensed milk (finished product) turned out. For the year 1912 the production of butter dropped to 76,609,528 lbs., while the quantity of cheese produced remained about the same. Taking the average for the four years ending December, 1911, New South Wales produced 71,012,063 lbs. per year.

Production per Cow.

The figures given by the State Statistician show that there has been an increase of 78 gallons per head in the yield of our dairy cows during the ten years ended 1911. Estimated at 6d. per gallon, which is about the value of whole new milk, the increase referred to, when calculated on the number of cows which were in milk on the date on which the statistical records were taken, represents a sum of £1,245,123 sterling. In other words, this is the sum which represents the annual increase from dairying by the improvement which has taken place in our dairy cattle.

Improvement in Quality of Milk.

Not only has the milk yield per cow increased during the last ten years, but the quality of the milk has shown a very material improvement. In the year 1902 it took 25.6 lbs. of milk to make one pound of butter, whereas in the year 1911 it took only 23.6 lbs. of milk for a pound of butter. In a butter-producing State like New South Wales, this item is scarcely less important than the increase in the milk yield of our cattle.

How Milk is Disposed of.

The following table by the State Statistician shows how the milk produced on dairy farms is disposed of:—

	Gallons.
Used on farms for making butter	14,410,738
,, ,, ,, cheese	2,033,426
Separated on farms, cream being sent to factories	180,784,095
Sent to butter factories or separating stations for butter	1,786,378
Sent to butter factories or separating stations for sweet cream	300,535
Sent to cheese factories	3,682,521
,, condensers	858,997
Pasteurised at factories for metropolitan market	3,598,773
Balance sold or otherwise treated	30,167,537
Total	237,623,000

Exports of Dairy Products.

New South Wales produces considerably more butter than is required for consumption within the State, and hence we are large exporters of butter, mainly to Great Britain. On the other hand, we produce scarcely sufficient cheese for our own requirements, and hence we do not export cheese to any extent. As a matter of fact, we still import cheese. The growth of the butter export trade has, however, been a vital factor in the development of the dairy industry. For instance, in the year 1896, the State exported butter to the value of £102,502, whereas for the year 1911 we exported butter to places outside the Commonwealth to the value of slightly over one and a-half million pounds (£1,500,000) sterling, in addition to which we exported butter to other States to the value of £225,000. Our average net exports outside the State for the four years ending 1911 are estimated by the Commonwealth Statistician at 28,613,126 lbs. It is estimated that New South Wales consumed butter to the extent of 26.23 lbs. per head during these four years. Probably no part of the world has a greater consumption of butter per head of population than in New South Wales, and this is no doubt an indication of prosperous conditions, and a factor which speaks very encouragingly for the future.

Supervision of Exports.

Under an Act passed by the Federal Government, no dairy produce can leave Australia without having been previously inspected as to purity, correctness of weight, and correctness of trade description. In addition to this, exporters may, if they so desire, have dairy products classified into classes or grades, and, as showing that this latter clause is considerably in favour with exporters and buyers in other countries, it may be stated that, of the total amount of butter exported from Sydney last year, 57% was classified at the request of exporters.

This work is done in the various States for the Commonwealth by State officials. This is an advantage for instruction purposes, because the Dairy Branch of each State is then placed in a position to know exactly those factories that are turning out inferior butter, and therefore may bring science and practice to bear in improving matters.

The Bacon Industry.

In every great dairying country the manufacture of bacon takes a very important place in the national industries. In Ireland, where dairying has been a leading national industry for centuries, bacon curing is also an important factor in the industrial life of the country; Irish bacon fetching higher prices than that produced in any other part of the world. Denmark, a country that exists almost entirely on its dairying industry, has also become a great bacon producing centre. Australia has taken an important place among butter producing nations, and there is no reason why it should not also become a very large bacon producing and exporting centre. Wherever milk is produced in great quantities for butter making purposes, there may bacon be produced under the best and cheapest conditions. It is a recognised factor in the production of good bacon, that milk, either separated or as butter milk, must form part of the daily ration of the pig. Milk is not only necessary to the sow when she is rearing her young, but is also necesary as an important part of the ration for fattening purposes. When pork is worth 3d. per lb., separated milk is worth 1d. per gallon, and to-day, when pork is bringing the record return of nearly 6d. per lb. to the farmer, separated milk should be worth about 2d. per gallon for the purpose indicated. Bacon has not been produced in Australia, and especially in New South Wales, in sufficiently large quantities to make export to any extent possible, but with the general shortage of bacon throughout the world, and consequent high prices, there is every reason to believe that Australian dairy farmers will produce pigs in such large numbers that a surplus for export will be available in the near future.

Large bacon factories are now being erected in New South Wales and in Victoria, and some of these have been put down under the direct guidance of an expert of European reputation, and all facilities for the making of bacon suitable for export are being provided. Any reduction in the price of butter may be more than compensated for by the increased value of bacon, and hence it is that many of our farmers to-day are rearing very few calves, and are fattening many more pigs than was the case a couple of years ago.

During the year 1912 bacon and hams were manufactured in New South Wales to the extent of 16,526,276 lbs., as compared with 8,995,856lbs. in 1902; the industry having thus almost doubled itself in 10 years.

Most of the bacon manufactured in the State is made by co-operative companies who run joint butter and bacon factories. The number of pigs in the State in 1912 was estimated at 293,653. There are representatives of the Berkshire, Yorkshire, Poland-China, large British Black, and Tamworth breeds in the State. The pig most in request by bacon merchants and farmers is undoubtedly one showing Berkshire blood in the main; crosses between the Berkshire and Tamworth are also becoming popular. The Large York did not find favour in this country in the same way that it has done in the British Isles and Denmark. To some extent this is due to the colour of the animal's skin and hair, as they do not stand the hot sun so well as the dark-skinned pigs. As the export trade develops, however, there is every reason to believe that the York pig will be especially suitable for crossing purposes in order to produce a large, long side of bacon, so much in request on British markets.

Modern Development and Dairy Education in New South Wales.

Needless to say, the main factor in improving our standards and conditions is that of education. Prior to 1897, very little had been done, except in an elementary way, in connection with dairy instruction, and the various sections of the industry had to be tackled individually and severally.

Instruction on Farms and in Factories.

There having been no school for the training of factory managers, the men who were in control of factory management prior to 1897 were those who had picked up their knowledge as a result of experience only; and as the experience of that date was very limited, butter-making was not on an advanced basis. As the industry gradually developed, a staff was obtained for instructional purposes in field and factory. In the meantime facilities for education were being rapidly improved, and an advanced course was instituted for dairy students at the Hawkesbury Agricultural College, where a number of those on the field staff of the Dairy Branch to-day obtained their training.

When home separation took the place of separation of the cream from the milk in factories, the farmer became a very much more important factor in the quality of the butter produced than hitherto, and, as a consequence, the farmer had to receive education and advice, though of an elementary character, in the proper treatment and method of ripening cream. Lectures were delivered throughout the various dairying centres, and the whole State was mapped into districts, each district being in charge of an officer of the Dairy Branch for the purpose of instruction. As the dairy industry is mainly centred along the coastal districts, the number of officers required to deal with it was not necessarily large; to-day there are seven officers doing this instructional work. The method pursued is as follows:—The officer, who acts not only as an Instructor, but also as an Inspector of Butter Factories, when on a visit to a factory in his district, inspects the various creams that arrive there and thereby obtains a list of the suppliers who send in inferior cream. He next pays a visit to the farmers where the inferior cream is produced, and by reason of his experience and training, is in a position to discover the cause of the inferiority and instruct the farmer how to mend matters. Sometimes, however, the farmer is indifferent; especially is this noticeable when the farmer is of uncleanly habits, and under such circumstances, if the dairy premises are not thoroughly cleansed and put in order, the Dairy Inspector has power to prosecute under the Dairy Supervision Act, which is administered by the Department of Public Health, but the Instructors of the Dairy Branch are appointed Inspectors under it also. It is rarely that extreme measures have to be taken in order to bring about the desired result.

All the members of the field staff have had training in cattle management, as well as in factory methods, and they are, therefore, in a position to give advice to the ordinary farmer on methods of improving their cattle, as well as improving the handling of their milk and cream.

One member of the field staff has special qualifications in cheese-making, having had considerable experience in that direction, both in Scotland and England before taking up his duties here. On cheese matters which demand the services of an expert he is made available for advisory purposes.

Advanced Training Schools.

Whereas a special dairy course which was arranged at the Hawkesbury Agricultural College provided for a good education in butter and cheese-making, especially for those students who had already obtained the College Diploma in Agriculture, still there was a want, as the terms were not sufficiently long to give the necessary training for all those who desired to become expert in dairy matters, and consequently an advanced course in dairying has now been provided at the Hawkesbury Agricultural College, the term extending over a period of two years. It is satisfactory to be able to state at this stage that there is a good attendance of students for this course. The Principal of the College, himself an old dairy teacher, is an enthusiastic worker in the interests of dairying, and has done his best to popularise the section.

Education of Factory Managers and Cream Graders.

As it was evident that, before a distinct advance could be made in knowledge relating to the scientific side of cream grading and butter manufacture, it would be necessary to give those engaged in the management of butter factories at the present some easy means of improving their knowledge on the science of the subject, a scheme was evolved whereby short courses have been held every winter during the last six years, at butter factories situated in suitable centres, whereby training in applied dairy bacteriology and dairy chemistry has been given. This has been an important factor in the grading of cream on sound lines, as it has been shown that almost all the taints produced in cream are traceable to injurious microbes. Those who have passed a satisfactory examination have been certified as cream graders, and these men know, not only the practice, but the science of the question.

Cattle Improvement.

As indicated elsewhere, not only have our cows increased largely in numbers, but a great improvement in productive capacity per head is also evidenced. We are, however, by no means at a satisfactory stage yet. The annual milk yield per cow is probably about 350 gallons, more or less, according to the character of the year, viz., whether it is a dry one or a season of good rainfall. This standard, though low, is much more satisfactory than the visitor to this country would at first imagine, for the simple reason that the milk of New South Wales cows is much richer than is that of the average cow of Great Britain. Probably the principal reason for this is the large percentage of Jersey and Guernsey blood which exists in our herds. In many cases the question of climate is also an influencing factor in this direction, and the Australian climate, especially in years of plenty, is calculated to enable cows to produce a milk richer in butter-fat than would be the case in a country where the climate was so severe that a number of them came into the dairy each spring in a low condition.

Methods Adopted to Stimulate Improvement.

Nearly every agricultural centre in New South Wales is represented by an Agricultural Society which holds an annual show. The prize money at such shows is subsidised by the Department of Agriculture to the extent of 10s. in the £. Needless to say, farmers in dairying districts are stimulated to procure by breeding or otherwise some cows worth showing, and the rivalry at local shows in the cattle section is extremely keen. This form of stimulus has been in existence for a great many years, but it was not until after the importations of 1898 that the average dairy farmer gave much consideration to questions such as the use of pure-bred bulls for dairying purposes. The importation referred to was a big advertisement for the necessity of dairy cattle improvement, and, as the stock came in for a great deal of criticism, it increased the attention which was given to the matter. The bulls, with the exception of some of the Shorthorns, were in good demand for leasing purposes, the Government deciding to lease them to dairy farmers or Agricultural Societies representing dairy farmers at the nominal fee of £7 10s. for six months. In this way dairy farmers in new districts who had never seen the result of the use of pure-bred bulls were astonished when they found that this pure-bred stock got up to 80 per cent. of their progeny from indifferent cows, all bearing the characteristics of the sire. The most notable successes resulted from the use of the Guernsey bulls on cross-bred Shorthorn cows. The series of experiments carried out on the Wollongbar Experiment Farm showed pure-bred bulls of dairying strain to be an important factor in the improvement of our dairy herds, and local farmers and others were not slow to take advantage of the information obtained. Later on the results of these experiments were published in the Departmental *Agricultural Gazette* and in the principal papers of the State, and a gradually increased stimulus was given to the use of pure-bred bulls for dairy purposes, until to-day all the intelligent dairy farmers in New South Wales are either using pure-bred bulls or are looking forward to the time when they will be able to purchase a bull of good breeding.

Meanwhile, the leasing of bulls continues, and the bulls leased by the Department continue to serve their purpose as an important educational factor.

State Breeding Farms.

The State formed a stud breeding farm after the importations of cattle in 1898, and, with the exception of the Coates Herd-Book Shorthorns, which were imported from England, all the breeds have done satisfactorily. The increase in numbers of the different breeds caused a dispersal, and a number of animals have been transferred from the State Stud Farm to various Experiment Farms throughout the State. Cattle are bred at these Experiment Farms and sold at reasonable prices. Only bulls from cows of certain standard are reared, and those animals which should be capable of improving the quality of our dairy stock. There has also been a very great increase in the number of private studs of dairy cattle established throughout New South Wales. In fact, the greater the number of people working in this direction, the greater the education afforded, and the greater the demand for pure-bred bulls of good strains.

Herd-Testing Associations in New South Wales.

Nearly every country deeply interested in dairying has made some effort towards establishing what the Danes have proved to be the surest way towards improving cattle, viz., co-operative cattle-testing associations. As elsewhere, these associations are conducted on co-operative lines in New South Wales, and it is estimated that this summer there will be about 30,000 cows whose milk yields will be checked once a month under this scheme, and the amount of butter-fat calculated will show dairy farmers the relative positions of their different cows. It was not until two years ago that any decided impression was made on dairy farmers with regard to the establishment of herd-testing associations, but new life has been given to the movement by the appointment of officers to organise and by subsidising the associations for the first year of their existence to the extent of 10s. in the £ of amounts expended.

Pure-Breeders' Testing Scheme.

Probably, however, the greatest factor in the improvement of our cattle is the steady progress being made by the Pure Breeders' Association. This is an association of breeders of all classes of dairy stock, which was organised about 18 months ago for the purpose of getting advocates of the different breeds to work on common lines, and to make a combined effort towards improving the pure-bred stock in the State. With the improvement of pure-bred stock must come the improvement of the ordinary cattle, because dairy farmers will then be in a position to select pure-bred sires. The main platform of this Association is a scheme for testing the milk and butter producing capacity of all pure-bred cows. The actual testing is done by officers of the Dairy Branch, and thus the reliability of the results is placed beyond suspicion.

It is now nearly twelve months since this scheme was put into force, and quite a number of pure-bred stock have been tested. The number is an increasing one, and we hope that within three or four years all the pure-bred stock in the State of any note will have been tested, and, therefore, breeders will be in a position to know where to select bulls of high milk and butter producing strains.

Individual Milk and Butter Yields.

As already shown, one Shorthorn cow has given 14,347 lbs. of milk, which it is estimated would produce 571 lbs. of butter during nine months. This cow, however, was not advanced in calf at the finish of the nine months period, and she is still milking well, but the cow "Champion III.," which gave 10,213 lbs. of milk, and 558 lbs. of butter, was advanced in calf at the end of the period, and would, therefore, produce a calf within 12 months from the start of the test.

The best of the Jerseys tested gave 6,243 lbs. of milk, showing 409 lbs. of butter.

A better yield than this, however, and one which will probably stand for some time as a record for a Jersey heifer in Australia, was put up by the young Jersey cow, "Yellow Aster," at the Yanco Experiment Farm, having been bred at Wagga Farm. This young cow on her first calf, from September 12th, 1912, to June 15th, 1913, gave 6,296 lbs. of milk, testing equal to 440 lbs. of butter. She is a very strongly constitutioned cow, and is by the Government-bred bull, "Golden Lord."

The Guernsey cow, "Calm II.," bred at the Government Stud Farm at Berry, gave in one period of lactation of 41 weeks, 7,548 lbs. of milk, which produced 503 lbs. of butter.

THE FRUIT INDUSTRY IN NEW SOUTH WALES.

By J. G. R. Bryant, Assistant Fruit Expert, Department of Agriculture, New South Wales.

The business of fruit-growing in New South Wales is rapidly forging ahead, and promises to be one of our staple industries. Progress has been shown all along the line, as will be seen from the following figures for the last ten years:—

Year Ending March 31st.	Citrus Fruit. Average Yield per Acre. Dozens.	Other Fruit. Approx. Value of Crop Per Acre.
1903	406	6 8 0
1904	584	7 13 0
1905	547	6 4 0
1906	589	7 10 0
1907	516	9 6 0
1908	789	6 8 0
1909	474	10 0 0
1910	726	11 12 4
1911	847	13 5 8
1912	975	19 1 9

There has thus been a marked improvement in the value of the output, increasing from a quarter of a million sterling in 1903 to about £600,000 last year. The statistics do not give the value of the citrus crop, which, however, shows a steady increase in yield, but the value has improved still more. As regards fruit other than citrus the jump from £6 8s. per acre in 1903 to nearly three times that amount in 1912 is striking evidence of the advance in methods of fruit culture during the decade.

The price of fruit in the market admittedly has appreciably increased, but it does not by any means represent the whole difference. How much better is it that one acre of summer fruit should have been cultivated in 1912 for £19 1s. 9d. than that three should have been tended for only £19 4s. in 1903? That is the relative position of the grower, though it has to be borne in mind that the cost of working an acre nowadays, as regards labour, manures, and the checking of pests, is distinctly higher than it was ten years ago, largely because more work and feeding are put into the orchard. An important factor in the better return is the greater care bestowed upon the trees and the land. One thing certain is that the total area now includes a much smaller proportion of worn-out, worthless orchards than was the case ten years ago.

The class of fruit-growing one wishes to engage in may be selected without fear of being unable to select a suitable district, for the climatic conditions and rainfall are such that the fruits of the tropical, semi-tropical, and temperate zones, may be all grown in different parts of the State where such conditions exist. From the accompanying particulars of the various districts it can at once be seen what a wide variation of fruit-growing country is available.

BATHURST (Central Tableland).—The country in this district varies from slaty ridges with granite to undulating and flat and sometimes swampy areas. The soil ranges from light sandy loam to stiff clay. Apple-growing has been extensively carried on, and up to the present the results have been very satisfactory. Apples for export have proved most suitable on account of their long-keeping qualities and excellent flavour. Pears, prunes and peaches have also proved admirably adapted to the district, and returns from orchards where these fruits have been grown have been excellent.

BATLOW (South-western Slopes).—The Batlow district, although situated some 300 miles from Sydney, offers splendid inducements to the intending orchardist. Land may be purchased reasonably cheaply, but clearing operations are heavy. On the other hand returns are quickly secured from the land by such crops as potatoes, peas, etc. Small fruits, such as raspberries and gooseberries do remarkably well. Apple, pear and prune growing are the chief factors in fruit production at present, and in addition English plums and cherries have been largely planted and have proved profitable. The rainfall is very good, and, as the altitude is over 2,000 feet, the climate is nice and cool.

COWRA, KOORAWATHA AND YOUNG (Western Slopes).—Closer settlement is rapidly taking place in this district, and greater attention is being paid to fruit. At Koorawatha prunes and peaches for drying have been largely planted. Prune-growing has proved to be quite a profitable investment, and as much as £800 was taken from ten acres during the 1911 season. The prices were, however, high, and the crop generally light. The Young district is one of the best cherry districts of the State, and during the 1912 season close on 50,000 cases were forwarded to market. Grapes, peaches, apricots and almonds have also proved their suitability.

Dubbo and Neighbourhood (Central Western Slopes).—The country for the most part is level, about one-third consisting of gravelly ridges. The climate is dry, very hot in summer and mild in winter, with occasional frosts. The rainfall is about 20 inches annually, of which about a third falls during January, February, and March. Fruit-growing is limited to stone fruits (in some localities), but chiefly citrus and grapes, which under irrigation have proved very profitable. The stone fruits are mainly used for local markets and for drying purposes.

Forbes, etc. (Central Western Slopes).—The country comprised in this district is fairly uniform in character, being for the most part undulating to flat. The soil varies, the typical being a rich red loam, generally with a rather stiff sub-soil. Chocolate loams and sandy loams of a light colour are represented, and black, sticky soils on the river flats.

The climate is fairly even over the district, and is very healthy, not being subject to extremes of heat and cold. The country is well adapted for irrigation. Parkes and Forbes are growing large quantities of stone fruit, grapes and citrus fruit. Under irrigation, prunes, cherries, almonds, and even apples and pears are being grown in parts of the district with a large measure of success.

Goulburn, Parkesbourne, Penrose and Tallong (Southern Tableland).—In the Monaro and Cooma districts lying to the south of Goulburn, the country varies from a rather sandy loam to red and dark loam. There is a good deal of red and black loam about Crookwell and Taralga, and granite with limestone patches about Goulburn itself. Cherries, apples, pears and all English fruits are grown in many parts of the district.

Grafton and Lismore (North Coast).—The climate throughout is sub-tropical and humid, with an average rainfall varying from 75 inches annually on the coast to 36 on the upper portions of the rise. The temperature for the whole district varies from 75 degrees Fahr. in summer to 56 degrees in winter.

Tropical fruits, such as bananas, pineapples, guavas, granadillas, passion fruit and citrus fruit, grow particularly well. Stone fruit is unsatisfactory on account of the ravages of the fruit fly. American grapes do well on the slopes, and are the most satisfactory vines to grow.

KEMPSEY, COFF'S HARBOUR AND PORT MACQUARIE (Lower North Coast).—In and around these districts stone fruits, citrus and passion vines, as well as bananas and pineapples, may be grown with profit. Fruit-growing on a large scale has not up to the present received much attention in these centres. The transport is for the most part hilly and rough, and on this account stone fruits have only been grown for local consumption. Some of the finest citrus trees in the State may be seen growing at the head of the Hastings River, and on the Comboyne the soil and conditions are most suitable for the growing of mixed fruits.

MAITLAND AND SINGLETON (Hunter River).—This includes some of the finest wine-growing districts of the State, and the Hunter River wines have a deservedly high popularity. Table grapes do particularly well. The principal vineyards are in the Pokolbin Range. Around Dungog, Paterson and the Bulga some very fine orchards have been planted, mostly to citrus and stone fruits. In the Sydney markets the Paterson River oranges are noted for their quality. Since the advent of the railway a great deal of orchard planting has been carried out.

GOSFORD AND WYONG (Central Coastal).—These districts are quite handy to the Sydney and Newcastle markets. Along the northern line are planted citrus, stone fruit and apple orchards, as well as a large area to passion vines. Peas, tomatoes and other inter-planting crops have been grown to a large extent from the time the young trees are planted until they reach bearing age.

The soil and rainfall are very suitable for the production of heavy crops, and, as the markets are so handy, fruit-growing in these districts has proved to be a very profitable undertaking.

A range of hills lying to the west of Gosford, known as the Penang Mountains, have been found to be very suitable for the production of citrus fruit and passion fruit.

NEW ENGLAND.—The country in the Armidale district is in general hilly, with tablelands and valleys, the New England Range running right through the centre. Basalt, granite and trap are the prevailing rocks. The richer soils are usually found in the valleys, and here all English fruits thrive particularly well, more especially cherries, plums, pears and bush fruits. The climate is very healthy and this district has been for many years a favourite summer health resort. The mean annual temperature is about 61 degrees Fahr., and the mean summer temperature about 71 degrees. The winters are cold and snow is common on the hills. The rainfall is good, the average being from 33 to 35 inches, about a third of which falls between December and February, and the whole district is well watered.

Whilst waiting for the trees to come into bearing, potatoes are grown extensively and pay very well, markets for these, as well as for the fruit, being found in Sydney, Newcastle and Queensland.

The Inverell district, which may be included, is undulating to hilly, with soil varying from black to light red loams of volcanic origin. Stone and citrus fruits have been found to grow very well in sheltered places in this district, whilst grapes, mulberries and figs thrive particularly well. The seasons are regular, without violent inequalities. Inverell provides a good centre for marketing produce in the north-west.

ORANGE (Central Tableland).—In and around this district apples, pears, plums, cherries and other cool country fruits are widely cultivated. In fact it is one of the largest cherry producing districts in the State. The soils are fairly rich red and chocolate loams, of a rather heavy type, with black soils in the valleys. Crops of peas and potatoes are largely grown by the orchardists between the rows of young trees. This enables the grower to secure an early return from his land before his trees reach bearing. Table grapes do well and are worth growing. The climate is ideal, and the district is largely used as a health resort.

RICHMOND, PENRITH, PARRAMATTA AND KURRAJONG (Metropolitan).—This is the birthplace of the fruit industry of the State. Parramatta and the outlying districts have been noted as great fruit-growing centres from the inception of orcharding in Australia. On the slopes thousands of acres of citrus fruits may be seen. Passion fruit are very largely grown in conjunction, and in Arcadia, Galston, Glenorie and Dural it is considered the most profitable procedure to plant these between the rows of young trees. In the hollows and sandy loams large areas are devoted to apples, more especially the varieties that have been proved suited to the coast. This fruit has sold at very high prices on the Sydney market on account of its earliness. Throughout the Hawkesbury River district on the alluvial flats great attention has been given to citrus and stone fruits, more especially the latter, and there can be no doubt of the high quality of the peaches. It is now difficult to secure land in these parts for planting unless one goes further back from the more settled parts.

On the better soils orange and mandarin-growing has proved very profitable, and many thousands of acres are planted to these fruits, which find a ready sale in Sydney, the country towns and for the Interstate trade.

Yanco and Hay (Riverina).—Citrus fruits, almonds, peaches, apricots, grapes, figs and wine grapes all thrive to perfection, and good crops are always assured, provided a sufficiency of water is available either naturally or by irrigation. Late table grapes have proved exceptionally valuable.

Stone fruits thrive in this warm climate, and if varieties suitable for canning, drying or dessert are planted, success is assured.

There is plenty of land available under the Murrumbidgee Irrigation Commission, and everything points to an enormous expansion of fruit production under irrigation in the near future.

The question is: With the wide interest taken in fruit culture, the increased planting and the improved methods, will the markets ever become over-supplied? In this connection it is worthy of note that prices were never higher and the local demand for good fruit is rapidly increasing. Not only have we the local markets, but trade has opened up with the United Kingdom, America and the East, and these give the intending planter a further field for the disposal of his products. The opening of the Panama Canal must certainly pave the way to the excellent markets on the east coast of America, so that fruit culture seems capable of almost infinite expansion.

In the dried-fruit trade, New South Wales is only commencing to place her products before the consumer. From prices received and the reports to hand from the leading commercial houses handling our products, they are equal to the best received on the market. We have in the Northern Murrumbidgee Irrigation Area a vast field for the production of the best in dried raisins, sultanas, currants, peaches, apricots, prunes, pears, etc.

There are several other fields of fruit-growing that will no doubt be considered, more especially as we are large importers, viz., nut fruits, olives, dates, etc.

The one big factor in fruit culture is the suppression of fruit pests. Our apple and pear industry was practically threatened with extinction some few years ago by the codlin moth. Through the medium of the Fruit Pests Act, administered by the Agricultural Department, this position was not reached. Inspectors are employed throughout the Metropolitan and country districts for the purpose of enforcing the regulations and compelling growers to spray for this trouble. The same condition exists in the suppression of the fruit fly. This attacks mostly citrus and stone fruits, but by constant attention to the destruction of infested fruit, and the regular picking up of windfalls, we are in the happy state of having the trouble practically under control.

The educational facilities extended to the fruit-growers of the State by the Government are very liberal. Agricultural colleges and experiment farms are situated in different centres throughout the State. At the principal ones large orchards are planted and are under the control of experienced orchardists and assistants. Students attend these colleges and farmers and orchardists and those interested visit whenever they wish, or secure information by writing.

The Fruit Expert and his staff visit the various agricultural societies, branches of the Agricultural Bureau, fruit-growers' unions, etc., for the purpose of giving instruction and lectures on the many subjects appertaining to the business.

Fruit-growing to-day is becoming more and more of a specialised business, and districts may be selected where special classes of fruits can be cultivated to the best advantage. The grower can receive expert advice from the Department and also observe from the neighbouring growers the methods pursued to secure success. At the same time the whole-hearted success is wrapped up in the person himself. It is a case of "no sluggard need apply." Hard work and constant attention, with careful judgment, will ultimately result in the production of an orchard which should give a handsome and independent living, if not a fortune, to its owner.

Chapter XI.

THE ECONOMICS OF THE EUCALYPTS.

By R. T. Baker, F.L.S. and H. G. Smith, F.C.S.,
Technological Museum, Sydney.

Historical.

The first settlers were early attracted to the valuable economies of these wonderful trees, more particularly the timber, but they set no mean value on the essential oil of the leaves as well as the kino exudation of the bark. It must have given great satisfaction to the founders of the Colony to find ready at hand such magnificent trees, yielding the finest hardwoods of the world, and in quantities which, to them, must have appeared inexhaustible. No greater recommendation could be given to these woods for durability than the structures erected in those early times, which remain intact in some instances to-day—the timber being as sound as when placed in position. But timbers were not the only economics of these trees to which the early colonists turned their attention. The therapeutic value of the oil was early discovered, for in "White's Voyages," published in 1790, occurs this statement:—"The name of 'Peppermint Tree' has been given to this plant by Mr. White on account of the very great resemblance between the essential oil drawn from its leaves and that obtained from the 'Peppermint' (*Mentha piperita*) which grows in England. This oil was found by Mr. White to be more efficacious in removing all cholicy complaints than that of the English 'Peppermint,' which he attributes to its being less pungent and more aromatic. A quart of the oil has been sent by him to Mr. Wilson."

It will thus be seen that little time was lost in investigating the commercial possibilities of the "Gum Trees," and, moreover, it would appear from this statement that Eucalyptus oil was probably one of the first natural products exported from Australia.

Since those early times, the commercial possibilities of the Eucalypts have been exploited to such an extent that to-day the importance of their economics are world-famed, and it must be acknowledged that in these trees Australia has an asset of enormous value.

Classification.

In dealing with the economics of the Eucalypts it would perhaps be well to consider the Genus in groups—and for preference, arrange them cortically rather than systematically. Although several schemes have been suggested for the general classification of these trees, yet no single arrangement has been considered as satisfactory, and strongly marked lines of demarcation separating the groups one from another are not in evidence, the members of one group often showing resemblances, in certain directions, to those of other groups. In the cortical system we have:—

(1) *Leiophloiæ.*—Smooth barks, such as "Blue Gum," "Red Gum," "Flooded Gum," etc.

(2) *Hemiphloiæ.*—Half-barks, such as "Blackbutt" or "Box."

(3) *Rhytiphloiæ.*—Such as have the bark persistent, everywhere wrinkled, full of clefts, and solid within, such as (*a*) "Bloodwoods," barks friable; and (*b*) "Peppermints"—barks checkered.

(4) *Pachyphloiæ.*—Those with persistent barks, such as "Stringybarks."

(5) *Schizophloiæ.*—Such as have the bark everywhere persistent, deeply furrowed, and solid within, viz., "Ironbarks."

(6) *Lepidophloiæ.*—Having the bark persistent at least on the trunk, laminated, friable, such as "Carabeen" (*E. tesselaris*).

The above groups must not be taken too literally as regards definition, as it is often difficult to arrange certain species in this way, but if considered broadly there is a certain agreement in chemical constituents, as well as in botanical features.

Barks.

The commercial purposes for which these have been utilised are quite limited. The bark of the "Stringybarks" is used in sheets in the early stages of settlement for thatching, when other material is wanting. The bark of the "Ironbarks" is usually plentifully impregnated with kino, and is in demand by wheelwrights. The barks of some Eucalyptus species are, however, of excellent quality for tanning purposes, the "Mallet" of Western Australia, *E. occidentalis*, being the one most exploited for this purpose; this is due principally to the large amount of tannin present in the bark. The value of "Mallet" bark shipped from Western Australia last year was £58,512. All Eucalyptus species whose barks contain a tannin suitable for tanning purposes, exude a kino, the crystalline substance of which is largely Eudesmin, and the more of this kino the bark contains, the richer it is in available tannin.

Another peculiarity with this class of barks is the large amount of Oxalate of Lime they contain, and by simply powdering the bark upon a microscopic slide, the characteristically shaped crystals of this substance can be easily seen. In some of these barks, the "Gimlet," *E. salubris*, for instance, oxalate of lime is often so abundant that it forms about 16 per cent. of the total air-dried bark, and it seems reasonable to suppose that if the tannin from these barks was prepared as a tanning extract, instead of being utilised directly, the residue could be made to supply a considerable quantity of oxalic acid, which, being entirely a by-product, should be valuable. An analysis of the "Gimlet" bark showed that one ton of the bark contained 416 lbs. of an excellent tannin extract (dry) and 308 lbs. of oxalic acid.

The commercial preparation of tanning extracts from suitable Eucalyptus barks and woods should be a profitable proposition, and appears to be the best way to utilise the tannin they contain. The barks of most Eucalyptus species, however, have no economic use in this direction.

Kinos.

It is worthy of remark that it was the occurrence of this substance in the wood and bark that gave rise to the common name, "Gum Tree," applied generally to the whole group. Although the Eucalypts are thus known, vernacularly, yet no gum, in the strict sense of the term, is obtainable from any species. They all yield astringent exudations or kinos, which differ considerably in chemical constituents. As a rule, however, they are in agreement with the oils secreted by the species. In the early members of the genus, or those with a leaf venation like a feather, the crystalline substance which can be extracted from their exudations is Aromadendrin. As the genus evolved in the direction of the "Box" group, another crystalline substance made its appearance; this is Eudesmin, and this continued to increase in amount until it almost supplanted the Aromadendrin; and in the exudations of the typical "boxes" (*E. hemiphloia*, etc.) Eudesmin is found to occur in maximum amount. Aromadendrin, however, is present in small amount also, and was thus not entirely supplanted by the Eudesmin.

The peculiarity with some of these exudations is that they do not gelatinize in tinctures, no matter how long they may be kept. This is of some economic importance, and pharmacists need not be troubled any more with gelatinized tincture of kino if they use the correct Eucalyptus product. It is remarkable, however, that at the more recent end of the genus the exudations gelatinize in tinctures more rapidly than any substance of a similar nature, thus again illustrating the diverse chemical nature of such products from different species of Eucalyptus. The exudations of the more recent members of the genus do not contain either Eudesmin or Aromadendrin, evolutionary processes having eradicated these substances. A third class of astringent exudation is that obtained from trees known as "Ironbarks," as well as from a few other species; this consists very largely of the glucoside Emphloin, and while this substance is easily soluble in water, it is quite insoluble in alcohol, and was thus, at one time, considered to be a gum. Some of these Eucalyptus exudations, viz., those which contain crystallised bodies might be utilised for tanning purposes if obtainable in sufficient quantities, as they readily combine with hide material; the other groups of these kinos, however, are of little use at present for this purpose, and are not at all promising as useful substances.

Timbers.

In this section of the Technology of the genus we have the greatest economics, and in these trees Australia has the most valuable hardwood asset in the world. Except for patches in the interior, representatives of the genus extend over the whole Continent. The commercial value of the timbers was early recognised, and timber formed no inconsiderable part of return freight for ships to England. The principal characteristics of these woods are their hardness and general durability under varying conditions, and commercially they can be utilised for almost every branch of technology. They vary exceedingly in texture; from hard, dense, interlocked wood, to open-grained, medium in weight or even light, and very fissile; consequently their avenues of utilisation are almost unlimited, for they are found in every branch of the timber trades.

The timber qualities are so appreciated outside Australia that enormous areas in the Western States of America and South Africa are now being given over to the cultivation of the Eucalypts.

The genus itself, from a systematic point of view, is certainly not easy of classification, and the timbers are equally difficult of identification, so that it is only by years of familiarity that a knowledge of Eucalyptus timbers can be mastered, and even this, of course, must be supported by a botanical and field acquaintance with the trees. Of the described species at present known, 80 per cent. yield excellent marketable timber, the exception being the "Mallees" or shrubby forms, most of the "Peppermints," one or two "Woollybutts," and a few others. The pride of place for durability is occupied by the "Ironbarks," which yield the hardest and most durable timbers of the whole genus, and are fairly quick growers, as hardwoods go.

Stringybarks.—The most widely distributed section of Eucalyptus trees are the "Stringybarks," a class of timber especially numerous in all the Eastern States, as well as in Tasmania. They pass under various common names, such as "White," "Red," "Brown," "Yellow Stringybark," etc.—names which refer more particularly to the respective colours of these woods. This class of timber is of medium weight, hard, close-grained, very durable in the ground, planes and dresses well, and in instances tried is very suitable for carving, and this is exemplified by some of the finest wood decorations in public institutions, banks, churches, as well as in private dwellings.

For building construction, floors, posts and rails, coach and carriage work, "Stringybark" is eminently suitable, and recently it has come into fashion as a furniture timber, being placed on the market in some cases as "Tasmanian Oak," the name "Stringybark," for some reason or other, being considered rather a term of disparagement; but people are beginning to realise now that this expression is only one of comparison, for when "Ironbark" was plentiful no one would take cognisance of "Stringybark," but now that that period has passed away, it is coming to be more appreciated.

Ironbarks.—On account of their extreme hardness, weight and durability, this timber is more particularly in request for beams in large buildings, wharf piles, railway sleepers, and wherever great strength is required, such as railway goods waggons, and heavy wheels, drays and trollies. "Grey or White Ironbark" (*Eucalyptus paniculata*), "Broad-leaved Ironbark" (*E. siderophloia*), "Narrow-leaved Ironbark" (*E. crebra*) are the principal members of this group. Sleepers of these which have been on the track for over a quarter of a century show comparatively slight evidences of wear and tear.

Gums.—The trees, known as "Gums,"—those with the smooth barks afford in many cases excellent timbers, and these may be classed as "Red," "White" or "Pale," the more important in the former being "Sydney Blue Gum (*E. saligna*), "Forest Red Gum (*E. tereticorhis*), "Murray Red Gum" (*E. rostrata*), and "Slaty Gum" (*E. Dawsoni*). Amongst the White Gums the most highly prized is "Mountain Gum" (*E. goniocalyx*), "A Blue Gum" (*E. Maideni*), and "Spotted Gum" (*E. maculata*).

Peppermints and Messmates.—The "Peppermints" and "Messmates" include some useful timbers, but also worthless ones, so that care should be taken in this connection when selecting material. The timber of the "Messmate" (*E. obliqua*) is in much request for house-building in the south-east portion of this State. It also makes splendid axe handles, oars, etc., and could be used for general coach-building. The "Sydney Peppermint" (*E. piperita*) is also a good timber; in fact, this is a group of trees requiring to be exploited for their timber economics.

Ashes.—In this section are to be found some of the finest timbers for general all-round work. The name has evidently been bestowed on these trees as a compliment to the quality of their timber, which has very much in common with the "Ashes" (*Fraxinus*) of northern climates. The wood is pale-coloured to almost white, strong, resilient, and could be utilised for all purposes to which the imported Ashes are employed. The best are:—*E. fraxinioides*, *E. Delegatensis*, *E. oreades*, and *E. Sieberiana*.

In a class by themselves stand such excellent timbers as "Tallow-wood" (*E. microcorys*), "Blackbutt" (*E. pilularis*), "Carbeen" (*E. tessellaris*), and others.

Eucalyptus timbers are principally utilised in the following directions:—

Heavy constructional work, such as girders and plankings for bridges and wharves; joists for floors; storey posts; house, shed and store buildings; piles and submerged structures; railway goods waggons; heavy framing for the under-carriages of railway and tramway passenger cars; framing of road vehicles; railway sleepers; poles for telegraph, telephone, and electric light purposes; blocks for street paving; wheels for road vehicles; joinery or heavy cabinet work; frames of boats; hulls of ships; fencing or other similar rough purposes; and in other directions where a hard, durable wood is required.

The small shrubs or "Mallees" are not large enough as timber trees for any industrial purposes, although in some parts of Australia the roots are used for firewood.

Essential Oils.

The Eucalyptus Oil industry is now of some importance in Eastern Australia, and many people find employment in its production and distribution. The Customs authorities inform us that there are over 200 stills of various kinds producing oil in Victoria. Although fewer stills are at work in New South Wales, yet, even in this State a considerable quantity of Eucalyptus Oil is distilled.

The three main directions in which the various kinds of Eucalyptus Oils are employed being:—

(*a*) For pharmaceutical purposes;
(*b*) In the separation of metallic sulphides;
(*c*) In perfumery.

(*a*) *Oil Used for Pharmaceutical Purposes.*—To satisfy the standard at present in force in various countries, it is necessary for pharmaceutical Eucalyptus Oils to contain Eucalyptol or Cineol as chief constituent. There are several species which yield oils of this class, often containing from 70 to 80 per cent. of Eucalyptol. In a few instances this figure has even been exceeded. The terpene usually occurring in the richer Eucalyptol Oils is pinene, although phellandrene also occurs in some oils rich in Eucalyptol, as, for instance, *E. Risdoni*, *E. linearis* and *E. amygdalina*, var. *Australiana*.

The principal species from which pharmaceutical oil is at present being distilled in both New South Wales and Victoria is *Eucalyptus polybractea*, the "Blue" or "Silver-leaf Mallee." The yield from this species is good, and the oil very rich in Eucalyptol, usually exceeding 80 per cent. in the rectified oil. There are advantages in using a species of this class, as it occurs in the shrubby or "Mallee" form, and it is a more gregarious species than most Eucalypts. Another species whose oil is equally rich in Eucalyptol, and with an equally good yield, is *E. Smithii*, but this tree grows to a large size, and occurs usually in mountainous country,

Leaf of Eucalyptus dives, Schau.

The venation indicates a predominance of phellandrene [illegible] with [illegible] peppermint" ketone.

Oils obtained from Eucalyptus species having this venation are now [illegible] the Mining industry for concentrating the sulphides in ores, [illegible]

(*From* "A RESEARCH ON THE EUCALYPTS," by [illegible])

consequently it is costly to collect the leaves from old trees. The oil, however, is, perhaps, for medicinal purposes, the most pleasant of all, as it contains less objectionable constituents. When the time comes for Eucalyptus species to be cultivated for their oils, *E. Smithii* would be an excellent one to utilise for Eucalyptol. A few other species are being worked in Eastern Australia for pharmaceutical oils, but the number is comparatively small. *E. dumosa* and *E. oleosa* have largely gone out of use, as the yield from these species is not first class. In Kangaroo Island, South Australia, the chief species worked is the "Narrow-leaf" (*E. cneorifolia*). The oil of this species is somewhat rich in Eucalyptol, and it also contains the aldehyde Aromadendral, while phellandrene is absent.

(*b*) *Oils Used for Mining.*—Within the last two or three years a considerable demand has arisen for the phellandrene Eucalyptus Oils, these being used somewhat extensively in the mining industry. At Broken Hill, Cobar, and other mining centres, large quantities of these cheaper Eucalyptus Oils are now employed. Their use is to aid the separation of the metallic sulphides from the gangue by a flotation process, and several contracts for the supply of from 50 to 100 tons of this class of Eucalyptus Oil have been entered upon.

The extraction of this kind of Eucalyptus oil, in such quantities, naturally gives employment to a large number of people, both in New South Wales and in Victoria. The species from which this oil is obtained are known generally as "Peppermints," applied to these trees originally from the Peppermint odour given to the oil by the ketone Piperitone. The "Narrow-leaved" and "Broad-leaved Peppermints" are the trees mostly used, principally because the yield of oil from these is considerable, and the trees do not usually grow to a large size, the material is thus somewhat easily collected. These species are extensively distributed throughout the highlands and spurs of the mountains of Eastern Australia, and usually grow in very poor country. They have the property, too, perhaps more pronounced than with other Eucalypts, of quickly renewing the growth of leaves, so that cutting them back only encourages a more prolific growth. They are also very tenacious of life, and the lower portions of felled trees are soon clothed with new growth. Natural plantations of these species might thus readily be established in those portions of the country where they naturally occur, so that a continuous supply of these phellandrene-bearing oils could be produced, and, with proper methods of extraction, at a very cheap rate.

A very large number of Eucalypts yield oils containing phellandrene, although with some of these the yield of oil is very small, and, as with the other constituents found in Eucalyptus Oils, the graduation is from traces in some to an abundance in others.

(*c*) *Perfumery Oils.*—It is more than probable that eventually some Eucalyptus species will play a considerable part in the supply of certain constituents used in the perfumery industry, as well as for flavouring purposes. *Eucalyptus Macarthuri* is one of these species, the leaf oil consisting very largely of the odoriferous alcohol Geraniol, together with the ester geranyl-acetate, not less than 60 per cent. of this constituent being present in the crude oil. This Eucalypt resembles others in the rapidity of its growth under favourable conditions, and when it shall have been successfully cultivated from seed, and considered as an ordinary crop, then a plentiful supply of the above-named constituents will be obtainable, and probably supplied at a cheaper rate than from any other source. The yield of oil from green leaves and terminal branchlets of old trees is about 0.2 per cent. as a maximum. The largest yield is from young material, and the oil from this also contains the greatest amount of ester. Another species of good promise is *Eucalyptus citriodora*, which yields about 0.75 per cent. of an oil consisting almost entirely of the odoriferous aldehyde Citronellal, and, as a cheap perfumery oil for soap and similar purposes, should be in considerable request. This Eucalypt should also pay to cultivate.

A third species having prospective value is *E. Staigeriana*. This tree yields an abundance of a citral-bearing oil which, when suitably rectified, would be an excellent substitute for lemon oil, and, of course, be very much cheaper. The principal terpene in this oil is lævo-rotatory limonene. The cultivation of this Eucalypt under proper conditions should have great possibilities.

Under the most favourable conditions of soil and climate, the returns derived from the cultivation of these species should be remunerative, and in Australia there is an abundance of land which might be found suitable for the purpose.

Although the yield of oil obtainable by steam distillation from Eucalyptus leaves varies from about 4 per cent. from green leaves with terminal branchlets, down to practically nothing, yet, each species has the property of secreting a comparatively uniform amount of oil. This varies somewhat with the seasons, being less in the winter months, or during the period when the growth of the tree is less active. In the spring or early summer the yield is usually more abundant, but the variation is not great, and this factor has now become one of those upon which the commercial value of a species for oil distillation is based. Although the oil from a poor yielding species may be identical in composition and physical properties to that from a more prolific one, yet, for this reason, it is unable to compete commercially. There are numerous instances of this fact, and several trees which yield an excellent Eucalyptol oil cannot be profitably worked. There are about 300 species of Eucalyptus in Australia, but those which can be utilised for their oil number at present less than 25. New Oil-yielding Eucalypts are frequently being discovered, and those worked to-day differ considerably from those utilised for the purpose a few years ago. Some of the present oil-producing species may possibly be supplanted by others yet undetermined, so that the desirability for chemically investigating the whole of the species growing in Australia is apparent. At the present time the oil products of about 160 Eucalypts have been determined, and the knowledge in this respect is thus somewhat extensive. There is a remarkable uniformity in the character of the oil of any particular species throughout its geographical distribution, and the same general character is experienced with identical species, whether growing naturally in New South Wales or in Tasmania, and this fact has assisted considerably towards a more correct botanical discrimination between the several species.

The constituents already recorded as occurring in the various Eucalyptus Oils are as follow. It will be seen that the list is already somewhat extensive, but, no doubt, even this will be added to from time to time as investigations proceed:—

Eucalyptol (or Cineol), Eudesmol; Geraniol; Methyl, ethyl, iso butyl and amyl alcohols; Globulol; Citral; Aromadendral; Citronellal; Butaldehyde; Valeraldehyde; Piperitone; Geranyl-acetate; Amyl Eudesmate; Valeric Acid Ester; Acetic Acid Ester; Formic Acid; Acetic Acid; Eudesmic Acid; Valeric Acid; Aromadendrene; Pinene (both active forms); Phellandrene (lævo form); Limonene (lævo form); Cymene; Paraffins.

Miscellaneous Products.

The possible preparation of Quercetin from Myrticolorin, a glucoside occurring in large amount in the leaves of certain Eucalypts, is also a matter worthy of consideration.

The preparation of acetic acid and its compounds, together with the other ordinary products obtainable by the destructive distillation of wood, may be carried out with the Eucalypts as satisfactorily as with other timbers, and a large factory for this purpose is in active operation at Yarra Junction in Victoria. The charcoal thus produced is also in considerable demand, so much so that independent charcoal works are in progress in many places in Australia.

As regards the suitability of Eucalyptus timbers for wood pulp little research has so far been systematically undertaken, although some efforts have been made in this direction with the wood of a few species. The diversity of structure and hardness exhibited by the members of the various groups of Eucalypts is, however, a matter that will have to be taken into consideration, as in this respect Eucalyptus timbers differ essentially from the soft woods or Pine timbers of Europe and America.

Chapter XII.

THE CHEMISTRY OF SOME NATIVE PLANTS OF NEW SOUTH WALES.

By James M. Petrie.

In the pioneering stages of Natural Science we recognise the work of collecting, describing and classifying the typical units as a fundamental necessity. The study of their morphology and their history belongs to a more advanced period. And so when we consider the vast and unique vegetation of this country from the biochemical side, we find that the little which has been accomplished here is pioneering work in this domain, and corresponds to its earliest period. The Eucalyptus Flora, so predominating, has rightly received the greatest attention, and of it alone have we anything to say of chemical and economic interest. Its essential oils, its kinos and tannins, have been well described, and a broad basis laid for future biochemical research. The question has scarcely yet been considered of the influence of these essential oils on the activity of the enzymes, and the chemical phenomena in the life of the plant, especially in the hydrolysis and synthesis of the tannins and glucosides.

Among the latter, the quercetin glucoside, myrticolorin, was isolated from the red stringy bark by H. G. Smith, in 1897, and this has since been identified with the glucosides of four other plants of very different orders (H. G. Perkin, 1902, 1910). The yellow colour quercetin is widely distributed. It is found also in our native lotus plants as a cyanogenetic compound, and is intimately related to the tannins.

About 20 of our native plants have been investigated chemically, and the following brief outline of their essential principles may suffice.

Plants of Sydney and the Blue Mountains.

Next to the Eucalyptus in importance are the Acacias. The "wattle" barks are used all over the world for tanning, and constitute the best of the catechol group of tannins. The species, *decurrens* and *dealbata* are grown and exported for this purpose. They contain 25-35 per cent. of tannin, but *A. pycnantha* (S. Aust.) bark is the richest in tannin of any known tree, often containing 50 per cent. Saponins have been detected in the pods and bark of a number of our acacias, and the gums are of commercial value.

Two native sassafras trees are of interest—*Atherosperma* and *Doryphora*—growing in the mountain gullies. They contain essential oils of the characteristic odour of sassafras, and are apparently similar in composition. They differ fundamentally from the American *Laurus sassafras*, in containing only small amounts of the fragrant safrole, whereas the Laurus consists almost entirely of this. Alkaloids have been isolated from both, and show many properties in common (Miss M. Scott, J. M. Petrie, 1912).

A plant very common round Sydney is *Bursaria spinosa*, whose leaves give blue fluorescent sols., and from which Professor Rennie isolated æsculin, in 1890. This substance was formerly known only in the horse chestnut and the jasmine, but recently has been recognised in many plants in a number of different combinations as lactones, esters, and glucosides. A fixed oil and phytosterol have also been isolated from the plant (E. Griffiths, 1909).

Among insectivorous plants, six species of DROSERA are found round Sydney. Their proteolytic enzymes have been studied by Dr. Jean White, of Melbourne. She showed that the enzymes were capable only of transforming protein into the peptone stage. Contrasted with this, the juice of nepenthe, which contains erepsin, can continue the digestive process to the stage of amino-acids. The secretion of the droseras is apparently antiseptic, and acts in either an acid, neutral, or alkaline medium. Though the droseras can live and feed like other plants, when fed on meat they greatly increase in weight, in number of flowers and capsules. They are, therefore, better nourished when fed on peptone-nitrogen. A number of organic acids have been identified in these plants and in many species a bright-red colouring matter is noticed in parts. From these, Professor Rennie isolated two crystalline compounds, which he identified as naphthaquinone derivatives.

In the N.O. Solanaceæ, two DUBOISIAS are native to this State. From their botanical descriptions they are apparently closely related, and yet considered from the constitution of their active principles they could not be more widely separated. *D. myoporoides* grows in the National Park and all along the eastern coast; its leaves contain hyoscyamine, scopolamine, and nor-hyoscyamine, alkaloids of the atropine group. *D. Hopwoodi* is a native of the far north-west, with different climate and soil. Its leaves contain the single alkaloid nicotine (Dr. Rothera, 1910). Mr. H. G. Smith has shown in his study of the Eucalypts that climate and soil do not alter the chemical constituents of the oil of a single species, and in the Duboisias we must look for fundamental differences in leaf-structure and metabolism.

Grevillea robusta (Proteaceæ) is a shrub growing plentifully round Sydney. Recently Bourquelot of Paris isolated the glucoside arbutin, and quebrachitol (C. R., 1912). Arbutin breaks up into hydroquinone and glucose, and is one of the few glucosides which have been synthesised. The second substance is an ester of inositol, and is of importance in connection with the phosphorus compound phytin, in plants.

The Giant Nettle-tree, *Laportea gigas*, is conspicuous in the thick coastal scrubs, north and south of Sydney. The surface of its great leaves are covered with formidable siliceous hairs filled with strong acid fluid. The sap of the leaves contains free formic acid .002 per cent. (of the fresh leaves) and formates .045 per cent., free acetic acid .177 and acetates .350 per cent. In comparison with these the common English Nettle, *Urtica urens*, contains only .002 per cent. of free acid (formic only). The former, therefore, contains 90 times as much. (Petrie, 1906.)

The Native Currant, *Leptomeria acida*, with its astringent berries, may be seen anywhere in the bush round Sydney. Professor Rennie (1880) obtained from the currants 31 per cent. of malic acid, also citric and tartaric, chiefly present as potassium salts.

The Australian Sarsaparilla plant, *Smilax glycyphylla*, also grows round Sydney. Professor Rennie isolated the sweet principle of its leaves, glycyphyllin, and identified its decomposition products as phloretin and isodulcitol. It is, therefore, closely related to phlorizin, from the apple, pear and plum tree. The species of smilax used by the pharmacists are Central American, and their roots contain three saponin glucosides.

One of our suburban ornamental trees is *Pittosporum undulatum*, the essential oil of whose fruits has been investigated in the Wellcome laboratories. The delicate rose-like fragrance is due to a new sesquiterpene.

Northern Plants.

Carissa ovata (N.O. Apocyneæ) was examined by Maiden and Smith (1894), and a very poisonous glucoside, carissin, was isolated. This compound was exceedingly bitter, was easily decomposed during the extraction, and resembled strophanthin in its reaction. The African arrow-poisons contain closely allied glucosides from exotic species.

The Moreton Bay Chestnut, *Castanospermum australe* (Leguminosæ), contains 14.5 per cent of a saponin, the active principle isolated from the beans by Brünnich, in 1894. When the crushed beans are soaked in water for a few days, the very soluble and poisonous saponin is removed, leaving a rather valuable nutritious food.

The areas in this State given up to the prickly Pear are in the North, though small patches are found nearer Sydney. Since many attempts have been made to destroy this pest by chemical means, the following analysis by Mr. W. M. Hamlet, is of interest, as showing the proximate constituents to be dealt with. The fresh leaves of *Opuntia monacantha* contain water, 89.6; fat, 0.42; albuminoides, 1.07; trace of starch, arabin and pectose, 6.77; cellulose, 0.54; min. matter, 1.43 (Roy. Soc. N.S.W., 1889). The leaves contain a large store of water, and the mucilaginous substance of the pulp is arabin. The aqueous solutions develop a deep rose-colour on standing. The fruits, on the other hand, contain much sugar, including arabinose and galactose, with mucilage and the red-colouring matter. The proposed making of alcohol would, therefore, depend entirely on the fruits.

The active principle of *Stephania hernandifolia* was recognised by Bancroft in 1889, as picrotoxin, from its physiological action. This substance was afterwards isolated by Rennie and Turner (1893). The commercial supply is at present obtained from another genus of the Menispermaceæ. These are apparently the only two known sources of picrotoxin. Associated with this substance the authors found an intensely poisonous alkaloid, which produced violent convulsions and death.

Eremophila maculata is an endemic plant of the Western Plains. The poisonous principle is a cyanogenetic glucoside examined by Brünnich in 1910. He found the glucoside in the leaves, and its enzyme in the fruits, separately. It yielded 0.3 per cent. of hydrocyanic acid.

The Darling Pea, *Swainsona* spp. grows in the pastoral districts. It was examined by Guthrie in 1893, who found that the poisonous principle was probably an oil (0.55 per cent.) which had a burning, disagreeable taste. The records of fatalities by this plant are numerous. Professor Martin conducted feeding experiments in 1897, and succeeded in reproducing all the characteristic symptoms of poisoning. He concluded that the ultimate cause of death was peripheral neuritis.

In addition to the plants already mentioned, there is a considerable number known to contain alkaloids, glucosides, saponins, and hydrocyanic acid compounds. These are but the observations of prospecting on the surface, and they suffice to show where lie rich fields for many future workers.

SECTION II.

NATURAL SCIENCE.

Chapter I.—ZOOLOGY.

THE FAUNA OF NEW SOUTH WALES.*

THE MAMMALS.

By Prof. W. A. Haswell, M.A., D.Sc., F.R.S.

The most primitive of the orders of mammals—the *Monotremes*—which are entirely confined to Australia, including Tasmania and New Guinea, are represented in New South Wales by the only two Australian forms—the Platypus or Duckbill (*Ornithorhynchus paradoxus*) and the Spiny Ant-eater (*Echidna aculeata*). Both of these are animals the observation of which in their natural haunts is fraught with much difficulty. Their habits are nocturnal, and they remain, for the most part, securely concealed during the day. The food of Echidna, under natural conditions, consists of ants, for the capture of which its long narrow tongue is specially adapted. During the day it is rarely seen in the open, hiding away in holes among rocks or about the roots of trees. If alarmed during its rare wanderings abroad in the day-time, it rapidly buries itself by burrowing downwards.

The Platypus spends most of its active life in fresh-water pools and streams, swimming and diving with dexterity and seeking its food, in the shape of molluscs, insect-larvæ and the like, among the water-weeds, the characteristic "bill" being used in the searching process like the corresponding organ in the duck. The Platypus, like the Echidna, is hard to find, even in districts where it is abundant enough, since it retires during the day to a burrow excavated in the banks of the stream, and when in the water shows very little above the surface.

Though the State of New South Wales does not contain certain of the most interesting of the Australian Marsupials, such as the Tasmanian Thylacine and Devil, the Banded Ant-eater of the West, or the Tree-Kangaroo of the North, its Marsupial fauna is extensive, comprising as it does, some thirty-seven species, twenty-seven of which belong to the Diprotodont sub-order and ten to the Polyprotodont. Of the former group there are three species of Kangaroos: *Macropus giganteus*, *M. robustus* and *M. rufus*. *Macropus*

* Edited by Prof. W. A. Haswell.

giganteus, the Giant Kangaroo, which is widely distributed over the Australian continent, reaches a height of about five feet, with a tail three feet in length It is an inhabitant of the plains of the interior, where it was once very abundant, but is now fast becoming rare. *M. robustus*, the Wallaroo, which is of about the same dimensions as the Giant Kangaroo, but thicker and heavier in make, is found in the mountain ranges in New South Wales, as of the other States, and does not descend to the plains. *M. rufus*, the Great Red Kangaroo, is larger even than *M. giganteus*, with a height reaching about sixty-five inches. The fur on the upper surface is red in the male; grey in the female. The Great Red Kangaroo occurs on the inland plains, but with the extension of settlement its numbers have greatly diminished in recent years.

Much commoner at the present day than any of the large Kangaroos are the smaller species of the same genus (*Macropus*) known as Wallabies. The Common Scrub Wallaby (*M. ualabatus*) is abundant enough in thick bush in the coastal districts, though, owing to its habit of hiding away in the most densely wooded parts during the day, it is not often to be seen except about dawn or on the approach of night. A larger form, the Red-necked Wallaby (*M. ruficollis*), is still numerous in rough, rocky, open country in New South Wales. The Black-striped Wallaby (*M. dorsalis*), which is distinguished by the presence of a broad black band running from the head to the middle of the back, is common on the far inland plains.

Parry's Wallaby (*M. parryi*), about three feet in height, lives in the open forest country of the mountains.

The Pademelon (*M. thetidis*) and the White-throated Wallaby (*M. parma*), are small Wallabies occurring in New South Wales.

The Brush-tailed Rock Wallaby (*Petrogale penicillata*) is abundant in rocky country along the coast, hiding away during the day in caves and clefts. The nail-tailed Wallabies of the genus *Onchogale*, which have the tail provided at the end with a hard spur or nail, are represented in New South Wales by one species called the Bridled Wallaby (*O. frenata*) on account of the presence of a white stripe running over the shoulder and continued along the back of the neck nearly to the ear. The Bridled Wallaby is an inhabitant of the interior of New South Wales as well as of Queensland and Victoria.

COMMON OPOSSUM
(Trichosurus vulpecula)

GREATER FLYING OPOSSUM
(Petauroides volans)

KOALA
(Phascolarctos cinereus)

WALLAROO
(Macropus robustus)
IN THE DISTANCE

GREAT KANGAROO
(Macropus giganteus)

DINGO
(Canis dingo)

COMMON WOMBAT
(Phascolomys mitchelli)

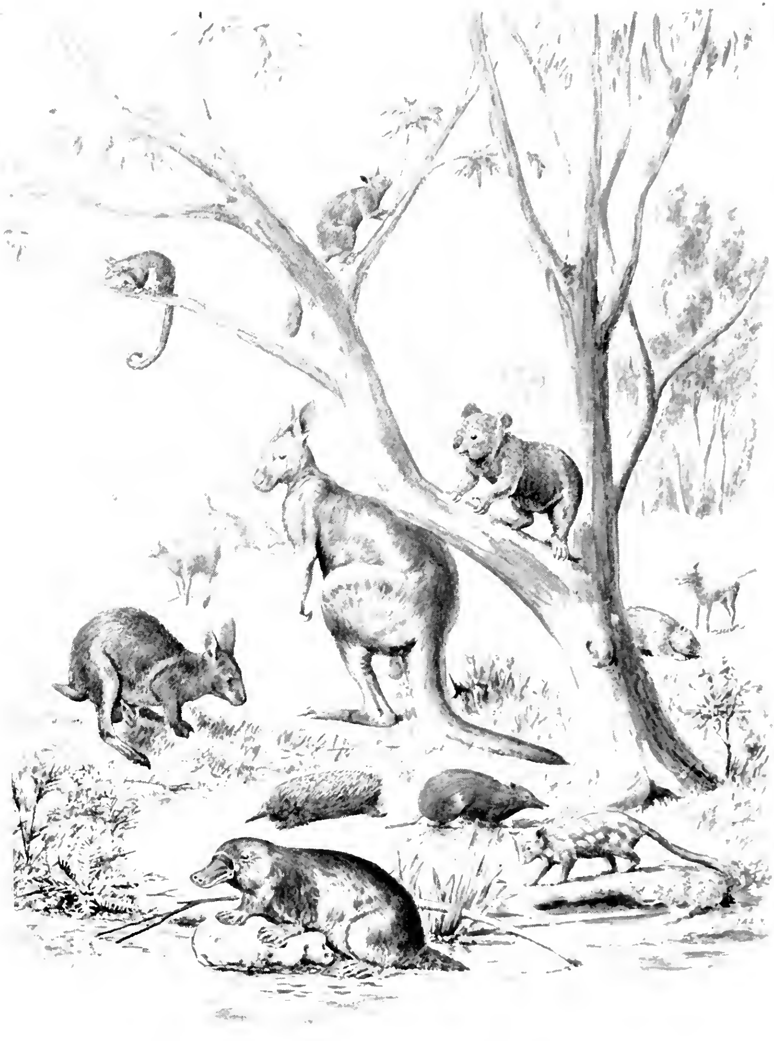
WALLABY
(Onchogale frenata)

SPINY ANT-EATER
(Echidna aculeata)

COMMON BANDICOOT
(Perameles obesula)

NATIVE CAT
(Dasyurus viverrinus)

PLATYPUS
Ornithorhynchus paradoxus



MARSUPIALS AND MONOTREMES

The Hare-Wallabies (genus *Lagorchestes*) are small Wallabies of hare-like size and habits; one of these *L. leporoides* is common to the internal parts of New South Wales and of South Australia.

The Rufous Rat-Kangaroo (*Aepiprymnus rufescens*) is a common small Marsupial in New South Wales, and does not occur elsewhere. Other Rat Kangaroos are the Brush-tailed Bettong (*Bettongia penicillata*), which is found over all Australia except the extreme north, and Gaimard's Bettong (*Bettongia Gaimardi*) which has only been recorded from New South Wales. The Bettongs differ from the rest of the Kangaroo group in having a prehensile tail, used for carrying the materials (grasses) used in the manufacture of the nest. The Common Rat Kangaroo (*Potorous tridactylus*) is widely distributed, not only in New South Wales, but in Victoria, South Australia and Tasmania. Though it has the limb-characters of the Kangaroo family in all essential respects, fore- and hind-limbs are not to a marked extent unequal in development.

The most widely distributed of all the Marsupials in New South Wales, as in most parts of Australia, are the Phalangers or, as they are commonly called in Australia, "Opossums." These are arboreal Diprotodonts, which have the fore- and hind-limbs sub-equal. Both the fore- and the hind-limbs have five complete digits, and both hand and foot are adapted for the purpose of acting as climbing organs; the second and third toes of the foot are small and united together by a web of skin (syndactylous). The tail is long and prehensile, capable, by becoming coiled round a branch, of giving added security in times of stress to the climbing animal. The Common Opossum (*Trichosurus vulpecula*) occurs all over Australia except in the Cape York district. It has long, rather narrow ears, and dense, soft fur. The upper surface is grey, the lower whitish or yellowish, with a rusty patch on the chest; the tail is thick and furry, black towards the end, naked below. The ordinary natural food of the Opossums consists of leaves of Eucalypts and other native trees and shrubs, as well as wild fruits; but they are serious enemies of fruit-growers, owing to a taste which they have developed for cultivated fruits of all kinds. They are nocturnal, like most of the Marsupials, and during the day hide in hollow trees.

The Short-eared Opossum (*Trichosurus caninus*), less common than *T. vulpecula*, and with a similar, though more restricted, range, is to be distinguished from the common species by its somewhat larger size, its shorter ears and shorter fur.

The Ring-tailed Opossums (*Pseudochirus*), which have the narrow tail invested above with a very short fur, are represented in New South Wales by one species only (*P. peregrinus*), which ranges along the whole of eastern Australia, and extends westwards to South Australia.

The Flying Opossums resemble the ordinary Opossums in most respects, but differ in possessing on either side of the body, extending between the fore- and hind-limb, an integumentary fold which, like a corresponding structure in the true Flying Squirrels, acts like a parachute in enabling the animal to fly or glide through the air from one branch of a tree to another. The largest of the New South Wales Flying Opossums is the Greater Flying Opossum (*Petauroides volans*), which is somewhat smaller than the Common Opossum. Considerably smaller are the Yellow-bellied (*Petaurus australis*), the Squirrel-like (*P. sciureus*) and the Lesser (*P. breviceps*) Flying Opossums. Related to these is the fairly common Pigmy Flying Opossum (*Acrobates pygmaeus*), an elegant little creature of the size of a mouse, with the parachute of the larger flying forms, and with a peculiar feather-like tail. The Pigmy Flying Phalanger which, unlike the other members of the family, is insectivorous, occurs in Queensland and Victoria as well as in New South Wales.

The Koala or "Native Bear" (*Phascolarctos cinereus*) is a widely-distributed animal, occurring over Victoria and South Australia as well as in New South Wales. It is an ally of the Opossums, but has a comparatively stout and thick-set body, with large furry ears, and a rudimentary tail. It is an essentially arboreal animal, and both hand and foot are adapted to grasping firmly the branches of the trees in which it lives. At night-time it moves about feeding on the leaves of the Eucalypts; in the day-time it is often to be seen curled up asleep in the fork of a branch. It is a passive and somewhat stupid animal, and quite harmless, though when it mistakes a bystander for a tree and begins to climb, the mistake may be embarrassing.

The Wombat family is represented in New South Wales by a single species (*Phascolomys mitchelli*), which extends to Victoria and South Australia. The Wombat is a thick-bodied, compact animal, about three and a half feet in length, with very short and powerful limbs and a rudimentary tail. The digits are provided with strong claws, except the hallux, which is reduced and clawless. The Wombats excavate extensive burrows, in which they usually lie concealed during the day, issuing forth at night in quest of the herbage and roots which constitute their food.

Of the Polyprotodont Marsupials, the family *Dasyuridæ*, or Native Cats, is represented in New South Wales by nine species in all. The commonest of these is *Dasyurus viverrinus*, the Common Native Cat, which extends over the eastern watershed of New South Wales, and is found also in Victoria, South Australia and Tasmania. It is a slight Marten-like animal, about eighteen inches long, with a tail of twelve inches. The ears are large; the tail covered uniformly with long hairs. The digits, of which there are five in the fore-foot and four in the hind-foot (the first toe or hallux being absent), are provided with sharp, curved claws. The general colour is pale-grey or blackish, with irregular white spots, which do not extend to the tail. The Native Cats are partly terrestrial, partly arboreal. Their hiding-places are hollow logs or crannies among rocks. Their food consists of small birds or any other animals they can capture, and they are often very troublesome visitors to poultry runs.

A second species, the Black-tailed Native Cat (*Dasyurus Geoffroyi*), which has an even wider distribution than *D. viverrinus*, differs from the latter in the presence of the hallux. The third, the Tiger-cat or Spotted-tailed Native Cat (*D. maculatus*), is a good deal larger than the others (the head and body, 25 inches long; the tail, 19 inches), and differs from them also in its heavier make, and in the extension of the white spots on the back to the tail. The Tiger-cat extends from central Queensland through New South Wales to Victoria, and is found chiefly in the ranges, though it occurs also on the coast.

Belonging to the same family as the Native Cats (the family *Dasyuridæ*), are five small Marsupials of mouse-like or rat-like size, known generally as "Pouched Mice." Of these, by far the largest is the Greater Brush-tailed Pouched Mouse (*Phascogale penicillata*), which occurs all over Australia except in the extreme north. It is not much more than half the size of the Native Cat, with coarse grey fur and a brush of black hairs at the end of the tail. The other Pouched Mice have the head and body only about three and a half inches long.

Only four species of the family of the Bandicoots (*Peramalidæ*) occur in New South Wales. Of the genus *Perameles* itself three species occur, viz., the Long-nosed Bandicoot (*P. nasuta*), the Short-nosed Bandicoot (*P. obesula*), and the Eastern Striped Bandicoot (*P. bougainvillei*, var. *fasciata*). These are somewhat like large Rats in general appearance, with slender limbs, the hind pair the longer, the fore-foot with only the three middle digits fully developed, while the hind-foot has a structure recalling that of the foot of the Kangaroo, with the hallux short and devoid of a claw, the second and third toes, small, with flat-twisted claws and united by skin (syndactylous), the fourth much the strongest, and the fifth complete but smaller than the fourth. The tail is rather short and nearly naked or covered with short hairs The ears are small or of moderate size.

The Bandicoots are very common animals, and are not quickly driven away by the advance of settlement, occurring sometimes in numbers on the very outskirts of towns. They are not often seen, however, as they are nocturnal in their habits, and hide away during the day. They are omnivorous in their diet, their chief food consisting of roots, earthworms and insect-larvæ, and they are active burrowers.

The Pig-footed Bandicoot (*Chæropus castanotis*) only occurs in the far-western districts of the State, and is there very rare. The Pig-footed Bandicoot has prominent, narrow ears; the tail crested above with large hairs, and has the digits even further reduced than in *Peramels*, there being only two digits fully developed in the fore-foot, and those of the hind-foot being all small except the fourth, which alone bears the weight.

If we leave out of account the marine forms, viz., the Whales, Dolphins and Seals, the non-marsupial mammalian fauna of New South Wales is not very extensive, and not of great interest. It consists of a number of indigenous species of Rats and Mice (true Rodents), of a variety of Bats, and of the Dingo or Native Dog.

The Dingo (*Canis dingo*) is a wild dog of about the size of a Collie, which is fairly numerous in less-frequented districts. Even less than thirty miles from Sydney, in the wilder parts of the bush along the coast, their weird howling cries may still be heard at night; and in the interior, hunting singly or in twos and threes, or small bands of five or six, they are often the cause of serious losses to sheep- and cattle-breeders, as well as to the poultry-farmers.

Remains of the Dingo have been found mixed with those of extinct Marsupials in Pleistocene deposits, so that it is an ancient inhabitant of the country—much more ancient than Man, so far as existing evidence shows.

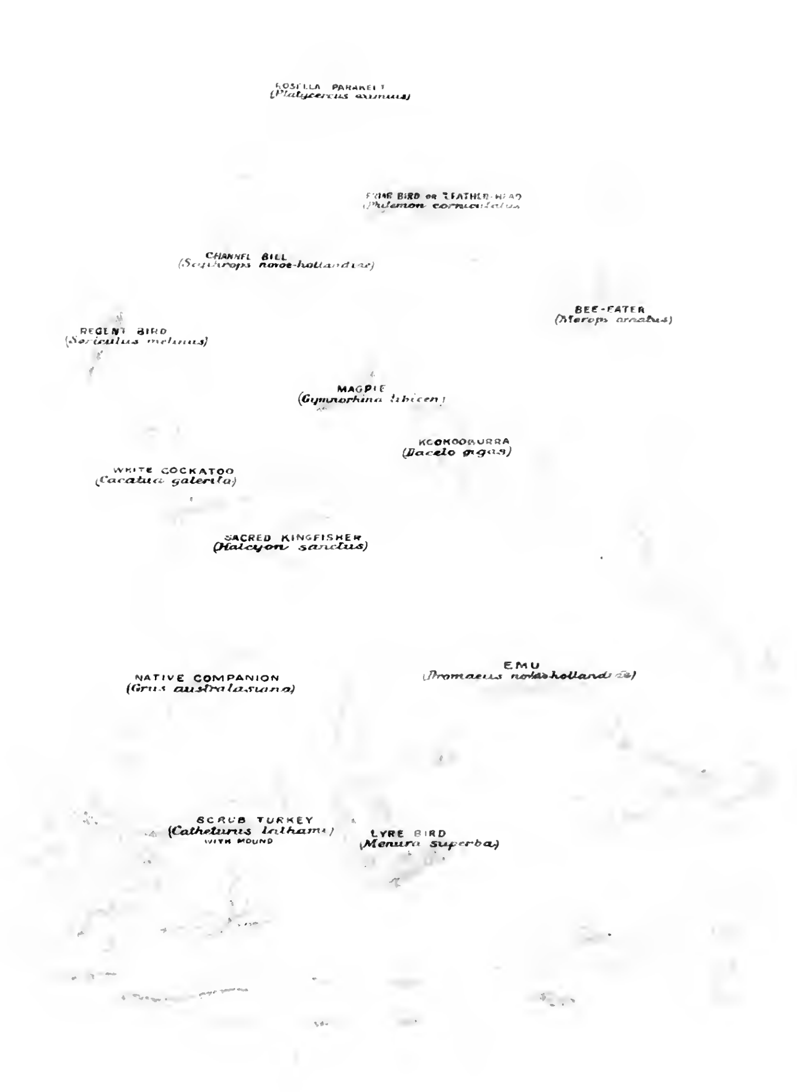
New South Wales possesses a number of species of Bats (order *Chiroptera*). The largest by far are the Fruit-eating Bats or "Flying Foxes" (*Pteropidæ*), a family which also occurs in Africa and Southern Asia, as well as in Fiji and Samoa. These large Bats, with a spread of the wings of three feet or more, are capable of swift and prolonged flight, and travel long distances from their diurnal haunts in remote gorges in the mountains to their feeding-grounds in districts where fruit is to be obtained. During the day they rest suspended by their claws from branches of trees, with the head downwards, congregating together in "camps" or "rookeries" sometimes containing thousands of individuals. At dusk they fly abroad in search of food, and often work great havoc in orchards.

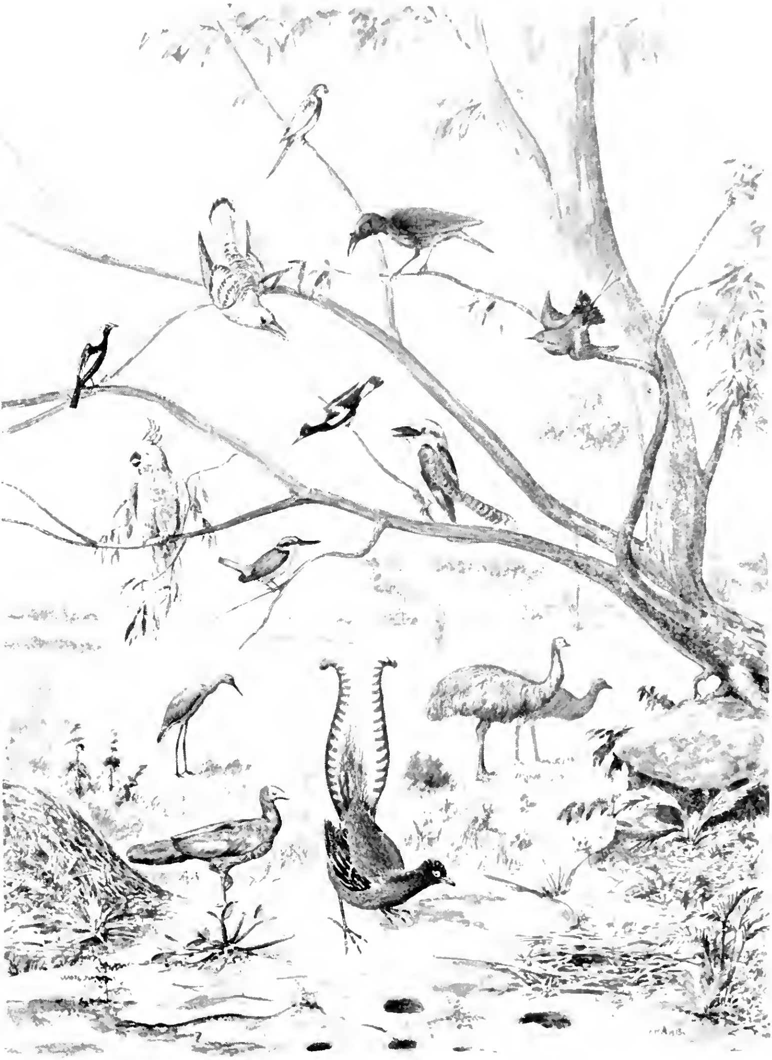
THE BIRDS.

By Alfred J. North, C.M.B.O.U., C.M.Z.S., Ornithologist to the Australian Museum, Sydney.

In round numbers about 775 species of birds are found in Australia and Tasmania, 360, or thereabouts, of which inhabit New South Wales. Few countries, if any, can boast of more singular and beautiful birds than our island-continent, and the once-popular belief that its feathered denizens are without song is as foundationless as the once-frequent statement that its flowers have no perfume. Want of space forbids making little more than a reference to some of its more important forms.

Of the Order *Passeres*, one of the most interesting groups is the Family Ptilonorhynchidæ, represented by the Satin Bower-bird (*Ptilonorhynchus violaceus*) of the coastal scrubs and undergrowth of the contiguous mountain ranges, the Regent Bower-bird (*Sericulus melinus*) of the sub-tropical brushes of the North-coast District, and the Spotted Bower-bird (*Chlamydodera maculata*) of the drier scrubs and belts of timber and bushes which are dotted about or intersect the plains of the Central and Western Districts of the State. The love of the beautiful is always displayed by these birds in the formation and manner of adornment of their playing-places, from the primitive bower made by the Regent Bower-bird to the larger and more compactly built structure of the Spotted Bower-bird, which is profusely decorated with bones, pebbles, pieces of glass, fresh-water shells, and seeds; also, preferably, any bright, metallic articles, such as nails, capsules, ends of wire, empty metal cartridge cases, etc., picked up about its haunts or pilfered from some tent, hut or dwelling. A single representative of the allied family, Paradiseidæ, in the Rifle-bird (*Ptilorhis paradisea*) inhabits the Northern Coastal Districts. Its egg is one of the most beautiful of all the eggs of Australian birds. Equally remarkable, too, is the Family Menuridæ, all the three species of which are found in New South Wales. Prince Albert's Lyre-bird (*Menura alberti*) occurs in the extreme North-eastern portion of the State, Queen Victoria's Lyre-bird (*M. victoriæ*) inhabiting the south-eastern corner, and the common Lyre-bird (*M.*


ROSELLA PARAKEET
(Platycercus eximius)
FRIAR BIRD or LEATHER-HEAD
(Philemon corniculatus)
CHANNEL BILL
(Scythrops novae-hollandiae)
BEE-EATER
(Merops ornatus)
REGENT BIRD
(Sericulus melinus)
MAGPIE
(Gymnorhina tibicen)
KOOKOOBURRA
(Dacelo gigas)
WHITE COCKATOO
(Cacatua galerita)
SACRED KINGFISHER
(Halcyon sanctus)
NATIVE COMPANION
(Grus australasiana)
EMU
(Dromaeus novaehollandiae)
SCRUB TURKEY
(Catheturus lathami)
WITH MOUND
LYRE BIRD
(Menura superba)



AUSTRALIAN BIRDS.

superba) ranging over the remainder of the coastal districts and contiguous mountain-ranges of Eastern New South Wales. In addition to possessing in the males rich, organ-like and other notes, they are the finest avian mimics in the world, imitating to perfection the notes of other birds frequenting the same haunts, and any sound they may hear, such as that produced by the sawing of wood or a dog barking. Within seven miles of Sydney, *Menura superba* may still be found about Middle Harbour, but on very rare occasions on the western side, owing to the comparatively recent clearing of the undergrowth. These birds are, however, more freely distributed the farther north one goes, and are fairly numerous in the scrub-covered gullies and ravines between the head of Middle Harbour and the Hawkesbury River. Unfortunately, in the mountainous districts in the south-eastern portion of the State, a large number of this fine species, and also of *M. victoriæ*, principally females, are destroyed every year by the introduced fox.

The numerous Family Meliphagidæ, or Honey-eaters, over thirty species of which occur in the State, frequenting chiefly the forests of *Eucalypti*, *Acaciæ*, *Banksiæ* and *Melaleuca*, and so well adapted with their brush-like tongues to secure their food, play an important part in the pollination of these and other trees and shrubs. No more beautiful sight could be witnessed by a bird-lover than to stand in winter beneath some giant "feeding-tree," preferably one of the *Eucalypti*, its foliage almost hidden by its large trusses of snowy-white flowers, and watch the different birds coming and going. Within a few miles of Sydney one may often see eight to ten species of Honey-eater feeding on the same tree. At Middle Harbour I have observed at one time the Fulvous-fronted, White-cheeked, Yellow-faced and Short-billed Honey-eaters busily engaged in extracting the nectar and small insects from a single flowering stalk of a Grass-tree (*Xanthorrhœa hastata*).

Over twenty species are found at one season or another in the neighbourhood of Sydney. Although they are called Honey-eaters, insects form a large portion of their food, while not a few are incorrigible fruit-stealers. Among the latter the chief offenders are the Yellow-faced Honey-eater (*Ptilotis chrysops*), the White-eared Honey-eater (*P. leucotis*), the Garrulous Honey-eater, or "Soldier bird" (*Myzantha garrula*), and the well-known Friar-bird, or "Leatherhead" (*Tropidorhynchus corniculatus*), which is very destructive in vineyards during vintage-time. Here, too, must be mentioned the Wattled Honey-eater (*Anthochæra carunculata*), known everywhere where it occurs in New South Wales as the "Gill-bird." This species affords good sport in the coastal districts, and shooting, either for pleasure or profit, is much indulged in during the late autumn and winter months. It retires again chiefly to the Blue Mountains and contiguous ranges for the purpose of breeding in the early spring. Among other birds in this Order, with fruit-eating propensities, may be especially mentioned the three species of Bower-bird, the Fig-bird, or "Mulberry-bird" (*Sphecotheres maxillaris*), the Olive-backed Oriole (*Oriolus sagittatus*), and the Pied Crow-Shrike (*Strepera graculina*).

The worst bird pest in New South Wales and also in Australia, is the Raven (*Corvus australis*); not only are orchards and vineyards plundered, other species robbed of their eggs or callow young, but the eyes of defenceless lambs and disabled sheep are ruthlessly picked out or are otherwise mutilated. The losses to pastoralists alone during every lambing season, or when the sheep become weakened with the effects of drought, is inestimable, and probably exceeds pecuniarily the entire damage done by all other species of harmful birds. Worthy of passing mention in this Order are the Magpie-Lark, or "Pee-wee" (*Grallina picata*), very common in and around Sydney, and occasionally breeding in the parks and gardens of the metropolis, the Apostle-bird (*Struthidea cinerea*), found in the Central and Western Districts of the State, and the White-winged Chough (*Corcorax melanorhamphus*), occurring both inland and in the coastal districts except on the extreme sea-board. All construct on the limbs of trees open bowl-shaped nests of mud, lined with dried grasses or bark fibre, in the latter species several birds assisting in building each nest. They are almost exclusively insectivorous, and the Magpie-Lark is also useful in destroying numbers of small land-shells, one of the intermediate hosts of fluke.

The Family Muscicapidæ is well represented by the various species of Flycatchers, Bush-Warblers and Robins. Of the Flycatchers, the Brown Flycatcher, or "Jacky Winter" (*Micrœca fascinans*), is the commonest resident species in Eastern New South Wales, frequenting and breeding in the parks and public gardens of Sydney, and the first species in early spring and summer to welcome in with cheerful notes the dawn of day. Another familiar species about the many public reserves of the metropolis is the Superb Warbler (*Malurus australis*), the adult male of which, in his velvety-blue and black attire and lengthened tail-feathers partially turned over his back, may be often seen, frequently in company with his modestly brown-plumaged consort, tripping over the grassy lawns or pouring forth his lively, tinkling notes from the top of some low shrub. Lambert's Superb Warbler (*M. lamberti*) is more recluse in habits, although it may still be observed in the larger gardens of Darlinghurst and Elizabeth Bay contiguous to the city, and, although not so common as *M. australis*, occurring like that species throughout the greater part of the Eastern District of New South Wales. The Black-headed, or Scarlet-backed Superb Warbler (*M. melanocephalus*) frequents the northern coastal districts, while the White-winged Superb Warbler (*M. cyanotus*), the Black-backed Superb Warbler (*M. melanotus*), the Turquoisine Superb Warbler (*M. callainus*), and the Purple-backed Superb Warbler (*M. assimilis*), are chiefly inhabitants of the drier scrubs and stunted vegetation of the Western District of the State.

The Family Turdidæ is represented by the Mountain Thrush (*Geocichla lunulata*) and Heine's Mountain Thrush (*G. heinii*), both inhabiting the coastal districts and contiguous mountain ranges, and the sub-family Sylviinæ by the well-known Reed Warbler (*Acrocephalus australis*), common during the spring and summer months in favourable situations in most parts of the State.

Worthy of notice in the Family Timeliidæ is the Pilot-bird (*Pycnoptilus floccosus*), frequenting the undergrowth of the heavily-timbered ranges of the Illawarra District and on the Blue Mountains, the Spine-tail (*Orthonyx spinicauda*), found in the palm and rich brush-lands of the eastern portions of the State, the Yellow-throated Scrub-Wren (*Sericornis citreogularis*), the Large-billed Scrub-Wren (*S. magnirostris*), found in the same localities as the preceding species, and the more generally distributed White-throated Scrub-Wren (*S. frontalis*), common alike to the brush-lands and scrubby undergrowth of Eastern New South Wales, and the Red-Throat (*Pyrrholæmus brunneus*), inhabiting the dry scrub-lands and stunted vegetation of the Western portion of the State. An interest attaches to the Rock Warbler (*Origma rubricata*), frequenting chiefly the rocky mountainous districts of Eastern New South Wales, occurring, too, in isolated pairs in favourable situations a few miles from the metropolis, on account of the unusual sites frequently selected for its nests. Normally the long, pendent, domed structure, formed of shreds of bark, rootlets and cobweb, is suspended by the top to some flake of rock in the roof of a well-concealed, gloomy cave or rock shelter, and well away from the light, but they have also been known to attach them to the underside of wharves, in engine-houses, in tents, deserted dwellings, and beneath tenanted houses; in fact, in any place they have access to in half-obscured light.

The clear, confident, swish-like note terminating in a vigorous crack of the Whip-bird (*Psophodes crepitans*) is more often heard in the low, dense undergrowth than this wary bird is seen. It inhabits the coastal districts and contiguous mountain ranges of Eastern New South Wales, and occurs in favourable situations in the outlying suburbs of Sydney.

The Family Laniidæ is represented by the Black-backed Crow-Shrike (*Gymnorhina tibicen*) and the White-backed Crow-Shrike (*G. leuconota*), familiarly known, both in Australia and Tasmania, as "Magpies." They are extremely useful birds, and rid the land of countless numbers of injurious insects and their larvæ. The Black-throated Crow-Shrike (*Cracticus nigrigularis*), an extremely wary species, and the Collared Crow-Shrike (*C. destructor*), known everywhere in Australia as "Butcher-birds," are more arboreal in habits, the former frequenting chiefly the far Central and Western Districts of the State. The latter is more common in Eastern New South Wales, and may be found breeding within a few miles of the metropolis. It has a *penchant* for abstracting canaries and other small birds, kept in captivity, through the wires of their cages. To the Sub-family Pachycepalinæ belongs the Yellow-breasted Thick-head (*Pachycephala gutturalis*) and the Rufous-breasted Thick-head (*P. rufiventris*), the former frequenting chiefly humid gullies in the coastal districts and contiguous mountain ranges, and the latter the open forests and sapling-scrubs of the coast, and extending as far as the belts of timber which intersect the plains of Western New South Wales. Around Sydney, where both are found, they are locally known as "Thunder-birds" from the habit of singing immediately after a peal of thunder, the report of a gun, or any other sudden, loud noise. Only one other species is found in the State, Gilbert's Thick-head (*P. gilberti*); it is extremely rare, and inhabits the arid scrubs of South-western New South Wales.

To the Family Certhiidæ belong the White-throated Tree-creeper (*Climacteris scandens*), the Brown Tree-creeper (*C. leucophæa*), inhabiting the open forest-lands and mountain ranges of Eastern and Central New South Wales, the Red eye-browed Tree-creeper (*C. erythrops*), and the White eye-browed Tree-creeper (*C. superciliosa*), of Western New South Wales. The food of these species, which consists of insects, is obtained chiefly on or underneath the bark of trees.

The Family Dicæidæ, with a single representative in Australia, has an important action on its flora. The Mistletoe-bird (*Dicæum hirundinaceum*), generally distributed over New South Wales, feeds largely on the viscid berries of the *Loranthus*, which it passes entire, and thus assists in the distribution of this parasite.

Four species of the Family Hirundinidæ are found in New South Wales, the Welcome Swallow (*Hirundo neoxena*), the Tree Swallow (*Petrochelidon nigricans*), and the Fairy Martin (*Lagenoplastes ariel*) are generally distributed, at one season or another, over the greater portion of the State, the White-breasted Swallow (*Cheramœca leucosternon*), a strictly inland species in New South Wales, being confined to the Northern, Central and the Western Districts.

The Family Artamidæ is represented by six species, the Dusky Wood-Swallow (*Artamus tenebrosus*), inhabiting chiefly the coastal districts, the remainder the inland portions of the State, except during periods of drought, when occasionally large flocks of the White eye-browed Wood-Swallow (*A. superciliosus*) and the Masked Wood-Swallow (*A. personatus*) visit the coast All are extremely useful birds, destroying large numbers of insect pests, but they are very destructive to bees, more especially *A. tenebrosus*, apiarists sometimes losing entire hives owing to the depredations of this species.

Finches, which belong to the Family Ploceidæ, are extremely numerous, eight species being found in the State; they are in much request as cage-birds by bird-fanciers, both in Australia and abroad. In the coastal districts the Red eye-browed Finch (*Ægintha temporalis*), or "Red-head," and the Chestnut-breasted Finch (*Donacicola castaneothorax*) are the most common, and the latter species about the Clarence and Richmond Rivers commits great havoc at times in the grain crops. The Chestnut-eared Finch (*Tæniopygia* *castanotis*), or "Zebra-Finch," as it is often called, frequenting chiefly the Western District, is there unusually numerous.

The Order *Passeres* contains nearly all the birds noted for their song or other musical powers, a few only of which can be noticed here. For richness and volume of sound, the different species of Lyre-bird must be placed first among the Birds of New South Wales. To hear a fine old adult male *Menura superba*, or *M. victoriæ*, especially before he has left his roosting-place near the top of some Blackwood or Sassafras, growing in a secluded gully, pour forth his melodious and varied natural notes to usher in the dawn of day, is an experience never to be forgotten. The White-backed and Black-backed Crow-Shrikes are also early risers, and their flute-like carols, pleasant to the ear; nor must the varied liquid-like whistling calls of their smaller congener, the Black-throated Crow-Shrikes or "Butcher-bird" be forgotten. Around Sydney and the suburbs the Brown Fly-catcher or "Jacky Winter" utters its melodious notes at the first break of dawn, and reigns supreme amongst the numerous smaller warblers during the early spring months; a small bird, too, that is sure to arrest one's attention at this time of the year with its lively trilling notes is the White-throated Bush-warbler (*Gerygone albigularis*), locally known as the "Native Canary." The Harmonious or Grey Shrike-Thrush (*Collyriocincla harmonica*), a tame and familiar species about the suburbs and homesteads in the country, too, with its clear whistling notes, must not be overlooked. As a songster, few, if any, can vie with the Brown Singing Lark (*Cinclorhamphus cruralis*). The rich, organ-like notes of the male are usually poured forth while it mounts up high in the air, and the song is accompanied by a tremulous motion of the wings. This migratory species inhabits well-grassed lands, and near the coast, dry, open heath and stunted bracken. Another of our most pleasing songsters is Horsfield's Bush Lark (*Mirafra horsfieldi*), occurring principally about grass-lands and cultivation paddocks. A fair amount of its time is passed on the wing high up in the air, singing all the while. At night at the same time of the year, among others, also may be occasionally heard, the melodious notes of the Reed Warbler (*Acrocephalus australis*), the mournful piping calls of the Little Grass-bird (*Megalurus gramineus*), and of the various species of Cuckoos, the "Sweet-pretty-creature" note of the Black-and-white Fantail or "Willy-Wagtail" (*Sauloprocta* *melaleuca*) and the somewhat harsh piping cries of the Sacred Kingfisher.

The Order *Picariæ* is numerically a small one. Its representatives in the Sub-order *Coraciæ* are the White-rumped Swift (*Cypselus pacificus*) and the Spine-tailed Swift (*Chætura caudacuta*), migrants to Australia from Eastern Asia, where they breed. They pass the day on the wing and appear to be more abundantly distributed during close, thundery weather in mid-summer, and are often the precursors of a storm. The White-throated Night-jar (*Eurostopodus albigularis*), a nocturnal species frequenting chiefly the coastal districts, and a much rarer form, the Spotted Night-jar (*E. argus*), very sparingly distributed over stony rises in the far western portions of the State. The Tawny-shouldered Podargus (*Podargus strigoides*), often erroneously called by the local name of "Mopoke," and the Owlet Night-jar (*Ægotheles novæ-hollandiæ*) are generally, but by no means freely, distributed in favourable situations over the State. The former, when perched in the fork of a tree and danger threatens, with tightly compressed feathers and head held in a line with its elongated body, bears a striking resemblance to the Lace Lizard (*Varanus varius*). The gaily-plumaged species of this Order, include the Bee-eater (*Merops ornatus*), the Dollar-bird (*Eurystomus pacificus*), both migratory species. In the Sub-order *Halcyones*, the Azure Kingfisher (*Alcyone azurea*), chiefly frequenting the wooded banks of rivers, creeks and dams of the eastern and central districts; Macleay's Kingfisher (*Halcyon macleayi*), inhabiting principally the north coast district; the Sacred Kingfisher (*H. sanctus*), generally distributed, but principally in spring and summer, over the State; the Red-rumped Kingfisher (*H. pyrrhopygius*), occurring in the central, and more common in the western district. Of more sombre plumage is the Laughing Kingfisher (*Dacelo gigas*), well known under the name of "Laughing Jackass," and by the natives, of "Kookooburra." All the Kingfishers are chiefly arboreal in habits, but *Alcyone azurea* is never found away from the vicinity of water, breeding in a hole tunnelled in a bank. The remainder breed in holes in limbs of trees, or at the end of holes made by the birds in Termites' nests built on trees. One is likely to be bewildered when hearing for the first time, the uproarious, eerie-laughter-like notes of *Dacelo gigas*, and more especially, about sunset, when several frequently congregate close together in a tree, and the bush fairly resounds with their shrieks of merriment. This species is found in the central and eastern districts, and is common in the outlying suburbs of Sydney; occasionally it is met with in the parks and gardens of the Metropolis.

The representatives of the Sub-order *Coccyges* includes in it the Pallid Cuckoo (*Cuculus inornatus*), the Fan-tailed Cuckoo (*Cacomantis flabelliformis*), the Square-tailed or Brush Cuckoo (*C. variolosus*), the Bronze Cuckoo (*Lamprococcyx plagosus*) and the Rufous-tailed Bronze Cuckoo (*L. basalis*). All of these species are more common in the eastern and central districts, during spring and summer, and occur in the neighbourhood of Sydney, *Cuculus inornatus* being the nearest approach to a strict migrant, while in very mild winters a few remain throughout the year, or are absent only for a short period. Flinder's Cuckoo (*Eudynamis cyamcephala*), the Channel-billed Cuckoo (*Scythrops novæ-hollandiæ*), occur principally in the north-eastern New South Wales; but in late summers and in autumn, examples sometimes wander over the contiguous portions of the State. To this Order also belongs the Pheasant-Coucal (*Centropus phasianus*), locally known as the "Swamp Pheasant," "Swamp Cuckoo," and the "Lark-heeled Cuckoo." It differs from the true Cuckoos in constructing a round nest of grass and debris on the ground, usually lined with Eucalyptus leaves, with an aperture on either side for ingress and egress. The swampy scrubs and brushes of the northern coastal district are its favourite haunts; it is, however, sometimes obtained in the neighbourhood of Sydney, and at Port Hacking and in the Illawarra district.

The Order *Psittaci* is fairly well represented in New South Wales, for out of the sixty species inhabiting Australia and Tasmania, thirty-six are found within its boundaries. In this Order hybrids often occur, and instances of albinism, partial or total, xanthrochroism, erythrism and melanism, are frequently met with. Those most worthy of notice are the different species of the genera *Trichoglossus* and *Glossopsittacus* in the Lories; *Cacatua* and *Calyptorhynchus*, in the Cockatoos; and *Platycercus*, *Psephotus* and *Neophema*, in the Parrakeets. Like the Honey-eaters, the hairy-tongued Lorikeets constituting the Australian numbers of the Family Loriidæ, aid in the pollination of plants and trees, as they feed to a large extent on the nectar extracted from the blossom of Eucalypti and other trees. The Blue-bellied Lorikeet (*Trichoglossus novæ-hollandiæ*), the Scaly-breasted Lorikeet (*Psitteuteles chlorolepidotus*), the Musk Lorikeet (*Glossopsittacus concinnus*) and the Little Lorikeet (*G. pusillus*) inhabit the coastal and central districts; all but the Scaly-breasted Lorikeet, which frequents chiefly the north-eastern part of the State, are generally distributed over these parts. They are at times very destructive in orchards, especially the Musk Lorikeet. In January and February, 1896, these birds amounted to a plague in country districts, and numbers were killed in fruit trees with sticks and stones. The Sulphur-crested Cockatoo (*Cacatua galerita*) is familiar to most bird-lovers in Europe and Britain, as well as in Australia and Tasmania, for it is in great request as a cage-bird or pet. It is a remarkably good talker, but is noisy and when semi-domesticated, very destructive to all kinds of woodwork, when allowed its freedom; in a wild state, in common with the Rose-breasted Cockatoo (*C. roseicapilla*) and many other species of the Order, it commits great havoc in grain crops. Except in the extreme portions of the western and the coastal districts, it is generally distributed over the State, as it is at all times wary and difficult to approach. Precisely the reverse is the Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*), somewhat sparingly distributed in pairs over eastern and central New South Wales. At Middle Harbour, near Sydney, I have known this species to be shot in low *Banksias*. Banks' Black Cockatoo (*C. banksi*) is found in the coastal districts, but not anywhere in the neighbourhood of the Metropolis; also along the course of the Darling River in north-western New South Wales. Solander's Black Cockatoo (*C. viridis*), used at one time to frequent the neighbourhood of Botany; but of recent years, Port Hacking is the nearest locality to the Metropolis in which I have known this species to be procured. It is distributed throughout the greater portion of the coastal districts and central New South Wales. Black Cockatoos feed largely upon seeds and kernels extracted from *Banksia* and *Casuarina* cones; also upon the wood-boring larvæ of insects. The Red-crested Gang-gang Cockatoo (*Callocephalon galeatum*), an inhabitant of the coastal districts and contiguous mountain ranges, is one of the rarest of cage-birds usually seen in this Order. The Crimson-shouldered Parrot (*Aprosmictus erythropterus*), inhabiting northern New South Wales, and the King Parrot (*A. cyanopygius*), distributed throughout the greater part of eastern New South Wales, are worthy of notice on account of the brilliancy of the strikingly contrasted plumage of the adult males; neither must be overlooked the different species of the genus *Platycercus*, of which the more familiarly known are Pennant's Parrakeet (*P. elegans*) and the Rosehill Parrakeet or "Rosella" (*P. eximius*), common within a short distance of Sydney, especially the latter. Extremely quarrelsome in confinement, are the "Blue-bonnets," or Crimson-vented Parrakeet (*Psephotus hæmatorrhous*), inhabiting principally northern New South Wales; and the Yellow-vented Parrakeet (*P. xanthorrhous*), the southern portions of the State. Bourke's Grass-Parrakeet (*Neophema bourkei*) and the Scarlet-chested Grass-Parrakeet (*N. splendida*), inhabiting chiefly the extreme western portions of the State, are far less frequently met with, especially the latter; while of the Chestnut-shouldered Grass-Parrakeet (*N. pulchella*), at one time common near Sydney, I have not seen a living example in a wild state during the past twenty years. The well-known Warbling Grass-Parrakeet, or "Budgerigar" (*Melopsittacus undulatus*) is still in thousands in good seasons, in central and western New South Wales; while the comparatively rare Ground or "Swamp" Parrakeet (*Pezoporus terrestris*), inhabiting chiefly the coastal district, still frequents the neighbourhood of Sydney in very limited numbers. Most of the Parrakeets breed in holes in limbs or trunks of trees, consequently they fall an easy prey to the Lace Lizard (*Varanus varius*), which destroys great numbers of them and their eggs.

With the exception of *Astur cruentus*, all the species of the Order *Accipitres* or the diurnal birds of prey inhabiting Australia and Tasmania are found at one season or another in New South Wales. The principal and the largest species of all, the Wedge-tailed Eagle (*Uroaetus audax*), locally known as the "Eagle-Hawk," is destructive in some parts of the State during the lambing season, and rewards are offered for its head by some Stock Protection Boards. The comparative little harm thus done by the Wedge-tailed Eagle is, however, more than counterbalanced by the immense amount of good it confers on the pastoralist by its persistent destruction of rabbits, which form the chief staple of its food in districts much infested with this rodent. The White Goshawk (*Astur novæ-hollandiæ*), the common Goshawk (*A. approximans*), the Collared Sparrow-Hawk (*Accipiter cirrhocephalus*), the Black-cheeked Falcon (*Falco melanogenys*), and the White-fronted Falcon (*F. lunulatus*), undoubtedly do commit havoc occasionally among fowls and pigeons, more especially in the country districts; but again this is counterbalanced by their destruction of rats, mice and reptiles, besides countless numbers of injurious insect pests; as a useful destroyer of vermin also, and principally in the latter respect, must not be overlooked the graceful Nankeen Kestrel (*Cerchneis cenchroides*). Mention, too, must be made of the Black-breasted Kite (*Gypoictinia melanosternon*), an inhabitant chiefly of the Western District, which assists largely in keeping down rabbits. The White-bellied Sea-Eagle (*Haliætus leucogaster*) frequents the inlets and bays of the coast, and is sometimes found on rivers over two hundred miles inland. Near Sydney it is occasionally seen soaring above the waters of Port Jackson.

Of the Order *Striges*, or nocturnal birds of prey, inhabiting the State, the most common are the Delicate Owl (*Strix delicatula*), a species very closely allied to—by some considered identical with—the Barn Owl of Europe, and the Boobook Owl (*Ninox boobook*). One of the latter birds was captured in 1908 in the vestibule of the Sydney Town Hall. At night-time this species often visits unprotected aviaries of small birds. In the dense coastal scrubs and brushes the rare Sooty Owl (*Strix tenebricosa*) and the large Powerful Owl (*Ninox strenua*) are found; one of the latter birds shot at Richmond, on the Hawkesbury River, had an opossum in its claws.

In the Order *Steganopodes*, the different genera found in the State, as in Australia, all belong to Old World forms, the members of which are noted chiefly for their fish-destroying proclivities, on which diet they almost, if they do not entirely, subsist. An instance of the voracity of the Black Cormorant (*Phalacrocorax carbo*) may be seen in the Australian Museum, where one of these birds is set up as captured by a water spaniel on the Murrumbidgee River, with a partially swallowed Murray Cod (*Oligorus macquariensis*), weighing over a quarter of the bird's weight, protruding from its throat. Much damage is done to the fishing industry by this and allied species, both in the inlets and large estuarine areas of the coast, as well as on the inland rivers and lakes. The Gannet (*Sula serrator*) may be seen flying some distance from the coast, dropping like a stone, ever and anon, into the sea, in order to secure its finny prey; occasionally it ventures into Port Jackson. The Australian Pelican (*Pelecanus conspicillatus*) frequents the islands, rocks awash, and the sand-spits of the bays and inlets of the coast, to the large inland lakes of the Western District, where it breeds; it also breeds on Cook Island, near the mouth of the Tweed River.

The Order *Plataleæ* is numerically one of the smallest in Australia, but it contains some of its most important birds. The Straw-necked Ibis (*Carphibis spinicollis*), the White Ibis (*Ibis molucca*) and the Glossy Ibis (*Plegadis falcinellus*) occur in thousands, and among other food, especially the former, are remarkably fond of locusts and grass-hoppers, etc., and they do an immense amount of good in ridding the grass-lands of the pastoralist of myriads of injurious insects and their larvæ. The Straw-necked and the White Ibis breed in large colonies in reed-beds, cane-grass and low bushes in flooded country, often together, and among them are sometimes found a solitary nest of the Royal or Black-billed Spoonbill (*Platalea regia*), the Yellow-legged Spoonbill (*Platibis flavipes*), the only other species of the Order occurring in New South Wales, also in Australia, constructing their nests, like the rarer Glossy Ibis, on the branches of trees, usually in flooded country.

Among the most important members of the Order *Herodiones* in New South Wales, are the Large White Egret (*Herodias timoriensis*) and the Plumed Egret (*Mesophoyx plumifera*). Although these birds are absolutely protected by law throughout the year, they are much sought after in the breeding season for their beautiful white plumes; also for their eggs. Both of these species are more abundantly distributed in the central and north-eastern districts. An extremely useful bird is the White-fronted Heron (*Notophoyx novæ-hollandiæ*), locally known in some parts of the State as the "Blue Crane," for it destroys numbers of small land molluscs, one of the intermediate hosts of fluke. This species is sparingly distributed around the neighbourhood of Sydney, frequenting trees growing on river banks and the sides of creeks and dams. At intervals along the rocky coast-line occurs, usually in pairs, the Reef Heron (*Demiegretta sacra*). Birds of both sexes may have the entire plumage of slaty-black or white, and the two forms may be found paired together. The Minute Bittern (*Ardetta pusilla*) is distributed, but in very limited numbers, over the greater portion of New South Wales. It is more frequently met with in the coastal districts, than in the dry, far inland parts of the State. Near Sydney it occurs in the swampy undergrowth from Randwick to La Perouse, and also in the Botany Water Reserve. Towering high above every other species in this Order, is the gigantic Black-necked Stork (*Xenorhynchus asiaticus*) or "Jabiru," inhabiting the large Tea-tree and other swamps of the northern coastal districts, its range extending to India, whence came the type originally described by Latham.

Seventeen out of the nineteen species of the Order *Chenomorphæ* inhabiting Australia, are found in the State. The well-known Black Swan (*Chenopsis atrata*) is generally distributed from the bays, estuarine areas, particularly if the latter are overgrown with mangroves, to the reed-beds, cane-swamps and lakes of central and western New South Wales. The Semipalmated or "Magpie" Goose (*Anseranas semipalmata*) is more abundantly distributed inland, as is also the Maned Goose (*Chenonetta jubata*), better known in New South Wales, as in other parts of Australia, as the "Wood Duck." It is from this Order that the chief supplies of edible waterfowl sent to the Metropolis is drawn, but only a passing reference to one or two of the more important can be made here. For table purposes the more popularly known Black, or more correctly named, Brown Duck (*Anas supercilcosa*) takes the pride of place, followed closely, but of smaller size, by the Chestnut-breasted Teal (*Nettion castaneum*) and the more common species, the Slender or Grey Teal (*N. gibberifrons*). The Pink-eared Duck (*Malacorhynchus membranaceus*) is noteworthy for the singularity of its typical nest, a rounded or oval-shaped structure, about a foot in diameter, of dark slaty-grey down plucked from the breast of the parent bird. The rarer and aptly-named Freckled Duck (*Stictonetta nævosa*) must not be overlooked, nor the Musk Duck (*Biziura lobata*), with a leather-like lobe depending from the centre of the under mandible, which is much larger in the male than the female. It is a solitary species, frequenting the inlets of the coast and the rivers and lakes inland, and although many be found in the same bay or lake, seldom two are seen close together. It is a poor flier, and its journeys are always performed at night. Near Sydney it may be occasionally met with, usually in summer, in Botany Bay, on the secluded waters of Hen and Chickens Bay, and Lane Cove, and farther afield at Narrabeen Lake.

The Order *Columbæ*, besides the beauty of form and plumage of many of its species, also contributes its share to the markets and poulterers' shops of the Metropolis, as all are edible; but notice can only be taken of a few of them. The Wonga Pigeon (*Leucosarcia picata*) at one time, either alive or dead, might frequently be seen exposed for sale in the city shops. For years past, however, it has been a forbidden delicacy, having been absolutely protected by an enactment which remains in force until 1924. It chiefly frequents the coastal districts and contiguous mountain ranges, and the nearest place to Sydney where occasionally it may be met with, is at National Park. Scarcely less sought after for sport and table purposes is the Bronze-wing (*Phaps chalcoptera*), more plentifully distributed about thistle-beds and Acacia scrubs in central and western New South Wales. Another toothsome species is the Partridge Bronze-wing (*Geophaps scripta*) or "Squatter," at one time a common inhabitant of the plains of the western district, but now rarely seen, driven away by the ever-increasing flocks of sheep and rabbits, or killed by domestic cats run wild, and foxes, or by poisoned baits. The Harlequin Bronze-wing (*Histriophaps histrionica*), a species chiefly inhabiting of late years, the northern, central and western districts, appears now occasionally in these parts in immense flocks in an unusually wet season following a prolonged drought. When it does visit the State, it appears in such countless numbers, as to darken the air. It feeds to a large extent on the seeds of the Nardoo (*Marsilea quadrifolia*), growing in profusion in marshy localities. Chiefly in the brushes of the northern coastal districts, the beautifully plumaged Magnificent Fruit Pigeon (*Megaloprepia magnifica*) and the Little Green-winged Pigeon (*Chalcophaps chrysochlora*) are found. Here, too, occurs the Top-knot Pigeon (*Lopholaimus antarcticus*), a species much sought after by sportsmen, and better known locally as the "Flock Pigeon," which feeds chiefly on different species of palm seed and those of the Lilly-pilly (*Eugenia smithii*). About the neighbourhood of Sydney, which in the early days of settlement and for a long while after was resorted to by many species of this Order, can now only be sparingly found the Brush Bronze-wing (*Phaps elegans*), chiefly in heathy and stunted vegetation about Middle Harbour, Manly and Botany; and the Peaceful Dove (*Geopelia tranquilla*) which, although nowhere common, has increased of late years.

Of the Order *Gallinæ*, two of the three species of mound-raising birds inhabiting Australia are found in the State. The Mallee-fowl, but more commonly called "Mallee-hen," frequents the dry inland scrubs, chiefly of the central and western districts; and the Brush Turkey (*Catheturus lathami*) is found in the rich and humid brushes of most of the coastal districts, although stragglers have occurred in western central New South Wales. Both of these species, instead of forming nests and incubating their eggs in the usual manner of birds, scrape up large mounds of soil or gravel, *débris*, in with which is intermingled leaves, decaying vegetable matter and grasses, and deposit their eggs therein, and which are hatched with the heat engendered in these hot-beds. These birds are much sought after as articles of food. In the central and western districts, Mallee-Fowls are often destroyed by the acclimatised foxes, and by eating poisoned baits laid for rabbits. The Family *Phasianidæ* largely contributes to the satisfaction of sportsmen, also to the food supply of the Metropolis, for it includes in it the favourite Stubble Quail (*Coturnix pectoralis*) and the Swamp or "Brown" Quail (*Synœcus australis*). The long strings of birds known as Quail, seen hanging in the poulterers' shops of Sydney, in the open season, chiefly consist of the latter species and the Varied Turnix (*Turnix varia*), or locally known "Painted" or "Dotterel Quail," belonging to the Order *Hemipodii*. Mention, too, must be made of the Collared Plain-Wanderer (*Pedionomus torquatus*), a comparatively rare species, allied to the *Turnicidæ*, and the only representative of the Suborder *Pedionomi*. This bird, which has the habit of crouching down, is not infrequently caught by dogs, or even with the hand.

Near Sydney, the swampy undergrowth, reed and weed-covered margins of ponds and dams about Randwick, Botany, and the mouths of George and Cook Rivers, constitute the haunts of many species of the Order *Fulicariæ*. Among those most frequently met with are Lewin's Water Rail (*Hypotænidia brachypus*), the Land Rail (*H. australis*), the Little Water Crake (*Porzana palustris*), and the Spotless Water Crake (*P. tabuensis*). With the exception of the former species, too, they are generally, but sparingly, distributed throughout the eastern and central districts. The Black-backed Gallinule (*Porphyrio melanonotus*) or locally known "Red-bill," the Dusky Moor-hen (*Gallinula tenebrosa*) and the Australian Coot (*Fulica australis*), are common in the same parts of the State; the Black-tailed Native-hen (*Tribonyx ventralis*, inhabits chiefly the central and western districts. At long intervals great irruptions of the latter species occur in western New South Wales, completely overrunning some districts, and after denuding them of grain, vegetables, and every edible plant, just as suddenly disappear again.

The Order *Alectorides* only contains two species. The Australian Crane (*Grus australasiana*), widely known all over the continent as the "Native Companion," at times commits great havoc, eating the seed on newly-planted grain-fields. The other, the Australian Bustard (*Eupodotis australis*), locally called the "Plain Turkey," is an inhabitant of the great plains of central and western New South Wales. It is a most useful bird, feeding largely upon insects procured on the ground about grass-paddocks; extremely wary, and much sought after for the table. Australia is paying dearly for the introduction of foreign mammals, for many birds are destroyed by poisonous baits laid for rabbits, or by the introduced fox, which is rapidly spreading over eastern Australia. Large numbers of birds, too, perish during periods of drought, especially in western New South Wales.

Belonging to the Order *Limicolæ*, many species will be found frequenting the sandy beaches and shallow inlets of the coast, also estuarine areas and contiguous lakes. Among them may be mentioned the White-breasted Oyster-catcher (*Hæmatopus longirostris*), the Golden Plover (*Charadrius dominicus*), the rarer Hooded Dotterel (*Ægialites cucullata*) and the Red-capped Dotterel (*Æ. ruficapilla*). Near Sydney, about the mud-flats at the mouths of Cook and George Rivers, and at other parts of Botany Bay, at one season or another, may be seen the Australian Curlew (*Numenius cyanopus*), the Eastern Bar-tailed Godwit (*Limosa novæ-zealandiæ*), the Marsh Tringa (*Heteropygia acuminata*) and the Grey-rumped Sandpiper (*Totanus brevipes*). Further inland are more abundantly distributed, the Spur-winged Plover (*Lobivanellus lobatus*), the Stone Plover (*Œdicnemus grallarius*), the Black-breasted Plover (*Sarciophorus pectoralis*), the White-headed Stilt (*Himantopus leucocephalus*) and the Red-necked Avocet (*Recurvirostra novæ-hollandiæ*). In central and western New South Wales are found the Red-kneed Dotterel (*Erythrogonys cinctus*), the Australian Dotterel (*Peltohyas australis*), the Pratincole (*Stiltia isabella*) and the Rhynchæa or "Painted Snipe" (*Rhynchæa australis*), Latham's Snipe (*Gallinago australis*), locally known to most sportsmen by the name of "Jack-Snipe," a migrant from

Japan, is a visitor at the latter end of August or early in September, chiefly to the eastern and central districts of the State.

The Order *Gaviæ* is chiefly represented by the Marsh Tern (*Hydrochelidon hybrida*), the Long-legged Tern (*Gelochelidon macrotarsa*), more common inland in the Central and Western Districts, where they breed, the Crested Tern (*Sterna cristata*), common in all the bays and inlets of the coast, and breeding on Cook Island in the north to Montague Island, which is getting towards the southern boundary of the State, and the White-shafted Tern (*Sternula sinensis*), found in the same situations, but more sparingly distributed, breeding in colonies on sand-spits and margins of brackish coastal lagoons. Fairly common along the coast is the Pacific Gull (*Gabianus pacificus*), while the Silver Gull (*Larus novæ-hollandiæ*) is in evidence in all the bays and inlets, large colonies of them breeding on Montague Island. In stormy weather great flocks assemble in grass paddocks contiguous to the coast, and both species have been observed hundreds of miles inland. The Pacific Gull is occasionally seen in Port Jackson and on the Parramatta, and the Silver Gull frequents the shipping in Farm Cove, on the lookout for scraps thrown overboard. It is the most familiar of all species to ferry passengers in Sydney Harbour. Between Sydney Heads and Bradley's Head, Richardson's Skua (*Stercorarius crepidatus*) is in some years remarkably common.

The Order *Tubinares* is principally represented by the White-faced Storm Petrel (*Pelagodroma marina*), the Wedge-tailed Petrel (*Puffinus sphenurus*), and the Short-tailed Petrel (*P. tenuirostris*), the last being the rarer of the three species, except in some years, when it appears in countless numbers. The White-winged Petrel (*Æstrelata leucoptera*), frequenting and breeding on Cabbage-tree Island, near the entrance to Port Stephens, is of circumscribed range, while the Giant Petrel (*Ossifraga gigantea*) is occasionally seen.

Although Albatroses occasionally venture inside Sydney Heads, and I have observed them as far up as the entrance to the Parramatta River, New South Wales seas are not by any means a stronghold of the genus *Diomedea*, and several of the substantiated records of the occurrence of certain species on the coast are founded on a few or single examples. They include the Black eye-browed Albatros (*Diomedea *melanophrys*), the Wandering Albatros (*D. exulans*), the Shy Albatros (*D. cauta*), the Culminated Albatros (*D. culminata*), and the Yellow-nosed Albatros (*Thalassogeron chlororhynchus*).

Three species of the Order *Pygopodes* are generally distributed over the State, the Crested Grebe (*Podiceps cristatus*) being comparatively very rare, the Hoary-headed Grebe (*P. nestor*), extremely common in Western New South Wales, as the Black-throated Grebe (*P. novæ-hollandiæ*) is in the eastern parts of the State.

A single representative of the Order *Impennes* inhabits the seas of the State—the Little Penguin (*Eudyptula minor*). It breeds on some of the larger islands contiguous to the coast, and may be occasionally seen in Port Jackson, about Manly, the entrance to Middle Harbour, and Bradley's Head.

Of the Sub-class *Ratitæ*, one of the two species representing the Order *Casuarii* in Australia, and inhabiting New South Wales, is the Emu (*Dromæus novæ-hollandiæ*), well known everywhere throughout the continent, and emblazoned on the Australian Coat-of-Arms. This species was first figured in Phillip's *Voyage to Botany Bay* in 1789 as the "New Holland Cassowary," and was characterised the following year by Latham in his *Index Ornithologicus* as *Casuarius novæ-hollandiæ*, Captain Tench, in his *Settlement at Port Jackson*, in 1793, first making us acquainted with its nest, eggs and young. Unfortunately its numbers are rapidly decreasing, for does it not consume grass, thereby endangering the staple product of the State, break wire fences, and disturb breeding ewes?—all unpardonable offences in the eyes of the pastoralist. Consequently, both birds and eggs are destroyed in a ruthless manner by men employed for these purposes; besides, the young birds have other enemies to contend with in the shape of dingoes and foxes.

When the British visitor arrives at Circular Quay, Sydney, provided he has not landed at any other Australian port, the question he will probably be asking himself, if he is an ornithologist or bird-lover, is: "Am I really twelve thousand miles away from home?" One of the first, if not the first bird to arrest his attention will be the House Sparrow (*Passer domesticus*), for it may be seen and heard in numbers about the goods sheds on the Quay before he leaves the steamer's side, although it is less common in the breeding season, which usually commences in August. In the city, however, and the public parks and gardens it is ubiquitous.

Another common acclimatised species is the Starling (*Sturnus vulgaris*), which may be seen about the larger public buildings of the city and the grass lawns of Hyde Park and the Botanic Gardens; farther afield in the outlying suburbs it occurs in autumn and winter in immense flocks.

Yet another introduced species may be seen in the parks and gardens of the metropolis and occasionally resorting to the larger buildings in the city—the Spotted-naped Dove (*Turtur suratensis*), of South-eastern Asia; it is common in the suburbs. About the mansions of Double Bay, Rose Bay and Vaucluse, may be seen another acclimatised species from the latter Continent, the Indian Myna (*Acridotheres tristis*). It is remarkable that this species, although it has frequented the localities named for many years past, has kept in the comparatively near neighbourhood and not spread over the surrounding country as it has in Victoria. The same, too, may be said of the introduced Skylark (*Alauda arvensis*), which is chiefly confined to the vicinity of Centennial Park, Randwick, Botany and the lowlands about the mouths of Cook and George Rivers. Frequenting mostly the introduced Pine (*Pinus insignis*) about Randwick, Botany and the western and northern suburbs, may be more often heard than seen, the by no means common acclimatised Greenfinch (*Fringilla chloris*). Far more numerous, in many of the outlying suburbs, especially about thistle-beds, is the Goldfinch (*Carduelis elegans*).

THE REPTILES AND AMPHIBIA.

SNAKES.

By A. H. S. Lucas, M.A., B.Sc.

New South Wales, forming part of a continent and extending northwards into a tropical region, has a very considerable Snake fauna. Snakes are to be found from north to south, on the western plains, on the succession of highlands, and in the Coastal districts. This is not, however, so alarming a statement as might appear. Snakes are not obtrusive and, in general, one has to look hard for them to find them. A long tramp in the untouched, unoccupied bush, along the creeks, across the swamps, often passes without the sight of a single Snake. In winter time the Reptiles are hibernating, hidden away in hollow logs or under larger stones or in burrows. In the summer only, in January and February, when they breed, are the Snakes too occupied to make hasty tracks when a human footstep is heard in the neighbourhood. They are as anxious to avoid man as man is to avoid them. The sluggish Death Adder is an exception; it lies still, no doubt hoping to avoid detection. Still, of course, it is wise to keep a look-out in the bush, for the unexpected sometimes happens, and in stepping over a log it is quite possible to put your foot down on an unsuspecting and preoccupied Snake. In the neighbourhood of the towns, where settlement has been at work, Snakes are rarely seen. In making a home and garden in virgin country, however, even in the outer suburbs of Sydney, Snakes are liable to appear about the grounds for the first few years of occupation. They have not yet been exterminated from the native fauna, though man and his cats, and especially his pigs, if he has any, wage perpetual war with them.

Different kinds are met with in different habitats. The Pythons are properly Tree Snakes, and require forest country. The Death Adder prefers sands and sandstone. The Black Snake is generally found near, often seen in, water. The Copper Head frequents the swamps of the southern highlands. The Tiger is met with in drier districts; often on the hills. The Green and the Brown Tree Snakes, as their name implies, are climbers of trees, the former hunting by day, and the latter by night. The Blind Snakes and the Ringed Snake are mostly turned up when digging or ploughing.

The Ground Snakes feed mostly on Lizards, and especially Frogs. The Pythons will devour small Wallabies, Rat Kangaroos, Bandicoots and Opossums, and the Rabbits. The Tree Snakes feed on young or incautious or disabled birds, and on their eggs, and on the tree geckoes. The Blind Snakes live on Ants and their eggs and larvæ.

The natural enemies of the Snakes are the birds of prey, the Butcher-birds and Crow-shrikes, and especially the Great Brown Kingfisher. The large Monitors will also eat the smaller Snakes; and, at all events in captivity, Snakes have been known to swallow other Snakes.

Our Snakes are included in the three families: *Typhlopidæ*, the Blind Snakes; *Boidæ*, the Carpet and Diamond Snakes; and *Colubrinæ*, the remainder.

The Blind Snakes, *Typhlops*, are small Snakes, a foot or less in length, specially adapted for an underground life, rounded in body, with short head and tail, with very rudimentary, functionless eyes, with polished and glossy scales, tiny mouth, with only rudimentary teeth in the upper jaw. They are more or less grey above, and of a lighter tint below. The tongue is forked, and employed in feeling for and annexing the Ant-food.

The common Python, *P. variegatus*, is usually about eight to ten feet long, though north of New South Wales it may reach fourteen feet. It is of a pale-brown above, with an irregular pattern of dark markings, and yellow below, barred and spotted with black. A variety or sub-species, the Diamond Snake, var. *spilotes*, occurs in a limited coastal district around Sydney. It differs in the darker back, with diamond-shaped clusters of yellow spots. Both are true Pythons, killing their prey by crushing, and non-venomous. They lay eggs, which they incubate, more or less, lying in a coil above them, for the sake of keeping the eggs, not warm, but moist. A rare form, Ramsay's Python, *Aspidites ramsayi*, is met with around Bourke.

Colubrine Snakes of the three sections are found. Of the *Aglypha*, with the teeth all solid, we have the Fresh-water Snake, *Tropidonotus picturatus*, belonging to the same genus as the English Ringed Snake, a good swimmer, and a handsome Snake, with salmon-tinted ventral plates, and red spots on the sides. Only about the rivers near the Queensland border. Also the Green Tree Snakes, *Dendrophis punctulatus*, up to seven feet in length, of varying shades of olive-green. They are perfectly harmless, and exceedingly graceful as they glide rapidly among the foliage of the trees. Oviparous.

Of the *Opistho-glypha*, in which some of the hinder fangs are grooved, our representative is the Brown Tree Snake, *Dipsadomorphus fuscus*, very slender like the Green, and attaining a similar length. The colour agrees with that of the bark. It is harmless to man. Oviparous.

The *Proteroglypha*, in which the front teeth of the upper jaw are grooved, the grooves leading from poison ducts, are all venomous, but the smaller ones are not more dangerous to man than is a bee or wasp.

The *Elapinæ* include all our dangerous land Snakes; the *Hydrophinæ*, the rarely visiting sea Snakes brought from the north by the sea current.

Among the most noticeable of the former are the Brown, the Black, the Copper-headed, the Tiger and the Death Adder. A serious bite on a naked part from any one of them may be fatal. Through clothing, as the fangs are short, though the venom is exceptionally deadly, bites are rarely attended by fatal results. The Brown Snake, *Diemenia textilis*, up to six feet, and fairly thick in body; hunts by day, and is perhaps the Snake most frequently seen in the neighbourhood of Sydney. The young issue from eggs, and are often prettily marked with black rings, disappearing in the adult, which is brown above and dirty-white below. Eggs, up to twenty. The Black Snake, *Pseudechis porphyriacus*, up to seven feet, though generally five or six; is black above, and carmine below. It is fond of water, swimming quickly and gracefully. It is prolific, bringing forth as many as twenty young at a birth. The Copper-head, *Denisonia superba*, is a southern form, about five or six feet long; of rather variable colouring, from black or dark-brown to a slate or a bright-red. The head is coppery in the young, but darkens in the adult. It frequents swamps and feeds on lizards and frogs. The Tiger Snake, *Notechis scutatus*, is the most truculent and aggressive of all our Snakes. It is found in drier parts, about logs and stumps; about five or six feet long; of a light or dark-brown ground colour, crossed by numerous bands of darker brown. It has rather longer poison fangs than most of the other Snakes, and must be treated with great caution. It is very prolific, viviparous, producing as many as fifty young in a litter.

The Death Adder, *Acanthophis antarctica*, is a short, squat, clumsy reptile, rarely more than two feet long, and the most deadly and dangerous of our Snakes. Its colours are those of the ground it frequents, grey or brown with darker bands, much fewer than in the Tiger. It has a pointed tail, ending in a long spine which, of course, is not its weapon of defence. It is particularly dangerous as it lies perfectly still and is of the colour of the ground on which it lies.

Other Colubrines are the pretty little Red-bellied Snake, *Pseudelaps squamulosus*, with a purplish cap, bordered by bright orange bands; the Red-naped Snake, *P. diadema*, the head and neck black, with a scarlet spot or collar on the nape; the Grey Whip Snake (very common), *Diemenia psammophis*, with a yellow spot around the eye; the Black-bellied Snake, *Denisonia signata*, olive-green or brown above, bluish-black below; the Black and White Ringed Snake, *Furina occipitalis*, the easiest Snake to recognise, as it is circled by alternate black and white rings. None of these are large; mostly about two feet; and none are at all dangerous to man.

The Sea Snakes are not indigenous, but only rare and involuntary visitors to our shores; they are all poisonous.

Chelonia.

While there are crocodiles in Northern Queensland and the rivers of the Northern Territory, there are none in the rivers of New South Wales. There are, however, representatives of the order Chelonia.

We have no land Tortoises, all our forms swimming freely, either as sea or freshwater forms. We are too far south for our shores to be visited by the green or the Hawksbill Turtles of the tropical Pacific, but the Luth, *Dermochelys coriacea*, is occasionally captured in our waters. It is the largest of all the Chelonians now living, reaching to a length of nine feet. It has a ridged, bony carapace and a thick, leathery integument. The colour is brown above, and below a mottling of pinkish-white. The typical New South Wales Chelonians are, however, the freshwater species, which are never met with far from water. The Long-necked Tortoise, *Chelodina longicollis*, is the commoner coastal form; and the Murray Tortoise, *Emydura macquariæ*, is abundant in the Murray Basin. Both lay oval eggs over an inch long, in shallow excavations, which the animal makes in the bank.

The former possesses a remarkable odour of garlic in the breeding season. It is not very rare in the Sydney district. It is easily known by the long neck, when this is protruded.

LACERTILIA—LIZARDS.

The Lizards are the Reptiles which will be most noticed by visitors from England to our shores. They are very numerous, and may be observed in the cities as well as in the bush. Five Families are represented: *Geckonidæ, Pygopodidæ, Agamidæ, Varanidæ, and Scincidæ.*

GECKONIDÆ.—The Geckoes get their name from the clicking sound of the voice, but our species are not by any means vociferous. They are all soft-skinned animals, with full complement of legs; scales on the ventral surface and around the gape; fleshy tongue; usually very brittle tail. The toes are furnished usually with soft, adhesive pads, so that the Lizards can run up and down walls or rock faces or trees with great ease. They are nocturnal feeders, and can best be found by hunting under bark or logs or stones. They lay round eggs with a hard shell. *Gymnodactylus miliusii*, is a tree Gecko, five inches or so long, of a handsome chestnut-brown above, with transverse rows of white spots; while *G. phyllurus* is a much-flattened, rather longer form, the tail flat and leaflike. It is found in crevices of damp rocks. Both have long claws at the extremities of the toes. Other genera, with well-developed pads and short claws, are: *Diplodactylus*, *Oedura*, and *Phyllodactylus*.

PYGOPODIDÆ.—These are elongated, snake-like, scaly Lizards, allied to the Geckoes in the structure of the skull. The limbs are quite rudimentary, hence the larger kinds are often mistaken for snakes, and suffer a wholly unmerited fate. The Family is confined to Australia. The one most frequently met with is the common Slow-worm, *Pygopus lepidopus*, not related to the British Slow-worm. It is rough to handle because half the scales are keeled. It reaches two feet in length, and when disturbed is sufficiently active, proceeding with snake-like movements. It is exceedingly brittle, snapping into two or more pieces if grasped anywhere behind the head. It is, of course, only the tail which breaks up, but this occupies three-fourths of the length of the Lizard. Occasionally other forms are seen, *Cryptodelma orientalis* (15 inches), *Delma fraseri* (18 inches), *D. impar* (12 inches), a prettily marked species, with light and dark longitudinal stripes, and *Lialis burtoni* (20 inches), with long, pointed head, flatter than the others, with a bifid tongue.

AGAMIDÆ.—The Dragons, allied to the Flying Lizards of the Malay Archipelago. They are Lizards with large head, stout body, and long, tapering, and not fragile tail. You can pick them up by the tail. The tongue is thick and fleshy, sometimes brightly coloured yellow or blue. They have the four limbs fully developed and are extremely active in the sunlight. The skin is rough, covered with scales of which some are conical or spinose. Oviparous. Among the commonest are three species of *Amphibolurus*. The Common Dragon, *A. muricatus* (12 inches), is abundant around Sydney. The Mountain Dragon, *A. angulifer* (8 inches), prefers southern mountain climates. The Bearded Dragon or Jew Lizard, *A. barbatus*, is our largest species (up to 21 inches). It has a way when irritated of raising its head, expanding the large frill of long spines, which fringes the head behind the ears and lower jaw, and at the same time flattening out the body; but like all its congeners, it is perfectly harmless. The Water Dragon, *Physignathus lesueurii* (3 feet), is our most aquatic Lizard. If disturbed on the bank as they are sunning themselves or catching flying insects, they at once plunge into the water and swim rapidly away. But they are not "crocodiles."

VARANIDÆ.—The Monitors are our largest Lizards, locally called "Iguanas." They are long animals, with long heads and tails, covered over with small scales. The tongue is forked like that of a Snake. The limbs are strong, with long claws. The commonest in the coastal region is the Lace Monitor, *Varanus varius*. It may be six feet or more in length. It is a tree Lizard, climbing in corkscrew fashion to rob birds' nests of eggs or young. It will, however, practically feed on any animal, alive or dead, which it can master and swallow, up to rabbits or even a leg of mutton. It is the terror of country poultry yards. Gould's Monitor, *V. gouldii* (4 feet), is a lighter coloured ground form, hiding in holes in the drier inland districts.

SCINCIDÆ.—The Skinks are our most abundant Lizards. They have flattened heads, roundish bodies, and long, cylindrical fragile tails. They are enclosed in a skin covered with smooth or keeled scales, and are ground Lizards. The larger have all limbs well developed, but in some of the smaller we have an interesting series, in which the limbs become gradually shorter and the toes gradually disappear.

The Egernias are larger, mostly black, with rough, keeled scales, found about rocks. *Egernia whitei* is exceptionally smooth, with longitudinal bands of colour. *Trachysaurus rugosus*, the Stump-tailed Lizard (14 inches), is a stout form, with short legs and tail, which has a reputation as an enemy to Snakes. The Blue-tongued Lizards, *Tiliqua scincoides* and *T. nigrolutea*, are remarkable for the broad, indigo-blue tongue. They are large Lizards, up to 2 feet, thick-set, but flattened, with comparatively short legs. They make easily kept pets, as they will feed on bread and meat, and lap up milk like a kitten. The species of *Lygosoma* are legion. They are smaller Lizards with brilliantly metallic scales, often with elegant patterns of colouring, bright and active, and capital devourers of insects. In some species the fore-limbs have vanished and the hinder are reduced to rudiments with a solitary toe.

Amphibia.

The only members of this Order in New South Wales or, indeed, in Australia, are the Frogs and Toads. Their life is mostly conditioned by the wetness or dryness of the season. After heavy rain, when the waterholes are full and the creeks running, there is in warm times a chorus of voices, ranging from the basso of the great Hylas to the falsetto of the little Crinia. They breed when they can, when the conditions are sufficiently warm and wet. The New South Wales Amphibia belong to the three Families, *Cystognathidæ*, *Hylidæ*, and *Bufonidæ*.

Cystognathidæ.—This Family of Frogs is common to Australia and South America. They differ from *Ranidæ* in the skeleton, the pectoral arch having more give in our forms. They include free-swimming forms like *Mixophyes*, burrowers like *Chiroleptes Heleioporus*, and *Philocryphus*, and swamp-frogs like *Limnodynastes* and the little *Crinia*.

Bufonidæ.—The Toads are all quite small; about an inch long. They are found under logs and stones, as *Pseudophryne bibronii* and *P. australis*, or burrow, as *Notaden bennettii*. The ova are few in number and are deposited in damp situations or on leaves. Mr. Fletcher states that the larvæ do not develop external gills. *P. australis* has a broad T-shaped yellow mark on the forehead. *Notaden*, in breeding dress, is a very brilliantly coloured Toad, the background green carrying a cross of black papillæ and patches of red, orange, and white. It occurs on the Western Plains, the others being found around Sydney.

Hylidæ.—The Tree Frogs are characterised by the broadly-expanded discs at the tips of the fingers and toes. They are generally good swimmers. They have considerable powers of climbing. The most common are the Great Green Tree Frog, *Hyla cœrulea*, which is not blue; the Bell Frog, *H. aurea*, green above, purplish below, with long bands of golden-yellow on the back; and the Brown Tree Frog, *H. ewingii*, smaller than the others (2 inches), with a dark spot on the head, dividing behind over the back.

THE FISHES OF NEW SOUTH WALES.

By Allan R. MacCulloch, Zoologist, Australian Museum.

About 550 species of fishes are recorded from New South Wales waters, but of these a considerable number are very rare here, and their inclusion in our catalogues is, in some cases, based on the capture of only one or two specimens. It must be noted, however, that we know comparatively little of the fishes from any part of the coast except that near Sydney, and it is certain that a systematic study of those occurring nearer the northern and southern limits of the State would reveal the presence of a considerable number of species which are at present either unrecorded, or, at least regarded as only occasional visitors to our waters.

Further, practically all the marine fishes caught and forwarded to our markets are obtained either in the coastal estuaries and lakes or within a few miles of the mainland. Beyond occasional, and often unauthentic records of their occurrence, we know almost nothing of the huge shoals of oceanic fishes of the Herring and Mackerel tribes, which are probably as abundant here, in certain seasons, as anywhere in the world. Within recent years only, a few of the more enthusiastic of our sporting fishermen have caught Tunny, *Thynnus;* Kingfish, *Seriola;* and Spanish Mackerel, *Scomberomorus* in large numbers; while even a Sword-fish, *Tetrapturus*, has fallen a victim to the rod and line. It is probable, therefore, that the larger sporting fish will, before long, attract more attention from anglers than they have done in the past, and we may hope to see the formation of large and wealthy fishing clubs here similar to those of California, which have added so much to our knowledge of the oceanic fishes of that region.

The efforts to investigate our deeper waters of one hundred fathoms and more—those mysterious depths wherein live some of the most strange types of animal life—can be counted on the fingers of one's hand. Yet our facilities for this particular class of work are equalled by but few other places, since we can reach one hundred fathoms within about twenty miles of Port Jackson, and from there the bottom slopes steeply downwards to two thousand fathoms and more. A successful haul of a large dredge made in 1906 in 800 fathoms, east of Sydney, brought to light several new fishes of the genera *Hoplichthys* and *Cœlorhynchus*, while the investigations of the Federal Trawler, "Endeavour," in southern Australian waters, have resulted in the capture of many species which are closely allied to, or even identical with well-known deep-sea types from the Mediterranean and Indian Ocean. Among these may be mentioned *Scymnorhinus*, *Oxynotus*, *Centrophorus*, *Hoplostethus*, and *Neoscopelus*.

The marine shore-fishes of New South Wales are comprised of two very distinct groups, the one being made up of those species which have extended their range southwards from Queensland, and the other including the more southern Australian types. There is naturally no fixed point at which the ranges of the two terminate, many southern forms being known to occur in Moreton Bay, while stragglers from the northern State are occasionally captured in Port Jackson. With a more complete knowledge, however, of the conditions governing their distribution, such as currents, temperature, food-supply, etc., we may find a limited length of coast-line where the northern and southern elements intermingle, but diminish rapidly in numbers immediately south and north of it respectively.

A warm current sweeping southwards along the coast for a considerable portion of the year serves as a highroad for the ingress of many tropical species into our cooler latitudes, which either perish when the current fails them or may find refuge in some sheltered harbour during the colder months. This current, which has been named the notonectian, carries along with it a wealth of minute organisms which afford a plentiful supply of food for the larger animals drifting with them. If an easterly wind arises, the beaches along the coast become strewn with their remains, and many small fishes are washed up among the other things. Such forms as *Zanclus canescens*, *Epinephelus lanceolatus*, *Aulostomus valenciennesii*, and *Parachætodon ocellatus* are mere stragglers from the coral regions, and their occurrence here is only very occasional.

The greater number of the fishes occurring around and south of Sydney belong to a fauna which is typical of southern Australia. Its representatives extend into New Zealand waters, and in a less degree, to those of South Africa also. Their northern limit is determined by the temperature of the ocean, so that many species, such as the Numb-fish, *Narcine*, and the Dories, *Cyttus* and *Zeus*, which are shallow-water species in Tasmania, descend into the cooler depths as they approach our shores. Others, such as the Barracouta, *Thyrsites*, are much more abundant on the New South Wales coast during the winter months than in the summer. As examples of this southern fauna one may cite the Morwongs, *Cheilodactylidæ;* Trumpeters, *Latrididæ;* Leather-jackets, *Cantherines;* Parrot-fishes, *Pseudolabrus;* Trevally, *Seriolella;* Sweep, *Scorpididæ;* and Flatheads, *Platycephalus*, of which the species are either confined to the southern Australian region or reach their greatest development there.

Most of the fishes marketed in Sydney belong to the following kinds:—Jew-fish, *Sciæna*, Black-bream, *Sparus*, Snapper, *Pagrosomus*, Black-fish, *Girella*, Flathead, *Platycephalus*, Whiting, *Sillago*, Mullet, *Mugil*, and Gar-fish, *Hemirhamphus*. As already mentioned, all these are obtained in the coastal lakes and estuaries, or within a few miles of the coast. The great shoals of Herrings, Pilchards and Anchovies which pass up and down at intervals throughout the year remain untouched by our fishermen, while Kingfish, Mackerel and other members of the Scomberidæ are only caught when they venture into the sheltered harbours.

The Snapper, *Pagrosomus auratus*, is generally regarded as the choice fish of the market, and always commands the highest price. It is usually taken "outside" in the neighbourhood of rocky reefs, and provides more sport for our fishing enthusiasts than any other fish. The smallest specimens sold are called Red-bream, and are of a beautiful pink colour with pale blue spots. As they grow they pass into the Squire stage, and only attain the full dignity of being Snapper when the occipital bone becomes so enlarged as to form a prominent hump on the neck. In very old examples the hump is greatly developed, and a fleshy protuberance is formed on the snout which gives the fish such a strangely human appearance that it becomes known as an old-man Snapper.

Related to the Snapper, and next to it in favour, is the Black-bream, *Sparus australis*. This species inhabits the harbours, estuaries and coastal lakes, and is captured in enormous quantities by net-fishermen. It is generally recognised as a good sporting-fish, being of a very cautious nature, so that the most tempting baits and finest tackle must be used for its capture. An allied species, the Tarwhine, *S.*

sarba, is often confused with the black-bream, but is a much less tasty fish, and not nearly so abundant, being a tropical species which only occasionally makes its appearance here in large numbers.

The Black-fish, *Girella tricuspidata*, is as abundant as the Black-bream, but has an inferior flavour, being largely a vegetable feeder. Its teeth are either chisel-shaped or tricuspid, and are arranged very close together so as to enable it to bite off the finest branches of its food. It is captured in great quantities by net fishermen, and also affords much sport to anglers who secure it with a weed-bait known as "sea-moss."

The family Platycephalidæ, to which the Flatheads belong, is largely represented in Australian waters, and several species are forwarded to the Sydney markets. The common Dusky Flathead, *Platycephalus fuscus*, is an inhabitant of the estuaries, where it is captured by both net and line fishermen. Like all other members of the family, it is provided with two sharp spines on either side of the nead with which it can inflict a nasty wound if incautiously handled. The long-spined Flathead, or Spikey, *P. longispinis*, is particularly well provided in this respect. Flatheads are bottom fishes, and they like to lie half buried in the sand or mud in wait for any little crabs and fishes that may chance to come by. Their eyes are on top of their heads, and their lower jaw is usually prolonged well in front of the upper one, so that the mouth is in a convenient position for snapping up anything venturing within range.

Whiting, of the family Sillaginidæ, are usually represented in the market by two species, the Sand-whiting, *Sillago ciliata*, and the Trumpeter Whiting, *S. maculata*, both of which are delicious eating, and always command a high price. They have neither resemblance nor relationship to the whiting of English waters, which is one of the cod-family, Gadidæ. A third species, the School Whiting, *S. bassensis*, is a southern fish, and is usually obtained in the deeper water "outside," and therefore does not appear in the market so often as the other two.

The Jew-fish, *Sciæna antarctica*, is scarcely distinct from the Maigre of Europe, and is one of our most important food fishes, since it is extremely abundant, and attains a weight of over sixty pounds The young are better flavoured than the larger examples, but all are eagerly bought by the hotel and restaurant keepers, who are very apt to pass it off on an unsuspecting public as Snapper. The otoliths or ear-stones are greatly developed in this species, which, on account of their pearly appearance, is often called the Jewel-fish.

The Mullets are undoubtedly by far the most important of our fishes from the market point of view, the Sea Mullet, *Mugil dobula*, in particular being the great stand-by of the fish-mongers. It is exceedingly abundant at all times, but congregates in enormous shoals between April and July for spawning purposes. It inhabits all the harbours, lakes and estuaries, and is even known from fresh water, but the full-grown fish migrate to the sea during the breeding season. As many as forty-five thousand baskets of Mullet, each weighing about seventy-five pounds, have been received in one year for disposal in the Sydney markets. Other important species of the Mugilidæ are the Flat-tailed Mullet, *M. peronii*, Silver Mullet, *M. georgii*, and the Sand Mullet, *Myxus elongatus*.

Gar-fish, Hemirhamphidæ, are commonly represented by two species, the Sea Gar-fish, *Hemirhamphus intermedius*, and the River Gar-fish, *H. regularis*. Both are very abundant, and are excellent food fish, their flesh being firm and flaky, and of good flavour.

Other fish commonly seen in the market are Sea Pike, *Sphyræna*, and Long Toms, *Tylosurus*, though the latter are regarded with suspicion as food fish by some on account of the green colour of their bones. The Australian Salmon, *Arripis*, is not much in favour as a table-fish, but it is exceedingly abundant, and periodically appears in enormous shoals. The young and half-grown fish are better flavoured than the adults, and are known as Salmon Trout on account of their trout-like markings. Sergeant Baker, *Aulopus*, Rock-cod, *Epinephelus*, and Nannygai, *Trachichthodes*, are captured both by the line and trammel-net, and always command a good price. Trevally, *Caranx*, Kingfish, *Seriola*, Tailer, *Pomatomus*, and Mackerel, *Scomber*, are valuable food-fishes, but, as they deteriorate rather rapidly after death, they are regarded as bad market fish. Yellow-tail, *Trachurus*, are sold principally for bait, but are, nevertheless, good eating, while Trumpeter, *Latris*, and Morwong, *Dactylosparus*, sell readily. Pilchard, *Clupanodon*, and Herring, *Harengula*, do not usually appear in any number in the market, but their abundance on our coast at certain seasons leaves no doubt that they will support a profitable fishing-industry in the future. Red Rock-cod, *Scorpæna*, and

Parrot-fish, *Labridæ*, are good eating, though the latter become soft if kept for any length of time. Soles, *Synaptura*, and Flounders, *Pseudorhombus* and *Ammotretis*, are excellent table-fish, and always find a ready sale at a high price.

The main river system of New South Wales is so intimately connected with that of Victoria and southern Queensland that it is not surprising to find a very close resemblance between the fresh-water faunæ of the three States. Practically every stream west of the Dividing Range in New South Wales is connected with either the Darling, Lachlan, or Murrumbidgee Rivers; these again join the Murray, into which most of the Victorian rivers flow. The fishes are, therefore, able to range over a very wide area, and we find a remarkable uniformity in the distribution of the greater number of the species. The Murray Cod, *Oligorus*, and the Australian Perch, *Percalates*, are to be obtained in almost every western stream, and they even occur in some coastal rivers in southern Queensland and northern New South Wales. Their presence in the latter is particularly interesting, and bears out the suggestion that the separation of the head-waters of the Darling system from the coastal rivers has taken place at a very recent geological period.

The Murray Cod is the most famous of our edible fresh-water fishes, and is an important article of food in the west. It attains a large size, occasionally growing to six feet long, and enormous quantities are caught and dispatched to the Sydney and Melbourne markets. The range of the Perch is even greater than that of the Cod, since it descends into the estuaries of the coastal streams to where the water is quite brackish or even salt. As is usual among fresh-water fish which live under many very diverse conditions, it is exceedingly variable in form, estuarine examples, in particular, being usually much deeper than those from the rivers, and it has accordingly had a number of specific names bestowed upon it by different authors. Other Perch-like fishes inhabiting the fresh-waters of the State are the Golden Perch, *Plectroplites*, the Macquarie Perch, *Macquaria*, and the Silver Perch, *Therapon*, all of which are abundant in the various western rivers, and are much used for food.

Most interesting from a naturalist's point of view are the little Eel-gudgeons or Native Trout, *Galaxias*, a genus of which the distribution is so much discussed in connection with the "Antarctic Continent" theory. They are allied to the Salmon and the Trout, Salmonidæ of European and American waters, but are small, scaleless fishes rarely attaining a greater length than eight inches. Several species occur in New South Wales, extending northwards to the Queensland border, but they vary so greatly, both in form and colour-marking, that their separation into species is a matter of great difficulty. *G. attenuatus* is common in streams not far from the sea, and it is known to descend into the salt-water to spawn, while *G. findlayi* ascends the Snowy River and its tributaries almost to the summit of Mount Kosciusko during the summer months. *Galaxias* occurs in the southern half of Australia, Tasmania, New Zealand, South Africa, South America, and the Falkland Island, while a species has recently been discovered in New Caledonia.

The Australian Grayling, *Prototroctes*, and the Smelt, *Retropinna*, are fishes with a distribution almost as interesting as that of *Galaxias*, since they occur in the freshwaters of New Zealand, Tasmania and south-eastern Australia. The former is confined, in New South Wales, to the coastal streams of the southern half of the State, where it makes its appearance in large numbers, at irregular intervals. The Smelt is a minute species, rarely growing beyond three inches long, and is exceedingly abundant in some streams near Sydney. Like *Galaxias*, it is exceedingly variable in form, and the specific characters of our one or more species have yet to be determined. Another interesting fish, of which the affinities are uncertain, is the River Blackfish, *Gadopsis*, inhabiting Tasmania and south-eastern Australia, and extending northwards through the Darling system into southern Queensland. It reaches a large size in some of the rivers of northern Tasmania, where it is esteemed for food, and attains a weight of about eight pounds, but is usually much smaller in New South Wales.

The Rough-backed or River Herring, *Potamalosa*, inhabiting the coastal streams, and its marine relative, the Sandy Sprat, *Hyperlophus*, are remarkable as being representatives of an extinct group of herrings which flourished during the Cretaceous and Eocene periods. They are characterised by a series of upstanding, keeled scales on the back before the dorsal fin, similar to those occurring along the ventral profile of most herrings. The Bony-bream, *Konosirus*, is another fresh-water herring which occurs in the western rivers of the State, and is distributed over the greater part of Australia. The range of the genus extends throughout the East Indies, and northwards to Japan, and the species are scarcely generically separable from the American *Dorosoma*.

Gudgeons of the sub-family Eleotrinæ, are represented by several genera and species in all our streams, while we have several species of a highly interesting family, Melanotæniidæ, of which representatives occur in Northern and Central Australia, New South Wales, Queensland and New Guinea.

Rainbow and English Trout, *Salmo*, have been successfully introduced from Europe and America into many of our rivers, while the Crucian Carp and the Gold-fish, *Carassius*, have spread over a very large portion of the State. They have brought about a marked change in the fresh-water fauna, and have practically exterminated the native fishes in some localities. *Galaxias* and *Prototroctes* are among those that have suffered, their spawn being devoured by the carp, while the fishes themselves provide excellent food for the larger trout.

THE INSECTS OF NEW SOUTH WALES.

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The State of New South Wales constitutes a large central division of the eastern portion of the Australian continent, which might be broadly systematised in at least four subdivisions, as regarding its insect fauna. The coastal region south of Sydney, right down to the bleak tablelands extending to the Victorian border; the semi-tropical forests from the Queensland border down the coast north of Sydney; the typical Hawkesbury sandstone country from the coast over the Blue Mountains; while the whole of the western country beyond the mountains from north to south may be taken as the fourth division. The insect fauna of the Hawkesbury Sandstone area is very characteristic, and rich in large and handsome insects, many of which are very interesting as they comprise the species first collected by Banks, Solander, Lewin and others, and some of which were figured by Donovan in his "Insects of New Holland," published in 1825.

The wealth of small flowering shrubs and dwarf trees, such as the Melaleuca, Leptospermum, Callistemon, Acacia, Angophora and Bloodwood, attracts a number of fine insects during the early summer months.

Commencing with the COLEOPTERA, we find the Family *Buprestidæ* represented by over 450 described species. Over half of this number is comprised in the Genus *Stigmodera*, which, with a few exceptions, are flower-haunting beetles, and chiefly confined to the coastal districts of eastern and western Australia. Feasting upon the large white flowers of the Angophora we find *Stigmodera macularia*, *S. variabilis*, *S. suturalis* and a host of smaller species; while the handsome black-and-yellow leaf-eating *Cyria imperialis* is found in the same localities upon the foliage of the small-leaved honeysuckle, *Banksia*. Some of the smaller species belonging to the Genera *Ethon*, *Paracephala*, and *Cisseis* in their larval state live in galls upon the roots or branchlets of the small shrubs. While dealing with this family, *Calodema regalis*, one of our most beautiful buprestids found in the most northern forests, cannot be omitted.

The Rose-chafers (*Cetonides*) are also well represented. The richly-coloured black-and-green "Fiddler" (*Eupœcila australasiæ*) and the spotted *Polystigma octopunctata* are very abundant, as well as *Micropœcila cincta*, which breeds in the decaying stems of the grass trees. The large brown Rose Chafer, *Diaphonia dorsalis*, has the curious habit of flying about in the streets of Sydney, and often comes buzzing in at an open window.

In the Cockchafers (*Rutelides*), the most typical are the members of the Genus *Anoplognathus*, of which the large metallic-golden "King Beetle" (*A. viridæneus*) is not uncommon about Sydney, while *A. porosus*, *A. analis* and *A. oliveri* often appear in regular swarms. The longicorn beetles comprise some very curious flower-haunting species, which in the Genus *Hesthesis* have the body banded with black, yellow or brown, and with abbreviated elytra, mimic flower wasps. *Tragocerus lepidopterus* and *T. spencei*, with broader wing-covers, have the elytra ornamented with tufts of fine hairs.

The Common *Cerambycid* which, in the larval state, feeds in the trunks of the coastal honeysuckle (*Banksia serrata*) is *Paroplites servilis*, a typical dark-brown beetle, measuring up to two inches in length. *Sceleocantha glabricollis*, not much more than half the length, has the body short, more rounded, and the sides of the thorax furnished with a fine spine on either side.

The typical Cerambyx is the silvery-brown longicorn (*Pachydessus sericus*), which breeds in the stems of the slender-leaved Acacia (*A. longifolia*), so common along our coast. The members of the Genus *Phoracantha*, with their biscuit-brown and shining ferruginous tints, spined antennæ and thorax, breed under the bark of Gum trees and Wattles. *P. semipunctata* is our common species, often found under dead bark on tree-trunks.

The Genus *Symphyletes* is represented by a number of stout elongate grey or brown longicorns, having the sides of the thorax and the elytra clothed with fine hairs. *S. neglectus* feeds upon and rings the twigs of the long-leaved Wattle. *S. solandri* cuts off the flower stalk of the Grass tree and pupates in the section beneath.

The commonest species of the stout, thick-set longicorns belonging to the Genus *Penthea* is *P. vermicularia*, dark-brown in colour, with the elytra curiously marbled with grey markings; it is very variable in size.

In the great Family of Weevils (CURCULIONIDÆ), the common species is the Wattle-feeding Weevil, which Donovan called the "Botany Bay Diamond Beetle" (*Chrysolophus spectabilis*) on account of its rich coating of metallic green scales. *Rhinotia hæmoptera* is a slender weevil, about three-quarters of an inch in length, with a black head and bright brick-red wing-covers; it feeds in the larval state in the stems of the sweet-scented Wattle (*Acacia suaveolens*). Two handsome weevils are always associated with the Kurrajong tree, which grows inland; both weevils hide in the crevices of the rough bark, the markings on their wing-covers harmonising with the colour of the surroundings. The larger beetle (*Axionecus insignis*) breeds in the dead branches, while the small one (*Tepperia sterculiæ*) feeds in the seed pods.

Turning to the carnivorous ground beetles, *Cicindelidæ*, the Tiger Beetles, we find them poorly represented on the coast, the only common species being *Cicindela ypsilon*, which can be found upon our sandy beaches in the summer time, often in numbers, hunting along the sea-shore.

The Family CARABIDÆ contains many fine species; but none of the larger species are very abundant near Sydney except *Calosoma schayeri*, which sometimes appears in the Sydney streets in great numbers, and which in the wheat-fields feeds upon "cut worms." The wingless burrowing *Scaritides* are more western forms, but the small green carenum (*C. bonelli*) is found about Sydney. The small yellow-and-brown Bombardier Beetle (*Pheropsophus verticalis*) is often found in the suburban gardens under stones or rubbish. One species of the Genus *Arthropterus* (*A. brevis*), representing the curious comb-horned beetles (*Paussidæ*), is found in the papery bark of the Ti-trees in the neighbourhood of Sydney.

LEPIDOPTERA.—Most of the diurnal lepidoptera are found in the coastal area from north to south, though some of the northern forms do not extend to the south of Sydney, and only a few species range right out into the western plains and scrubs. The "Common Blue" of the Black Wattle, *Ialamenus evagoris*, found along the coast, is represented by *I. ictinus* upon the Weeping Myall (*Acacia pendula*) in the western scrubs. Among the Swallow-tails, the beautiful Bird-winged Butterfly, *Ornithoptera richmondia*, only ranges south from Queensland to our northern rivers; while *Papilio erectheus* is common in our orchards, the larvæ feeding upon citrus trees; *P. sarpidon* feeds on the Camphor trees; *P. macleay-*

anus feeds upon the *Sassafras* about the Illawarra scrub, but has a wide range along the eastern coast of Australia. The black-and-yellow butterfly (*P. sthenelus*) is one of the few large butterflies found in the western scrubs.

The common white butterfly (*Pieris teutonia*) feeds upon the wild Caper bushes growing in the far western scrubs. They frequently become so numerous that they migrate and appear in great clouds upon the coast, travelling hundreds of miles from the land of their birth.

While we have many of the cosmopolitan Hawk Moths, there are several fine forms characteristic of this State, such as the distinctive banded small Hawk Moth, *Cizara ardenia*, the larvæ of which feeds upon a native vine in the Illawarra district. In the Genus *Coquosa* two large variegated buff-yellow and brown species are found along the coast; *C. triangularis* has a very remarkable rough-skinned dull-green caterpillar which has the typical anal spine and also a shining black bead-like process on either side of the claspers like a small eye. It feeds upon several species of the Geebung (*Persoonia*).

The great Wood-Moths (HEPALIDÆ) are remarkable for their numbers, size, and beauty. The Bent-wing (*Leto staceyi*) is a very fine moth, with a wonderful blending of yellow, brown, red and buff tints; its outspread wings measure seven inches across from tip to tip. Among the members of the Genus *Zeuzera*, our commonest species *Z. eucalypti*, in the larval state kills many Wattles by boring through the branches; and the giant of the family, *Endoxula boisduvalli*, a great brown moth, up to ten inches across the wings, does considerable damage to the Eucalypts while in the larval state.

The Case or Bag Moths (PSYCHIDÆ) form the most striking cocoons in the bush, being covered with sticks, leaves, or grass, and formed for and used as a protective covering by the caterpillars from the time of their birth. Though the moths are rare insects, several species, such as Saunders' Case-Moth (*Metura elongata*), the Faggot Case-Moth (*Entometa ignoblis*), and the Leaf Case-Moth (*Thyridopteryx hubneri*) which also often uses pine needles for its outer covering, are all common in the vicinity of Sydney.

Among the Brown-tails (LIPARIDÆ) the most interesting group are those included in the Genus *Teara*. These are gregarious in the larval state, feeding upon the foliage of Wattles and Eucalypts during the night and sheltering during the day under cover of a "Bag-shelter," formed of stout silken strands among the foliage of the trees they infest. Not only do they strip all the leaves off the trees, but the hairs upon their bodies are very irritant when entering the skin of persons handling them or their bag-shelters. *Teara contraria* is the common western species, defoliating the "Weeping Myall" (*Acacia pendula*).

One of the largest moths that used to be very common about Sydney until a few years ago, often coming to the gas lamps in the streets of the suburbs, is *Chelepteryx collesi*. The larvæ are large reddish-brown caterpillars beset with stout spines which, when pupating, they shoot out through the silken covering, making themselves as awkward to handle as a cactus leaf.

In the great family of Silkworm Moths (BOMBYCIDÆ) we have no very striking species, but in the allied SATURNIDÆ we have in the Genus *Antheræa* a number of very handsome brown, fawn, or buff-coloured moths, with large eye spots on their wings. The handsome deep-green caterpillar, covered with small clusters of pink and blue spines, often found feeding upon the foliage of the Gum trees, is the larva of *Antheræa eucalypti*.

The NOCTUIDÆ are represented by a number of indigenous and cosmopolitan species belonging to the Genus *Agrotis* and other allied genera, which are known in the larval state as "Cut-worms." One of the most common, *Agrotis infusa*, is known in New South Wales as the "Bugong Moth;" and it was collected by the natives in the early days of settlement under the rocks on the Bugong Mountains, near Tumut, and used as food.

HYMENOPTERA.—The Saw-flies (TENTHREDINIDÆ) are well represented in the fine Australian Genus *Perga*, with their short- clubbed antennæ, deep metallic and yellow tints, and stout, thick-set bodies. Clusters of the elongate black larvæ, clinging to the stems of small Gum saplings, upon which they feed at night, are very common in the bush around Sydney. *Perga dorsalis*, one of the larger metallic-blue species, is common; *Perga lewisi*, a smaller brownish-yellow species, deposits her eggs in the tissue of the leaf of the Bloodwood and stands over them until the tiny larvæ hatch and move off on their own account. At least half-a-dozen species are found about the Hawkesbury sandstone region. Though the curious slender-tailed larvæ of the members of the Genus *Pterogophorus* feed chiefly upon *Leptospermum*, both *P.*

cinctus and *P. interruptus* are very often taken upon the flowering lance of the Grass tree, their bright blue colour, with rich reddish-yellow markings makes them very noticeable. Many dainty little saw-flies are found upon the small flowering shrubs.

Among the MICRO-HYMENOPTERA are many curious forms, but those most likely to attract the visitor's attention are some of the gall-makers, and the *Blastophaginæ*, which infest the different wild figs. In the hard fruits of the Moreton Bay Figs, so largely planted around Sydney, three have been described, of which *Pleistodontes froggatti* is the common black species.

The remarkable long-tailed Wasps (MEGALYRIDÆ) lay their eggs in the larvæ of longicorn beetles, which they find boring between the bark and sap-wood, and these wasps though seldom seen, can be often bred from infested timber, *Megalyra fasciipennis*, one of the medium sized species, is easily recognised by its blotched wings.

Perhaps no group of the hymenoptera are more characteristic of the flowering shrub-country than the handsome flower-haunting wasps of the Family THYNNIDÆ. In the early summer, when the *Leptospermum* and *Melaleuca* bushes are in flower, probably over 50 species could be taken in a day or two of collecting around Sydney. The rich shining metallic-blue female of *Diamma bicolor*, with its cylindrical wingless body and powerful sting may be often noticed on the sand patches; from its stinging habits it is popularly called the "Blue Ant." Though not allied, the handsome Flower-wasps, SCOLIIDÆ, are often met with in similar localities; and in the larval state both families are parasitic upon beetle larvæ in the soil. No wasp is more noticeable than the beautiful shining black *Scolia*, with its glittering prussian-blue wings (*Discolia soror*), and it may be seen any summer day flitting round a decaying stump, under which it burrows and deposits its eggs upon the beetle grubs in the vegetable mould beneath.

The Ants (FORMICIDÆ) are very abundant, but can be only very briefly noticed in a paper like this. The sandy soil of the coastal districts is the home of a number of large species. The Sugar Ants, *Camponotus*, make their nests under flat stones; in *Camponotus intrepidus* forms curious little tubular processes over the opening into the nest. *Camponotus nigriceps* is the parti-coloured dull-yellow and black ant that invades the pantry for sweets, jam, etc., and is known as the Sugar Ant. The common Mound Ant (*Iridomyrmex detectus*) is plentiful all over New South Wales, where it raises its rounded domes of excavated material, with many vertical shafts leading downward, in all open forest country. The well-known stinging "Bull-dog" Ants are well represented, particularly in the sandy coastal area, by four or five species of the genus *Myrmecia*, of which *M. gulosa* is the common red species. *M. albo-cincta*, one of the smaller but most active species, is known as the "Jumper." One of the commonest and most widely distributed species, and common in the gardens and lawns, is the "Green Head" (*Ectatomma metallicum*), which is furnished with a well-developed sting.

The Sandwasps Pompilidæ and Sphegidæ are well represented along the coast by some fine species. *Exeirus lateritus* is one of our largest reddish-yellow and black species, with opaque yellow wings. It is very common about Sydney when the Angophora bushes are in flower. It makes a large burrow in the loose, sandy soil, and often stores the nests with the large Cicadas. *Sphex vestita* is the largest black species, and has a wide range over the State. It stores its burrow with small brown crickets in the Sydney gardens, but out west usually captures short-horned grasshoppers. The common Mud Dauber (*Pelopæus laetus*) is a typical yellow and black slender-waisted wasp that comes about the house, making its clay cells under shelter of the verandahs, and storing the cells chiefly with spiders.

The Solitary wasps, belonging to the Family Eumenidæ, are very well represented in all parts of the State. The two handsome, large, thick-set, black and yellow wasps, *Abispa splendida* and *A. ephippium*, construct very solid clay nests in sheltered situations, in the cells of which they store various kinds of caterpillars. In the two closely allied genera, *Odynerus* and *Alastor*, we have a large number of species of small mason-wasps that form more delicate tubes and cells of clay; these are generally met with in the vicinity of water.

The Paper-Nest wasps are social in their habits; *Polistes tasmaniensis*, the commonest large species, often constructs a circular paper nest as large as a saucer under the shelter of a verandah or out-house, and when disturbed often stings severely. The tiny little wasps included in the genus *Icaria* make elongate rows of cells that are usually attached to a twig or branch of a shrub.

The State is rich in bees. Besides the small black stingless native bees (*Trigona*) which form large nests of dark-coloured wax with jug-shaped honey-cells in the cavities in forest trees, we have many large and handsome species. The beautiful deep metallic green bees of the genus *Lestis*, that form regular cells in the flower stalk of the grass trees, are common about the Sydney bush. The large, dull-yellow bee, *Sarapoda bombiformis*, sometimes comes blundering into the house on a summer day; while several species of the pretty active bees of the genus *Anthophora*, with their hairy thorax and blue banded body, are common in the garden in the summer time. A large number of small bees belonging to the genera *Prosopis*, *Euryglossa*, *Pachyprosopis*, *Parasphecodes*, etc., are to be taken upon the flowers of the Angophora.

Australia is rich in the Leaf-cutting Bees (*Megachile*). Some of these make their nests on dead wood, others in old walls, and a few form their cells of leaves under stones. It is not uncommon to see rose bushes in the gardens with circular bits snipped out of every leaf. *Megachile chrysopyga* is one of our commonest species.

DIPTERA.—This order is well represented by most of the typical families. In the Gall Gnats (CECIDOMYIDÆ) we have a number of very interesting species in the vicinity of Sydney. The rounded bract-like galls of *Cecidomyia frauenfeldi* are very abundant upon the foliage of the Leptospermum bushes growing along the coast-line. The aborted flower buds of *Acacia longifolia* become irregular masses of finger-like tubes containing the larvæ of *Cecidomyia acaceæ-longifolia*. Round, red, shot-like excrescences upon the foliage of several of the large-leaved eucalypts are formed by *Hormomyia omalanthi*. Small red blisters with a key-hole-like slit in the centre upon the leaves of the bloodwood (*Eucalyptus corymbosa*) are the work of *Diplosis paralis;* while a second species of this genus (*D. frenelæ*) forms hemispherical seed-like galls upon the foliage of the Desert Cypress in our western scrubs.

The Mosquitoes (*Culicidæ*) are only too well known all over New South Wales; the common species in the house in the early part of the summer is the large brown mosquito with banded legs (*Culex albo-annulatus*); it comes into the houses and is a regular pest. But later on in the summer the smaller dark species (*Culex marinus*) is the house mosquito; it has the curious habit of breeding in sea-water in the rock-holes along the coast, but will thrive just as well in fresh water. The famous "Hexham Grey" is a very large, hairy, grey mosquito found in the swamps from the Maitland district, and was described by Westwood as *Culex alternans*. A number of species of the genus *Anopheles* have been described; and one species ranging from Adelaide through New South Wales to Queensland, *Stegomyia notoscriptus*, has recently been placed in the genus *Skusea*.

The common Sandfly (*Ceratopogon molestes*) is found in similar places along the rivers where mosquitoes congregate.

Among the Crane Flies (TIPULIDÆ) there are several very characteristic species common around Sydney and the Blue Mountains, where the deep, damp glens and gorges form suitable breeding-grounds and shelter for the adult flies. In the early summer the large brown Crane Fly (*Macromastix costalis*) is one of the commonest insects among the low scrub, and the Painted Crane Fly (*Gymnoplistia bella*), with its black and orange markings, is a short-legged species found in similar localities. In the genus Semnotes, some of which are found in the Blue Mountains, we have some of the giants of the family.

March Flies (TABANIDÆ) are found in the shaded gullies and open forest country towards the end of summer; a small grey species (*Tabanus brevidentatus*) is the commonest biting fly that pesters one in the bush.

Among the Robber Flies (ASILIDÆ) are some very large and handsome black hairy species with the upper surface of the flattened abdomen richly coloured with brick red; these are found in the interior. *Craspedia coriaria* captures and kills large cockchafer beetles. A smaller species with a more heart-shaped body and with a metallic, bronzy tint, *Blepharotes splendidissima*, is not uncommon in the Sydney Botanic Gardens in the early summer.

There are several Hover Flies (SYRPHIDÆ), to be always found in the Gardens; *Syrphus vividiceps*, with its yellow banded abdomen, haunts roses and other plants infested by Aphids, while the large Bee or Drone Fly (*Eristalis tenax*) is usually noticed about the flower beds, its rat-tailed larvæ living in putrid, stagnant water.

In the Family TRYPETIDÆ are found several species of the fruit-infesting *Dacus*. The Queensland Fruit Fly (*Dacus tryoni*), one of the serious orchard pests, is now known to be a native of this State, breeding in several wild fruits in the coastal district. Others form galls; an undetermined species

(*Trypeta* sp.) forms a very large gall upon the twigs of the Snow-bush (*Aster ramulosus*). Another very beautiful blue fly with dark mottled wings rests on the foliage of the grass tree; it belongs to an allied group, and has been described under the name of *Ortalis coerulea*.

The large Forest Flies, often ornamented with rich metallic tints, that belong to the Family DEXIIDÆ, are often met with resting on the trunks of trees. *Amenia leonina* is a very handsome fly about half an inch in length, with a bright yellow head, and with a rich metallic thorax and abdomen, the latter marked with several rounded white spots. The members of the genus *Rutilia* are larger flies, with the typical metallic tints; *Rutilia formosa* varies in tint from rich blue to shades of coppery red; their larvæ are parasitic upon the underground larvæ of the lamellicorn beetles.

The Great Family MUSCIDÆ contains the common house flies, bush flies and blow flies, all of which are widely distributed over the State. The Cosmopolitan house fly (*Musca domestica*) is a very great pest in summer time, while the smaller bush fly (*Musca corvina*) simply swarms over the dry western country, and is one of the worst enemies of the bushman travelling out-back.

The true blow flies (*Calliphora*), of which there are five or six common indigenous species, are common about the houses in Sydney. The common house species (*Calliphora villosa*), with the abdomen clothed with soft golden pile, and *C. oceaniæ*, with its blue abdomen blotched with yellow on either side, are widely distributed over the country. Together with several of the metallic blue species, they have, within the last ten years, developed the very bad habit of blowing any soiled wool on otherwise healthy sheep, and the resultant maggots cause an immense loss to the sheep-owners in wool, lambs and sheep.

Many of our birds and some of the marsupials are the hosts of one or more species of Lice Flies (HIPPOBOSCIDÆ), which, when travelling through the bush and scrub, often leave their natural host and alight on man or his horse. Coming down the Bulli Pass I have several times had a large louse-fly, that probably lives on the large fruit pigeon, alight on my neck. The kangaroo hunters generally know when their dogs have killed a wallaby, because when they return they generally have several wallaby flies (*Ortholfersia macleayi*) clinging to their noses.

HEMIPTERA.—The insects comprised in this Order form a number of very distinct groups well represented in all parts of Australia. Taking the first group, which contains all the plant, carnivorous and water bugs, we find many well-known plant pests. In the Family PENTATOMIDÆ we have all the large and often brilliantly coloured Shield bugs. The Fruit Bug (*Peltophora pedicilata*) is of a uniform metallic green, with blackish spots on the back, and the scutellum marked with deep red. It measures half an inch in length, and often attacks soft cultivated fruits like cherries and figs.

The more tropical *Tectocoris lineola*, a broader, shorter bug, variable in colour, the ground work varying from orange to brown, with purple spots and scroll-like markings on the back, is also a fruit pest, and ranges over the northern scrubs of this State. A large and very evil-smelling species (*Stilida indecora*) lives on the wild finger lemon in our northern scrubs, and since the growing of oranges in the district, has turned its attention to cultivated fruits and has become an orchard pest.

Where there is plenty of small gum tree scrub we usually find one or more species of plant bugs belonging to the Family COREIDÆ feeding upon the young shoots. They are dull-coloured brown or greyish-black bugs, with flattened, elongate backs, and the hind legs usually more or less thickened. *Mictis profana*, the "Crusader Bug," has a distinct white or yellow cross on his back. Though a native of the bush, it has been found sucking the sap out of the young shoots of the orange trees. In the genus *Amorbus* we find the bulk of the gum-tree bugs which give off a very strong odour when handled.

The Family LYGÆIDÆ contains a great number of small bugs which often swarm in immense numbers, and do a great deal of damage to plants. Two are very common in this State—the Rutherglen Bug (*Nysius vinitor*), a small, silver-grey bug infesting many fruits, and the Coon Bug (*Oxycarenus luctuosus*), a black and white species that swarms over the western plains.

Most of the Assassin Bugs (REDUVIIDÆ) are of moderate size. They take on all kinds of structure for protective or hunting purposes; armed with a curved, horny beak or rostrum, they stab all kinds of soft-bodied insects and suck out the contents of the body of their victim. *Gminatus* *nigroscutellatus* is a typical red and black form common on tree trunks.

The Great Fish-killer (*Belostoma australis*), common in the swamps and waterholes, is sometimes found in the streets at times when flying round at night. It is attracted to the street lamps, and, falling to the ground, cannot get up again.

The Cicadidæ.—Among the most striking of all our insect fauna in the vicinity of Sydney are the Cicadas, commonly known as "locusts;" striking not only for their size and beauty, but for the incessant din they make all through the long summer days, from the first week in November until early in February. Without including either the "Squeakers" or the small black species belonging to the genera Melampsalta and Pauropsalta, which sometimes appear earlier in the season, there are six large species which are to be found some time through the season in the coastal forests within a radius of twenty miles round Sydney. The "Green Monday" (*Cyclochila australasiæ*), with its deep green tints, is the common species in the suburban gardens; the writer has counted 40 upon the stem of a small oak tree on a summer morning, and every tree will be tenanted by two or three. Strange to say, this species has never been seen sucking up sap. On the other hand, the Black Cicada or Red Eye (*Psaltoda moerens*), which swarms over the branches of the smooth white gums, sucks up so much sap through the bark that the tree is constantly discharging a fine spray. The "Double Drummer" (*Thopha saccata*), our largest, chestnut and brown species, frequents the rough-barked gums in the open forest, and sends forth a very distinct, loud note or series of notes. The "Floury Miller" (*Abricta curvicosta*), a large reddish-brown species with spotted wings, dusted over with fine white pubescence, is another of our common species. The "Fiddler" (*Macrotristria angularis*) is a larger brown species, with mottled wings, that is often found in company with the "Double Drummer." *Henicopsaltria eydouxi* is mottled with brown and chestnut, with three irregular bands across the wings, and simply swarms in hundreds on the rough-barked gum trees about the Gosford district. The curious "Bladder Cicada" (*Cystosoma saundersi*), pale green with opaque wings, small head and a great swollen bladder-like abdomen, once so common in the Newcastle district, ranges northwards to Armidale and Glen Innes, where it is found on the willows and among the sweet-briars.

In the Family Cercopidæ we have in the genus *Eurymela* a number of small wedge-shaped frog-hoppers that cluster together upon the stems of the young gum trees in all stages of development, sucking up the sap, and laying their eggs in slits in the bark. They have opaque, usually dull-blue tegmina spotted or marked with red or white; *Eurymela bicincta* is half an inch in length, of a uniform dark blue tint, richly mottled with bright red. The common "Cuckoo-spittle" (*Chalepus teliferus*) can be noticed in the larval state making bubbles of froth upon the stems of Casuarinas and Wattles.

The Family Membracidæ contains a number of frog-hoppers that are remarkable for the curious horns and other projections upon the thorax. Usually brown or green in colour, they frequent small shrubs; one, *Sextius virescens*, is our commonest green species, and is found upon the Black Wattle.

Coming to the Family Psyllidæ, we have a remarkable and very interesting group of the Hemiptera which are very plentiful in Australia, and which seem to take the place of the Aphidæ, or plant lice, which are not indigenous to Australia, though many species have been introduced. They are popularly known as "Lerp Insects," on account of the remarkable structures they form from the surplus sap they suck up and discharge from the abdomen, using the hind legs to spin it into all kinds of dainty nests or scales. Others simply cover themselves in the larval state with white cottony secretion, and a number produce leaf galls. The perfect Psyllids resemble Cicadas in miniature, and both fly and jump very readily when disturbed. They are active little creatures, clustering over the young foliage and twigs upon which they lay their eggs, so that they can be studied in all stages of development upon the same twig. The Common Sugar Lerp (*Spondyliaspis eucalypti*) covers the surface of the young gum trees with their little conical caps of white manna-like secretion, under which the green frog-like larvæ dwell. *Lasiopsylla rotundipennis*, common inland on several species of gums, forms a large, white, flattened, irregularly rounded lerp scale. In the genus *Cardiaspis* are several species that construct delicate net-like cages of crossed filaments, under which one can watch the development of the enclosed larvæ; *C. artifex* is sometimes very common upon the foliage of *Eucalyptus robusta* around Manly, and very noticeable, as, where each is produced, a brown spot appears on the leaf through the sucking up of the sap.

In the genus *Thea* we find species with large, flattened larvæ enveloped in white flocculent material, hiding under flakes of dead bark on tree trunks. Among the typical members of the genus *Psylla* are a number that, in the larval state, use no hiding-place or protective lerp scale, but are usually naked or clothed with woolly filaments; nearly every kind of wattle is the home of some species. The Kurrajong has one species; the Black Wattle three species; *Capparis mitchelli* two species.

One of the most curious, with a broad, squat, grey larva, is *Mycopsylla fici;* it swarms on the under-surface of the large leaves of the Moreton Bay Fig (*Ficus macrophylla*), and, puncturing the tissue, envelops itself in masses of the viscid sap; when numerous, it causes the leaves to fall. Most of the gall-forming species belong to the genus *Trioza*, in which the larvæ are flattened creatures, sometimes shield-shaped, the outer margin fringed with fine filaments. They rest at the bottom of the fleshy leaf-galls, or are enclosed in the centre of the solid wooden galls; they confine their attention to the foliage of eucalypts.

In the Great Family Coccidæ we find this State very rich in species, and, besides the many introduced cosmopolitan species, there are some very remarkable forms confined to Australia. The Mealy Bugs (*Dactylopius*), though plentiful, do little damage to plant life, as they have so many external and internal parasites that feed upon them. The Round Scales (*Aspidiotus*) are numerous on native shrubs, and the two allied genera *Mytilaspis* and *Chionaspis* are also abundant. In the genus *Eriococcus* there are several species that infest the eucalypts; *Eriococcus coriacea* forms masses of white, oval sacks enclosing the scale upon the twigs and foliage.

In the Sub-family Brachyscelinæ there are some of the most remarkable Coccids in the world. They produce galls of surprising beauty and size; but the male and female galls are not a bit alike. The most typical galls are formed by members of the genus *Apiomorpha;* the adult female is a thick-set, top-shaped grub, with the remnant of a head, three pairs of short, rudimentary legs, and with the tip of the abdomen terminating in two slender pointed tails; the body is covered with rows of short, blunt spines. The adult male is a delicate, two-winged creature with large eyes and slender antennæ, and the long, slender, pink body terminating in two slender filaments. Most of the male galls are slender tubular processes, with the apex dilated, and are situated singly or in masses on the leaves or smaller twigs. In the cockscomb group the male galls spring out from the side of the oval female gall, a mass of consolidated tubes curving down, and often many times larger than the female gall.

Apiomorpha duplex consists of a stout, four-sided basal portion of woody tissue, three inches in length, enclosing the great white coccid, which has two pointed black tails, and is enveloped in floury secretion. The apical portion of the gall is produced into two long, flattened appendages like aborted leaves, often nine inches in length. As in all the group, the female is impregnated through the apical orifice, either circular or like a narrow key-hole; and she rests in the gall on her head, with the tip of the body just beneath this opening. She finally becomes a sack of eggs; the larvæ hatch out in the shelter of the chamber, and, crawling out through the opening, spread out over the foliage. *Apiomorpha pileata* is an oval gall with the apex truncate, and with a narrow, slit-like opening; in the early development of this gall the apex is protected with a thin papery cap. In *Apiomorpha urnalis* the female gall is like a little flask, sometimes alone, at other times forming large masses; *Apiomorpha fletcheri* produces several galls in a branch, the whole forming into a mass of solid woody tissue. *Apiomorpha pharatrata* is one of the oval galls with the male galls attached. In the genus *Frenchia* the coccids infest the Casuarina, causing short, rounded, truncate tubes to grow up out of swellings on the twigs, at the base of which the female rests. In the genus *Opisthoscelis* the females make curious thorn or spine-like galls upon the foliage or twigs, but the coccid is easily distinguished in the adult state by the aborted fore legs and the long, slender hind legs often curled over the back. In the genus *Cylindrococcus* the galls are produced upon the twigs, and are so like the seed cones of the Casuarina that they have been figured on several occasions as such. These galls consist of a number of bracts enclosing a tubular process in which the cylindrical female coccid rests. At times these galls are so numerous that the whole of the twigs are covered. *Sphærococcus pirogallus* is the type of another remarkable group. Formed like a little brown pear, with an opening in the stalk, the enclosed female coccid rests in a little saucer-like depression at the apex. Thousands of the smaller bushes of *Leptospermum flavescens* around Sydney are smothered with these galls, which sometimes cause the death of the plants.

THYSANOPTERA.—The Family *Thrypidæ* contains a number of minute black or brown insects remarkable for their curious mouth structure and slender, feathered wings. *Idolothrips spectrum*, nearly half an inch in length, is a giant among thrips; is very abundant under dead gum bushes, resting among the fallen leaves in all the stages of development. In the western scrubs we have a number forming galls on the leaves or causing the leaves to curl up by their presence. The terminal buds of one of the Bottlebrushes (*Callistemon*) are aborted into crinkled, thin, biscuit-like material, forming irregular galls.

ORTHOPTERA.—The Orthoptera are numerous and interesting. In the western scrubs and plains we frequently have immense swarms of plague locusts (popularly known as grasshoppers) which, breeding out on the "scalded plains," do an immense amount of damage. Several species are responsible for this, but the commonest one is *Chortoicetes terminifera*, a small, mottled, light-brown grasshopper. A smaller species (*C. pusilla*, is more yellow, with the legs bright yellow. Though seldom a gregarious species in the southern division, the Yellow-winged Locust (*Gastrimargus marmoratus*) gathers together in the northern districts, and does damage in orchards and cane-fields.

A rare and beautiful species of the long-horned grasshopper is found in the western country; *Alectoria superba* is rich, mottled green, with the apex of the thorax raised into a large, flattened disc, shaded with red and blue. The little green singing Grasshopper (*Cædicia valida*) is common in the orchards and gardens; in the citrus orchards they gnaw the surface of the young oranges, and thus cover them with brown blotches. The Mountain Grasshopper (*Acridopeza reticulata*) is a remarkable dark-brown insect which differs much in the sexes; the male has long, straight elytra over well-developed wings, while the female is wingless, with the elytra short and shell-like folded over a brightly tinted abdomen.

The Family BLATTIDÆ is well represented, a number of Cockroaches being common in the scrub, under stones, on decaying wood, or under dead bark. After the domestic species (*Periplaneta americana*), the one best-known is the large, bronzy, chocolate-brown wingless cockroach (*Polyzosteria limbata*), which is common in the low scrub about Botany Bay; it often rests on stumps or fence posts in the sunshine, protected from its enemies by the fœtid matter it discharges when disturbed. Another wingless species is *Panesthia lævicollis*, which lives and breeds in decaying logs; its whole structure is well adapted to the life it leads.

In the PHASMIDÆ we have several very handsome species. Before all the large trees were cut down about Sydney, the Great Brown Phasma (*Acrophylla titan*) was common. The Gregarious Phasma (*Podacanthus wilkinsoni*) is a destructive forest pest; appearing in countless millions, they strip every leaf off the gum trees for miles in the northern districts of this State. The beautiful Pink-winged Phasma (*P. typhon*) is a large species with green tints and beautiful pink wings. The Spiny Phasma (*Extatosoma tiaratum*) is, in the female, a large, dull-green phasma with the legs flattened and cut out like ivy leaves, and the edges of the large, swollen body are spined and foliated on the edges. It is common in our coastal scrubs, but its wonderful protective form renders it difficult to detect among the foliage unless it is moving about. The small-winged male is quite a different-looking insect, and is rare in comparison with the female.

The MANTIDÆ are not numerous, and only two moderate-sized ones are common. *Archimantis latistylus* is found in the bush around Sydney; it measures about four inches in length, and varies from dull green to yellowish-brown, seeming to adopt the foliage which suits its colouration. *Tenodera australasiæ* is found in the same class of country, and is provided with much longer wings, is of a general brown colour, with the front of the elytra striped with green, and the wings are mottled.

NEUROPTERA.—The lace-wing flies are not very striking insects in this State; and, with the exception of the few large dragon-flies that sometimes appear in great numbers, are not very noticeable. *Hemianax papuensis* and *Aeschna brevistyla* are two of the common species, hawking over the ponds and lagoons. The Ant Lions (HEMEROBIIDÆ) are common, and several species of *Glenurus* form regular pits in the sand. *Stiliopteryx costalis* is a remarkable creature; it is like a large dragon-fly with short clubbed antennæ, and the wings are clouded along the costal edge with blackish-brown, In the genus *Psychopsis* there are some very curious moth-like ant-lions with rounded, downy wings, buff or grey mottled, with reddish or brown lines.

ISOPTERIA.—The white ants or termites are common, and even in the city often damage houses, eight species being found within a short distance of Sydney. Two species of *Eutermes* make nests under bark in dead wood or on the tree trunks, where they are known as "Negro Heads." *Rhinotermes reticulatus* lives on dead stumps in small colonies. Swarms from these nests produce the clouds of "flying ants" that come forth in the early summer. The Milk Termite (*Coptotermes lacteus*) is the destructive species that does so much damage to woodwork, and also forms the rounded domed nests ranging up to four feet in height met with in the coastal area.

THE LAND INVERTEBRATES.

By Thos. Steel, F.L.S.

New South Wales, in common with her sister States, is particularly rich in the land invertebrates which have been aptly termed "cryptozoa" by Prof. Dendy,[1] and amongst these are certain forms of exceptional interest. Some of the groups are very imperfectly known, whilst others have been the subject of study by capable observers for some years, and we are now in possession of a very fair knowledge regarding them. In Australia, land invertebrates are chiefly found under logs and pieces of wood lying about paddocks adjacent to scrub. In the scrub itself they are not so readily found, because of the larger amount of available shelter. Small, easily turned logs are the more prolific, large ones lie too close to the ground to give room for the movement of the animals. Many good specimens may be secured by breaking up rotten logs with a strong knife.

The creatures under consideration are found most abundantly where the soil is rich, this fact being doubtless due to the resultant good food supply and equable moisture conditions. In most of the groups no general distinction can be drawn between the various Australian States for, although certain species are local in their occurrence, others have an exceedingly wide range.

In the important group of land mollusca we have some exceedingly fine species, one of which, *Panda Falconeri* (Reeve), is not only the largest land shell in Australia, but is amongst the finest occurring anywhere. It is not uncommon in the rich coastal scrubs of the northern part of the State. This shell is closely related to *Helicophanta*, from Madagascar.[2]

The moist scrubs, both north and south of Sydney, afford a congenial habitat to a considerable variety of other large and handsome species, amongst which, in the northern scrubs, may be mentioned *Thersites Frazeri* (Gray) and *T. Richmondiana, Pf.* The former is a common shell, while the latter is much scarcer. *T. Richmondiana*, though a thick,

1. Aust. Assn. Adv. Science, VI., 99, 1895.
2 Hedley.—Proc Linn. Soc. Lond., Sess. 124, 1911-12, p. 85.

strongly-keeled shell, is eaten by the Noisy Pitta, *Pitta strepitans*, Temm., being collected to central points in the scrub, where a chance stone, or even a heavy bone happens to be lying, and which is used by the bird as an anvil on which to break the shell. Large numbers of broken shells of the species in question are to be found lying around these spots. Doubtless the predilection of the bird for this particular mollusc is the cause of its comparative scarcity.

An interesting form of common occurrence is *Eudodonta sericatula*, Pf., a small discoidal shell with delicate radiating riblets; whilst in wet weather, *Thersites Jervisensis* Q. et G., a globose shell, three-quarters of an inch in diameter, appears in numbers amongst the sandhills. It has the habits of a desert snail, and buries itself in the sand for long periods during dry weather. *Rhytida capillacea* Fer., is a carnivorous snail, bearing a thin, glossy-brown shell. Unable to withdraw into the shell is *Helicarion Freycineti*, Fer., which, as its name implies, is half-snail, half-slug.

Gardens in the settled districts are infested with a number of species of imported snails and slugs, notable amongst which is *Helix aspersa*, (L.). Quite the most remarkable of the land-molluscan fauna is the curious bitentaculate slug, *Aneitea Graffei*, Humb., which is frequently met with under logs in the Blue Mountains and the Illawarra district. In this interesting slug, the lower pair of tentacles are absent, the large ocular ones being alone developed. It grows to a length of four to five inches, and may be readily recognised by the beautiful red margin of the dorsal surface and the similarly outlined triangular shield. An allied and very fine species, *Antharacophorus* (*Janella*) *bitentaculata*, having the dorsal surface ornamented with delicate leaf-like venation, occurs in New Zealand. An excellent account of the group is given by Hedley.[3] The Myriapoda have not received as much attention as their importance warrants, but a recent valuable paper by Broleman[4] gives a good account of a considerable number of species. Amongst the more notable members of the group are several fine species of *Scutigera*, one of which is of common occurrence about dwelling houses and warehouses in Sydney.

3. Proc. Royal Soc. Queensland. V., 162, 1889.
4. Records Australian Museum, IX., 37, 1912.

The interesting Prototracheate, *Peripatus*, is of such wide-spread occurrence in Australia as to constitute one of our most notable invertebrates. The genus *Ooperipatus* was erected by Prof. Dendy[5] for the reception of several species occurring in Australia, Tasmania and New Zealand. Of these, one, *O. oviparus*, Dendy, has been found by the writer in the Moss Vale district, New South Wales, associated with the more commonly occurring characteristic local species, *Peripatoides orientalis* (Fletch.); and by Helms, at Mount Kosciusko. In the female of the former species the fleshy ovipositor is conspicuous, and with the beautiful diamond dorsal pattern, serves as a ready means of identification. *P. orientalis* has been found in a great many localities in this State, though it is nowhere common, and usually but seldom met with; one of the best districts in which to look for it is about Moss Vale. It also occurs in the Blue Mountains and Illawarra district and at numerous scattered localities. An account of its habits and life-history was published some years ago by the writer.[6] A noteworthy feature regarding this species is the great variation in colour. Individual specimens collected side by side range from deep-black to light-tawny-brown.

Coming now to the lowly but extremely interesting Nemertinea and Turbellaria. Of the former one species, *Geonemertes australiensis*, Dendy, is known from Australia; it has hitherto only been found in Victoria and Tasmania and in the Manning River district of New South Wales. This remarkable little worm is white, with a pair of dark eye-spots at anterior tip. When touched, it shoots out a long white proboscis, which is armed with a terminal calcareous spine. Prof. Dendy, who has done so much to elucidate the land invertebrates of Australia and New Zealand, gives an excellent account of the land nemertines of both countries.[7]

One of the most notable features of the land invertebrate fauna of Australia, Tasmania and New Zealand, is the abundance, variety and beauty of the Land Planarians. Everywhere one goes these interesting worms are to be met with, not only in the scrub and clearings, but in gardens and parks wherever a little cover is available. A considerable

5. Quarterly Jour. Micros. Sc., 45, N.S. 363; and Zool. Anzeig., Bd. xxiii., 509, 1900, and xxx., 175, 1906.

6. Proc. Linnean Soc. N.S. Wales, 1896, 94.

7. Proc. Royal Soc. Vict., 1892, 85 and 127; Trans. N.Z. Instit., 1894, 191 and 214.

number of species have been described from the various States by Fletcher and Hamilton, Dendy, Spencer and the present writer.[8] Each State possesses a number of endemic species. Thus, in Victoria, the magnificent *Geoplana Spenceri*, Dendy; in Western Australia, *G. fusco-dorsalis*, Steel; in New South Wales, *G. quinquelineata*, F. and H., *G. ponderosa*, Steel; in Queensland, *G. regina*, Dendy, *G. parva*, Steel, *G. scaphoidea*, Steel; in Tasmania, *G. Tasmaniana* (Darwin), *G. typhlops*, Dendy, *G. Dovei*, Steel, *G. lyra*, Steel, and others, are peculiar to those States and have not been recorded elsewhere. On the other hand, such species as *G. sanguinea*, Moseley, *G. mediolineata*, Dendy, var. *simularis*, Steel, *G. cærulea*, Moseley, and a number of others, range over a very large area.

A curious point, first noticed by Dendy and confirmed by the writer, is that the egg-capsule in Australian Land Planarians is normally liberated from the genital atrium by the rupture of the dorsal surface, the wound so formed, quickly healing again. So far as is known positively, these creatures are almost entirely carnivorous, feeding upon insects of all kinds, snails, worms, and even *Peripatus*, in spite of the slime-discharging powers of the latter. It has, however, been reported to the writer that a small, undetermined species was observed feeding on over-ripe peaches at Mount Kembla.

Of the genus *Rhynchodemus*, we have in New South Wales three or four species, but they are small in size, of rather rare occurrence, and are dark and inconspicuous. On one occasion a large number of *R. obscurus*, Fletcher and Ham., were found feeding on heaps of bran which had been laid in a garden at Strathfield, near Sydney, for the purpose of trapping slugs.

Land Planarians are most abundant under logs in places where the earth remains moist. During wet weather several species are to be found freely crawling about in the open, while in times of drought they burrow into the soil and form hollow balls of earth, in which they remain until moist conditions return. A full account of the habits and method of collecting and preserving, by the present writer, was published some years ago.[9]

Of Land Leeches several highly interesting species occur in New South Wales. These belong to the Genera *Philæmon*

8. Trans. and Proc. Royal Soc. Vict., 1891-92; Proc. Linn. Soc. N.S. Wales, 1887, 1897 and 1900.

9. Proc. Linnean Soc. N.S. Wales, 1900, p. 568.

and *Geobdella*. and are found in similar locations to Land Planarians. The first of these genera is represented by one species only, *P. pungens*. while we have two in the other. *G. australiensis* and *G. Whitmani*. A third species, *G. tristriata*, is recorded from New Guinea.[10]

New South Wales was long considered poor in earthworms, but while this is quite true of the drier parts, in the moist coastal and upland districts the worm fauna is both numerous and varied. The only systematic work of any note which has been carried out on the earthworms of this State, is that of J. J. Fletcher, who in a series of papers,[11] has described a large number of species, some of which are of considerable interest, necessitating the erection of several new genera. While we have nothing so large as the huge *Megascolides australis*, McCoy, of Victoria, such fine species as *Didymogaster sylvaticus*, Fl., and *Megascolides (Notoscolex) grandis*, Fl., are deserving of note, and are in places quite common.

10. Proc. Linnean Soc. N.S. Wales, 1910, p. 72, and 1909, p. 728.
11. Proc. Linnean Soc. N.S. Wales, 1886,-89.

THE MARINE INVERTEBRATES.

By Charles Hedley.*

Though a visitor may find in Australia a new heaven and a new earth, the sea remains unchanged; the ocean is still blue and the surf breaks upon the beach in the familiar way. But the creatures of the southern sea from tide pool, zostera flat or mangrove shrubbery are as novel to a visitor and as interesting to a naturalist as southern stars or southern forests.

Perhaps it is the extraordinary wealth of the marine life here, compared to that of an Atlantic coast, which would most impress a visitor. This is shown both in individuals and in species. Rocks may be turfed with ascidians on which a person may tread for yards without finding an inch of bare stone. Oysters sheath the rocks in places with a continuous crust. There is a crab that marches in regiments. Quite above tide level a small gregarious periwinkle packs together in scores. Once a collector picked up a derelict bottle among the rocks at Watson's Bay. With patience he washed out its contents and catalogued them. This chance handful actually contained 155 distinct species of shells.

A century of study has not yet completed the record of the local fauna, for new species constantly come to light and whole groups require revision. Imperfect knowledge shows this fauna to be little inferior in extent to that of the coral zone. The narrow limits of Sydney Harbour probably include more species of marine invertebrata than the whole of the British marine area, though that extends from the Channel Islands to the Faroes, stretches far into the Atlantic, and embraces most of the North Sea.

In this latitude a northern or Solanderian overlaps a southern or Peronian fauna, but the latter may be considered the basis. This Peronian fauna extends south to Tasmania and meets at Bass Straits another Australian component, the Adelaidean element. A powerful warm current,

* I have to thank Prof. Haswell for help in the preparation of this article. Those who desire a further acquaintance with the subject can consult an excellent index of the marine invertebrate fauna of Port Jackson by Mr. T. Whitelegge.—Proc. Roy. Soc. N.S. Wales, xxiii., 1889, pp. 163-323.

the Notonectian, comparable to the Gulf Stream, runs south along the coast, bringing strays from lands of reef and palm. It scatters on our beaches empty nautilus shells, cocoanuts and pumice; with these sometimes come turtle and the venomous sea-snakes. In this way tropical forms arrive and linger for a short time, but eventually perish in an uncongenial climate.

Floating down this current drift myriads of pelagic organisms, pellucid as glass or jelly, purple and silver. Usually these pass by, but after an easterly gale are blown ashore in such quantity that the drift paints a long purple streak upon the sand. Here by thousands are wrecked frail *Ianthina*, one the size of a pea, another somewhat the size and shape of a garden snail, with which, indeed the father of natural history classed it. Fast to the purple snail, is a little raft of packed bubbles which float it on the surface and on which its eggs are laid and hatched.

Another raft is that of *Velella*, an oval film, hung round the rim with purple tentacles. Slanting across the deck is hoist the sail which drove it to destruction on the beach.

Prominent among the sea-drift is *Physalia*, the hated Portuguese Man-of-war. From a clear oblong bladder trail yards of purple tendrils. These drifting across a man's bare flesh can raise a weal like a whip-lash and sting with a scalding, enduring pain, so bathers go in dread of them. When dried upon the hot sand these bladders explode like crackers under the feet.

Beside them lies a purple disc, *Porpita*. A lump of Medusa blubber is all that remains of the once graceful blue or brown *Crambessa mosaica*. Silver sheen catches the eye from the outstretched arms of *Glaucus*, a much modified Nudibranch. The gelatinous bells of Salpæ, either singly or in chains, are tossed among the drift. Nestling in an empty hull of one of these may lie, snugly curled, the quaint crustacean, *Phronima*.

Strewn along the beach are cuttle bones of several kinds, from the great *Sepia apama* to the tiny *Sepia braggi*. Plentiful also are the empty post-horn shells of *Spirula*, the modern heir of the mesozoic belemnites. After a gale it is not rare to gather shells to which morsels of flesh still adhere, and complete specimens have been obtained more than once. Perhaps on no other coast is there so good a chance of gathering this biological treasure. Apparently the *Spirula* lives in deep water beyond the continental shelf, clinging in life by the posterior sucker to some perch among the ooze. But after death the float lifts it to the surface, where the easterly winds blow the carcase shorewards. Watchful gulls are ever on the alert to seize the dainty, so that the few that reach land whole are usually concealed in a mass of drift-weed. At intervals of several years a fleet of Argonauts, or Paper Nautilus, comes ashore. Sometimes the venomous sea-snake, *Hydrus platurus*, coloured in segments of black and yellow, with a flat, oar-like tail, is thrown upon the beach.

Like a shadow the swift sand-crab, *Ocypoda ceratopthalma*, disturbed from feasting on the wreckage and the flies which have settled on it, flits across to its burrow in the dry sand above the high-tide mark.

Most of the pelagic fauna at which we have glanced range all over warm seas. To find a fauna more characteristic of Australia another outlook must be chosen. The shoreline of Port Jackson winds by so many creeks and coves that from Head to Head it extends for a hundred and eighty-three miles. At the upper end of Middle Harbour or on the banks of the Parramatta River, the estuarine fauna is well developed. Low trees and bushes of *Avicennia* Mangrove line the shore, and the sand of the seaward beaches is replaced by mud. Dull and sombre colours here prevail among all classes of animals, but unattractive as they appear, a zoologist will find a fascinating œcological study in the mangrove fauna. Plastered on roots and trunks are those marvels of travellers' tales, "oysters growing on trees" (*Ostrea cucullata*). Here a Periwinkle, *Melaraphe acuta*, forsaking its proper element, has adopted an arboreal existence, and may be gathered from its perch on leaves or twigs. Among the roots and along the mud-flats a little brown crab, *Helœcius cordiformis*, darts to cover, while another, *Sesarma erythrodactyla*, crouches under the stones.

The litter of sticks along the water's edge harbours an amphibious group of mollusca, the Auriculidæ, represented here by several genera, *Ophicardelus*, *Cassidula*, *Plecotrema* and *Leuconopsis*. Here *Onchidium* is common, a small slug with warts on its back, and on each wart an eye.

From the belt of mangroves at low tide there extends a level expanse of sandy mud, overgrown with Zostera. Squadrons of a small blue crab, *Mycteris longicarpus*, parade the flat. If pursued they retreat, marching with closed ranks, but if pressed too hard, they stop, burrow into the ground and vanish. Indeed, the faculty of disappearing underground is common to most of the inhabitants of the zostera flat. A furrow marks where a large globular shell-fish ploughs under the surface. When unearthed the shell is concealed by the voluminous flesh, but as the animal shrinks it appears with a handsome red lip. This is *Polinices plumbeus.* Common on the zostera flat is the great *Pyrazus herculeus*, known to the old-fashioned shell fanciers as the Hercules Club, and to local fisherman as the whelk. It is said that a few gathered by the sailors of Capt. Cook in Botany Bay realised many guineas apiece in London. A large, ribbed, white "cockle," half-sunk in the mud, its projecting part masked by a tuft of weed, is *Arca trapezia.* Piles of empty shells in the middens of the extinct local tribe of aboriginals show how much its flesh was relished by them. Several Cockle Creeks were named by early explorers in allusion to it. A large Opisthobranch mollusc which creeps among the weed is *Bulla australis.* Planted upright in the mud, with its blade awaiting an unguarded foot, is the large bivalve *Pinna menkei.*

If we move from the estuary to some position nearer the Heads, such as Manly, Watson's Bay or Middle Head, we exchange the fauna as completely as we do the landscape. Not a species of the area of mud and mangroves which we have left continues among the fauna inhabiting the clean, sandy beaches or the pools of clear water among the rocks.

Here we touch the fringe of the coral zone. Now and then in the deeper pools appears a vivid emerald patch like a tuft of moss growing under the sea. This is a glimpse of a colony of *Plesiastræa urvillei.* In the shady side of flat rocks grow the separate cups of *Cylicia quinaria.* A not uncommon Gorgonid found adhering to rocks is *Telesto smithii;* and there may sometimes be seen at low spring tides the red or yellow fan-like expansions of another member of the some Order, *Mopsella coccinea.* Several handsome Sea-Anemonies occur in the rock pools and rooted in the cracks. One is bright red, another green.

Rocks that receive the shock of ocean waves are thickly overgrown by the massive and gigantic ascidian, *Cynthia præputialis*, known by the aboriginal name of Cunjevoi. The soft interior is eviscerated for bait, which has wrought its destruction round accessible fishing grounds. Perhaps the most prominent and peculiar feature of the local seascape is afforded by the dense masses of Cynthia in the break of the surf. Associated with these, but afloat at the lowest tide, sway the red and orange masses of brightly-coloured *Boltenia australis*, like tulips transplanted from some earthly garden. Compound ascidians of such genera as *Botryllus*, *Botrylloides* and *Circinalium* and of numerous species are spread on stones, dead shells or stalks of seaweed.

Often the rocks are thickly crusted between tide-marks with the small rough tubes of an annelid *Vermilia cæspitosa*. So closely do these grow that from a little distance the rocks seem smeared by whitewash. In the tubes of this serpulid Prof. Haswell discovered a queer little crustacean, *Eisothistos vermiformis*, accommodated to its narrow abode by the assumption of a worm-like form. In pools at low-tide occurs that most handsome worm, *Spirographis australiensis*. It is of considerable size, and when undisturbed expands a whorl of branchiæ like the petals of a flower. But a too close approach of an admirer makes the blossom shrivel into a large membranous tube. Among other tubicolous Polychaeta may be mentioned species of *Terebella* and *Cirratulus*, which are both very common; *Ammochares* (Owenia) *tenuis*, which occurs under stones on sand, and *Clymene integrinatis*, which burrows deeply in sand and gravel. Of free-living or errant Polychæta the most common is a species of Nereid—*Nereis dumerilii*—which occurs everywhere; and another form which is of extremely common occurrence is *Syllis corruscans*, one of those remarkable forms so exceptional among the Polychaeta that reproduce by means of buds. Common also are certain forms of *Polynoe* and allied genera, of which those most frequently met with are: *Thormora argus*, *Antinoë præclara* and *Lepidonotus jacksoni*. A species of *Antinoë* is almost invariably to be found within the tube of a common species of *Terebella*, just as *Terebella nebulosa* of European seas shares the shelter of its tube with *Antinoë nobilis*. The large and common *Halla australis* is remarkable for the change from bright orange to deep-purple induced by exposure to sunlight.

Species of a Gephyrean worm, *Phymosoma*, are common and easily obtainable by unpicking clusters of mussels. A large Sipunculid of the same class, *Dendrostoma dehamata*, is thrown up in numbers on the sandy beaches of Middle Harbour after heavy weather.

Several Brachiopods occur, a large species, *Magellania flavescens*, is uncommon; it hangs in clusters in dark corners.

The small *Kraussina lamarckiana* adheres to stones at low tide.

The first echinoid likely to be seen is *Strongylocentrotus erythrogrammus*, purple-black, with short spines, and about the size of a cricket ball. It has a curious habit of excavating a cup in the sandstone rock, within which it lies flush with the surface. Less frequently to be met with is *Centrostephanus rodgersii*, with long and slender purple spines. From its usual refuge, some deep crevice among rocks, it is difficult to extract without breaking. Still rarer is the species with a few thick spines like slate pencils, *Phyllacanthus parvispinus*. On a sandy beach there usually appears *Amblypneustes ovum*, an elevate form with short, sparse pink spines.

The starfishes are most ferquently represented by *Asterina exigua*, a pentagon about an inch across. Also abundant is *Asterina calcar*, a parti-coloured boss, with eight short digitate rays, and *A. gunnii* with six. Very common also, under stones, is the irregularly developed *Stichaster polyplax*; and *Asterias calamaria* will also sometimes be found there, though its usual abode is in deep water. Much rarer are the bright-scarlet *Asterias globifera*, ornamented on the back with numerous rounded knobs; *Pentagonaster dubenii*, also bright-scarlet, but smooth and marked with white lines; and *Asteropsis vernicina*, a dull-purple species, with remarkably slimy surface. The commonest Ophiurid under stones is *Ophiactis resiliens;* and of the Crinoids stray specimens of *Antedon pumila* are sometimes met with, and in certain places a fine large *Actinometra*.

Holothuroidea are not common, being more developed in the tropics than here. But under stones the soft, limp, pink, worm-like *Chirodota australiana* and *Synapta japonica* are of frequent occurrence. Though high magnification is needed to view the anchor spicules contained in the cuticle of the latter, their effect appears in the way the creature clings to the collector's finger.

A profusion of sponges characterise these waters. No fishery has yet been instituted, but a native sponge, *Euspongia illawarra*, has as fine a texture as any in the market and may prove worthy of commercial notice. A fan-spread black sponge is *Ianthella flabelliformis*. An elegant little vase is formed by species of *Sycon*. This and a branching kind (*Sycon gelatinosum*) represent the Calcispongiæ. The most conspicuous of the horny sponges on rocky shores is *Dactylochalina reticulata*, a light coloured sponge with long cylindrical branches which may reach the height of a couple of feet. By dredging a great variety are procurable, many sponges from deep water being of large size and some brightly coloured. Hydrozoa are abundant on old piles, in tide pools and under rock shelves, most of the genera are of world-wide distribution. A common epizoic species is *Sertularia elongata*, found trailing over the stems of Alcyonaria and along the fronds of sea-weeds.

The Bryozoa are both numerous and varied, representing many genera, most of which are, however, of world-wide distribution. Species of *Membranipora*, *Schizoporella*, *Cellepora*, *Diachoris*, *Carbascea*, *Bugula*, *Discoporella*, *Crisia*, and many others may be found growing on almost every stone at low-water. Of the Endoproct Bryozoa, the genera *Pedicellina and Loxosoma* are both represented—the former occurring among the zoophytes, especially *Obelia*, on the piles of jetties, etc.—the latter on the surface of a burrowing Annelid, *Clymene integrinatis*.

The Crustacea do not fail to contribute worthily to the invertebrate population. On our approach to the rocks we are greeted by *Leptograpsus variegatus*. This common crab warily creeps away, equally ready to snatch at a morsel of food or to rush to shelter if its capture be attempted. Representatives of the Spider Crabs are *Microhalimus deflexifrons*, *Halimus spinosus*, and *Gonatorhynchus tumidus*. Floating in small pools is a little prawn with delicate chelipeds, *Leander intermedius*. A Hermit Crab, *Diogenes custos*, lives in stolen shells along the wash of the waves on the sand. The edible crabs of the fishmongers are *Portunus pelagicus* and *Scylla serrata;* the so-called lobster is *Palinurus hugelii*, while two species of *Penæus*, viz., *P. canaliculatus* and *P. monodon*, are sold for prawns.

Turning to the Amphipods we find a common Sandhopper, *Orchestia macleayana*, in myriads around the piles of sea-weed thrown up by the waves. Common Isopods between tide-marks are *Sphæroma*, which bores both into wood and sandstone, *Cymodocea pubescens*, *Cilicæa crassa*, *Haswellia carnea*, and *Paranthura australis*. Of the Læmodipoda numerous specimens will be found, particularly among sea-weeds and bryozoa, the commonest species being *Caprella danilevskii*, *Caprella æquilibra*, *Protella gracilis* and *Phtisica novæ-hollandiæ*.

In discussing the Crustacea, those degenerate members of the class, the barnacles, must not be overlooked. Several species of *Balanus* stud the surface of the rocks; the largest of these is *B. nigrescens*, with a base sometimes two inches in diameter; another common species is *B. trigonus*. Also common is a curious hairy species found under stones, to which Quoy and Gaimard gave the name of *Lepas hirsuta*. Attached to the roots of Laminariæ is another, *Lepas australis*.

Several Pycnogonoids may be collected, especially on Clark and Shark Islands, under stones in the rock pools. *Nymphon æquidigitatum* occurs in a few fathoms; while *Ammothea longicollis* and *A. assimilis* are shallow-water forms.

About a thousand species of marine mollusca are known from the vicinity of Sydney, so that the Harbour is a paradise of the shell collector. Above ordinary tide-level certain shell-fish, such as *Tectarius nodulosus*. *Melaraphe mauritiana*. *Bembix melanostoma* and some *Acmæa* seem to have altogether retired from salt water and to have established themselves on dry land. A zone lower down, just below high-water appear the round, smooth black shells of *Nerita melanotragus* and a top-shaped shell, striped with buff and chocolate, aptly termed *Monodonta zebra*. Among these will be the small knobbed shells of *Drupa marginalba*, of whose destructive work numerous small half oyster shells adhering to the rock afford mute token. Huddled in a crevice beside it is its fellow-carnivore, *Thais succincta*, a large, spirally-ribbed shell, one of the first of this fauna to be described in Europe. The Sydney limpets, *Helcioniscus tramoserieus* and *Acmæa alticostata* find beside these a congenial nook, and with them nestle a chiton, *Liolophura gaimardi*, with a bristly girdle chequered black and white.

Deeper, where the water only leaves the stones bare for shorter intervals, the collector becomes bewildered by multitudes of various forms. Any rock dragged from a pool and exposed to show its under surface, offers a naturalist rich materials for study. From the light many sorts of chitons crawl away to hide as quickly as they can in the darker crevices. The profusion, both in species and individuals, of this group is a feature of the southern fauna, which fails on approaching the tropics. A large and common kind is the olive-brown *Ischnochiton australis*. The pretty little *I. crispus* is distinguished by a white dorsal stripe. Most peculiar is the large worm-like *Cryptoplax striatus*, whose little valves project at distant intervals from the tough enveloping girdle. *Chiton jugosus* has a crimson splash on one valve. *Onithochiton quercinus* is worth picking up to examine the wonderful dorsal eyes which stud the surface of the valves in rays.

With these associate many gasteropods. A minute yellow speck the size of a pin-head represents *Schismope atkinsoni*, the nearest to *Pleurotomaria* we have. In such haste to escape is *Gena strigosa* that if interfered with it will sometimes detach its tail for ransom, like a frightened Gecko does. A soft black slab, on being touched, shrinks, and an opening reveals the white trough-like shell of *Scutus anatinus*. The key-hole limpets have a fine example in *Fissuridea lineata;* unperforated relations found are common —*Subemarginula* and *Emarginula*, *Megatebennus*, *Lucapinella* and *Zidora*.

The empty ear-shells, *Haliotis naevosa*, at the bottom of a pool attract the eye of the passer-by with its glitter. But the living mollusc of this large and handsome species if not taken by surprise will defy aught but main force and a strong knife. By the Chinese these were considered a dainty, but are not eaten by the European population.

The Trochidæ are here numerous though not reaching the size of tropical species. There are several *Clanculus*, *C. floridus* and *C. omalomphalus* being seen everywhere. Other genera are *Minolia*, *Gibbula*, *Cantharidus* and *Calliostoma*, most members of which are brightly coloured. *Cantharidus eximius* is mounted sometimes for the head of a hat-pin, and *C. fasciatus* after an acid bath makes a pretty nacreous necklace.

Among the weed and crevices commonly occur one of the largest shells that a visitor will see, *Turbo stamineus*, which when plucked from its home, slowly withdraws a black foot into the shell and blocks by a strong ear-shaped operculum, the silvery nacreous entrance. The rough exterior may be removed with acid to make a handsome ornament of lustrous mother-of-pearl. Akin to this is the tent-shell, *Astralium tentoriforme*, a little congregation of which mimic in a pool a military encampment.

Other large shells which may be found are *Cymatium costatum*, cloaked in a dense mass of epidermis; *Charonia rubicunda*, the Conch or Trumpet Shell; the white-lipped *Argobuccinum australasiæ;* the cask-shell, *Tonna variegata*. Several species of Volutes occur in this neighbourhood;

Scaphella magnifica lives, or used to live, in the Harbour, and *S. marmorata* in the open sea.

Several species of *Arcularia*, the largest of which is *A. glans*, inhabit rock pools, and exhibit their indignation at being taken from their native element by vigorously whisking about their bodies and tails.

Though *Conus* does not here attain the magnificence of the tropics, the local *C. anemone* is not the least pretty of its family. The approach of warmer seas is indicated by several species of Cowries, of which *C. vitellus* and *C. caput-serpentis* are the commonest. Strayed from coral reefs is the *Strombus luhuanus*, from the red lip of which is cut the beads of Papuan dandies. Only in one place in the Harbour does this interesting species live.

Sydney Harbour has a great wealth of Nudibranchs, exquisite creations, quaint in design and gorgeous in colouring. They seem to be fond of roaming, for they appear and disappear at uncertain intervals. Perhaps the most gorgeous is the crimson *Plocamophorus imperialis*. A simpler gem is the dainty *Goniodoris daphne*, its sky-blue body tipped and belted with red. *Coryphella macleayi* and *Flabellina ianthina*, the first small, the second large, are plumed along the back.

A cloud of purple suddenly appearing in the water shows where *Tethys sowerbyi* resents being rudely disturbed. Some Cephalopods haunt the rock pools, commonest of all being the vivacious little *Polypus pictus*, painted with rings of blue.

In Sydney Harbour was dredged the first living representative of *Trigonia*, but it is too rare for a visitor to expect to find. Except in Australia this brilliantly nacreous bivalve became extinct with the Mesozoic. So it is interesting to find that this *Neotrigonia margaritacea*, var. *lamarcki* and another "living fossil," *Heterodontus*, the Port Jackson Shark, still linger on together.

On the beaches to the north of Port Jackson the aberrant group Enteropneusta is represented by *Ptychodera australiensis*. It is fairly abundant near Barrenjoey under stones among sand between tide-marks.

THE FRESHWATER FAUNA.

By Prof. W. A. Haswell, M.A., D.Sc., F.R.S.

The little Fishes commonly known as "Minnows," "Native Trout" or "Mountain Trout" (species of *Galaxias*), common in nearly all the streams of the State, as of extra-tropical Australia generally, belong to a family, the *Galaxiidæ*, with a remarkable distribution. There are only two genera—*Neochanna* and *Galaxias*. *Neochanna* is a marine fish, and is confined to New Zealand. Of *Galaxias* some twenty-two species are known, of which the majority occur in Australia, Tasmania, New Zealand and the Auckland and Chatham Islands, while seven species are found in southern South America, Tierra del Fuego and the Falkland Islands. One inhabits the streams of Cape Colony; while one (*G. attenuatus*) is found not only in the southern extremity of South America, with Tierra del Fuego and the Falkland Islands, but also in Tasmania, New Zealand and the Chatham Islands. These facts relating to the distribution of *Galaxias* in general, and, in particular the occurrence of the same species on opposite sides of the Pacific, have often been adduced as affording strong evidence in favour of the view that a land connection existed between South America, Australia and New Zealand at a period not very remote geologically. But much of the force of this evidence has been destroyed since it has been made clear (as was, indeed, stated by Hutton in 1872) that *G. attenuatus* goes down to the sea to spawn, and since that species has been found in great numbers in the sea at the Falkland Islands.

Three species of this interesting genus occur in New South Wales—all small fishes, reaching at the utmost a length of seven or eight inches. One, *G. scriba*, a narrow, elongated species, semi-transparent and sparsely covered with small dark spots, is common in most small creeks in the seaward parts of the County of Cumberland. A second, *G. coxii*, inhabits streams in the Blue Mountains. The third, *G. findlayi*, occurs about Mount Kosciusko.

An interesting freshwater fish, sometimes met with in abundance in certain New South Wales rivers, is the so-called "Grayling" (*Prototroctes muræna*). This has no connection with the English Grayling (which belongs to the true Salmon family), but is a member of a family, the *Haplochitonidæ*, having representatives outside continental Australia only in Tasmania, New Zealand and South America, so that it forms an interesting additional connecting-link between those countries. The Grayling is decidedly Trout-like in general appearance, and further resembles the Trout in the presence of an adipose posterior dorsal fin. It differs from the Trout in the extreme minuteness of the teeth, which are almost microscopic. It has been found, Mr. A. R. McCulloch tells me, in the Grose and Nepean (Hawkesbury) Rivers, and in the Kangaroo, Pambula and other coastal streams in the southern part of the State.

English Brown Trout and American Rainbow Trout have been successfully introduced into many of the rivers; but the only indigenous member of the Trout family (*Salmonidæ*) is a little fish known as the Smelt (*Retropinna retropinna*), a small, narrow, almost colourless fish with the characteristic adipose fin of the Salmonidæ. This is common in the creeks about Sydney and passes down into salt water.

Several members of the Herring family (*Clupeidæ*) live habitually in the rivers, or ascend them occasionally. Such is the Freshwater Herring (*Potamalosa novæ-hollandiæ*), which occurs plentifully in the Hawkesbury, the Clarence, the Richmond and other rivers. Several freshwater members of the Catfish family (*Siluridæ*) also occur, and are remarkable, like other members of the family, for the care taken of the eggs by the parents. The common Freshwater Catfish (*Copidoglanis tandanus*), which occurs throughout the far-spreading Murray River System, and is valued as an article of food, belongs to a genus which extends into Asia. Eels (*Anguilla reinhardtii*) are common and reach a fair size.

Of the members of the Perch-like family, *Serranidæ*, the best known is the so-called "Murray Cod" (*Oligorus macquariensis*), a very valuable food-fish which grows to a large size, and is common in the Murray and its tributaries as well as in the Clarence and Richmond.

The largest and most conspicuous of the Freshwater Crustacea of New South Wales are the Crayfishes. There are very few streams or stationary bodies of fresh water, however small, in which Crayfish are not to be found. Two very distinct forms of Crayfishes occur abundantly in New South Wales—the smaller Smooth or Two-keeled Crayfish (*Chæraps bicarinatus*) and the Spiny Crayfish (*Astacopsis serratus*).

The former is more especially an inhabitant of dams and waterholes, or of pools in the more sluggish streams, and excavates innumerable burrows in the banks, often doing serious damage in this way to mud or clay embankments of storage dams and reservoirs.

In clear-running streams the prevailing Crayfish is the Spiny Crayfish (*Astacopsis serratus*), of which there are a good many varieties. Some of these are very brilliantly coloured—the prevailing colours being green, blue, red and scarlet, which vary in their proportions and arrangement. In the larger rivers, such as the Murrumbidgee, these Crayfish reach a large size, assuming dimensions almost as great as those of the largest of the European Sea-Lobsters; and even in very small coastal streams specimens of great size are occasionally met with. The Spiny Crayfish, like the Smooth form, is an active burrower, and is able, by taking refuge in a deep burrow with a little water at the bottom, to survive periods of prolonged drought.

Extremely common in the streams of New South Wales is a little transparent Shrimp-like Crustacean which has been found to belong to a species, *Xiphocaris compressa*, originally described from Japan, and since found in Norfolk Island.

River Crabs of the genus *Geothelphusa* occur far inland in the Darling River and its tributaries. When the creeks and rivers dry up, these, like the Crayfishes, burrow into the banks and, by burying themselves in moist clay, escape desiccation.

One or two species of freshwater Isopods occur, but have not been critically examined. Only one freshwater Amphipod has been observed—a species of *Gammarus*.

Phyllopoda are very abundant. *Apus* and *Lepidurus* are sometimes extremely numerous in favourable seasons in the inland western districts. The Bivalved Phyllopoda (*Limnadidæ*) are also plentiful. The smaller *Cladocera* or "Water-Fleas" are represented by species of the cosmopolitan genus *Daphnia*, and also by species of *Lyceus*, *Moina*, *Macrothrix*, *Lynceus* and others.

The Australian freshwater *Copepoda* and *Ostracoda* have not received so much attention as the *Phyllopoda*. But of the former order species of the genera *Cyclops* and *Diaptomus* have been described from the neighbourhood of Sydney, and of the latter a number of species of *Cypris*.

The freshwater Ringed Worms (*Oligochæta*) are very numerous and nearly all the families are represented, though only a few have been studied. *Enchytræids* are common; *Chætonotus*, *Dero*, *Nais*, *Æolosoma* and *Tubifex* also occur—the last-named being present, sometimes in enormous numbers, in muddy creeks. The *Phreodrilidæ* is the most characteristic Australian family. It is represented elsewhere only in South America, in Kerguelen, in New Zealand and in South Africa. In New South Wales there are at least two peculiar genera—*Phreodriloides*, found in the Blue Lake on Mount Kosciusko, and *Astacopsodrilus*, two species of which live on the surface, or in the branchial cavities, of the Spiny Crayfish.

The commonest freshwater Leech is *Limnobdella australis*, the Medicinal Leech of the Sydney pharmacists. Less abundant are species of the widely-distributed genera *Glossiphonia* (*Clepsine*) and *Herpobdella* (*Nephelis*), and one each of the genera *Dineta* and *Semilageneta*, which are peculiar to Australia.

The commonest of the freshwater Polyzoa is the familiar European species, *Plumatella repens;* and another widely distributed form is *P. princeps*, while *P. aplinii* appears to be peculiar to Australia. *Lophopus lendenfeldi*, which has only been found at Parramatta, and *Fredericella australiensis*, which occurs abundantly in the Potts Hill Reservoir of the Sydney Water Supply, are also Australian species. A species of *Alcyonella* has also been found in the neighbourhood of Sydney.

The freshwater Polypes comprise at least one species of *Hydra* (*H. hexactinella* or *oligactis?*) common in creeks about Sydney, and a species of *Cordylophora* (*C. Whiteleggei*) occurring in Parramatta Park. Several species of Freshwater Sponges (*Spongillidæ*) are found in the rivers, creeks and reservoirs.

Chapter II.—BOTANY.

SKETCH OF THE BOTANY OF THE COUNTY OF CUMBERLAND.

By J. H. Maiden, Government Botanist and Director of the Botanic Gardens, Sydney.

The County of Cumberland is the metropolitan County, and its name will have a familiar sound to our visitors. It was given by our first Governor (Phillip) in the year 1788, and at first was not so extensive in area as it was defined later. Collins states that it was named in honour of His Majesty's (George III.) second brother, H.R.H. the Duke of Cumberland.

The Sydney flora is usually considered to be that found in the County of Cumberland, which is about 63 miles long and 38 broad, comprising an area of about 1,530 square miles, bounded on the east by the Pacific Ocean, on the north by the Hawkesbury River, on the west by the Hawkesbury River (called the Nepean south of Penrith). The southern boundary is less well-defined; starting from Bulli, on the coast, we have an artificial boundary north-west until the Cataract River is reached, thence the course of the river is mainly westerly up to its junction with the Nepean. It will be thus seen that the county is almost an island, the Hawkesbury-Nepean forming (with the Pacific Ocean), its water boundary. It is an undulating plain, with no great elevations—probably none attaining a thousand feet. We have the long, blue ridge of the lower slopes of the Blue Mountains, just over the Nepean, to bound the western horizon.

The River Nepean (Hawkesbury) is the principal one, and besides a number of creeks of no great importance there are two rivers—the Parramatta, which is a salt-water estuary, forming the upper part of Port Jackson, while George's River (which receives the Woronora, and which flows into Botany Bay) is mainly tidal.

The county has four noble estuaries, which exhibit charming scenery, and which give great facilities for botanical exploration. The most northerly one (*a*) Broken Bay, is the largest, and they gradually diminish in size as we go south, viz., (*b*) Port Jackson, (*c*) George's River, which opens into Botany Bay, a suburb of Sydney, and (*d*) Port Hacking.

Broken Bay, the estuary of the Hawkesbury River, which has been compared to the Rhine, offers endless attractions to the tourist and the botanist. Port Jackson, in spite of being the seat of a large city, is still encircled with most interesting indigenous floral wealth, while George's River, though still interesting to the botanist, is inferior in its botanical attractions to Port Hacking.

The county mainly consists of rocks of the Hawkesbury series (Triassic). These comprise the Hawkesbury sandstone, of which the greater portion of the north and south is composed, and which give it a picturesque, and, it may be added, a barren character. As compensation, the sandstone supports one of the most beautiful and varied floras in the world.

Then we have the Wianamatta shale overlying the sandstone; this occupies a very large area comprising the centre and western portions of the county.

Thirdly, we have the Narrabeen shale, which is comparatively rare; it occurs sparingly on the coast, chiefly near Narrabeen on the north and Otford on the south. Both these formations produce soil of fair quality, and support orchards, arable and grazing land.

The Wianamatta shale is country of open forests (Savannah), undulating grass lands dotted over with trees, of which *Eucalyptus hemiphloia* F. v. M., the Grey Box, is, perhaps, the most gregarious. *E. pilularis* Sm., the Blackbutt, is not rare. Particularly towards the west, and chiefly on flats, on the alluvium, the Appletree (*Angophora intermedia* DC.) forms large trees, very umbrageous and often of singular beauty.

Volcanic soil is of rare occurrence. There are large areas of fertile alluvial land chiefly on the banks of the Nepean and Hawkesbury, and sandy, not very fertile land of the same character in the coast district, chiefly around Botany Bay.

The county is not a district of extremes, except, perhaps, as to barrenness, for we have many rock masses either quite or nearly bare. There are no alpine areas, neither have we the rich brushes, in their highest development, of the northern rivers of this State, or of coastal Queensland.

Within this area about 1,300 plants have been recorded, to say nothing of cellular cryptogams. These are divided into 110 families and about 520 genera, so it will be at once seen that in a brief sketch of this character one must touch very lightly upon the vegetation. Most of the plants of which I shall take cognisance are quite common.

Following are a few localities in the immediate neighbourhood of Sydney where the visiting botanist, with but a short time at his disposal, may expect to obtain a representative collection of our local flora.

Brush.—Illawarra line at Otford, Stanwell Park and National Park, Bulli Mountain, Narrabeen.

Sandstone Flora.—National Park, Manly, South Head to Bondi, Head of Middle Harbour, Hornsby to Peat's Ferry, George's River, Woronora River (Heathcote Station), Nepean (Penrith to junction of Nepean with Warragamba).

Sea Coast, South of Port Jackson.—Bulli, Clifton, Cronulla Beach, Maroubra Bay. North of Port Jackson.—Middle Harbour, Manly, Narrabeen, Pittwater.

Salt Marshes on Parramatta River at Homebush and Haslem's Creek.

Swamps.—Waterloo, Botany, Maroubra, La Perouse, Narrabeen.

It will doubtless be interesting to our visitors to note that in the Sydney Botanic Gardens we can fix the precise site of the origin of the agriculture and horticulture of a continent—a thing that probably cannot be said in regard to any other continent.

The colony of New South Wales was founded on 26th January, 1788. Governor Phillip had collected, both at Rio de Janeiro and at the Cape, many economic plants, while he had brought wheat and other cereals from England. Simultaneously with finding shelter for his people, he set apart land for a farm and garden. This was the site of the present Botanic Garden, and the origin of the name Farm Cove on which it abuts. The impress of the old ploughed fields of cereals is still left in the Botanic Gardens in the shape of the large oblong beds which, at the present day, mainly compose the middle garden.

The attention that had been given in Europe to the remarkable vegetation of New Holland caused the directors of botanical establishments and proprietors of nurseries to compete eagerly for seeds and plants of this country. Sydney had practically a monopoly of such productions, and hence it came about that cases of plants were consigned to the

Botanic Garden of Sydney by almost every ship in the early part of the nineteenth century.

TREES.

Probably the most interesting flora of the county to the visiting botanist will be found that of the Hawkesbury sandstone, which supports a stunted and xerophytic flora consisting mainly of shrubby Leguminosæ, Myrtaceæ, Epacridaceæ, Proteaceæ and Rutaceæ. The TREES, as a rule, are stunted, nor are their timbers commercially valuable; Eucalypts form the majority.

EUCALYPTUS.—This has been called the national genus; we have about thirty species in the neighbourhood of Sydney. Amongst the smooth-barks we have Blue Gum (*E. saligna*), which prefers rich, moist soil; *E. hæmastoma* (White Gum), and its variety *micrantha* (White, Scribbly or Cabbage Gum), common in sandy or rocky situations, particularly near the coast; *E. maculata* (Spotted Gum), with blotched bark, Liverpool district; *E. tereticornis* (Forest Red Gum); *E. punctata* (Grey Gum), with whitish, irregular blotches on its grey bark; and *E. virgata* and its variety *obtusiflora*, dwarf Eucalypti resembling Mallees, found near the coast.

Turning to the Half-barked Eucalypts, we have a depauperate form of the Mountain Ash (*E. Sieberiana*), which attains its northern-most limit in the coastal districts near Sydney; *E. pilularis* (the Blackbutt), one of the largest trees in the Sydney district; *E. hemiphloia* (the Box) found sparingly in the western suburbs, and abundantly as the Blue Mountains are approached; *E. longifolia* (the Woolly Butt), with large flowers which are in threes, not rare in the western suburbs, and more abundant towards the Illawarra line; *E. Baueriana* (Blue Box), an umbrageous tree with broad leaves which have a bluish cast, found on the banks of the Nepean and a number of its tributaries; *E. Bosistoana*, allied to Box, to be found near Cabramatta, and *E. piperita* (the Sydney Peppermint), abundant in sterile country throughout the district. *E. squamosa*, having scaly bark and flower-stalks in pairs, will be found in rocky country from National Park south towards Bulli.

Then we have the White Mahogany (*E. acmenioides*), found north of Port Jackson, and, usually at no great distance from the sea; *E. botryoides* and *E. robusta*, the Bastard and Swamp Mahogany respectively, both lovers of damp soil near the coast; *E. resinifera* (the Red or Forest Mahogany), sparingly distributed in the Sydney District; *E. corymbosa* (the Bloodwood), so called because of the blood-like stains on its scaly bark; *E. eximia* (the Yellow or Mountain Bloodwood), closely allied to the preceding, from which it chiefly differs in its sessile flowers and yellowish bark—it is to be found on the ridges on the North Coast line and westerly. The Stringybark Group includes *E. capitellata* and *E. eugenioides* (the large and small fruited Stringybark respectively). The Ironbark Group comprises *E. siderophloia* (the Broad-leaved Ironbark); *E. paniculata* (the Grey Ironbark); *E. crebra* (the Narrow-leaved Ironbark), and *E. sideroxylon* (the Red Ironbark), which often has pink flowers.

Following are the closest relations to the Eucalypts; they are all trees of varying size, and belong to the Myrtaceæ:—

Angophora intermedia is the Rough-barked Apple, and is a valuable shade-tree. Very large specimens are exceedingly picturesque. The Smooth-barked Apple (*Angophora lanceolata*) is common, and is remarkable for its tendency to the self-grafting of its branches, for its gnarled and gouty limbs, and for the frequency of its flows of kino.

Tristania neriifolia is a yellow-flowered, small tree which frequents the sides of streams, *e.g.*, the Woronora, and is really shapely and ornamental. *T. laurina* has larger leaves, but the two trees are closely related, and require deep, moist soil.

Backhousia myrtifolia is the Grey Myrtle, and is found in most gullies containing running water in the coast and coast mountain districts. It is a small or medium-sized tree, with myrtle-like leaves and pleasing white flowers.

Rhodamnia trinervia (Three-veined Myrtle). Its three-veined leaves are quite ornamental, and the plant is especially handsome when young, by reason of the beautiful appearance of the branches, loaded as they are with the fruits of the size of peas, and of all shades of red.

Shrubs.

Following are some Shrubs:—*Calythrix tetragona*, sometimes called Fringed Myrtle, is a small shrub which, when in flower, is very beautiful. The calyx-lobes are lengthened into fine hair-like awns. The flowers are profuse, and white or flesh-coloured. *Micromyrtus microphylla* is a neat, ground-loving, minute-leaved, white or pinkish-flowered shrub. *Bæckea* is a genus of small, free-flowering shrubs. The prettiest of them all, in my opinion, is *B. linifolia*, a slender, linear-leaved shrub, of a few feet, bearing a profusion of white flowers, and gracefully bending over watercourses. Other species worth mentioning are *B. brevifolia*, *B. crenulata*, *B. diosmifolia*, and *B. densifolia*, all with small and even minute leaves of various shapes and white flowers, and *B. diffusa*, with pink flowers.

Leptospermum is a genus of so-called Tea-trees, and different species vary in height from two or three feet to a tall shrub, and even a small tree. *L. scoparium* is simply charming, with its profusion of white or pinkish flowers of varying tint, reminding one of small peach-blossoms. This, like *L. flavescens*, is a tall, slender shrub. The latter is very graceful, and bears a profusion of white flowers with just a suspicion of yellow. *L. arachnoideum* is a smaller shrub, with pungent leaves. Other species of *Leptospermum* are:—*L. lanigerum*, *parvifolium*, *stellatum*, and *L. attenuatum*.

Callistemon is, perhaps, best known by *C. lanceolatus*, the so-called Red Bottle Brush, now very extensively cultivated. Naturally it frequents moist situations, as on the banks of creeks. The swamps near Narrabeen are in the spring ablaze with the crimson flower spikes of this species. *C. salignus* is a taller shrub; flowers white to yellowish, and even yellow.

Melaleuca hypericifolia is a tall, bushy shrub, with handsome foliage, and very beautiful dull crimson bottle-brushes. It occurs in sandy land, not far from the sea, from Sydney to the southern boundary of the county. *M. thymifolia* (thyme-leaved) is a shrub of one or two feet, preferring swampy, sandy land. It has pale purple flowers.

Acacias.—We have about thirty species and well-marked varieties; they are known in Australia as Wattles. Most of them flower in the spring, others for several months of the year. *A. Baueri* (Botany Bay to Port Jackson) and *A. hispidula* are very dwarf shrubs, while *A. decurrens* (Green or Black Wattle) and *A. elata* are trees up to 40 or 50 feet high. *Acacia pubescens* (the last three bipinnate species) is a most dainty tree found near Cabramatta, etc. *A. discolor*, is a small shrub, also belonging to the bipinnate section, and is found everywhere in the barrenest places. Very common species are the prickly *A. juniperina*, the whip-stick *A. falcata*, *A. suaveolens*, with its cream-coloured or pale yellow, sweet-scented flowers, *A. linifolia*, *A. myrtifolia*, *A. longifolia* (locally called Golden Wattle), swamp loving; *A. floribunda* (Sally), a very floriferous small tree found on the banks of rivers; *A. glaucescens* (Coast Myall), with glaucous leaves, found on the banks of the Nepean, George's River, etc.; *A. prominens*, a beautiful species from the Hurstville district.

LEGUMINOSÆ.—Most of our local plants belonging to this Family have yellow or orange-coloured flowers. *Oxylobium trilobatum* is sometimes called Native Holly because the leaves remind one of that plant; it is a very handsome shrub. *Gompholobium latifolium* and *grandiflorum* have handsome, large, rather fugitive flowers; they are slender shrubs of three or four feet high. *Viminaria denudata* is a broom-like plant which grows in moist places. It is very floriferous. The *Daviesias* have triangular pods and contain some prickly species; the broad-leaved ones have a bitter taste, hence their name of Native Hops, while *Bossiaea* includes *B. scolopendria*, an interesting leafless shrub with flattened branches.

Pultenæa is a large genus of beautifully yellow-flowered plants whose stature varies from a few inches to that of several feet. *P. flexilis* has thin, supple branches, and sometimes forms small, dense "scrubs." *P. stipularis*, *P. glabra*, and *P. aristata* are small shrubs with the flowers in dense terminal heads, and are uncommonly handsome. *P. daphnoides*, *P. retusa* and *P. scabra* are more straggling plants, but very floriferous and pretty.

Dillwynia floribunda is a slender, pretty species, a foot or two high, the branches bearing a profusion of nearly sessile yellow flowers, giving it a spike-like appearance. The plant is common in the coast districts, preferring moist, sandy soil. *D. ericifolia* is even more plentiful.

Jacksonia scoparia is a beautiful small tree, with silky linear foliage, or rather no foliage at all, for the "leaves" are branches. It has a pendulous habit, and the yellowish flowers are borne in profusion. It frequents the most rocky, barren situations.

The broad-podded *Platylobium formosum* is also a common species. *Phyllota phylicoides* is a neat plant of a few inches. *Cassia australis*, a neat shrub with buttercup-like flowers and pinnate leaves, is not rare.

There are several Leguminosæ which we may notice which have flowers not of the prevailing yellow colour. Amongst them are the prostrate *Mirbelia reticulata*, with pink flowers; *M. speciosa*, from National Park, the largest and showiest of the purple-flowered species; the purple-flowered *Hoveas*, small, slender shrubs; *Indigofera australis*, our Native Indigo; a *Swainsona* or two; the climbing *Desmodiums* and *Glycines*, with their not very showy purple flowers; and the *Kennedyas*, elsewhere alluded to.

PROTEACEÆ.—This is the Family which includes the Native or Wooden Pear (*Xylomelum pyriforme*), a small tree, always found on stony land; also the Waratah (*Telopea speciosissima*). It includes, also, the so-called Honeysuckles (*Banksia*), of which we have several species. *B. latifolia* is a broad-leaved species, found amongst other localities in damp land near Rose Bay. *Grevillea* includes *G. punicea* and *G. oleoides*, two beautiful crimson-flowering species. The first is common about Sydney; the second, which has larger leaves, is most abundant in the rocky country between Sydney and the Illawarra. Several other less showy species are very abundant. The *Hakeas* have mostly needle-shaped leaves, small, white flowers, and woody fruits. The *Persoonias* are commonly known as Geebungs. They have small yellow flowers, and succulent drupes, usually of a green colour. Some are small, prostrate herbs, while others are small trees, and they are widely diffused. The *Petrophilas* and *Isopogons*, with fruits like cones, are abundant, and so are the white-flowering, woolly-flowered *Conospermums* and Honey Flower (*Lambertia formosa*), with pink tubular flowers, and here it may be mentioned that most of the flowers of this Family are rich in honey. All are usually found on rocky, sterile soil.

EPACRIDEÆ.—*Styphelia* produces "Five Corners," poor fruits, dear to the heart of school boys. *S. triflora* is a most beautiful shrub, the foliage being often tinged red, while the flowers of various shades of pale red and creamy yellow are very pretty. *S. tubiflora* is a very free flowerer, the flowers being of a crimson colour. *Astroloma* is a prostrate shrub, called "*Ground Berries*," because of its fruits. *Monotoca elliptica* is a shapely shrub, called "Pigeon Berry."

The genus *Leucopogon* contains many beautiful plants—dwarf woody shrubs. A *Leucopogon* may easily be known by the white beard inside the corolla. The colour of the flowers of all is white. *L. biflorus*, with short, prickly, nearly linear leaves, and flowers in pendulous twos, is a charming plant. *L. amplexicaulis*, with its leaves, cordate-ovate, clasping the stem, is a slender shrub. *L. microphyllus* has small flowers, but they are very abundant, and give the plant a pleasing appearance. *L. virgatus* is a dwarf shrub, very floriferous. *L. lanceolatus* is a shrub of several feet, whose singularly graceful foliage (which does not readily fade) is as ornamental as the flowers.

Epacris is a beautiful genus of (usually) dwarf woody shrubs. *E. longiflora* is one of the so-called Native Fuchsias, with the tube white and crimson. *E. obtusifolia* has pretty white or creamy flowers, possessing a delicious carnation odour. *E. paludosa* is another pleasing species, also with white flowers, and, like its predecessor, found in moist situations. It is widely distributed. *E. microphylla* is one of the commonest species, and its neat, pure white flowers give the shrub a very pleasing appearance. *E. pulchella* is taller than most of the species. It has pretty white flowers. *E. purpurascens* is a handsome species. It is one or two feet high, and the branches are covered with the sessile flowers, which are white, with all tints of pink.

Sprengelia incarnata is a beautiful plant, with pink, star-like blooms borne freely. It frequents swampy ground, and it may be mentioned that it is most lasting as cut flowers.

RUTACEÆ.—This Family includes some of the most beautiful of our flowering shrubs. The *Boronias* will at once occur to us. The prevailing colour of the flowers is pink. *B. serrulata,* with terminal flowers, is the well-known Native Rose. The closely allied *B. pinnata* and *B. floribunda* are singularly graceful, and *B. ledifolia* is very ornamental. We have several *Eriostemons,* and these are beautiful also. Let me single out for special mention *E. salicifolius* and the closely-allied *E. hispidulus, E. buxifolius* and *E. scaber.* They are all dwarf shrubs with pinkish flowers, and they flourish in the poorest soil. *E. myoporoides* is a bush of five or six feet. It prefers a moist soil, and may be found a few miles from Sydney in several directions, *e.g.,* it is abundant on the Woronora River. *Crowea saligna* and *E. exaltata* are small, pink-flowering shrubs. The former is common, and the latter by no means rare, south of Sydney, in the coast district. The *Phebaliums* are neat plants, with flowers of a yellowish white colour. Of the common Sydney species I may mention *P. dentatum* and *P. squamulosum.*

Philotheca australis and the hardly different *P. Reichenbachiana* are very pretty dwarf plants, bearing a profusion of purple flowers, while *Correa speciosa* (one of our Native Fuchsias), has tubular flowers of a lurid red colour. It is a straggling, small shrub, which hides in the shade of stronger plants.

The *Zierias* have white flowers. *Z. Smithii* is a tall shrub, with evil-smelling leaves. *Z. lævigata* is a neat dwarf shrub, well worthy of cultivation, and *Z. pilosa* is hardly less pretty.

COMPOSITÆ.—This Family is largely represented in the district, but few genera require special mention. We have several *Olearias*, of which *O. ramulosus* is our most widely-diffused species. In the spring it is covered with small white flowers, and is hence sometimes called "Snow-bush." Then we have a number of small daisy-like plants belonging to the genera *Calotis* and *Brachycome*, usually with purple flowers. *Cassinias*, usually shrubby, and with not particularly ornamental white flowers, are common, while there are numerous Everlastings belonging to *Helichrysum* and *Helipterum*. Various species of *Senecio*, weak-growing herbs, are conspicuous by their bright yellow flowers.

Humea elegans, sometimes erroneously called Native Tobacco, is a tall, slender shrub, found in rocky country north and south of Sydney. It has a large, loose terminal, gracefully drooping panicle of small red flowers, which have a coumarin smell.

Turning to plants belonging to a few miscellaneous Families we have:—

Exocarpus cupressiformis (Santalaceæ), the well-known Native Cherry. It is an ornamental, pyramidal-shaped, cypress-like tree, often taken for a conifer at a little distance. Its smaller relations, the *Leptomerias*, are called "Native Currants" because of their small green fruits.

Casuarina torulosa is the Forest Oak. It has graceful, pendulous branches, whilst its "leaves" (branchlets) are fine in texture. It reminds one of some conifers. In my opinion, it is the handsomest of the she-oaks, but *C. Cunninghamiana* (River Oak), a large tree which edges streams, and *C. suberosa* (Black Oak) are also ornamental. *Casuarinas* largely fill the same place in the landscape that pines do in Europe.

Phyllanthus Ferdinandi (Euphorbiaceæ) is a moderate-sized tree, which is very neat in shape, and forms a shade tree.

Callicoma serratifolia (Cunoniaceæ), the so-called Black Wattle (not to be confused with *Acacia*), is of frequent occurrence. It is found near watercourses in most parts of the county. Its regularly serrate leaves and beautiful globular heads of creamy flowers help to render it a beautiful plant. The above are trees of larger or smaller size. Following are some shrubs:—

Hibbertias (Dilleniaceæ) have yellow flowers. Some of them are so neat in habit, and bear such a profusion of blossoms, that they are worthy of cultivation. They are worthless as cut flowers. Some of our prettiest *Hibbertias* (they have no common names) are:—*H. nitida, bracteata, pedunculata* (very pretty), *virgata, fasciculata*. There are many others.

Citriobatus multiflorus (Pittosporeæ). This shrub, with its profuse and pretty orange-yellow fruits and abundant thorns, is of a very ornamental character. Its small leaves are frequently variegated.

Tethratheca (Tremandreæ). To this genus belong three of our daintiest little plants. They have four pink petals, and the flowers are borne in profusion. *T. thymifolia* has leaves resembling those of the common thyme in shape; *T. ericifolia* (heath-leaved) is very abundant; *T. juncea* has rush-like or wiry stems, is less abundant than the preceding two, and is simply charming.

Bauera rubioides (Saxifragaceæ). I cannot leave out that dainty little pink-flowered, straggling shrub which, in spite of its comparatively small flowers, sometimes goes under the name of "Native Dog Rose." It grows by the side of rocky streams everywhere, sometimes forming a tangled mass of vegetation.

Pseudanthus pimelioides (Euphorbiaceæ) is a woody shrub of a few feet, with usually acute linear leaves, and bearing a profusion of white or cream coloured flowers. The plant is usually found in damp, sandy soil, as in river beds. *Ricinocarpus pinifolius* is sometimes called "Native Jasmine," but the name is not happy. It is a neat shrub of two or three feet high, with linear leaves and a profusion of white flowers.

In the Class Coniferæ, Family Pinaceæ, we have *Callitris cupressiformis*, the common Cypress Pine of Port Jackson, giving quite a picturesque appearance to the Eucalyptus vegetation of the steep, rocky banks of Middle Harbour, Woronora River, etc. *C. Muelleri* occurs in less abundance.

The genus *Podocarpus*, of the Family Taxaceæ, contains two species, the Berry or Brown Pine (*P. elata*), a tree of moderate size, found in brushes, and *P. spinulosa*, a small, spreading shrub with pungent leaves. These plants have seeds situated on a fleshy receptacle known to small boys as "plums."

Cycadaceæ.—This Family is represented by the Burrawang (*Macrozamia spiralis*), very abundant in some of our less-frequented sterile, sandstone country. The female cones, which present a superficial resemblance to a pineapple, are handsome.

Monocotyledons.

The Families chiefly represented in the Sydney flora are:—Orchideæ (Orchids), Liliaceæ (Lily Family), Palmeæ (Palms), Cyperaceæ (Sedges), Gramineæ (Grasses).

Orchideæ.—We have many terrestrial and epiphytal Orchids. *Dendrobium speciosum* is the Rock Lily, while *D. linguæforme* (with fleshy leaves shaped like a tongue) and *D.teretifolium* are not rare. *Sarcochilus olivaceus* may be found on *Backhousias* in the brush, while terrestrial Orchids belonging to the genera *Thelymitra*, *Diuris*, *Prasophyllum*, *Pterostylis* (Hood Orchids), and Caladenia are very abundant, particularly in the spring. The prevailing colour of the flowers of *Thelymitra* is purple; of *Diuris*, yellow; and of *Pterostylis*, green.

Iridaceæ.—Amongst the Irideæ we have *Patersonia sericea* and *P. glabrata*, two charming plants, growing in the most sterile sandstone soil, and widely diffused. The petals are three in number, and of a beautiful pale blue. *Libertia paniculata* has foliage grass-like and about 18 inches long, while the green is relieved by a large number of rather small, neat, white flowers.

Amaryllidaceæ.—The amaryllids include *Doryanthes excelsa*, the Gymea, or Gigantic Lily, which is, of course, not a Lily at all. It has very long sword-shaped leaves, forming a radiating tuft several feet across. The stem is (say) 10 to 15 feet long, and is surmounted by a dense terminal globular head of large succulent red flowers, with conspicuous yellow or green anthers. The plant grows on sterile sandstone ridges at Heathcote, Waterfall, etc. *Crinum pedunculatum* is a handsome, succulent plant, popularly known as Lily. It has white flowers, and is found in the coast districts in damp places.

Liliaceæ.—*Blandfordia* is a genus named Christmas Bells, though the beautiful waxy, orange-red, bell-shaped flowers are found during many months of the year. They frequent moist places; the small one is *B. nobilis;* the larger ones (*B. grandiflora* and *B. flammea*) are not found within the limits of the County. *Thysanotus junceus* and other species are known by all as Fringed Violets. They are dainty, fragile little plants, found in grass-land in many places. *Sowerbæa juncea* is a neat plant, usually about a foot high, with tufts of linear leaves. The heads of flowers are nearly globular, say an inch in diameter, and of a pale-purple colour. The plant is common in the coastal districts. Other common plants belonging to the same Family are: *Smilax glycyphylla* (Sweet Tea or Sarsaparilla) and *S. australis;* also *Dianellas*, with long sword-shaped leaves and bluish flowers. *Stypandra glauca*, with charming blue flowers, and bearing a profusion of stem leaves, occurs all along the Nepean. Of the *Xanthorrhœas*, or Grass Trees, we have four species, of which *X. hastilis* is the commonest.

PALMEÆ.—Our local Palms are two, viz., the Bangalow Palm, *Archontophœnix Cunninghamiana*, a tall tree, with large leaves divided into numerous narrow, lanceolate segments, and *Livistona australis*,, the common Cabbage Palm, very well known. Both are found in the coast brushes.

RESTIACEÆ.—If the expression be admissible, one might say that the Restiaceæ are the most diœcious plants in the whole vegetable kingdom, or rather the diœcism is most strongly marked in this Family. The diversity of structure in the male and female plants is not only confined to the flowers, but the whole male and female plants are often (not always) so different in appearance that it is extremely difficult to match them correctly. The genus *Leptocarpus* shows this great diversity well. The genus *Restio* includes six species, all ornamental, but the palm will have to be awarded to the very graceful *R. tetraphyllus*, not rare in sandy flats near the coast. All prefer moist, sandy situations. We have, in addition, four species of *Lepyrodia* and two of *Calostrophus*. *L. anarthia* is, when in flower, very attractive, the bracts having a sheeny, gossamer appearance.

CENTROLEPIDACEÆ.—Included in this Family are two species of the genus Centrolepis (*C. fascicularis* and *C. strigosa*), both very small, tufted annuals, notable because of the contrast in stature they present to that of most other local genera of the Family.

CYPERACEÆ.—Amongst the Sedges, *Caustis recurvata* and *C. flexuosa* merit special notice, as they are very common, and they attract attention by their gracefully recurved, numerous filiform branchlets. Sometimes they are called "Curly Wigs." *Cyperus* is represented by eighteen species.

and *Scirpus*, *Schœnus*, and *Gladium*, by about a dozen each; *Heleocharis*, *Lepidosperma*, and *Carex*, being next in numerical importance. We have several other genera belonging to this interesting Family.

GRAMINEÆ.—We have over forty genera of Grasses. On the sea-coast will be found the diœcious *Spinifex hirsutus*, with very long-rooting stems; also *Schedonorus littoralis*, recommended also as a sand-binder, *Zoysia pungens*, and *Sporobolus virginicus*. In damp situations will be found several species of *Paspalum* and *Panicum*, *Isachne australis*, *Chamœraphis*, *Hemarthria compressa*, *Glyceria fluitans*, and others. *Phragmites communis*, a tall, cosmopolitan grass, marks the boundaries of swamps. Our pastures are composed of Kangaroo Grass (*Anthistiria ciliata*), while species of *Danthonia* and *Andropogon* are abundant and much esteemed. *Cynodon dactylon*, or Couch Grass, is the chief grass of our lawns. Other common grasses are the somewhat ornamental, but innutritious, Blady Grass (*Imperata arundinacea*), *Ehrhartia stipoides*, various species of three-prong grasses (*Aristida*), Spear Grass (*Stipa*), *Chloris*, the worthless Parramatta Grass (*Sporobolus indicus*), various species of Love Grass (*Eragrostis*), Tussock Grass (*Poa cæspitosa*).

BRUSH.

BRUSH in Australia is the name given to what is known in India as jungle, and consists of sheltered, well-watered, usually rich-soil areas, but often deep alluvium from sandstone hills, chiefly in the coast belt and coast tablelands, which not only support rich arboreal vegetation, but also creepers and climbers of various kinds, and shrubby undergrowth. The tree vegetation is of a very varied kind, but rarely includes Eucalypts. These brushes are comparatively dark, and sombre and luxuriant vegetation takes the place of the showy floriferousness common outside. The Brushes are not well developed in the County, usually on the coast; patches of them may be found on the banks of rivers and creeks, and in shady gullies in many parts. Brush vegetation may be conveniently inspected on the Illawarra line, say from the Otford and Stanwell Park Railway Stations. The trees of the Brushes include Figs (*Ficus*) of two or three species, *Syncarpia laurifolia*, the Turpentine Tree, one of the best of our indigenous shade trees. It forms handsome clumps, and equally handsome single specimens. *Melaleuca styphelioides*, the prickly-leaved Tea Tree, found in the coast districts, is a small or moderate-sized tree. *M. linariifolia*, *M. genistifolia*, and *M. pauciflora* are closely allied trees. They have white flowers, and their bark is foliaceous, or like sheets of paper. *Eugenia Smithii* is the Lilly Pilly. Its handsome glossy foliage, and its beautiful clusters of white fruits, often tinged with pink or purple, render it very handsome. *E. myrtifolia*, the Brush Cherry, is a beautiful small tree, whose neat white flowers are succeeded by crimson fruits.

Eupomatia laurina is a tall shrub belonging to the Anonaceæ, with shining, oblong leaves, and very long, weak branches. Its flowers are whitish or cream-coloured, of a waxy lustre, and of sweet perfume.

Drimys dipetala belongs to the Magnoliaceæ, and is a tall shrub whose flowers have two petals, as its name denotes.

Doryphora sassafras is the well-known Sassafras. Its leaves are glossy, of a refreshing green, while both leaves and flowers are pleasantly aromatic. It bears white flowers in profusion. *Hedycarya Cunninghamii*, with yellowish, mulberry-shaped fruit, and *Kibara (Mollinedia) macrophylla*, with leathery, serrate leaves and blackish fruits, are allied plants.

Hibiscus heterophyllus is one of the Kurrajongs, and belongs to the Malvaceæ. It is a beautiful flowering small tree, the flowers being large and white, with a purple centre. It is common in the coast Brushes, as far south as the Illawarra. A closely-related Family, the Sterculiaceæ, contains *Sterculia acerifolia*, the gorgeous Flame Tree, ablaze with cup-shaped scarlet flowers.

Polyosma Cunninghamii (Cunoniaceæ) is the Feather Wood or Wine Tree, is a small tree, with irregularly-notched ovate-elliptical leaves, greenish-yellow flowers, and small, purplish-black egg-shaped fruits.

Ceratopetalum gummiferum, the Christmas Bush, is a tall shrub or small tree. Its leaflets in threes are ornamental, and it bears a loose panicle of neat white flowers. Later the calyx enlarges, turns pink (about Christmas), and the plant is then largely used for decorative purposes. *C. apetalum*, the Coachwood, found in most gullies in the coast districts, is a handsome tree, whose foliage resembles that of *Schizomeria*. Its calyx enlarges like the Christmas Bush, but the colour is not so showy as the inflorescence of the latter plant. These plants belong to the Saxifrageæ.

Litsæa dealbata is a small tree with beautiful glaucous under-leaves and prominent veins. The foliage is most ornamental and uncommon. *Cryptocarya glaucescens* and *Endiandra Sieberi* also belong to the Lauraceæ. Both are small trees.

Cudrania javanensis is the Cockspur Thorn. It belongs to the Moraceæ, and forms tangled masses at the edge of brushes. The Red Ash (*Alphitonia excelsa*), a tree belonging to the Rhamnaceæ, with pale under-leaves, will be found, as also the graceful *Panax elegans*, palm-like, and a member of the Araliaceæ. The skirts of the brushes will also be found to contain two or three species of *Rubus*, two species of Native Elder (*Sambucus*), *Duboisia myoporoides*, the Cork Wood, with neat white flowers, and whose leaves have been used in medicine.

Pennantia Cunninghamii (Olacaceæ) is a handsome glossy-leaved tree, which bears a profusion of dark purple fruits of the size of small cherries.

Elæodendron australe, of the Celastraceæ, is the Blue Ash, a small, smooth-trunked tree, with neat foliage, but whose most striking character is its large ovoid or globular drupes of a bright-red colour.

Synoum glandulosum, of the Meliaceæ, is the Dog Wood or Bastard Rosewood. It is a tall shrub or small tree, with glossy foliage and small, dainty, rose-coloured flowers. But its fruits are its chief beauty; they are an inch in diameter, obscurely angled, and of a red colour, opening, showing shining seeds.

Clerodendron tomentosum (Verbenaceæ) is a tall, slender shrub, with velvety leaves, and bearing a profusion of white, tubular flowers. The fruiting calyx enlarges, is of a red colour, and the contained drupe is purplish-black and ornamental.

Climbers and Creepers.

Of *Clematis*, we have two species, with pure white flowers and feathery fruits.

Hibertia saligna and *dentata* have yellow flowers. The former has usually lanceolate, silky leaves; the latter has oblong, distantly-toothed leaves, and belong to the *Dilleniaceæ*.

Pericampylus incanus (*Cocculus Moorei*) has handsome leaves, nearly orbicular, sometimes slightly peltate, up to nearly six inches in diameter. *Stephania hernandiæfolia* is a smaller plant than the preceding, the foliage being smaller, but towards autumn it becomes loaded with small drupes of all shades of red, which give the plant a very ornamental appearance. Both belong to the Menispermaceæ.

Billardiera scandens, or "Dumplings," is a widely-diffused dainty little creeper, has lemon-yellowish flowers, and belongs to the Pittosporaceæ.

We have three native grape-vines (*Vitis*): *V. hypoglauca* has digitate leaflets, glaucous on the under side, and is a rampant grower. *V. antarctica* has irregularly-toothed leaves, is a less rampant grower than the precedin. *V. clematidea* is a more delicate-looking plant than the other two. Trailing or climbing in the brush, it looks very much like a slender cucurbitaceous plant. Its small black berries are borne in profusion.

Aphanopetalum resinosum is a Cunoniaceous plant, which in early spring literally covers the tops of many of our small brush trees with a profusion of white or creamy-white flowers.

A native Passion-vine (*Passiflora Herbertiana*) is common in the brushes. It has a greenish and rather insipid fruit.

Hardenbergia monophylla, wrongly known as "Sarsaparilla," a name which properly belongs to *Smilax*, is a well-known leguminous climber or trailer, with a profusion of small, purple flowers and neat foliage. *Kennedya rubicunda* has larger flowers, which are of a lurid red colour. Both plants are very widely distributed.

Tecoma australis is a neat climber, which bears a profusion of creamy-coloured flowers, tinged inside with reddish-purple. It belongs to the Bignoniaceæ.

Just a word to remind of our pretty and small, blue creeper (*Comesperma volubile*), whose flowers are of an unusual colour in our climbers.

Cassytha is a genus of leafless stringy plants, which form a tangled growth, often impeding the pedestrian. They are parasitic, except in the earliest stage of growth. And, speaking of parasites, we have five or six species of *Loranthus* (Mistletoe), and two species of *Notothixos*, which are more or less yellow in colour, and parasitic on Loranthus.

Marsdenia suaveolens is a neat little climbing plant, well worth cultivation, because of the sweet perfume of its small, white flowers. We have two other species of this genus, also two of *Tylophora*, also belonging to the Asclepiadaceæ, and two of *Lyonsia* (Apocynaceæ), found climbing on large trees, and quite common.

Turning to the Liliaceæ, *Eustrephus latifolius* is a slender flexuose climber, with broadly ovate-lanceolate, nearly translucent leaves, and beautiful orange-coloured fruits about half-an-inch in diameter. *Geitonoplesium cymosum* is closely related to the preceding. Its leaves are usually linear, and its fruits are black, inferior in size to those of *Eustrephus*.

Rivers and Lagoons.

It is not always possible to separate plants which are entirely aquatic from those which frequent swampy land.

The straggling *Adrastea salicifolia*, found in swamps, has yellow flowers, and is closely allied to *Hibbertia*, *Euphrasias*, or "Eye brights," which frequent similar situations. Their flowers are usually purple. The genus *Utricularia*, interesting for its utricles, has seven species in this district. They frequent swampy land.

Villarsia reniformis and *Limnanthemum geminatum* are Gentianeæ, and are found in mud or shallow water in many parts of the coast districts. They have yellow flowers, usually under an inch across.

Myriophyllum variafolium and *M. verrucosum* are two small and widely diffused water plants. They are not showy, but their whorls of small linear or pinnatifid leaves add diversity to aquatic vegetation. They belong to the Halorrhagidaceæ.

I would invite attention to the *Droseras*, or "Sun-dews," which grow in boggy places, and even in shallow water. *D. binata*, a tallish species, with large delicate white flowers, is very beautiful.

Jussiaa repens is an aquatic plant, belonging to the Œnotheræ, found throughout the coast districts. It has flowers of a buttercup colour, and is not a large plant.

Ottelia ovalifolia has leaves on long petioles, tufted at the bottom of the water, the leaf-lamina, two to four inches long, and ovate or oblong in shape. The flowers are pale-yellow, and about two inches in diameter. *Vallisneria spiralis*.—This well-known aquarium plant is also indigenous to the neighbourhood of Sydney. Both these plants belong to the Hydrocharitaceæ.

We have also several representatives of the aquatic orders Alismataceæ, of Potamogetonaceæ, of which Potamogeton is especially worthy of mention, Lemnaceæ and

Characeæ; also Juncaginaceæ (*Triglochin*); *Philhydrum lanuginosum*, a coarse, yellow-flowered species (Philhydraceæ)

Seaside.

Following are some coast-loving plants not hitherto referred to:

Cakile maritima, a Crucifer, with thickish lanceolate leaves and white flowers.

Correa alba is neat in appearance, with white flowers. It forms dense masses of vegetation, which tend to arrest the progress of shifting sands. It flourishes even in the open spray.

Pelargonium australe, a small plant, with pink flowers; *Euphorbia Sparmanni*, a small prostrate plant; some plants of the salt-bush family, belonging to the genera *Rhagodia*, *Atriplex*, and *Chenopodium;* also *Salsola kali*, *Salicornia australis*, and *Suæda maritima*. *Wikstrœmia indica* is a shrub which belongs to the Thymelaceæ, and has greenish-yellow flowers, and red fruits. *Wilsonia Backhousia*, a small plant, with short, thick, flat linear leaves, is common in salt marshes on the Parramatta River. It belongs to the Convolvulaceæ. *Convolvulus Soldanella* has nearly kidney-shaped leaves, and is common on the coast sands. *Ægiceras majus* and *Avicennia officialis* are two local mangroves: the former is a tall shrub, with white flowers and horn-shaped fruits.

Melaleuca leucadendron, the "White Tea-Tree," is a large, shapely, umbrageous tree, which has broad leaves, and white or creamy flowers, and is found in nearly pure sea sand, or by the side of brackish creeks.

Chapter III

THE FLORA OF THE SOUTH COAST.

By A. G. Hamilton.

In the vicinity of Sydney, we find two types of vegetation—the sandstone, and the clay floras—which are mostly typical Australian, although differing slightly from each other. But to the south of Sydney, from Waterfall on, we find a very distinct flora. Here basaltic flows occur, and in the neighbourhood of these, the hillsides and gullies are clothed with a rich sub-tropical vegetation quite distinct from that prevailing on the clay or sandstone areas.

The Illawarra district is the most easily accessible part of the South Coast. It consists of a gently undulating plain along the coast, enclosed by the Illawarra Range, a crescent-shaped range running from Clifton, on the north, to Nowra, on the south, at an average distance of five miles from the sea. Ecologically, it may be divided into four plant communities: first, the beach flora and sand-dune flora, which in general resemble those found in other countries, but with a facies to some extent Australian; second, the coastal plain association—open forest of Eucalyptus, Casuarinas and Palms, with here and there, on the creek banks, a denser coating of the same plants, mingled with a few of the jungle plants. This association extends to the foot-hills, and there it is also mixed with the jungle plants. Third, the sub-tropical jungle (locally called the "brush") found in the gullies and on the seaward slopes of the mountain range. Lastly, there is the sandstone association, occurring on the top of the range, and extending a considerable distance on the inland slope. Outliers of this formation sometimes thrust themselves downward for some distance through the brush on the seaward face, but the association in such a situation is rarely pure; there is generally a large admixture of the coast-plain plants and some of the brush plants also.

The plants of the sandstone are very interesting on account of their perfect adaptations to their environment, but for beauty, the basaltic association is pre-eminent.

The brush flora contains few Australian types, but many of Malayan type.

The density of vegetation in the brush is so great that the ground beneath is almost bare; a few shade-loving plants may be found, principally ferns and other Cryptogams, but very few low-growing flowering plants. The forest trees, usually of many species, shoot up to great heights without branches. The trunks are usually slender and smooth-barked; whitish, with brownish patches where covered with scale-like Hepaticæ, or green with mosses, or orange from microscopic fungi. Many of the trees, particularly the Figs, have great buttresses running out from the trunks, and from these proceed roots which curve up to the buttresses and form there plank-like ribs, running along above the ground for twenty or thirty yards from the tree.

Another striking feature is the large number of climbing stems, hanging from the trees like tangled rigging on a storm-worn ship. Sometimes a tree trunk will be seen entirely coated with the glossy green leaves of some creeper; this is the early stage. When they reach the top, they riot all over the branches and spread to neighbouring trees. The soft-wood trees die and decay very quickly, and the vines then hang down in loops and festoons. They are locally known as "bush ropes," and form convenient swings for the children. Among the commoner climbers are: *Clematis*, *Lyonsia*, *Marsdenia*, *Piper*, two species of *Vitis*, *Nephelium*, *Passiflora*, *Morinda*, *Chilocarpus*, and *Palmeria*. One of the species of *Vitis* is known as the "Water Vine;" bushmen used to get water from it. A long thick stem was selected and a notch cut nearly through, as high up as possible. Then eight or ten feet down, the stem was cut through, and the water which dripped from it, caught in a pannikin. It was perfectly clear, but slightly astringent. *Palmeria* is remarkable as an example of a rare climbing method. The plant sends up tall, naked shoots, eight or ten feet long. At the nodes, short branches develop in the form of an anchor fluke, and as the tall, flexible shoot sways about in the wind, the flukes catch over some neighbouring branch and hold tightly. The branches are arranged at right angles to each other, which increases their chance of grappling some support. The shoot continues to lengthen above the anchored part, and so goes on swarming up among the branches of the surrounding trees. When the plant is firmly hooked, the tips of the branches turn upwards, and in a short time bear no trace of their anchoring functions. One interesting little point is the thickening of the fluke where it joins the stem; just where the strain will be greatest, it is reinforced.

The brush supports a great many Epiphytes. Those most likely to catch the eye are the Bird's Nest Fern, *Asplenium Nidus*, and the Elk-horn Fern, *Platycerium alcicorne*. The Bird's Nest Fern is found on trees and rocks; its simple fronds sometimes exceed six feet in length, and are of a beautiful golden green, contrasting with the very dark green of the forest trees. The Elk-horn Fern is not confined to the brush. Enormous masses of it grow on Casuarinas, near the coast. *Asplenium falcatum* commonly grows associated with it.

Quite a number of ferns grow epiphytically on the trees and rocks, and orchids of many species are also found. The best known and largest is the "Rock-lily," *Dendrobium speciosum*, but *D. tetragonum*, *D. æmulum*, *D. pugioniforme*, *D. linguæforme*, *D. teretifolium*, and *D. striolatum* among the Dendrobs, and *Bulbophyllum Shepherdi*, *B. exiguum*, and *B. minutissimum*, *Sarcochilus tridentatus*, *S. falcatus*, *S. montanus*, *S. Ceciliæ*, *S. olivaceous*, and *Cymbidium canaliculatum* are not uncommon. Some of these, as *Sarcochilus falcatus*, and *S. montanus*, *Dendrobium speciosum* and *D. æmulum*, are very beautiful, while *Bulbophyllum minutissimum* is interesting as being the smallest Australian orchid. The minute pseudo-bulbs are hollow, and the flowers one-tenth of an inch long. The plant looks more like an encrusting lichen than an orchid. *Cymbidium* is more saprophytic than epiphytic. It grows in hollow, decaying branches of trees, and when not in flower might be mistaken for a sedge. The blossoms are borne in long racemes, and are waxy-yellow, spotted with transparent brown, and richly scented.

There is in the undergrowth a great variety of ferns, some extremely beautiful. Some of the tree ferns occur in large numbers in suitable localities, and are a very attractive feature. The common species are *Alsophila australis*, *A. excelsa*, and *Dicksonia antartica*.

Many of the brush trees have domatia on their leaves —a structure not found in any of the sandstone plants. It is rather remarkable that the majority of domatia-bearing plants are found in the southern hemisphere. Among Australian species, *Pennantia Cunninghamii*, has the best developed domatia. On the underside of the leaf there are small, round openings, with a thickening round the orifice, occurring at the axils of the primary and secondary veins, and again in the secondary and tertiary axils. These open into an almost spherical cavity, showing as a little hump on the upper side of the leaf. Domatia are generally believed to be what may be called hereditary galls, caused in far-back time by minute acari, but in time becoming hereditary and produced without the mites—a good instance, if true, of the transmission of acquired characters. But long continued observation of these structures in their natural environment does not favour this theory, first advanced by Lundstrom. At the same time, it must be acknowledged that no other satisfactory explanation has been put forward.

One of the brush plants, *Eupomatia laurina*, which is found, not only in the jungle, but also on the banks of creeks intersecting the coastal plain, is noteworthy for its method of pollination. The plant grows to a height of twelve or fifteen feet, with slender, rather drooping, branches. The leaves resemble laurel leaves, but are not so stiff, and much glossier. The flower buds resemble a short, fat Eucalyptus bud, and like these, have an operculum covering the floral organs. Late in December, these drop off and the flowers open. They are rather like small ivory-coloured sea-anemones. The centre of the flower is a flat disc with raised patches of stigmatic surface. These are closely covered by a number of staminodes, broad, flat, and highly polished, which arch over them. Outside these are a large number of stamens, which are closely pressed over the staminodes, but after a time, bend outwards and down, so as to hang like a fringe all round the flower. The scent is very rich and strong, with faint reminiscences of pineapple, mango, and decaying fish. If the flowers are handled, the scent clings to the fingers for some considerable time. The air for a considerable distance round a flowering plant is filled with scent. At once, thousands of very small weevils—*Elleschodes eupomatiæ*—resort to the flowers. They bore through the staminodes and feed on the secretion of the stigma. In alighting, they cling to the stamens and get thoroughly dusted with pollen, and when they have exhausted the food in one flower, they fly to another, taking the pollen with them, and so cross-pollinating the second and all other flowers they visit. After pollination the staminodes and stamens drop off in a little ring. The beetles have not been collected except on the flowers. They are provided with spurs on the tibiæ to enable them to cling to the polished staminodes.

Hibiscus heterophyllus is a very abundant small tree, with blossoms five inches across, pure white with a deep-maroon centre. When the tree is in bloom, it looks at a distance as if a flock of white birds had alighted on it. It grows easily from seed, shoots up rapidly to a height of fifteen or twenty feet, and flowers profusely. The bark is very fibrous and was once used by the aborigines for cord; the boys make whips out of long straight shoots by peeling bark to within a foot or so of the bottom, cutting all the wood off above that and plaiting the bark. The White Cedar, *Melia Azedarach*, and the Red Cedar, *Cedrela toona*, are fairly common in the brush, but none of large size; the value of Red Cedar as a timber ensures that. They are remarkable among Australian trees in being deciduous. In the spring, when the young, transparent red leaves appear in clusters on the bare limbs, they are very beautiful.

A very striking tree is the "Flame Tree" or "Fire Tree," *Sterculia acerifolia*. It has dark-green, shining-lobed leaves, but about the middle of November, the leaves drop off and the tree flowers. It is then a mass of racemes of a vivid-scarlet, bell-shaped flowers; even the pedicels and peduncles are of this tint; and a tree of this species stands out among the dark foliage of the brush like a flame. Sometimes the leaves on the lower boughs remain, forming a dark-green base to the brilliant mass of flowers. The settlers have an idea that the tree flowers but once in seven years, but this is incorrect. They are irregular in this respect; I have known a tree flower three years in succession, and on the other hand, a tree may go several years without blooming.

The "Native Tamarind," *Diploglottis Cunninghamii*, is fairly common. The stem is tall and slender, covered with a velvety-brown pubescence. The leaves are pinnate, with ten or twelve large leaflets, up to a foot long. It bears quantities of three-celled capsules, which open when ripe and disclose seeds covered by an amber-coloured, semi-transparent arillus, which has a pleasant flavour, although very acid. They are made into a jelly, which is very palatable, with a pleasant tang of the wild about it.

The only striking leguminous plant in the brush is *Kennedya rubicunda*, and it does not occur in the denser parts, but just along the margin. It is very common on the clay, however. The large dark-red blossoms resemble Dampier's Desert Pea, but the red is duller, and there is no black spot. A few Wattles, *Acacia*, are found on the outskirts of the brush, but they like a more open habitat.

Quintinia Siebera is a tree often found growing out of a tree fern trunk. As it grows it gradually encloses and strangles its host, but it is not a parasite. Seedlings may sometimes be found growing in the joints of retaining walls of roads and similar situations, so that it is not entirely dependent on the tree ferns.

The Coachwood, *Ceratopetalum apetalum*, is one of the commonest of brush trees. Like its congener, Christmas Bush (*C. gummiferum*), the sepals enlarge and become brightly coloured after the flower is pollinated, but it is not so bright as the Christmas Bush. I am not aware that any explanation of this peculiarity has been offered. *Backhousia myrtifolia* has a similar habit.

The Myrtaceæ do not bulk largely in the brush. Eucalyptus trees occur here and there of large size. The Blackbutt is one of these (*E. pilularis*). A very fine specimen grows near the foot of the Bulli Pass. This tree was measured by Mr. J. H. Maiden in 1891: "Girth at ground, measuring from buttress to buttress, 57 feet 6 inches; the girth at 3 feet above the ground was 45 feet; and at 6 feet above the ground, 40 feet. The taper was then very gradual for about 90 feet (estimated), where the head is broken off. There are ten principal buttresses, of an average diameter of over 2 feet, but they practically cease to flute the trunk at a height of 10 to 15 feet." *Tristania*, *Syncarpia*, *Rhodomyrtus*, *Backhousia*, *Rhodamnia*, and *Eugenia* are the commonest of the order. The last named includes *E. Smithii*, the Lillipilli, and *E. Australis*, the brush Cherry. The first has clusters of white or pale-heliotrope berries, the other pear-shaped crimson berries.

There are several species of Mistletoes found on the brush trees. One of the most beautiful, *Loranthus dictyophlebus*, has broad, shining leaves, and long, tubular crimson and green flowers. *Viscum articulatum* is a curious leafless Mistletoe, the branches of which look like short, green tapeworms. All the Mistletoes attack fruit and ornamental trees, the seeds being carried by honey-eaters. Mr. J. J. Fletcher has recorded double and triple parasitism among the Loranths.

The Native Elder, *Sambucus xanthocarpus*, with yellow instead of black berries, occurs in the brush. The berries taste and smell like the English Elderberry.

The brush is not strong in compositæ, but there are two remarkable species, the Musk tree, *Aster* (*Olearia*) *argophylla*, is a small tree with large, shining, green leaves, the undersides being silvery-white. They are strongly musk-scented. The Wild Tobacco, *Humea elegans* is a herbaceous perennial with large, amplexicaulal leaves, white beneath. It bears a beautiful pink or bronzy plume of very small florets, and has an aromatic scent which is very characteristic of the brush.

Trochocarpa laurina is the only Epacria which habitually grows in the brush. It is a small tree and bears dark-bluish berries. It is sometimes known as Beech.

Goodenia ovata occurs on the edge of the forest. It also has an aromatic scent. Some of the old Irish people call it "Hunger-weed," and say that if you walk through it, you will get a good appetite. The plant, like all others of the Goodeniaceæ, has a remarkable method of pollination. The stigma is at the bottom of a cup, the edges of which are set with stiff hairs. In the early bud, the five anthers surround this cup and overhang it. Just before anthesis, the style begins to grow and forces the cup up between the anthers, which open at this stage. The stiff marginal hairs brush all the pollen down into the cup on top of the stigma. Then the sides of the cup close up so that the pollen is quite shut in. At this stage the flower opens, and the petals are so arranged that the cup is ensconced behind two of the petals which bend backward, while the other three spread out in front and form an alighting platform for insects. The stigma, which is quite immature, now begins to grow up from the bottom of the cup, and in doing so, of course, forces the pollen out of the mouth of the cup, the fringe of hairs forming a kind of strainer. An insect, alighting on the platform and pushing in to the nectary, causes the two rear petals to open, and the spring of the style brings the mouth of the cup down on its back, depositing some pollen there. Finally the stigma grows so much that it projects from the mouth of the cup, and then becomes mature and moist. An insect carrying pollen visiting a flower in such a stage, has the moist stigma come down on its back and take up the pollen, This is the method of pollination in all the Goodeniaceæ, with various modifications.

Prostanthera lasianthos, one of the Labiates, grows into a tree about thirty feet high. In December it is so covered with bloom that very little green can be seen about it The flowers are large, tubular, and irregular, pure white, with purple and rusty-brown blotches. There is another of the genus with violet blossoms, a very free bloomer, and a beautiful shrub. It has, unfortunately, a strong and disagreeable smell.

Sassafras, *Doryphora sassafras*, is one of the commonest of brush trees. It has glossy, coarsely-serrate leaves, and in spring produces quantities of white flowers, which are rather complex in structure. There are a number of staminodes of peculiar structure, and no doubt is pollinated by some special insect. The leaves, wood, and bark, are all strongly scented from the presence of a volatile oil. Settlers used an infusion of the bark medicinally. Dr. J. M. Petrie has recently examined the plant and shown the presence of an essential oil or resin and an alkaloid which has the power of paralysing animals. The timber lasts very well. In an old cottage at Mount Kembla, I saw a door made of this wood fifty years old, and it was perfectly sound, although it was neither painted nor varnished.

There is a very beautiful Gesneraceous plant which creeps over rocks in damp places, *Fieldia australis*. It has velvety-green leaves, and bell-shaped, pale-yellow flowers. The berries are waxy-white, and the seeds show through the skin as minute purplish-brown specks.

In all four formations, shrubs may be seen covered with a tangle of leafless, olive-green cords, known to children as "brush twine" or "devil's twine." It is a leafless parasite—*Cassytha*. The flowers are minute and white, and are succeeded by olive-green berries about the size of a Holly berry. When the seed germinates, it sends up a bright green thread-like shoot, which swings round and round till it comes in contact with some living plant—it is not particular what kind—it coils round this, haustoria are formed, and as soon as it has begun to draw sap from the host, the lower part of the shoot dies off and the plant becomes a holo-parasite. In the early stages the shoot contains chlorophyll, but later, is entirely without it.

The Proeteaceæ are not strongly represented in the brush. The Beefwood, *Stenocarpus salignus*, is the finest tree of the order found on the South Coast.

In open situations on the foot-hills, *Cœlobogyne (Alchornea) ilicifolia* is plentiful in places. It is remarkable as being parthenogenetic. On the slopes of Mount Kembla there are acres covered with the plant, but although I watched them for a number of years, I never succeeded in finding a male flower. I believe they have been seen in the northern river scrubs. Nevertheless, the plants produce fruits very freely, indeed, and the seeds germinate readily. Several of the Euphorbiaceæ attain the size of trees—*Phyllanthus Ferdinandii*, *Baloghia lucida* and *Omolanthus populifolius*—the Bulli poison plant. The young trees of this species are very attractive. The leaves are large, with a very long petiole, and of a very brilliant green. In October many of them turn a very vivid scarlet. The plant, as its name indicates, has a bad reputation—it is said to cause the death of cattle when eaten. *Croton Verreauxii*, a shrub of the same order, is also said to be injurious—causing red water in cattle. It is commonly known as Cascarilla by the farmers, on account of a cascarilla-like smell given off by the crushed leaves.

Three species of Figs are found in the South Coast brushes: the Moreton Bay Fig, *Ficus macrophylla;* the small-leaved fig, *F. rubiginosa;* and the rough-leaved fig, *F. aspera.* The last is sometimes called the "Sandpaper Tree." The leaves are so rough that they can be used as sandpaper; they polish bone or hardwood quite easily. The first two species usually start life as stranglers. Flying foxes and birds eat the fruits and the seeds are dropped everywhere. If they happen to get into the fork of a tree where there is a little vegetable *debris,* they germinate and send roots down the trunk of the supporting tree till they reach the ground. They then grow rapidly laterally till they touch each other and form a network all over the trunk of their host, eventually crushing the life out of it completely. There is a fine example of a fig on a giant Nettle tree some distance from the top of Cambewarra, on the inland side. The roots growing together have a suggestion of having been in a plastic condition and having flowered together. Both these figs grow to an enormous size, with buttresses standing out from the trunk and running along the ground for some distance. There is a fine specimen of Moreton Bay Fig on the roadside, at the little village of Figtree, near Wollongong; it is said to be the largest in the district, but there are many larger trees in the brush above Dapto.

The Stinging Tree or Giant Nettle, *Laportea gigas*, is very common in the brush. It reaches a height of 100 feet or more, with a very thick trunk. The leaves are very large, of a beautiful light-green, and softly hairy. The stinging hairs are not of great size, but are exceptionally virulent—stock have been known to die from being badly stung. I once saw a cow which had rushed through a lot of small plants; she lost all her hair and looked like an india-rubber cow. The big aroid—Cunjevoi—(*Colocasia macrorrhiza*), growing in similar situations, is reputed to be a remedy, just as the dock is said to give relief to nettle stings, when rubbed in. The fruits of the nettle are curious irregular, semi-transparent pink lumps interspersed with stinging hairs. The calyx and pedicel become fleshy and imbed the fruits.

The Native Cherry, *Excarpus cupressiformis*, is sometimes found in the jungle. It is leafless and resembles a Cypress. The so-called fruit is the fleshy peduncle, bright orange in colour, the hard nutlike fruit surmounting it. They are pleasant to the taste, but slightly astringent. The tree is a root parasite; its roots have haustoria which fasten to the roots of neighbouring plants.

The Natural Order Coniferæ is represented by *Podocarpus elata*, a tall and fine tree, which bears its seeds on the end of a fleshy, dark-purple peduncle. It is generally called Grey Plum. The bark is grey and wrinkled, and in the brushes is often covered with plants of *Dendrobium æmulum. æmulum.*

There are, as already mentioned, many species of epiphytal orchids. *Dendrobium teretifolium* is usually found growing on the stems of native oaks in the scrubs on the banks of creeks. It is fairly common on the creeks flowing into Lake Illawarra. On the Cambewarra Mountain the fig trees bear huge clumps of the Rock-lily, *Dendrobium speciosum*, which in the spring, are masses of creamy-white flowers.

There are not many terrestrial orchids in the brush. Two saprophytes are common, *Gastrodia sesamoides* and *Dipodium punctatum*. Both are leafless, with large, tuberous, scaly roots. *Gastrodia* much resembles the American orchid called Indian Pipe. The flower-stalk and ovary are golden-brown, the tubular flower a waxy-white. It usually grows in the deep vegetable mould in the darkest recesses of the brush. *Dipodium*, on the contrary, affects the open, and is more common in the sandstone country. The stalk is deep maroon; the flowers, pink with purplish blotches. It is commonly called "Plum Pudding Flower." West of the dividing range there is a yellow variety with crimson spots. *Pterostylis* is a genus containing many species. Its favourite habitat is in shady moist places, in vegetable mould. It is said to be a saprophytic group, but I doubt it very much. It is so well supplied with chlorophyll that it can scarcely be entirely saprophytic. The flowers are helmet-shaped, and the labellum is sensitive. In some species, such as *P. rufa*, *P. Woollsia*, *P. Mitchelli*, and *P. longifolia*, it is very sensitive, flying up with a sudden snap. Small insects, generally Diptera, alighting on the labellum, are jerked into the flower and enclosed. In escaping out of a small opening at the summit of the flower, they first pass over the stigma and then over the anthers, withdrawing the flat pollinia. On visiting another flower they smear the pollen on the stigma as they pass over it. Most of the terrestrial orchids of the brush are small and insignificant. They are much finer in ordinary soils and open country.

On the creek banks, *Crinum flaccidum* is found, a fine amaryllidaceous plant with white starlike flowers, four inches across.

Two aroids are common in the brush. The most striking is *Colocasia macrorrhiza*, the Green or Spoon Lily or Cunjevoi. The spathes are green, and have a delicious scent, rather like that of violets. The fruits grow in a large cluster and are bright orange-red. The root-stocks are full of starch, but are extremely poisonous when raw, but the poisonous principle is volatile and dissipated by heat. The other aroid is *Gymnostachys anceps*. It is not at all like an aroid, and might easily be mistaken for a sedge. The inflorescences grow at intervals on a long stalk, the spathe very small, while the spadix attains a length of two or three inches. In old times it was used for tying bundles, etc., hence the name "Settler's Twine." The fruits are blue berries.

Two palms grow in Illawarra. The Cabbage Tree, *Livistona australis*, is found everywhere. The Bangalow, *Ptychosperma Cunninghamii*, is rarer. The former has palmate leaves; the latter pinnate.

Among the cryptogamic plants there are only a few lycopods, but the curious *Tesipteris Tannensis* and *Psilotum* *triquetrum* may be found growing in crevices of the rocks in moist, dark glens.

The ferns are a very prominent feature of the brushes. Tree ferns are found everywhere. In shady places the rocks are coated with *Hymenophyllum Tunbridgense*, and the trunks of tree ferns are often coated with a mass of small *Trichomanes*. In old stumps, crevices of rocks, and the masses of staghorn ferns the hare's foot—*Davallia pyxidata*—grows luxuriantly, and everywhere there are brakes of giant maiden-hair—*Adiantum affine*. This fern is gathered in quantities, tied in bundles and exported to Germany, where it is dyed with an anilin green and re-exported to Australia for decorative purposes. Several fine species of *Pteris* abound, including the cosmopolitan bracken. *Lomaria*, *Blechnum* and *Doodia* (*Woodwardia*) have a good many species, and in all three genera the young fronds are often of a delightful pink. *Aspidium* and *Polypodium* have very many conspicuous species, and *Asplenium* gives us some of our finest and most beautiful ferns.

As for the lower Cryptogams, their names are legion, that is, if they all have names. Hepatics and mosses are everywhere, covering trunks and branches to the very tips. The mosses even grow in huge bundles from the down-hanging twigs, and a brush bird commonly makes its nest in them. Many species of lichens are found, some even growing on the glossy surface of the leaves.

Introduced plants do not get much hold in the virgin brush, but wherever it is disturbed, there are certain noxious plants which make headway. The worst of these are inkweed (the American pokeweed)—*Phytolacca octandra*—which springs up wherever the ground has been burned; *Lantana camara*, and the blackberry—*Rubus fruticosus*. All three have the same method of dispersal—juicy berries, which are eaten by the honey-eaters and satin birds, and the seeds so scattered abroad. Wherever the blackberry has not been kept in check it has smothered everything round about it. Near Bulli it is so plentiful that 80 to 100 tons of fruit are annually sent to the Sydney jam factories from Bulli alone. About Mount Kembla deep gullies are filled up to a depth of 20 feet with the plant.

The peach, rough-skinned lemon, Cape gooseberry and passion fruit are common enough in the brush near settlements.

When the top of the range is reached, where the sandstone outcrops, we find a flora of a very different character. The jungle flora shows every character of plants with sufficient moisture; their ample leafage, glossy leaf surfaces, dense growth, soft wood, all tell of their flourishing in a congenial habitat and under easy conditions.

But the sandstone flora has a light, easily dried soil, and, as a consequence, the plants respond by producing few and small leaves, with a dull greyish-green coloration, scraggy trunks and branches, very hard and woody, and a very open growth which intensifies the dry conditions by allowing hot sun and drying winds free play. The plants, too, are largely Australian endemic types, as against the Malayan types of the brush flora. Where, as in the Leguminosæ, the order is world-wide, the species take on a totally different facies.

The commonest *xerophyllous* character is the reduction of leaf surface, and it is this that gives the sandstone flora its peculiar aspect. Some plants have the leaves long and very narrow, terete or acicular, while in others the breadth is almost equal to the length, this dimension, however, being very small. The reduction of leaf surface is carried to the extreme of no leaves at all. Then the stems take on the work of the leaf, having a layer of palisade cells and stomates. The leafless plants are found in quite a number of orders, but most examples are probably found in the order Leguminosæ.

An adaptation allied to this is the alteration in the position of the leaves from horizontal to vertical. This is very evident in the genus *Eucalyptus*, but I cannot think that it is of very great value in lessening transpiration. In such cases both sides of the leaves bear stomata, and at almost any hour of the day one or other side will be fully exposed to the sun's rays. Where, as in the Compass-plant, the leaves are all oriented in one direction, it may be of service, but where, as in our Eucalyptus trees, they are turned in all directions, I think it is little or no use.

The thickening and toughening of the leaf is very common, even where other adaptations are found. The epidermis is abnormally thick, particularly the cuticle, the palisade tissue is much deeper, and may have two, three or even four layers of cells, there is practically no spongy tissue, and the whole of the mesophyll is closely packed with very few and small intercellular spaces. There is also usually a great increase in the amount of scherenchyma found in the leaves; the vascular bundles contain a large proportion of thick-walled fibres, and these are very closely packed. Not only so, but in many plants there are great numbers of stone-cells (scleroids) developed in the mesophyll, generally in the palisade tissue; these are of various forms, massive branched, starlike, or columnar cells. Much of the stiffness and hardness of the leaves of the sandstone plants arises from the presence of the stone cells.

A very common feature of true desert plants is the thick coating of hair on the leaves. This prevents a free circulation of air near the surface, and so diminishes transpiration. Few of our sandstone plants show this feature in the adult stage, although many of them have the young leaves thickly coated with hairs. There is, however, in some species, a special development of hairs in connection with the stomates, but the hair is confined to a distinct area, and not all over the leaf-surface. There is an allied means of protection which is not uncommon, *i.e.*, the coating of the leaf with some protective material, such as bloom, wax, varnish or rubber. This is present in very many plants on the young leaves, and it persists all through the life of the leaf in a few.

The sinking of the stomates below the surface occurs in a great many plants. It is effected in several ways. Where the epidermis is very thick, the guard cells are at the bottom of a chimney-like vestibule; or they are found on the inner sides of grooves; or the margins of the leaves are rolled over so that the stomates are well covered; in this case the midrib is usually greatly thickened, and fills up the space between the two rolled margins, so that the only opening to the stomates is by two long, narrow crevices running the whole length of the leaf. Still another method is that the stomates are grouped together in little cavities or crypts on the underside of the leaves. These have a narrow circular orifice, but widen into a balloon-shaped cavity. The stomates, rather large in size, cover the whole of the inner surface, and between them grow peculiar hairs with bulbous bases, and from these a very long and thin cilium grows which is twisted and curled. The cilia all project from the mouth of the crypt and form an effectual plug, reducing the interchange of air between the interior of the cavity and the outside atmosphere. Hairs of this particular type, *i.e.*, having a bulbous base and a very fine termination, are also found in the rolled leaves and in stomate-bearing grooves. They have possibly some special function, but it is likely that they are also capable of absorbing water or perhaps water-vapor.

Very many of the sandstone plants secrete essential oils, and in consequence are strongly scented. This is a well-known character of desert plants, and it has been suggested that, as the vapor of these oils absorbs radiant heat, they form a screen opaque to heat all round the plant.

A characteristic of dry climate plants is thorniness. This is not very apparent in our sandstone plants; few of them are thorny.

Most of them have some of the cells filled with tannin, which has been supposed to act as a water storage substance. This is a common feature in the Leguminosæ and the Proteaceæ.

All the foregoing adaptations are contrivances to enable the plant to live within its water income. But desert plants also protect themselves against dryness by storing up water in the favorable seasons. The storage reservoirs may be roots, stems or leaves. This is not at all a common adaptation among the sandstone plants.

Most of the plants of the genus *Hibbertia* exhibit leaf reduction, and a few of them in addition have rolled leaves. *Comesperma ericinum* rolls its leaves, while *C. volubile* and *C. defoliatum* are leafless, the stems having taken on the leaf functions. *Tetratheca* is another genus favoring the rolled leaf method. *Correa* has the leaves coated with the hairs, as have several of the *Zierias*. *Boronia ledifolia* has rolled margins to the leaves, and so have several of the *Eriostemons* and *Philotheca*. Like all the Rutaceæ, these five genera have oil glands in the leaves. *Lasiopetalum* has not only the leaves but the flowers densely hairy.

The Euphorbiaceæ have reduced leaf surface, rolled leaves in many instances, and in *Amperea* there are no leaves, the angular stems functioning as leaves.

In *Ficus* the stomates are collected in groups and protected by hairs; there is in *F. microphylla* a slight lowering of the surface where the stomates are placed (in some Malayan species there are stomatiferous crypts).

All the Casuarinæ are leafless, the vestiges of the leaves occurring in whorls at the nodes as minute scales. There are grooves, showing as white lines, on the twigs, and the stomates are in the grooves, and are further protected by a growth of massive hairs, which, projecting from the grooves, give the appearance of white lines. There is a considerable development of sclerenchymatous fibres in the twigs.

Some of the species of *Dodonæa* are coated with a sticky varnish which persists through the life of the leaf. In *Portulaca* and *Claytonia* there is water storage in the leaves, and so are the *Mesembryanthemums*, or pigfaces.

The order Leguminosæ contains many plants showing marked adaptation. *Jacksonia*, *Sphærolobium*, *Viminaria*, and *Bossiæa scolopendria* are leafless, the last has flattened stems. *Viminaria* and *B. scolopendria* have leaves in the seedling stage. In *Viminaria* the first leaf grows on a short petiole, and is broadly elliptical, the next is narrower and longer, and on a longer petiole, and this narrowing and lengthening goes on till the leaf is almost linear. Then the first slender cladode appears, and the plant begins to assume its broom-switch aspect. The *Bossiæa incutioned*, sometimes, when the rainfall is heavy, produces leaves on the cladodes. In *Daviesia* the leaves are inclined to become spines. The Gompholobiums and Pulteniæas have mostly rolled leaves, and in *Dillwynia* the rolling is carried so far that there is only a groove in which the stomates lie. Here there are peculiar thick-walled, conical hairs.

The majority of the Acacias have phyllodes instead of leaves, and these are sometimes protected by a coating of white bloom, and are then called Silver Wattles. All of them produce true leaves in the seedling stage, and sometimes on suckers.

The Crassulaceæ all have their leaves developed into storage systems.

Among the Myrtaceæ we find all sorts of protective contrivances, the presence of essential oils being common to all. The brush plants of the order, on the other hand, are not specially protected, they resemble the tropical Myrtaceæ, while the sandstone plants of the family have quite a different aspect. Mr. E. C. Andrews, in a paper read before the Linnean Society of New South Wales, puts forward very weighty arguments in favour of the view that these last are special forms evolved in Australia after its separation from the northern land mass, under the changed conditions of environment. A remarkable feature of some of the order is the great length of time that elapses before the fruits open. I have seen fruits on a species of *Callistemon* which were eight years old, and partly embedded in the wood, which were not open. And yet, if you cut off a cluster of even one-year fruits and lay them aside for a few days, they open and the numerous minute seeds drop out.

Among the Umbelliferæ, leaf reduction is the rule, and two genera, *Actinotus* and *Xanthosia*, are markedly hairy. The Flannel Flower, *A. helianthi*, is so named on account of the woolly texture of the floral bracts.

In the Natural Order Santalaceæ, *Choretrum*, *Leptomeria*, *Omphacomeria*, and *Exocarpus*, are all leafless or have the leaves reduced to mere rudiments. The first three species are commonly known as Native Currants; the fruit is very acid, but makes a jelly which is very good with roast mutton.

The Loranthaceæ have tough, leathery leaves, and stone cells all through the mesophyll; these are often star-shaped with long slender arms. *Loranthus linophyllus* has terete leaves, very much resembling the cladodes of *Casuarina*, on which it grows. *Notothixos subaureus* is a parasite on *Loranthus;* the leaves are small and covered on the underside wih a vestiture of beautiful golden, star-shaped hairs.

Among the Proteaceæ, the *xerophyllous* characters are very strongly marked indeed. In the genus *Petrophila*, the leaves are very much dissected with the segments terete. *Isopogon* has divided leaves, but flattened. *Conospermum*, reduced or rolled leaves in most cases. *Xylomelum*, the Wooden Pear, has tough leaves, thickened and with scleroids. *Lambertia*, the Honey Flower, has very hard leaves, slightly rolled. *Grevillea* has very many forms of protection. Some of the species have curious mushroom-shaped hairs of microscopic size, on the underside, generally sunken in the epidermis.

The species of *Hakea* come under two heads; they are either flat-leaved, the leaves very tough, with thick cuticle and the stomates sunk in below the surface, the mesophyll being full of massive-branched scleroids; or terete-leaved, in which case there are radiating columns of sclerenchyma, running the depth of the two rows of palisade cells, and evidently acting as mechanical strengthening elements.

In the Banksias we find two types, flat-leaved and rolled-leaved species. The flat-leaved species, such as *B. serrata*, have the stomates in crypts, with the bulbous and ciliated hairs projecting from the orifices. In this species they show as minute white dots on the underside, but in *B. integrifolia* they project sufficiently to cover the whole under-surface of the leaf with a thick, white mat. The rolled-leaf species, such as *B. ericifolia* and *B. spinulosa*, have the stomates under the rolled margin, and the same curious hairs project out of the two crevices between mid-rib and margins.

The Epacridæ all show xerophilous structures, mostly reduced leaves of extremely hard texture, and often with a spine at the end. Even those species which grow in swampy places show these characters very strongly, a fact which is attributed to the necessity for the plant to reduce transpiration so that it may not take up too much of the swamp water, full of injurious substances like humic acid.

There are many interesting methods of pollination among the sandstone plants. *Wahlenbergia*, the Blue Bell, has a long style, with glands which secrete a sticky substance. The long anthers are closely pressed to this, and open in the bud, all the pollen sticking to the style. When the flower opens, the anthers dry up and are blown out by the wind. The flowers are frequently visited by the blue-banded bee and the little native bee, which roll themselves round and round in the bell, and so remove the pollen from the style. In the next stage the trifid stigma opens, so that any visitor to the flower rubs against it in making an entrance, and if it carries the pollen, deposits some of it on the stigma. Both species of bees above-mentioned, if overtaken by darkness, camp all night in the flower, which hangs mouth downward at night as a protection to the pollen from dew. *Wahlenbergia* is an exceedingly variable plant. The flowers vary from an inch across to not more than one-twelfth of an inch. The normal number of corolla lobes is five, but I have seen as few as four and as many as seven; the style may be long or short; and the stigma have two, three, or four lobes. The corolla is usually a beautiful sky-blue, but it may bo white, pale-blue, deep-blue, or pink. The outside of the corolla is white, pale-blue, or rusty-buff. The stamens are normally five, but may be three or four.

The Australian species of *Lobelia* are pollinated in much the same way as European species.

Candollea (*Stylidium*) *graminifolia*, and its congeners are remarkable for having the anthers and stigma on a disc at the end of a long arm—the gynostemium or column—which is bent over one side of the flower. In the early stages the stigma is very small, and not functional, it is completely covered by the two anthers, which open at once. When an insect, usually a bee, visits the flower, it goes to the opposite side to the column, and as soon as its proboscis is about half-way down the tube, the column flies over with a jerk; apparently there is a ticklish spot down there. The end of the column bearing the open anthers strikes the insect on the thorax with considerable force, but evidently the bees are accustomed to it, for they are not at all alarmed. A patch of pollen is left on the bee's back. After a time all the pollen is dispersed, and the anthers shrivel up, leaving the stigma visible. It soon grows to a considerable size, developing short papillæ all over its surface, and becoming sticky and ready for pollination. After the column has been sprung, it slowly goes back to the first position, and after a varying resting period, is ready for action again. In the second stage it takes up pollen from the bee. The flowers grow in spikes, the lower flowers open first, and as the bees begin at the bottom and work upward, the likelihood of a flower being pollinated by another on the same plant is obviated. If small creeping insects visited the flowers, the column would be sprung to no purpose, and this is prevented by the whole of the flower stalk being thickly covered with sticky trichomes.

In almost all the Proteaceæ the anthers are sessile on the tips of the four perianth segments, and surround the stigma in the bud, resting on the wide disc which lies all round it. They open in the bud, and the pollen adheres to the disc. After the flower opens, the style arches over the flower so that insects or birds visiting must rub against it. The stigma is not ready to receive the pollen for some time, during which visitors gradually remove all the pollen, and in visiting other flowers in which the stigma is mature, leave some pollen on it. In the Banksias, Grevilleas, Waratah (*Telopea*) and *Lambertia*, the agents responsible are the honey-eaters, particularly the spinebill (*Acanthorhynchus tenuirostris*). All these plants produce enormous quantities of flowers, but comparatively few leaves. I made a careful count of flowers and fruits on a few Banksia trees, and came to the conclusion that not more than one in a thousand flowers bore fruits. But it is quite common to see a head of fruits containing fifty to one hundred fruits on a Banksia, showing that the birds work for a long time on one flower spike. It is a rare thing to see fruits on a Waratah. But I once chanced to see a spinebill on a Waratah. He worked on it for nearly half-an-hour. Next year there were eight fruit capsules on that shrub, while all around there were acres of plants without a single fruit.

In the Banksias the style is extremely hard and elastic —quite like whalebone—and the pollen tubes would have no possible chance of penetrating it. But this is provided for by its being hollow, and the inner surface produces a fluid which nourishes the tube on its journey.

Conospermum is remarkable for having sensitive anthers. The style lies behind them, and is held up by them, At a certain stage, if a bee inserts its proboscis, the anthers burst open and throw the pollen downwards on the insect. At the same time, the elasticity of the style brings it down, so that any future visitor will have to push under it to reach the nectary.

Among our remarkable plants are the Sundews, of which we have six species on the sandstone. One of these, the forked Sundew (*Drosera binata*) was experimented on by Charles Darwin, and may, in consequence, be looked upon as a classical plant. It grows at its best on moist rocks, but may be seen in the Centennial Park, on the banks of a stream running into the ponds. The leaves are narrow and binate, but sometimes they fork again and have six segments. The most interesting point about it is that it has often an insect as messmate. This is one of the assassin bugs (*Reduriidæ*). It is of small size, but of very brilliant colouring, and usually camps on the back of the leaf. The coloration, though so bright, is thoroughly protective, consisting of an irregular pattern of green, red, yellow, and white, which is unnoticeable on the red glands, green surface, and glittering drops of secretion. When an insect is caught by the glands, the bug comes and sucks its juices. In West Australia, there is an insectivorous plant, *Byblis gigantea*, usually considered to be one of the Droseraceæ, but by some authors placed among the Polemoniaceæ. It has long, simple leaves, not unlike the segments of leaf in the forked Sundew. On this plant I found a bug extremely like the one found on our sundew, and living in the same way. The insect has not been seen on any of the other species of sundew, and it is, as yet, undescribed.

The best localities for seeing the South Coast flora are within a few hours of Sydney. Something of it will be found in National Park (18 miles rail), or Loftus (16 miles rail and walk to the Park). A better trip for those who are walkers is rail to Waterfall (24 miles), then walk to Clifton or Scarborough (11 miles), mostly down-hill. The first part of the journey is through the sandstone flora, a notable plant being the giant lily, *Doryanthes excelsa*. At Bald Hill there is a long descent, partly through the brush country. The scenery from Bald Hill to Clifton is very fine. At Clifton, just where the range approaches most nearly to the sea, there is a good deal of brush, although much of it has been destroyed. If desirable, a return from Clifton or Scarborough could be made by rail. But if something more was desired, the visitor could go on to Bulli (42 miles) or Wollongong (48 miles), Albion Park (61 miles) or Nowra (92 miles). From Bulli, a walking trip to the top of Bulli Pass would show a good deal of the jungle flora, and incidentally, the big Blackbutt tree near the foot. From the top of the Pass there is a good view.

From Wollongong, the best trip would be up to Andrew's Look-out, near Mount Kembla (coach eight or nine miles). Here a track on the left leads down to Dapto and the coast plain, through very rich country; while on the right is American Creek—also brush. American Creek was visited by the U. S. Expedition in 1844. The path to the top of Mount Kembla, an easy half-hour's walk, begins here, and from the summit, 1760 feet, there is a magnificent view of the Illawarra district. From Andrew's Look-out, the road zig-zags through brush to the top of the range, and then down to the Cordeaux River, where there are reservoirs supplying Wollongong with water. A track on the left leads out to the swamps, where there is a little brush and some typical sandstone vegetation.

From Albion Park, a coach-drive up the Macquarie Pass is through brush, but it is not very striking. From Nowra, over Cambewarra Mountain to Kangaroo Valley, is a fine drive through the richest of the South Coast brush. A very interesting trip, passing through very different zones of vegetation, would be Sydney to Moss Vale (rail, 87 miles), then coach to Nowra, stopping at Kangaroo Valley one night and then on over the Cambewarra Mountain. There is a look-out point where the road crosses the range, from which what is probably the finest view in Illawarra may be seen.

The trips to National Park, Waterfall, with walk to Clifton; or Bulli, with walk up the Pass, could be easily done in one day. But the Wollongong and Nowra trips would take at least two to see the vegetation properly.

Round about Gosford (Northern line, 52 miles) the same flora is found, and this would also be an easy one day's trip.

VEGETATION OF KOSCIUSKO PLATEAU ABOVE THE TREE LINE
(Danthonia robusta, F.V.M., in foreground).

TABLELAND AND SUB-ALPINE AREAS.

By J. H. Maiden and R. H. Cambage.

The mountain region in New South Wales extends throughout the length of the State, approximately parallel to the coast-line, and at an average distance of about 100 miles therefrom.

It consists largely of uplifted tablelands, which still retain their general level over long distances, while in parts they are entrenched by deep gorges. The eastern or ocean side is more humid, and in winter is also warmer than the western side, the influence of these factors being noticeable in the floras from east to west.

The greatest elevation of the mountain region is at Mount Kosciusko, in the south, 7,328 feet; while much of the northern portion, known as New England, ranges from 3,000 to 4,000 feet above sea-level, with a few peaks up to 5,000 feet. For a short distance, near its central portion, around the head waters of the Hunter River, the altitude of this main divide is less than 2,000 feet. and the continuity of the mountain flora is broken for about 50 miles, its place being taken largely by species which have come through from the west.

The geological formation of this area includes both igneous and sedimentary rocks, which range from basic to extremely siliceous, by far the greater number of species being found on the latter formation. The rainfall averages about 34 inches annually, with a range from about 20 to 60 inches in various portions. Snow falls over the greater part of the tablelands every winter, to the depth of a few inches and upwards; while Mount Kosciusko is snow-clad from about April to December each year, and is subject to intermittent falls during the remaining months.

The semi-tropical flora of the coast is absent from the mountains, excepting in some of the gorges, or where the aspect is eastern, and the plants are sheltered from the cold and drying winds of the west.

Mount Kosciusko is the highest mountain on the Australian continent. It is about 320 miles south-westerly from Sydney, and a luxurious hotel, at an elevation of 6,000 feet on the mountain, may be reached about 15 hours after leaving Sydney. The mountain is, therefore, conveniently accessible to the visiting botanist.

The vegetation is so preponderatingly Tasmanian (about 80 per cent. at least of the plants occurring on that island) that it can be usefully botanised over with a flora of Tasmania.

Eucalyptus coriacea, A. Cunn., var. *alpina*, the "Snow-gum" forms the limit of tree vegetation at 6,000 feet, forming small trees with smooth barks and umbrella-like branches. Just below them are large patches of *Dianella tasmanica*, with sword-shaped leaves, six feet long, and with a profusion of the most beautiful blue flowers.

From the tree-line to 7,000 feet, the zone exhibits a fairly uniform flora, that is to say, most of the plants enumerated are widely distributed over its area. The whole plain is a carpet of verdure. The grasses furnish the ground colour of course, the most conspicuous being the coarse endemic species, *Danthonia robusta*, F. v. M., which is very fattening. There are abundant patches of *Epacris* and *Phebalium ovalifolius;* yellow *Oxylobium alpestre;* and scattered in the grass-land, yellow *Ranunculi;* purple *Brachycomes;* masses of white daisy, *Olearia stellulata;* and silver daisy, *Celmisia longifolia;* and the handsome though not showy umbelliferous plant, *Aciphylla glacialis;* then there are little mats of the dainty *Stackhousia pulvinaris*, *Raoulia Catipes*, and *Epilobium confertifolium.*

The country is granite, and there are very shallow pools of the clearest water. To see some of the floors of these lagoons, dotted all over with *Ranunculus Millani* in full flower under the water, like golden nails studding a floor of sombre colour, is a charming sight.

Myriophyllum pedunculatum is so abundant in another lagoon as to give the appearance of a bright red carpet.

Near the summit of the mountain there is an enormous preponderance of white flowers; green and inconspicuous and yellow being next in abundance, with blue flowers very rare. Red tinted flowers are scarce.

Many plants have that moss-like growth often observed at high elevations, *e.g.*, *Scleranthus mniaroides* and *biflorus*, *Colobanthus*, *Drapetes tasmanica*, and perhaps the whole of the Epacrideæ found on the mountain. Hummocky forms are seen in *Epacris*, *Kunzea Muelleri*, *Oxylobium ellipticum*, *Olearia floribunda*, *Helichrysum baccharoides*, and, speaking generally, in most of those plants which assume a rock-clinging habit, such as *Podocarpus alpina*, R. Br., *Grevillea australis*, *Oxylobium ellipticum* var. *alpinum*, *Phebalium ovalifolium*, *Pentachondra pumila*, *Orites lancifolia*, and *Drapetes tasmanica*.

Those mat-forming plants, which form matted growths fairly uniform in appearance, include *Claytonia australasica*, *Stackhousia pulvinaris*, *Epilobium confertifolium*, *Nertera depressa*, *Raoulia Catipes*, *Graphalium japonicum* var. *radicans*, *Goodenia hederacea* var., *Pentachondra pumila*, *Pimelea alpina*.

Claytonia australasica has beautiful white flowers; *Stackhousia pulvinaris* emits a perfume, both powerful and sweet; *Epilobium confertifolium* is a beautiful glaucous-leaved plant, bearing a profusion of creamy-white flowers; *Nertera depressa* is a dainty little plant, with a profusion of reddish berries, which has long been in cultivation in Europe; *Raoulia Catipes*, the Australian Edelweiss, is one of the daintiest of our alpine flora, and quite as beautiful as its European namesake.

Then the Mount Kosciusko plateau is the place for Buttercups. The largest is a white flowering species, *Ranunculus anemoneus*, the flower two or three inches in diameter, while the smallest is *R. Millani*, a dainty little species often less than an inch high, and present in innumerable quantities. The sight of the dwarf and spotlessly white *Caltha introloba* growing on the fringe of the snow-drift, or actually under the snow, is very beautiful. *Brachycomes*, white and purple, are in profusion. The *Olearias* or daisy bushes are hardly less beautiful, while *Helichrysum rosmarinifolium* in its various forms might also be called Snow-ball Bush, in such profusion does it bear its trusses of white flowers. *Podolepis longipedata*, var. robusta, is a large Composite, bearing a profusion of yellow flowers, and large, very flannel-looking leaves.

We have two plants, with longish, silvery leaves; one a pretty white daisy, *Celmisia longifolia;* and the other a Liliaceous plant, *Astelia alpina*. It grows at the fringe of permanent snows. The purple *Euphrasias* are both abundant and beautiful, while at lower levels, *Veronicas* of two or three species adorn rock masses with a profusion of blossoms of the same colour.

Prostanthera is represented by two or three free-flowering shrubs bearing purplish blooms, while we have an Australian Gentian (*Gentiana saxosa*) with pale-purplish flowers, and known to residents of the mountain under the name of "Snowdrop."

The crispness of the air, the beauty of the scenery, and the charm and profusion of the flora of the mountain render it one of the very choicest botanising grounds in Australia, and the only drawback will be, especially if the season is late, that the flowers will not be at their best as early as the Association's visit.

Goulburn Plains.

The lowest part of the tableland is that around Goulburn, Yass, Queanbeyan, and Braidwood, the general level of which ranges from about 2,000 to 2,500 feet. The flora of this area consists chiefly of various species of Eucalyptus, such as *E. viminalis, rubida, dives*, on the western portions; *amygdalina*, on the eastern side; *melliodora, maculosa elæophora, aggregata, cinerea*, and *tereticornis*, with *coriacea* and *stellulata* in the colder portions. An isolated occurrence of *E. globulus* may be seen just north of the Burrinjuck Dam.

The principal Acacias are: *A. decurrens*, var. *dealbata*, and var. *mollis A. implexa, A. melanoxylon, rubida*, with a little of *A. armata, diffusa, Dawsoni* and *decora*.

The Casuarinas are represented by *C. suberosa* in the eastern portions; a little of *C. stricta* in the south-western; while *C. Cunninghamiana* occurs on portion of the Murrumbidgee and Shoalhaven Rivers.

The genus Banksia is poorly represented, *B. spinulosa* being found in the eastern parts, and *B. marginata* in various places where the soil is siliceous.

Except on the eastern portions, the shrubs are not numerous, and much of this section of the tableland consists of fairly open plains.

Blue Mountains.

That portion of the plateau around Katoomba and Mount Victoria lying to the west of Sydney, has a general elevation of about 3,000 to 3,500 feet, and being composed of a highly siliceous sandstone, and having a good rainfall, is most prolific in genera and species. It is here that the dominating effect of climate in regulating distribution may be seen, for while the same sandstone formation continues from about sea-level at Sydney to upwards of 3,000 feet on these mountains, many species common around Sydney do not thrive at the higher levels, but in many cases, give place

THE GROSE VALLEY, SHOWING A TYPICAL MOUNTAIN SANDSTONE VEGETATION.

to others which do not occur at Sydney. This appplies to many genera such as *Boronia*, *Eriostemon*, *Acacia*, *Melaleuca*, *Eucalyptus*, *Persoonia*, *Grevillea*, and others.

As the first road from Sydney to the interior passed over these mountains, the locality is one which was largely collected over by the early botanists, including Allan Cunningham, and is, therefore, to some extent, a *type* locality.

The family Leguminosæ (sub-order Papilionaceæ) is quite a feature of these mountains, and has many beautiful representatives in such genera as *Mirbelia*, *Daviesia*, *Phyllota*, *Pultenæa*, *Dillwynia*, and *Bossiæa*, while the sub-order Mimoseæ, is in parts well represented by the Acacias, members of both the pinnate and phyllodineous forms of this genus occurring intermittently throughout. The stately *Acacia elata*, with its broad, pinnate leaves, may be seen in sheltered gorges, and reaches a height of 60 to 80 feet. The Myrtaceæ is best represented by such genera as Bæckea, Leptospermum and Eucalyptus, while others, such as Callistemon, Melaleuca, Angophora, and Eugenia are not common above the 2,500 feet level.

The genus Eucalyptus has many representatives, some of which occur around Sydney, including *E. piperita*, *E. eugenioides*, *capitellata*, *hæmastoma*, *stricta*, *Sieberiana*, while *amygdalina*, *dives*, *fastigata*, *goniocalyx*, *Moorei*, *viminalis*, and *maculosa*, are chiefly above elevations of 2,000 to 2,500 feet.

In addition to some of the above, *E. melliodora*, *stellulata* and *elæophora* are found on the granite around Cox's River. The family Epacridaceæ is also well represented, such genera as Leucopogon and Epacris being very common.

Ascending the Blue Mountains from Emu Plains we observe *Eucalyptus siderophloia*, Broad-leaved Ironbark; *eximia*, Yellow Bloodwood; *crebra*, Narrow-leaved Ironbark; *punctata*, Grey Gum; and *eugenioides*, Stringy Bark; together with *Acacia decurrens*, var. *mollis*, *falcata*, and *elata*. *Syncarpia laurifolia* (Turpentine); *Eriostemon*, *myoporoides*, *Elæocarpus*, *recticulatus*, with Prussian blue fruits; *Ceratopetalum gummiferum*. Christmas Bush; *Angophora lanceolata*, smooth-barked Apple; *Backhousia myrtifolia*. and *Callicoma serratifolia*.

At an elevation of several hundred feet we see *Eucalyptus hæmastoma*, Sm., var. *micrantha* (White Gum); *Acacia longifolia* (Golden Wattle); and *Xylomelum pyriforme*, the well-known Wooden Pear, together with a profusion of a Myrtaceous shrub, *Leptospermum flavescens*, with white flowers which have a soupçon of yellow; *Kunzea corifolia*, another Myrtaceous shrub, with white flowers, is less abundant.

Eucalyptus resinifera (Forest Mahogany) now appears 40 miles from Sydney; and some trees of *E. Consideniana;* while *E. piperita*, Sm., is abundant, and *E. corymbosa*.

Around Springwood an umbrageous White Gum is *E. Deanei.* This pretty mountain town owes much of its attractiveness to the presence of Wianamatta shale, which supports a good sward, and beautiful umbrageous Turpentine trees (*Syncarpia laurifolia*), which give the place a park-like appearance. Springwood is, however, but an oasis in the barren sandstone of which the mountains are composed.

The somewhat local *Acacia trinervata* is seen between Springwood and Faulconbridge, and shortly afterwards the small Eucalypt, *E. stricta*, appears, together with two shrubby Acacias, *A. rubida*, so called because of the colour of its phyllodes, and *A. oxycedrus*, a prickly shrub. The Red Honeysuckle, *Banksia serrata*, is not rare, nor is *Eucalyptus Sieberiana*, F. v. M., the Mountain Ash.

Approaching Linden, we have the Blue Mountain Cypress, *Callitris Muelleri;* a specimen of the Christmas tree, *Ceratopetalum gummiferum*, which attains the unusual size of over 30 feet high and 18 inches in diameter; together with *Helichrysum adnatum*, a dwarf and somewhat rare shrub.

At Linden Station we have *Goodenia decurrens*, *Kunzea capitata*, while a little further on we have a profusion of Red Bottle Brush, *Callistemon lanceolatus*, on the banks of a shallow stream. The rare *Acrophyllum venosum* is found here under a dripping rock, while *Banksia ericifolia* is a shapely shrub of 10 or 12 feet, with *B. spinulosa*, *Atkinsonia ligustrina* (a shrubby Loranth), and *Pseudanthus pimeleoides* close by.

Around Lawson the Eucalypts are: *corymbosa*, *piperita*, *eugenioides*, *Sieberiana*, and *hæmastoma*, while *amygdalina* (Peppermint) makes its first appearance near the road, on the first hill towards Wentworth Falls, but occurs also in a valley to the north of Woodford. Soon afterwards, *Grevillea acanthifolia* and *laurifolia* are seen, the former in swamps, and the latter prostrate.

Eucalyptus maculosa, plentiful higher up, is a White Gum which appears at Wentworth Falls and between Leura and Katoomba.

Blackheath and Mount Victoria are the highest parts of the Blue Mountains. The principal trees are: *Eucalyptus Sieberiana, piperita, dives, eugenioides, capitellata, amygdalina; goniocalyx* in the valleys, and a few others.

The *Acacias* include: *penninervis, longifolia* var., *rubida, discolor*, and *melanoxylon* (rare).

The Mallee-like *Eucalyptus stricta*, Sieb., and the narrow-leaved *E. Moorei*, Maiden and Cambage, are abundant.

The shrubs, large and small, include: *Hakea pugioniformis* and *dactyloides, Banksia serrata, paludosa, spinulosa*, and *collina, Persoonia myrtilloides*, A. Cunn. (a very coarse, bushy plant). The white-flowered *Leptospermums* include: *attenuatum, flavescens, arachnoideum, scoparium*, and *lanigerum; Olearia dentata*, with its purplish ray flowers; *Persoonia nutans*, a "ground berry" (because of its prostrate habit) has malodorous flowers; *Lomatia silaifolia*, with fern-like foliage and white flowers.

In the gullies, where there is alluvium, plenty of moisture, and adequate shelter, there is a different vegetation, similar to that of many of the "brushes" on the coast. The trees include the Sassafras, *Doryphora sassafras, Quintinia Sieberi; Callicoma serratifolia;* the Coachwood (*Ceratopetalum apetalum*); Turpentine (*Syncarpia laurifolia*); Beefwood (*Stenocarpus saligna*); Blue-berry (*Elæocarpus reticulatus*), *Tristania laurina, Notelæa longifolia, Hakea saligna.*

In going from Mount Victoria to the Jenolan Caves, the sandstone is soon left behind, and an area of granite, not very siliceous, is crossed, when a great diminution in the number of species is apparent, even where clearing operations have not been carried out.

Large trees of *Casuarina Cunninghamiana* may be seen in places lining the banks of the River, but this species does not discriminate between geological formations, its desideratum being running fresh water, at elevations between extremes of heat and cold. It also occurs on both the Silurian slates, and limestone near the Jenolan Caves. In this locality are also *C. suberosa* and *C. torulosa.*

Hartley to Jenolan.

Many of the genera found around Katoomba and Mount Victoria occur also near the Jenolan Caves, though, owing to the more siliceous nature of the soil in the former localities, the species are more numerous at those places. Amongst those genera which are perhaps better represented towards the Jenolan Caves than near Mount Victoria, are:—Ranunculus, Viola, Bursaria, Brachychiton (*B. populneus*, which always shows a partiality for limestone), Dodonæa, Hovea, Callistemon, Backhousia, Senecio (*S. macranthus*, with showy yellow flowers), Gaultheria, Veronica, Tecoma, Lomatia, Ficus, Lepidosperma, Panicum, Andropogon.

The Eucalypts on this area include: *coriacea*, *stellulata*, *hæmastoma*, *Stuartiana*, *dives*, *melliodora*, *viminalis*, *rubida*, *maculosa;* and amongst other plants are: *Acacia melanoxylon* (Blackwood); and *penninervis* (Black Wattle); *Banksia marginata* (Honeysuckle); *Acacia decurrens*, var. *dealbata*, (Silver Wattle); *Bursaria spinosa*, *Pomaderris ledifolia*, *Stypandra glauca*, *Daviesia latifolia*, *Platylobium formosum*, *Helipterum incanum*, *Brachyloma daphnoides*, *Dodonæa attenuata*.

MOUNTS BANKS, TOMAH, WILSON AND IRVINE.

In contrast to the ordinary, somewhat dwarfed sandstone flora of the Blue Mountains, a most luxuriant "brush" vegetation occurs, a few miles to the northward of the railway line, on basaltic hills, known as Mounts Banks (King George), Tomah, Wilson and Irvine. To some extent the species occurring on the two formations are different, but all those on the basalt are most luxuriant when compared with their neighbours a few hundred feet away. A feature of these volcanic areas, in addition to the majestic height and girth of the trees, is the robust growth of tree-ferns, examples of *Alsophila australis* and *Dicksonia antarctica* showing a most vigorous growth. It is evident that these luxuriant forms are due to the better soil produced by the decomposition of the basalt. At the same time the elevation is such (over 3,000 feet) that some plants which flourish on similar soils at lower levels towards the coast are not found on these mountains, owing to the much cooler climate.

On approaching Mount Wilson from the railway line, and while still on the sandstone, we see charming shrubs of *Humea elegans*, with their gracefully drooping, loose panicles of reddish flowers, while as soon as the basalt is reached, the road enters an avenue of the most luxuriant specimens of *Prostanthera lasianthos* (Wild Lilac), whose masses of beautiful pale-lilac flowers in mid-summer are displayed in glorious profusion all around and overhead.

BRUSH GULLY IN BLUE MOUNTAINS
(Hawkesbury Sandstone).

New England Tableland.

The northern portion of the tableland from near the head of the Peel and Hunter Rivers to Queensland is known under the name of New England. Its general elevation is upwards of 3,000 feet, with a few summits of 5,000 feet, and it has an average annual rainfall of about 34 inches. The geological formation of this division consists largely of basic volcanic rocks, with some areas of granite, portions of which are basic, while others, known as the tin-granites, are highly siliceous. The general facies of its flora differs considerably from that of the Blue Mountains, owing largely to the more basic nature of the greater area of New England rocks, but where the formations approach each other in silica contents, as amongst the sandstones of the former, and the tin-granites of the latter, the similarity between the two floras, both as regards genera and species, is most marked. This is the only portion of northern New South Wales where the cold-loving Tasmanian flora may be found, and as an evidence of the effect of climate upon the distribution of plants, it may be mentioned that of about 160 species which are growing between the 3,000 and 5,000 feet levels on one portion of the Nandewar Mountains, west of Barraba, 60 per cent. occur in Tasmania, where the climatic conditions are somewhat similar.

Excepting in a few nooks which are sheltered from westerly influence, ferns are not common on New England, and their absence is most noticeable from the western portions of the plateau. Such genera as Acacia and Eucalyptus are represented throughout, and constitute the principal portion of the flora, while on some of the more siliceous granites a large percentage of the flora is made up of other genera, including: Daviesia, Pultenæa, Leptospermum, Olearia, Cassinia, Podolepis, Helichrysum, Helipterum, Senecio, Goodenia, Styphelia, Lissanthe, Leucopogon, Epacris, Prostanthera, Persoonia, Hakea, Banksia, Casuarina, Exocarpus, Callitris, Diuris, Stypandra, Xanthorrhœa, Andropogon, Anthistiria, Arundo, Poa, and Cheilanthes.

Armidale to Glen Innes.

Among the Eucalypts which may be seen from the train between Armidale and Glen Innes, at elevations from 3,300 to 4,500 feet, are: *E. viminalis* (Manna Gum); *E. melliodora* (Yellow Box); *E. Stuartiana* (White Peppermint); *E. Muelleriana* (Yellow Stringy Bark); *E. rubida* (White Gum); *E.*

nova-anglica (Red Peppermint); *E. coriacea* (Snow Gum or White Ash); *E. stellulata* (Sallow or Sally).

Other genera are represented by the following species: *Acacia decurrens* var. *dealbata* (Silver Wattle); *Angophora intermedia* (Apple); *Hardenbergia monophylla*, *Exocarpus cupressiformis* (Native Cherry); *Bursaria spinosa*, *Banksia integrifolia* (White Honeysuckle; scarce); *Casuarina suberosa* (Black Oak; scarce); *Loranthus sp.; Xanthorrhœa sp.*

GLEN INNES TO TENTERFIELD.

All the above species mentioned as occurring between Armidale and Glen Innes may be seen from the train between Glen Innes and Tenterfield, and in addition the following may be noticed:—*Eucalyptus Banksii*, *E. Baueriana*, var. *conica*, *E. Andrewsi*, *E. Deanei*, *Jacksonia scoparia*, *Angophora subvelutina*, *Acacia neriifolia* (on the Bolivia Hills, a most charming object about the end of August, with its clusters of dark-yellow flowers); *Callitris calcarata*, (Mountain or Black Pine); *Casuarina Luehmanni* (Bull Oak, near Dundee and Deepwater); *C. torulosa* (Forest Oak, near Bluff Rock); and *C. Cunninghamiana* (River Oak), on creek banks towards Tenterfield.

GENERAL APPEARANCE OF WESTERN PLAINS VEGETATION.

THE WESTERN PLAINS.

By R. H. Cambage and J. H. Maiden.

They form portion of the Great Plains which extend from the Gulf of Carpentaria in the north to the Southern Ocean, including Western Queensland and New South Wales, and much of Victoria, excluding, in these three States, the East Australian Highlands. Westerly, these Plains include the Lake Eyre basin in South Australia.

The flora of the Western Plains is very different from that of the coastal or mountain areas, and this is chiefly owing to the difference of climate and rainfall, for while the eastern localities are comparatively moist, the conditions in the west are both dry and hot. The mean annual rainfall over the whole of the western division is about 13-14 inches, with less than 10 inches at Broken Hill. The rainfall in the north-eastern portion is practically double that of the south-west. In contrasting the flora of this hot and dry district with that of cool Tasmania, it may be mentioned that not a single species of Eucalyptus, found on the Western Plains, is recorded from Tasmania. The vegetation of this western division is more stunted than in any other portion of the State. A Eucalypt 100 feet high is here regarded as a very tall tree, the average not exceeding 50 feet, with a gradual diminution in height as the far west is approached. Over much of the central part, say around Bourke and Cobar, the forests do not average more than 40-50 feet.

As climatic conditions, rainfall and aspect are similar over a great part of the Western Plains, the various changes in the flora may be regarded as due to variations in the geological formations, or to the difference between rocky and alluvial situations; and some of these changes are very marked. The hills are generally only a few hundred feet above the surrounding plain, and, stretching away for many miles from their bases, are almost level tracts of deep, friable soil, fine in texture, often reddish in colour, and made up largely from the weathering of the surrounding elevations, and partly from the decomposition of the rocks *in situ*. This class of soil extends from the hills until it meets the river country, or what is generally known as the black soil plains, and this latter type of country, which appears to be perfectly level, may extend in places 15 or 20 miles back from the course of the stream. The black soil is of a close, sticky nature, and has apparently been spread over a vast area of the western country in geologically recent time.

Generally speaking, the floras of the red and black soil plains are distinct, and in several instances, certain genera may be represented by species which are peculiar to the one or other class of soil.

The flora of the Western Plains or interior of New South Wales may be regarded as the sub-arid type of the Australian flora, and contains many of the nearest representatives in this State of the true endemic type of the Australian vegetation.

The eastern boundary of the Western Plains follows approximately that of the line of profitable cultivation of wheat, but the latter, by means of drought resistant varieties and improved methods of cultivation, is being pushed further west, towards the line of the 10 inch rainfall, between April and October—the wheat-growing period.

The Western Plains flora keeps fairly well to its geographical area, being more or less diffused up the western slopes until it is arrested by cold and increased rainfalls.

It directly commingles with the flora east of the Great Divide by means of gaps in the tablelands and coastal ranges, to which T. Griffiths Taylor has given the title of Geocols, the Upper Hunter or Cassilis Geocol is best known, and such western plains plants as the following have been traced towards the coast, which are assumed to have traversed this route:—Brigalow (*Acacia harpophylla*, F. v. M.); Yarran, (*A. homalophylla*, A. Cunn.); Cooba (*A. salicina*, Lindl.); Wilga (*Geijera parviflora*, Lindl.); Bull Oak (*Casuarina Luehmanni*, R. T. Baker); a Cottonbush (*Kochia villosa*, Lindl. and *K. microphylla*); Tarwhine (*Boerhaavia diffusa*, L.); Silky Heads (*Ptilotus exaltatus*, Nees); Rosewood (*Heterodendron oleafolium*, Desf.); Butter Bush (*Pittosporum phillyraoides*, DC.); *Eucalyptus rostrata*, Schl. (River Red Gum); *Tribulus terrestris*.

A feature of the western plains is the marvellous rapidity with which recovery is made from a drought. During a dry period the black soil plains especially, may become reduced to dust with not a vestige of herbage for many miles, though shrubs and trees, many species of which are valuable as fodder, may remain alive. Within a week after the rain has come, all this is changed, and the country becomes covered with a green mantle, which in a few weeks furnishes luxuriant pasture. In the spring time the most conspicuous flowers of the open black soil plains belong to the Compositæ, such genera as *Helichrysum*, *Helipterum*, *Senecio*, and *Brachycome*, particularly the first two, presenting a blaze of colour, graduating from white to yellow and pink. The genus *Ptilotus* is exceedingly abundant in individuals, the colours of the flowers being chiefly pink and white. Prostrate species of the genus *Goodenia* are also very common, with their yellow flowers. Small plants of Cruciferæ are countless in number, the colours of their flowers being usually white and yellow. Another family which is strongly represented on the black soil plains is Salsolaceæ, which includes many species of the genera *Rhagodia*, *Chenopodium*, *Atriplex* (all three called Salt Bush), *Kochia* (Cotton Bush), and *Salicornia*.

The grasses, even more than the Salt Bushes, have rendered the western plains of great value to the pastoralists. There may be enumerated the genus *Panicum*, of which there are many species: the Mulga Grass (*Neurachne*); the Silver or Wallaby Grasses (*Danthonia*); the Mitchell Grass (*Astrebla*); the Blue Grasses (*Andropogon*); and many others.

Small succulent herbs are by no means rare, the Portulacaceæ being well represented, chiefly in the genus *Calandrina*, some species of which have pink flowers, sufficiently large to be ornamental; they are all acceptable to stock, and form a substitute for water.

Amongst numbers of the genus Eucalyptus may be found those characters which develop as a response to arid conditions, such as thickened leaves and large root-stocks. Both of these characters are well exemplified in that peculiar form of Eucalyptus growth known as Mallee. What are termed Mallee Scrubs often extend for several miles, and consist of numerous individuals of various species with large root-stocks, from which ascend several thin stems, perhaps ten or twelve, averaging something like ten feet high. That the roots of these curious little trees store up water, is evidenced even in drought time, from the fact that sufficient for a drink can easily be obtained from some species by cutting the roots into short lengths and standing them on end. It is well known that the aborigines were assisted in their journey across very dry tracts of country by obtaining water in this way.

The Mallees consist of *E. uncinata*, Turcz. and *E. oleosa*, F. v. M., both often called Red Mallee; *E. incrassata*, Labill., var. *dumosa; E. acacioides*, A. Cunn. and *E. Morrisi*, R. T. Baker. Along watercourses, or where water lodges after rain will be found the River or Red Gum, *E. rostrata*, Schlecht; (the most widely diffused of the genus), *E. microtheca*, F. v. M., the Coolabah; *E. bicolor*, A. Cunn., the Black or Flooded Box; all with more or less pendulous foliage; the Bimble or Poplar-leaved Box, with shiny leaves (*E. populifolia*, Hook.), can scarcely be confused with any other, and grows in arid country, while Bloodwood, *E. terminalis*, F. v. M., sparingly occurs on barren sandstone and slate hills, *e.g.*, Mount Oxley and Mount Dijon, near Bourke.

E. intertexta, R. T. Baker, a Red Box, occurs in the Bogan country and further west, while nearer in, extending to the western slopes, we have Mugga or Fatcake Ironbark, (*E. sideroxylon*, A. Cunn.), so called because its bark reminded the early colonists of a burnt cake; *E. tereticornis*, Sm., var. *dealbata* (the western variety of the coastal Forest Red Gum), and three so-called Boxes, *E. hemiphloia*, F. v. M., var. *albens* (White Box); *E. melliodora*, A. Cunn., the Yellow Box, so called because of the bright yellow colour of the inner bark. *E. Baueriana*, Schauer, var. *conica* (Fuzzy Box); *E. Woollsiana*, R. T. Baker (Black Box).

The Acacias, which are called Wattles, unless they bear a definite name, as above indicated, are abundant as to individuals, and very floriferous, and, since the flowers are usually of a deep-yellow colour, the shrubs or trees are alike conspicuous and beautiful. They include:—*Acacia aneura*, (Mulga); *decora* (Silver Wattle); *doratoxylon* (Currawang); *triptera* (Wait-a-while); *Oswaldi* (Umbrella Bush); *cyperophylla*, *Kempeana*, *spectabilis*, *polybotrya*, and *cardiophylla*.

Other species of Acacia which grow into small trees and are typical of the western districts are:—*A. pendula*, known as Myall in the north, and Boree in the south; *hakeoides*, (Black Wattle); *homalophylla* (Yarran); *excelsa* (Ironwood); *harpophylla* (Brigalow); *Cambagei* (Gidea); *salicina* (Cooba); and *stenophylla* (Eumung).

Acacia doratoxylon always grows on elevated land, often on the summits of hills, while *A. aneura* selects the red soils, and *A. pendula*, *homalophylla* and *harpophylla* are to be found chiefly on the black soils.

The majority of the Acacias of the western plains belong to the phyllodineous type, though the pinnate-leaved form is not altogether absent.

In the spring time many of the hills assume a golden hue owing to the presence of numerous trees of *Acacia doratoxylon*, which become laden with a profusion of beautiful spike flowers hanging in masses.

Several acres of the foot-hills and slight elevations are sometimes covered with low shrubs of *A. decora*, and in September, the whole is transformed into a golden mass, the flower heads being so numerous as to practically obliterate the foliage from view.

Other members of the Family Leguminosæ are frequently met with in the interior and include some beautiful flowering plants, amongst which may be mentioned *Templetonia egena*, *Clianthus Dampieri* (the beautiful Desert Pea), *Swainsona Greyana* (Darling Pea), *S. galegifolia* and others, *Cassia eremophila*, *artemisioides*, *circinata*, *Sturtii*, *Petalostyles labicheoides*.

A beautiful glaucous, conical conifer, termed White Pine (*Callitris robusta*, R. Br.) is gregarious, and is much esteemed for the durability of its timber, and especially its resistance to the ravages of white ants, while both the Bull Oak (*Casuarina Luehmanni*, R. T. Baker) and the Belah (*C. lepidophloia*, F. v. M.) are also pine-like trees, though less symmetrical, and add diversity to the landscape.

Several species of Cassytha or leafless vines (Dodder), may be seen in places climbing over and smothering the Mallee and various high shrubs, the whole mass, in some parts, becoming so entangled as to be almost impenetrable, and often forming quite a canopy. Children consider the fruits edible.

Lyonsia eucalyptifolia is a vine widely distributed in the west. It covers many of the large trees, and in some instances gradually kills them. This vine looks somewhat out of place in the dry country, and is suggestive of the idea that only a high rainfall is needed to turn the comparatively sparse forest areas into a jungle.

Amongst the best examples of the effect of moisture in the western districts is the vigorous growth of *Eucalyptus rostrata* along the banks of streams. This fact was commented upon by the early explorers who, when standing upon even a slight eminence, could see the courses of the rivers, often a very welcome sight, outlined for many miles by the presence of the River Gums. As the higher country is approached this species gives place to *Casuarina Cunninghamiana* (River Oak), which takes possession of the river banks until stopped by the cold of the higher mountain region.

A feature of the timbers of the interior is their excellence for firewood, there being scarcely any western tree, when dead, which is not suitable in this respect, but amongst the favourites for cleanliness and slow burning are *Acacia pendula* (Myall); *A. Cambagei* (Gidgea); *A. homalophylla*, (Yarran); and *A. excelsa* (Ironwood); all of which, after being once lighted, burn right away to a pure white ash.

Amongst the shrubs may be noted the leafless *Apophyllum anomalum* (Currant Bush); *Eremophila Mitchelli*, Benth., (the Budtha or Sandalwood) and *E. Sturtii*, both charming plants when laden with their masses of whitish flowers; and also a number of other congeners, *Pittosporum phillyræoides*, DC., Butter Bush, willowy in habit, with a profusion of yellow flowers and fruits which display red sticky seeds.

Bertya Cunninghamii (Broom Bush) grows to a height of six to ten feet, in masses of several acres.

Two species of Myoporum, *M. platycarpum* and *M. deserti*, usually known as Dogwood, are fairly common, and exude a resinous substance from the bark. They are covered with white flowers, about October, and are then showy little trees or large shrubs. When there is no herbage, rabbits show a distinct preference for the bark of these little trees. The bark of Capparis Mitchelli (Wild Orange) is also much sought after by rabbits.

Trees of a larger size are the Kurrajong (*Brachychiton populneus*), readily eaten by stock, and a stand-by in periods of drought; *Fusanus acuminatus*, R. Br. (Santalaceæ), the Quandong, with an acidulous red fruit, enclosing a large, pitted, spherical stone; *Owenia acidula* (Meliaceæ), the Colane, which is a handsome shade tree, and which also yields an edible fruit to the blacks; *Geijera parviflora*, Lindl. (Rutaceæ), the Wilga, a charming shade tree; *Capparis Mitchelli*, Lindl., the so-called Native Orange or Wild Pomegranate, yielding a large fruit, eaten by the blacks, but not tempting to most white men; *Canthium oleifolium*, Hook. (Rubiaceæ), the so-called Wild Lemon. In early November, this species is covered with a profusion of strongly sweet-scented, white flowers.

Heterodendron oleafolium, Desf., the so-called Rosewood, and *Atalaya hemiglauca*, F. v. M. (Whitewood); both belong to the Sapindaceæ; and *Ventilago viminalis* (Rhamnaceæ), is a valuable tree, called Supple Jack or Vine Tree. Amongst the Proteaceæ we have *Hakea leucoptera*, R. Br., called Needlewood because of its needle-like leaves, and *Grevillea striata*, the Beefwood.

Flindersia maculosa, F. v. M. (Meliaceæ), the Leopard Tree (so-called because of its spotted bark), is interesting because of the fact that it begins life as a straggly, thorny bush, and in the midst of this emerges the leader which forms the stem. In this way the tender plant is protected from grazing animals. Other western trees which have this character, though perhaps in a less degree, are *Acacia excelsa*, *Grevillea striata*, and *Capparis Mitchelli*. Although our western country corresponds to much South African country, yet we have comparatively few thorn bushes as compared with South Africa. In South Africa vegetation had to defend itself against enormous numbers of wild herbivora, and so, in process of time, the shrubs evolved into the characteristic thorn-bushes, and the herbaceous plants into perennials with a thick, often tuberous root stock. In our western plains the flora of this dry tract, in its natural state, supported but few herbivora, and when large numbers of sheep were introduced by man, they ate down the annuals, which were dependent on annual seeding, while certain useless weeds, protected by evil-smelling oils, resinous exudations, or bitter and deleterious substances, spread largely over the country side, to be ousted again by the indigenous vegetation after a good season.

THE FLORA OF THE NORTH COAST OF NEW SOUTH WALES.

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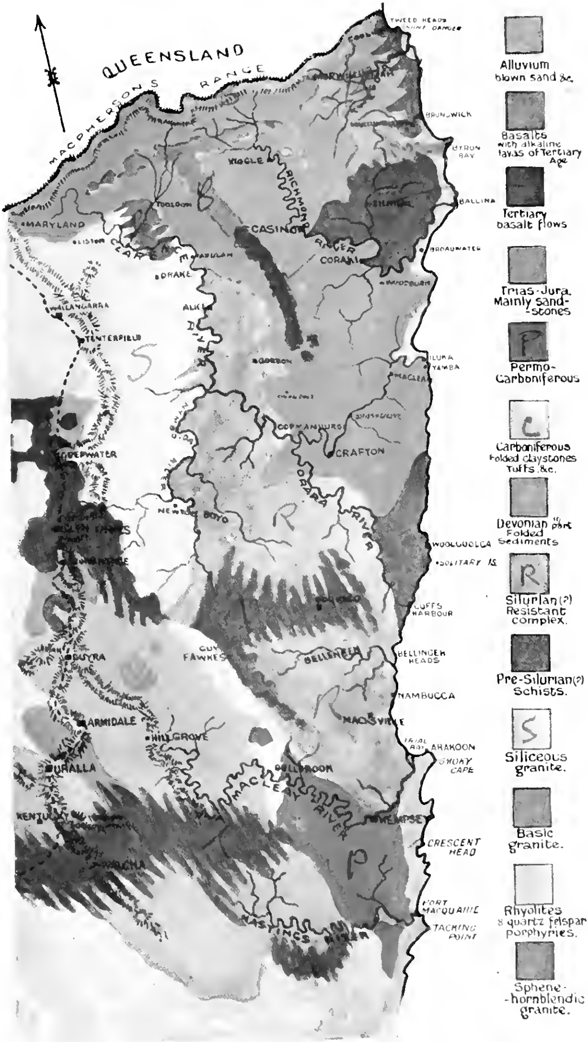
Introduction.

The term "North Coast" carries with it a certain amount of political significance, whilst it also designates fairly well a certain physical region in the north-east portion of this State. To serve the purpose of this paper, it may be said to include that area of country bounded on the north by the Macpherson Range of Mountains, on the south by the Manning River, on the west by the New England Plateau, and on the east by the Pacific Ocean, and thus we have a fairly natural region.

In this area will be found a fairly varied vegetation, indeed, characteristic specimens of some of the world's floras. The two most pronounced groups are the typical Australian and the typical Indo-Malayan, both of which, in a certain measure, are restricted to particular geological formations; and in some instances this is noticeable to a marked degree, especially that portion named by the earliest settlers, and also known to-day as "brush" or "scrub," to differentiate it from the open forest country or "bush," as commonly so-called.

Ecologically studied, it will be found that the "brush" or "scrub" flora is mostly restricted in its geological distribution, and wherever the tertiary basalts occur, either in extensive areas or as outcrops in the smallest patches, there will be found representatives of the Indo-Malayan flora, and the line of demarcation is in most instances well pronounced. The accompanying coloured map will give some idea of the position of these geological areas. It must not, however, be thought that *each* formation has its distinctive flora exclusively, for in some instances certain species of Eucalypts, at least, will be found on two or three different geological areas. But then again other plants are more restricted, as for instance, on the sandy patches of ground occurring at various places on the sea coast, for here one sees a flora, with



GEOLOGICAL MAP OF THE NORTH COAST OF NEW SOUTH WALES.

E. C. ANDREWS.

one or two exceptions, similar to that found on the Hawkesbury sandstone country around Sydney.

Although there is a difference in the flora of each geological formation, as far as our knowledge goes at present, yet much remains to be done on the Ecology of this particular portion of New South Wales. However, certain Eucalypts, such as "Spotted Gum," *E. maculata;* "Ironbark," *E. paniculata;* "Blackbutt," *E. pilularis,* "Mahogany," *E. resinifera;* "Flooded Gum," *E. saligna, var. pallidivalvis;* "Tallow-wood," *E. microcorys,* extend throughout the open forest areas, but are generally found on the sandstone patches or basalt, whilst one or two Eucalypts, such as "Flooded Gum," "Tallow-wood," "White Mahogany," *E. acmenoides,* are sometimes found in the "brush" or "scrub," but only on the borders.

As the Eucalypts may certainly be regarded as typically Australian and intrusive amongst the Indo-Malayan flora, an effort was made to account for their presence some little distance in from the edge of the "brush," and it was found that where the former grew, the soil was only disintegrated basalt to a depth of a few feet—two or three feet in some cases, and that their roots, passing through this, found a lodgment in the subsoil of schist or other favourable, congenial ground for their sustenance. Again, one of the best illustrations showing a line of demarcation between these two floras is at the Bald Hill, in the Forest Reserve, about seven miles north of the township of Dorrigo, past Paddy's Plains. Here the depth of basaltic soil ends abruptly, and just as suddenly does the flora change, for on the one hand, where these two soils meet are *Eucalypts*—"Flooded Gum," "Tallow-wood," etc.; and on the other, true brush growth, "Hoop Pine," *Araucaria Cunninghamii;* "Red Cedar," *Cedrela Toona,* and other cognate specimens of this characteristic "brush" flora; this magnificent flora is, however, fast disappearing before the devastating axe and fires of the settlers; in fact, the famous "big scrub," which originally covered many square miles of country, is practically a memory, although patches of it, or of similar vegetation are still to be found throughout the district. A journey through this country brings to mind the words of the poet:—

"Keen is the axe, the rushing fire streams bright,
Clear, beautiful and fierce it speeds for man,
The Master, set to change and stern to smile,
Bronzed pioneer of nations. Ay, but scan
The ruined beauty ruined in a night,
The blackened wonder God alone could plan,
And build not twice; a bitter price to pay
Is this for progress—beauty swept away."

W. P. REEVES.

The best known of the whole flora of the district or North Coast is the "Brush Forest" country, with its luxuriant growth of sub-tropical vegetation, which is almost impenetrable, for it is only by cutting a path that the hidden depths of this magnificent flora can be brought to light. To the botanical collector the tracks of the timber-getter and his bullock teams are the only means of traversing this delightful hunting ground, which is characterised by many noble trees of great height, decorated with "Staghorn," "Elk-horn," and other ferns. Occasionally "Orchids," giant climbers and twiners extend from the ground to the tops of the trees in great variety, whilst palms and tree ferns are conspicuous features of the landscape, or perhaps one might say "bush-scape"—the undergrowth being a maze of creepers, ferns, and smaller shrubs.

Prominent amongst brush timber are giant Fig Trees, *Ficus spp.*, with their enormous buttresses, sometimes enclosing stems of the original host, in the branches of which the seed of the Fig first germinated, and by means of numerous, at first aerial, roots, obtained a hold on the ground and eventually smothered its victim.

The vegetation is so closely packed, that the trees in their race to reach the sunlight, give out very few lateral branches, and this circumstance adds another to the many factors which go to render this an almost impenetrable brush; in fact, even in the middle of the day, the direct rays of the sun are quite shut out from the lower portions. Yet a walk along a bullock track in this wonderland of Nature produces feelings of delight and admiration at the gorgeousness and grandeur of everything surrounding one in such a primeval spot. The profusion of foliage, epiphytes, creepers, climbers, and bulbous flowers is quite bewildering, and where these can be seen on the face of a mountain such as at Dorrigo, one's admiration can go no further.

VIEW IN DORRIGO BRUSH (Hoop Pine in the foreground).

The Brush Flora.

The most common of the arboreal flora of the brush are "Cedar," *Cedrela Toona;* "Hoop Pine," *Araucaria Cunninghamii;* "Beech," *Gmelina Leichhardtii;* "Black Bean," *Castanospermum australe;* "Blue Fig," *Elæocarpus grandis;* "Corkwood," *Ackama Muelleri;* "Maiden's Blush," *Echinocarpus australis;* "Red Bean," *Dysoxylon Muelleri;* "Rosewood," *Dysoxylon Fraserianum;* "Sassafras," *Doryphora sassafras;* "Teak," *Flindersia australis;* and representatives of such natural orders as Magnoliaceæ, Anonaceæ, Menispermaceæ, Pittosporeæ, Sterculiaceæ, Tiliaceæ, Rutaceæ, Simarubeæ, Meliaceæ, Olacineæ, Celastrineæ, Rhamneæ, Sapindaceæ, Anacardiaceæ, Leguminosæ, Saxifrageæ, Myrtaceæ, Araliaceæ, Caprifoliaceæ, Rubiaceæ, Myrsineæ, Sapotaceæ, Ebenaceæ, Styraceæ, Jasmineæ, Verbenaceæ, Monimiaceæ, Laurineæ, Rosaceæ, Euphorbiaceæ, Urticeæ, Cupuliferæ, Coniferæ, Palmæ, may be said to almost complete the list of "brush" trees, which orders include 496 genera and about 950 species.

From the above it will be seen that many natural orders of the plant world, famous for yielding the finest timber trees, are to be found in our brush forests, and the supply of timber from these parts of the North Coast has been very great in the past.

In such an extensive botanical range, naturally one finds a great diversity of timbers—from very hard and heavy, such as "Ironwood," *Geijera salicifolia;* "Teak," *Flindersia australis*, etc.; to very light, such as "Flame Tree," *Sterculia spp.* The woods, however, from the "brush" are in great request for cabinet work, and it is doubtful if any country in the world is so rich in these as this part of New South Wales and (if it might be introduced here) in similar country in Queensland.

To give a full list of all the species found in the "brushes" would be too long for a limited article such as this, so that only the best known species can be particularised here. The most important product yet exploited from a technological point of view is their timbers, which may be divided in this connection into cabinet and constructional woods.

The "brush" produces the principal cabinet timbers, which, taken in botanical sequence, are:—

1. "Ironwood" or Crowsfoot Elm," *Tarrietia argyrodendron*, Bentham.

This timber should be cut on the quarter as the best figure is to be obtained for cabinet work, and seasoned quickly, as it is liable to deteriorate rapidly if left in the log. Its chief character is a neat, very pretty figure, the medullary rays being numerous and well marked; medium in weight, rather open in the grain, dresses well, and takes a good polish. It has been used for interior panelling in some of the Queensland railway carriages, being suitable for most kinds of inside decorative work, especially railway passenger cars and ships cabins, also for brush backs, ornamental boxes, turnery, furniture, etc.

2. "Blue Fig," *Elæocarpus grandis, F. v. M.*

The vernacular name has been unfortunately chosen, as the tree has no connection with the true fig (*Ficus*), as shown by the systematic name, the timber of figs being notoriously worthless. In this instance we have a splendid pale-coloured, light timber, which shows a sheen on planing. It is open in the grain, dresses well, takes a good polish, and is much used in the furniture trade.

3. "Scrub Hickory," *Penteceras australis*, J. D. Hooker.

In some respects this might be regarded as a good substitute for English "Hornbeam," both in colour and texture, although it has a better figure. The tree grows to a fair average size, and so produces a timber of sufficient dimensions for cabinet work. It is hard, close grained, pale-yellowish in colour, dresses well and takes a fine polish, which brings out a natural sheen not shown by planing.

4. "White Cedar," *Melia Azedarach*, Linn.

This wood is light in colour and weight, and has a figure and texture not at all unlike English "Elm" (*Ulmus campestris*). It is open in the grain, has large annual rings, is very easy to work, and known in the trade as Golden Cedar as well as White Cedar. It is useful for all kinds of cabinet work.

5. "Rosewood," *Dysoxylon Fraserianum*, Benth.

This wood has been extensively employed in furniture manufacture, and is so to an extent now, although it has a serious drawback in some specimens in that it "sweats," to use a trade expression. It would be a distinct gain if this objection could be removed, for it would add an otherwise most valuable addition to our cabinet timbers.

6. "Red Bean," *Dysoxylon Muelleri*, Benth.

The colour is very attractive, being of a warm red character when freshly cut, but becomes lighter in seasoning, and takes a splendid polish. It is easy to work, slightly open in the grain, and often has a decorative figure.

7. "Red Cedar," *Cedrela Toona*, Roxb.

This—the first cabinet timber used in Australia—was the pride of the early timber-getters, and was for long the champion of the brushes as regards its dimensions, but almost all the giants of its race have fallen a victim to the ruthless war of the axe-man. Traces of this monarch of the forest will, however, remain with us, for its name is perpetuated in such localities as Cedar Gully and Cedar Mountain, and these are fairly common in the Coast districts wherever the Cedar previously flourished, but is now a tree of the past.

Some of the finest office decorations, counters, etc., of Sydney, Melbourne, Brisbane, Hobart, Adelaide, and Perth, are made from Cedar. In the early days of the Colony it was used for doors, tables, wainscotting, panels, and stairs, but it is too soft for the latter.

8. "Queensland Maple," *Flindersis Chatawaiana*, Bail.

The common name might conjure up in one's mind a replica of the familiar maple of Canada; but, if so, one would err, for there is very little resemblance between these two timbers. In this instance the colour is slightly darker than the Canadian timber, and the figure, which is different, being less "bird's eye," is obtained by the waving lines caused by the interlocking texture, and is very often effective. It is fairly hard, takes a beautiful polish, and is eminently suited for all kinds of cabinet work.

9. "Black Bean," *Castanospermum australe*, A. Cunn.

Timber-getters of the two neighbouring States have given distinctive names to this wood, the northern men have bestowed the appellation of "Moreton Bay Chestnut," evidently from the seed of the pod resembling the "Horse Chestnut" of Europe, whilst the Walesian has derived his designation of it from the pod, prefixed by an adjective suggestive of the colour of the timber.

It is an attractive wood, much resembling English and American Walnut in colour and often in figure, being dark or almost black, with a pronounced grain. For doors, desks, panels, particular kinds of furniture, it is well suited, and may be regarded as a good all-round heavy cabinet timber.

10. "Blackwood." *Acacia melanoxylon*, R. Br.

As a cabinet timber for all-round usefulness this one might, perhaps, be placed next to "Red Cedar" (*Cedrela Toona*), and its utilisation in this connection dates probably almost as far back in the State's history. It can be made into beautiful furniture, as it takes a good polish, which gives it a satiny sheen, thus enhancing its often ornamental figure.

11. "Beech," *Gmelina Leichhardtii*, F. v. M.

The common name selected for this timber is unfortunate, as it is not a true "Beech," like "Negro-head Beech" of New South Wales or the "Red Myrtle" of Tasmania. It is, however, too late to alter it now. The timber, a light-grey in colour, is highly prized by the trade in general, being light in weight, durable, easily worked, and strong.

12. "Silky Oaks, (a) *Orites excelsa*, R. Br.; (b) *Grevillea robusta*.

A description of the timber of "Silky Oak" (*Grevillea robusta*) applies equally to this timber, for microscopically there is no difference. It is a timber much in request by coachbuilders and also saddle-makers, who assert that it has a capacity of holding nails not possessed by other timbers. It is strong and durable, with a beautiful figure, being suitable for any kind of office or shop fittings, general cabinet or joinery work.

13. "Hoop Pine, *Araucaria Cunninghamii*, Ait.

This Conifer is one of the giants of the "brush," and some millions of feet have been drawn from these forests since the occupation of this continent by the white man, as it is one of the few pale, soft timbers of this country. It is light in weight and colour, free working, possesses all the characteristics of a Pine timber, and is used extensively for flooring, linings, mouldings, skirtings, doors, and joinery generally, in addition to all the cheaper kinds of cabinet work. It can also be used for panelling in railway carriages. Decays quickly on exposure to dampness.

14. "Brown Pine" or "Yellow Pine," *Podocarpus elata*, R. Br.

It is a straight-growing tree in its native habitat. The timber is at first white, but tones down on exposure to a very pale-brown. It is light in weight, soft, close-grained, dresses beautifully, and is altogether a first-class pale-coloured timber for panelling.

BRUSH ON TWEED RIVER
(Bangalow Palms, with Brush Box in Centre).

The principal constructional timbers of the "brushes" are:—

"Teak," *Flindersia australis*, R. Br. This is a very hard, heavy, straight-grained, greasy timber, having a yellowish colour, and is principally used in parts of ship-building, bridges, decking, heavy goods-waggons.

"Long Jack," *Flindersia Oxleyana*, F. v. M., is a timber specifically lighter in colour and weight than "Teak."

"Brush Box," *Tristania conferta*, R. Br., is a hard, close-grained, light-chocolate coloured timber, used for wood-blocking amongst its other utilities.

"Scrub Ironbark," *Bridelia exaltata*, is an almost similar timber, but is closer grained and altogether superior to it.

"Mararie," *Weinmannia lachnocarpa*, F. v. M., is a splendid pinkish timber, hard and durable.

Some of the *Flindersia spp.* are regarded as hardwoods, and are much in request, being fairly heavy and very pale in colour.

"Negro-head Beech," *Fagus Moorei*, F. v. M., is fairly common and is in general use for heavy work.

"Red Ash," *Alphitonia excelsa*, Reisseck, is very hard and heavy, and derives its common name from its red duramen.

"Brush Bloodwood," *Balogia lucida*, Endl., may also be mentioned in this connection, although not of the best with those timbers on the market.

Amongst the principal climbing or twining plants will be found *Clematis*, with its numerous clusters of white flowers at the top of the trees upon which it has ascended. *Sarcopetalum* and *Stephenia* of the Menispermaceæ, and nearly every species of *Vitis* found in the State are recorded from the "brushes" of the North Coast. The Natural Order Asclepiadeæ contributes representatives of three genera in this class:—*Tylophora*, *Marsdenia*, and that rare genus for Australia, *Hoya australis*. Bignoniaceæ has in *Tecoma jasminoides*, with its large, white and purple-spotted, bell-shaped flowers, one of the most showy of the bush. Liliaceæ has two representatives in *Smilax* (Native Sarsaparilla) and *Rhipogonum*.

The trees and climbers have been dealt with first, as they are most characteristic of the "brushes," but the elegant "Bangalow Palm," *Ptychosperma Cunninghamii*, is none the less conspicuous, indeed, in some parts these trees are the distinguishing feature of the landscape.

Characteristic of the impenetrable undergrowth are the

Rubus spp., especially the "Bush Lawyer," *R. Moorei*, which eventually becomes a tall climber. These species are all armed with hooked prickles, which successfully prevent any rapid walking in the "brush," and one's progress is equally impeded by the "Lawyer Palm," *Calamus Muelleri*, the long stem of which forms with other smaller growth, an intricate thicket.

Orchids and Ferns are much in evidence—of the former, *Cymbidium suave* and *C. canaliculatum* are most common amongst the epiphytal specimens of this order—being found at all altitudes on trees and stumps. *Dendrobium*, *Bulbophyllum*, *Sarcochilus*, *Galeola* and other Genera are also represented.

The most conspicuous of the Filices are the tree ferns, *Alsophila australis*, and its allied species, whilst the epiphytal "Stag" and "Elk-horn" Ferns, *P. grandis* and *P. alcicorne*, respectively, are prominent features on the "brush" trees, and these, with the common *Pteris* and a few other genera, complete in a measure, the rich vegetation of the "brushes."

The Open Forest Flora.

Open Forest Country is a term that might be applied to the area not occupied by the "brush" flora, and as certain trees are the salient features of the latter vegetation, so in this case, Eucalyptus trees are the dominant factor of open forest country. Representatives of the Natural Orders endemic, so to speak, of the "brushes" are here quite absent, their places being taken by that section of the Myrtaceæ more closely allied to the Eucalyptus, such as "Tea Trees," *Melaleuca spp.*; "Apple Trees," *Angophora spp.*; "Turpentine," *Syncarpia*. "Wattle Trees," *Acacia spp.*; *Casuarinas*, and other species which go to make up a unique flora.

In this particular area of the North Coast of New South Wales there are distinct geological formations with species restricted to each, but at the same time there are some species common to several, and this is particularly the case with such species of Eucalyptus as "Spotted Gum, *E. maculata*; "Grey Ironbark," *E. paniculata*; "Tallow-wood," *E. microcorys*; "Red Gum," *E. tereticornis*; "Box," *E. hemiphloia*, etc., which occur on the Trias, Jura, Silurian and Carboniferous. The non-Eucalypts, however, do not appear to be so cosmopolitan, but show a preference for particular soils, and this especially applies to such species as *Angophora subvelutina*, and *Casuarina suberosa*. *Eucalyptus campanulata* is, however, restricted to the Permo-Carboniferous form-

BLACKBUTT FOREST (On the Road to Macksville)

ation, and other examples might be given. Of course, instances of preference and non-preference could be much extended, but space will not permit, and the subject is only touched upon in order to demonstrate how the two sciences of botany and geology can be of mutual advantage in the study of each.

Naturally, the prevailing trees of the open forest country being Eucalyptus, a large timber trade is carried on in this district. The principal Eucalyptus trees cut for timber are:—

1. "Spotted Gum," *Eucalyptus maculata*, Hook.

A greyish-yellow coloured timber, with a close grain, which is sometimes straight, but occasionally interlocked, hard, tough, and elastic. It is an excellent cabinet timber. Used for spokes, shafts, poles, swingle-trees, wood-paving, and building construction generally.

2. "Tallow-wood," *Eucalyptus microcorys* F. v. M.

A greyish-yellow timber, hard, close-grained, heavy, strong, and very durable. Good for any purpose requiring great strength. Used for shafts, wood-paving, parquetry flooring, etc.

3. "White Ironbark," *Eucalyptus paniculata*, Sm.

This species produces the best timber of all our ironbarks. Its colour varies from pale to a dark-grey. It is very hard, close-grained, and difficult to dress, and is, perhaps, the most durable of all our timbers. Used for railway sleepers, girders, and wherever great strength is required.

4. "Red Mahogany," *Eucalyptus resinifera*, Sm.

It is a fresh red-coloured timber; open free-working; in many respects very similar to "Jarrah." Used in the building trade for joists, girders, etc. A good timber for wood-paving and rusticated weatherboards.

5. "Forest Red Gum," *Eucalyptus tereticornis*, Sm.

This is a lightish red-coloured timber, with interlocked grain, being hard, durable, and heavy. It is excellent for bridge-work, wood-blocking, cartwrights' work, telegraph poles, fencing, etc.

6. "Blackbutt," *Eucalyptus pilularis*, Sm.

One of our largest forest trees, with a light-coloured timber, straight-grained, hard, strong, and very durable. Occasionally defective by the presence of small gum veins. Highly recommended for ship-work, wheelwrights, buildings, etc.

7. "Box," *Eucalyptus hemiphloia*, F. v. M.

A pale-coloured, hard, heavy, close-grained, interlocked, durable timber. Suitable for bridge-work, etc. Occurs in the eastern watershed.

8. "White Mahogany," *Eucalyptus acmenoides*, Schau.

A pale-coloured, hard, close, straight-grained, heavy timber. Suitable for building purposes, bridge-work, etc.

9. "Flooded Gum," *Eucalyptus saligna*, var. *pallidivalvis*, R. T .B. et H. G. S.

A light-coloured, straight-grained, free-working timber, often substituted for "Blue Gum," *Eucalyptus saligna*, which it somewhat resembles. Fairly plentiful.

Other Eucalypts which also occur in the north are: "Swamp Mahogany," *E. robusta;* "Grey Gum," *E. propinqua;* "Manna Gum," *E. viminalis; E. carnea; E. campanulata; E. Seeana; E. Rudderi.*

Sandy Soil (of the Coast) Flora.

At certain places along the North Coast are patches of sandy soil, evidently similar in constituents to that found near Sydney sea-shore, and belonging to the geological formation known as Hawkesbury Sandstone. The flora of these areas are almost identical. The species of *Banksias*, *Hibbertias*, *Epacrideæ*, *Cupanias*, Wattles, and those of other genera are common to all.

Swamp Flora.

Inland from, and in juxta-position to, the above districts are sometimes found extensive areas of swamp lands, and these also have their restricted floras. The prevailing trees here, almost to the exclusion of all others, are "Tea Trees," the most prominent being the broad-leaved "Tea Tree," *Melaleuca Maideni*, R. T. B., which can easily be differentiated from its congeners by the fragrant, delicious perfumes emitted from its leaves. This constituent is, however, more highly developed in its southern affinity, *M. Smithii*, R. T. B.

In concluding this all too brief outline of the plants of the North Coast district, mention must be made of the lower forms of the Vegetable Kingdom—the Fungi, Mosses, and Lichens—which present happy hunting grounds for the specialist in these "seed pearls" of Nature.

Naturally, only a portion of the flora can be touched upon in such a limited article as this is, but with greater amplitude, how much greater justice could be done to the subject? "And if, with the geologist, we were to dive into the bowels of the earth, and gaze with wonder on a flora long extinct, the very district that we have been considering, would assist us in investigating the shadowy forms which are imprinted on the rocks."

THE EUCALYPTS OF NEW SOUTH WALES.

By J. H. Maiden.

We have in New South Wales over a hundred species, those of all Australia being more than twice as many (I speak with diffidence as to precise figures, as the genus is undergoing active revision). Hardly any eastern forms extend to the other side of the continent, *E. rostrata*, the Red Gum, being an exception, travelling across by means of rivers and creeks, or places where water lies during some part of the year. *E. microtheca*, F. v. M., is another, but it does not extend so far east as *E. rostrata*.

The genus was founded on a plant which was collected in Tasmania during Cook's second voyage, but L'Heriter's first species, *obliqua*, was not described till 1788. During the very same year, the foundation of Sydney took place, but by the close of the century only about a dozen species had been described, and all (with the exception of *obliqua*) came from Port Jackson. Then came the stay of Robert Brown at Sydney, and his longer Australian voyages, chiefly of circumnavigation, but his Eucalyptus material was mislaid, or at all events, regrettably set aside for many years. Next in order we have the collections of Sieber, which were exclusively made in New South Wales, and which were described in the twenties under the auspices of De Candolle and Sprengel, together with the collections of Allan Cunningham, partly made in New South Wales. Eucalypti from that State (or Colony as it was then) were described by other botanists in the early part of the 19th century, and, being the oldest settled Colony, and the principal seat of Government for many years, it is not surprising that most of the early Eucalyptus work was based on New South Wales material; that of Tasmania and Western Australia followed. Bentham and Mueller cleared up many doubtful points in regard to New South Wales species, and workers of late years have been further engaged upon them, but much remains to be ascertained in regard to this widely diffused and protean genus.

Variation is the key-note of the genus; seedlings, juvenile and mature foliage, buds, anthers, fruits, barks, timbers, indeed every character varies. Under cultivation the plastic character of the genus is brought out in a remarkable manner. Only of late years has there been much activity in ascertaining the limitations of species, and we must confess that we are only at the threshold of knowledge of the subject, for, in the three millions of square miles (the greater part of it yet unexplored) over the surface of which these plants are more or less thickly overspread, new forms are frequently discovered, throwing light upon the development and inter-relations of species hitherto vaguely defined as "strong." Additional information in regard to particular species (a species being as yet an indefinite entity) will permit us to improve our conjectures as to their affinities, and perhaps their places in an evolutionary scheme.

Many species have adapted themselves to their environment, thus we have the tall, straight species with small canopies in those areas in the coast districts and tablelands where good soil is accompanied by a sufficiency of moisture, and sometimes with warmth in addition. In less favoured places, as in sandstone and granite areas, with shallow soils, the trees are more stunted and branched, while in alpine areas, but particularly in certain dry lands of the western division, there has been evolved the "Mallee" form, with a thickened woody root-stock, out of which springs, often radially, many thin, tough, bare stems of approximately equal diameter and length, the whole surmounted by a thin and uniform canopy. In the mountain districts, with sterile soil, the dwarf trees often take on a mallee-like character, in which the thickened root stock is almost entirely wanting.

As a rule, Eucalypts are not umbrageous. The leaves have approximately an equal number of stomata on the two surfaces, while in light-loving places, and in areas in which there is not much food-supply, they are also, by a twist of the petiole, so arranged as to but slightly obstruct the passage of light to the ground and hence, speaking generally, the genus has acquired the epithet of shadelessness.

Eucalypts may attain a gigantic size. For example, there are remains of Blackbutts (*E. pilularis*) in the Bulli district approximating 20 feet in diameter, and these must have carried an enormous amount of timber. Monster trees were those of the Lansdowne River,—Tallow-woods (*E. microcorys*), felled for timber, with the stumps still standing. Trees 250 feet in height and more were not rare in coastal New South Wales, but the height (325 feet) of the Victorian

Mountain Ash (*E. regnans*) has not, I believe, been exceeded in any other part of Australia, although some "King" Karris (*E. diversicolor*) of south-western Australia may, if scientifically measured, be found to attain an equal height. But the vast majority of Eucalypts in New South Wales will be found to be under 150 feet in height, while in the western districts a tree of 100 feet is accounted a large one.

Some few species, perhaps the descendants of denizens of tropical or sub-tropical rain forests, are very shade-giving, their foliage not dry, while their juvenile foliage in particular is horizontally disposed, with the underside pale in colour, markedly differing in this respect and in the relatively high number of stomata from the upper surfaces.

Nor are the trees of the western districts free from umbrageousness. It is hoped that some of our visitors may be able to visit them, if only, by inspection of the arboreal growth, to see for themselves how wrong it is to call these areas "desert," as is the habit of some authors, who do not speak from personal knowledge. These trees have adapted themselves to conditions of low rainfall, it is true, but a very small percentage of the area of New South Wales can properly be termed desert. To meet these dry conditions, the leaves of many of the western Eucalypts have a more or less shiny surface; this is markedly the case with the Poplar- or shiny-leaved Box (*E. populifolia*), from whose foliage light and heat rays are reflected.

The seedlings vary somewhat in shape and vestiture, so also do the adventitious shoots ("suckers," they are invariably called in Australia), but there is a parallelism between the two sets of organs which has yet to be fully worked out, while the value of the "suckers" (the term "juvenile leaves" I have preferred to apply to them, in contradistinction to "seedling leaves") for diagnostic purposes is great in experienced hands.

Most Eucalypts are heteroblastic, where the juvenile leaves are different from the mature ones, while in cases where the juvenile and mature ones are similar, the term homoblastic is applied. Instances of the latter are *E. parvifolia*, Cambage, a rare species from the highest part of the Southern Tableland, and *E. pulvigera*, A. Cunn., a dwarf, almost extinct species from the Tableland, while *E. cinerea*, F. v. M., also from the Tableland, and *E. melanophloia*, F. v. M., the Silver-leaved Ironbark from the north and north-west, are species intermediate between the two groups and doubtless extended search will disclose additional intermediate forms.

The shape of the flower bud is of great assistance to the botanist, and usually the cap or operculum (the concretion of petals, which are otherwise absent in the genus) which covers the stamens, is the most characteristic portion. This is sometimes hemispherical, but more commonly conoid, varying in length, beaked (rostrate); when much drawn out it is said to be pointed. As a very general rule the operculum and the calyx-tube are of the same diameter at the line of demarcation, but less frequently the operculum is of less diameter, and thus we have the form that I have designated (not very elegantly) "egg-in-egg-cup." Sometimes the buds (usually more marked in the fruits) are gracefully curved like an urn, and to these forms the term urceolate is applied. The buds may be warted or ribbed, and occasionally the opercula may be coloured.

Over one bud, or including a whole umbel of buds, there may often be noted, at an early stage, a membranous covering called a double operculum, and the morphological character of this organ has given rise to some differences of opinion.

The inflorescence is usually an umbel, and by the lengthening of the axis the panicle or corymb may be developed.

The anthers have two cells, which vary in size, shape, attachment, and dehiscence. In careful hands they are of considerable value for diagnostic purposes, but like every other character in Eucalyptus, they vary, and hence must be used carefully. The connective is thickened into a small gland which varies a good deal in size or in position relatively to the cells.

The filaments in the vast majority of New South Wales species are white or cream-coloured, and their colour (since there are no petals in the ordinary sense) determines that of the flower. Those of *E. sideroxylon* are very often pink or crimson in addition, and hence it is considered the most ornamental of our local species. In the western Drooping Box (*bicolor*) the filaments are often pink, as well as white, but never in anything like the abundance of *sideroxylon*. To an even less extent pinkish or purplish colouration has been seen in the following New South Wales species:—*E. hemiphloia*, Grey Box; *E. Sieberiana*, a Mountain Ash; *E. tereticornis*, Forest Red Gum; *E. Baueriana*, var. *conica*, Fuzzy Box; *E. Bosistoana*, a Yellow Box; *E. viminalis*, a Ribbony Gum In very few species the filaments are more or less glandular.

The fruit of Eucalyptus consists of a more or less enlarged tough, leathery, or woody calyx-tube, adnate to and enclosing the horny capsule. The valves or capsular teeth (*i.e.*, the tips of the capsule) sometimes protrude beyond the calyx-tube; in other cases they are flush with the top or sunk beneath the level of the calyx-tube. The calyx-tube has usually a circular sculpture or marking, termed the "rim;" this shows the original position of the operculum. The capsule has an axis which varies in length and shape. It is sometimes a column, at other times quite small. Sometimes the calyx-tube has blunt teeth, but that is unusual.

In New South Wales Eucalypts we have probably all the kinds of barks to be found in the genus, and as I have described these barks at some length in the "Federal Handbook," perhaps I may be excused from going over the ground again.

The timbers display a considerable amount of variation. They are all technically "hard woods," in contradistinction to the so-called "soft-woods" of commerce, but the distinction is not an abrupt one, while there are many grades of hardness amongst the Eucalyptus timbers themselves. The best Eucalyptus timbers (the Grey Ironbark, *E. paniculata*, is the highest type) are interlocked, heavy and dense, and cut almost like horn, while they are very durable and of great strength.

They may be of the deepest red in colour, such as some of the Ironbarks,—*creba*, Narrow-leaved Red Ironbark; *siderophloia*, Broad-leaved Red Ironbark; and *sideroxylon*, Mugga or Fat-cake Ironbark; Red Box, *E. polyanthemos;* the Red Gums, *rostrata* and *tereticornis;* New South Wales Blue Gum, *saligna;* Forest Mahogany, *resinifera;* and others.

Others may be brownish of shades, such as Blue Box, *Baueriana;* Grey Box, *hemiphloia;* Shiny-leaved Box, *populifolia*. Some are very pale, almost white, such as Blackbutt, *pilularis;* New England Blackbutt, *Andrewsi;* Mountain Ash, *Sieberiana, gigantea;* but a hard and fast line cannot be drawn between the pale and the brown ones.

While the Ironbarks, most of the Gums, Tallow-wood, and Spotted Gum (*maculata*) have interlocked or at least non-fissile timbers, those of *regnans*, var. *fastigata*, *obliqua*, *gigantea*, and the Stringybarks generally, are fissile.

Then we have at least two groups of timbers, so-called Boxes, usually with fibrous bark on the trunk, but often with nearly smooth bark; according to the colours of the timbers they may be called Pale or Red Boxes; these have interlocked timbers.

The Bloodwoods have timber which is inclined to shell, from the presence of gum-veins (which may enlarge and become pockets of kino).

In addition we have many kinds of timber, some economically valuable, some very inferior. I have elsewhere submitted provisional groupings of these, but there is not space to deal with them exhaustively here.

The term Gum is often used by writers as if it were synonymous with Eucalyptus, but this is by no means the case. It is usually only applied to species with barks smooth or nearly so. As a matter of fact, the barks of very few indeed are quite smooth, most species having more or less rough bark (usually hard-scaly or ribbony) at the butt. The word Gum is usually prefixed with an adjective, which is not employed according to a fixed rule. Thus, if the bark be white, the tree may be called White Gum (*hæmastoma, coriacea*); if the foliage be glaucous or blue, we have Blue Gum (*globulus*); if the bark be, by comparison, blue, we have also Blue Gum (*saligna*); yet no timber is called Red Gum because of the colour of its bark, but of its timber (*rostrata, tereticornis*); while in Western Australia their Red Gum (*calophylla*) is so called because of neither timber nor bark, but because of the profusion of kino which exudes. As a matter of fact it would not in the eastern States be called Gum (certainly not Red), since it is a rough-barked tree and has pale timber.

Some obvious character, such as broad-leaved, poplar-leaved, narrow-leaved, lead-coloured, is occasionally prefixed to Gum, while to indicate softness or sappiness of bark or timber, or perhaps of both, the prefix cabbage is not rarely applied (*hæmastoma*, var. *micrantha, coriacea*). This by no means exhausts all the designations, for the bushman feels himself at liberty to apply almost any prefix to a Gum.

The inelegant word "bastard" is applied to timbers, and especially to Eucalyptus, by Australians to an extent equalled in no other part of the world. It must be borne in mind that a civilised race has only come into contact with these trees during very recent times, and they are very different to those in any other country. With difficulty the first workers amongst them gave names to certain trees or groups of trees, such as Ironbark, Box, Blackbutt, Blue Gum, Red Gum, and constituted these as types in their own amateur way, at all events, over more or less limited areas. Then, as a man's experience widened, it dawned upon him that certain trees or timbers did not conform to the standards he had set up. His nomenclature had been used up, and yet he wished to indicate resemblance to his prototypes, and so some ingenious person first thought of the prefix "Bastard," and it has stuck to Australian trees with remarkable pertinacity. Originally there was no idea of cross-pollination, but the use of the term in the mouth of the intelligent bushman may, in some cases, afford a suggestion to the botanist. As a rule, however, the term merely means a difference from an accepted standard, however arrived at, and this difference may be brought about by environment as well as by polliniation.

I now proceed to give a rough and ready classification which may be of some little use in a general way to visitors whose time is short. I have taken two obvious characters; general appearance of the bark, and size of plant, whether shrubby or not. It would be out of place in a sketch of this sort, to go much into specific details.

Ironbarks.—These have corrugated, indurated barks, either grey or black externally. They include *E. paniculata*, Sm. (White or Grey Ironbark), with pale-coloured timber, and the commonest Ironbark about Sydney. *E. siderophloia*, Benth. (Broad-leaved Ironbark), with coarse foliage, is found in the western suburbs and further afield, especially on the Northern Rivers. *E. crebra*, F. v. M. (Narrow-leaved Ironbark), has pendulous foliage and is widely diffused all over the State. Both this and the preceding one are known as Red Ironbarks from the colour of their timber. *E. melanophloia*, F. v. M. (Silver-leaved Ironbark), is a somewhat straggly tree, found chiefly in the north-west, in regions of low rainfall; it does not occur near Sydney. *E. sideroxylon*, A. Cunn., is found in the Sydney district to the south, sparingly, but chiefly on the western slopes of the State. *E. Sieberiana*, F. v. M. (a Mountain Ash), common in the South Coast districts, is placed here because where it attains its best development, its bark strongly resembles that of an Ironbark. It has a pale timber.

Stringybarks.—These are trees with thick, rather loose fibrous barks. They include *E. eugenioides*, Sieb., and *E. capitellata*, Sm.; common about Sydney, and well diffused in the coastal districts and tablelands; *E. macrorrhyncha*, F. v. M., a common species of drier, elevated districts of the interior; *E. Muelleriana*, Howitt (Yellow Stringybark), found south, west and north of Sydney in coldish situations; *E. obliqua*, L'Herit. (Messmate; a term often applied to Eucalypts, and originally intended to refer to one species being associated or "messmating" with another), common on the Southern Tableland, and not rare in New England; *E. acmenioides*, Sieb. (White Mahogany), found in the North Coast districts and Tablelands; *E. resinifera*, Sm. (Red Mahogany), found about Sydney, not proceeding far south, also in the Blue Mountains at a moderate elevation, but commonly in the North Coast forests; the colours of these so-called Mahoganies refer to their timbers; *E. microcorys*, F. v. M. (Tallow-wood), because of the greasy texture of its timber, which is interlocked, and one of the most valuable timbers of New South Wales and, indeed, of Australia. It occurs in the coast forests north of Broken Bay.

WOOLLYBARKS.—By this term I refer to barks which are matted and comparatively smoothish externally, not with the fibres longitudinally disposed and coarse, as in the preceding section. These include *E. pilularis*, Sm., the common Blackbutt of Sydney and the coast districts, yielding a valuable timber; *E. piperita*, Sm., Sydney Peppermint, common on poor sandstone, chiefly to the south, very inferior for timber; *E. hemiphloia*, F. v. M. (White Box), on the better soils of the County of Cumberland and further south; in its variety *albens*, it occurs over enormous areas on the Tablelands and western slopes. *E. longifolia*, Lk. and Otto (Woollybutt) is a large-fruited, red-timbered species found chiefly south of Sydney—in the coast districts. *E. Stuartiana*, F. v. M. (Apple Tree) and *E. elaophora*, F. v. M. (Bundy), extensively diffused on the Tableland, the former on flats, the latter on hills; *E. amygdalina*, Labill. and *E. dives*, Schauer, narrow and broad-leaved Peppermints respectively, common on the Tablelands. E. Andrewsi, Maiden (New England Blackbutt). *E. cinerea*, F. v. M. (Argyle Apple), found on the Southern Tableland, north of Bathurst; its variety, *nova-anglica*, common in New England. *E. gigantea*, Hook f. (Tumberumba Mountain Ash); and *E. regnans*, F. v. M., var. *fastigata* (Cut Tail), both yielding fissile timbers, the latter occurring in the coldest parts of the Southern Tableland and on the basalt-capped outliers of the Blue Mountains, where it forms huge trees. *E. Baueriana*, Schauer (Blue Box), in the south coastal strip, and its variety, *conica*, found in the Northern Tableland; *E. polyanthemos*, Schauer (Red Box), widely diffused on the Tablelands and *E. Rudderi*, Maiden, closely allied to the preceding, but with narrower leaves, and chiefly occurring east of the coast ranges and north of Sydney; *E. melliodora*, A. Cunn., the common Yellow Box of the Riverina, Tablelands and Western Slopes, so called because of the yellowness of its inner bark. *E. populifolia*, Hook f. (Bimble or Shiny-leaved Box); *E. microtheca*, F. v. M. (Coolabah) and *E. bicolor*, A. Cunn. (Drooping or River Box) are also species of the Western Plains. *E. robusta*, Sm. (Swamp Mahogany); *E. botryoides*, Sm. (Bangalay) and *E. Planchoniana*, F. v. M. are coast species, the last being large-fruited and local on the Northern Rivers and Tableland.

Bloodwoods.—These trees have scaly barks, and they exude a reddish, pulverulent kino so freely (that of *maculata* is greenish) that the tree often looks blood-stained. *E. corymbosa*, Sm., is common about Sydney and on the sandstone north and south; *E. terminalis*, F. v. M., is an interior form, found on the summits of hills on the Western Plains. *E. eximia*, Schauer (Yellow Bloodwood), found on the Blue Mountains and its spurs; its bark has a very yellowish cast. *E. trachyphloia*, F. v. M. (White Bloodwood), found only in the north-western districts. *E. tessellaris*, F. v. M. (Carbeen), from the same localities; the specific name is owing to the fact that the bark of the lower part of the trunk is blackish and in cubical pieces like tesseræ; *E. maculata*, Hook. f. (Spotted Gum) is a smooth-barked species with blotches, it has not the true Bloodwood's bark, but is closely related to the Bloodwoods.

Grey Gums.—*E. punctata*, DC. and *E. propinqua*, Deane and Maiden, are the common Grey Gums of New South Wales, the former of the Sydney district and the South and North Tableland, the latter from the North Coast districts. They have blotched grey bark, the grey portion being rough and giving the trunk a characteristic appearance.

Gums in General.—We have a lengthy list of trees with smooth or nearly smooth barks, and I will give notes on the chief of them. *E. hæmastoma*, Sm., and its variety *micrantha* (White Gum), found in the coast districts and Tablelands. *E. coriacea*, A. Cunn. (Cabbage Gum), and *E. stellulata*, Sieb. (Sally), the former a White Gum and the latter with a green or lead-coloured stem; both are found in the coldest districts. *E. Smithii*, R. T. Baker (Gum Top), a tall species of the Southern Tableland, rich in oil; *E. globulus*, Labill.; and *E. Maideni*, F. v. M. both Blue Gums of the Southern Tableland, the former common in Tasmania and Victoria also. *E. goniocalyx*, F. v. M. (Mountain Gum), a ribbony Gum, is found in valleys on the Southern Tableland. *E. saligna*, Sm. (Sydney Blue Gum), is a species of the coastal districts which grows in rich soil, and its red timber at once distinguishes it from the Blue Gums just referred to. It has a variety with glaucous fruits, known as Flooded Gum. *E. Deanei*, Maiden (Brown Gum), chiefly occurring on the Northern Tableland, is an umbrageous species allied to the preceding, and *E. rostrata*, Schl. (River Gum or Red Gum), the widest diffused Australian Eucalypt, is the most gregarious Eucalypt of New South Wales, forming the principal timber of the Murray River flats. *E. tereticornis*, Sm. (Forest Red Gum), is a species which grows in drier situations, has a number of more or less marked varieties, and, in one or other of its forms, has an extensive range. *E. intertexta*, R. T. Baker (a Red Box), is found in the Bogan district.

MALLEES.—This term has been already explained. This dwarf vegetation is relatively unimportant, and occurs on the Western Plains, some of the species being very gregarious. The four chief dwarf species are *E. uncinata*, Turcz., *oleosa*, F. v. M., *calycogona*, Turcz., var. *gracilis*, and *E. incrassata*, Labill., var. *dumosa*. *E. Morrisi*, R. T. Baker, occurs in the Bogan country; *E. acacioides*, A. Cunn. (*viridis*, R. T. Baker), is found on the Western Plains and also on the Western Slopes. *E. odorata*, Behr, occurs on the Western Plains and Slopes; and *E. Behriana*, F. v. M., is a taller smooth-barked Mallee occurring amongst other Mallees at Wyalong.

OTHER DWARF SPECIES.—These include *E. virgata*, Sieb., and its varieties, a form with blunt operculum (*E. obtusiflora*, DC.) and the common Blue Mountain form, *E. stricta*, Sieb.); *E. Moorei*, Maiden and Cambage, a Blue Mountains species with narrow leaves, allied to *E. stellulata*, and *E. pulvigera*, A. Cunn., a disappearing species, known only from two localities between the Blue Mountains and Bathurst.

FERNS, MOSSES, AND HEPATICS.

By Rev. W. Walter Watts.

I. Mosses.

The Moss Flora of New South Wales has had closer attention, within the last 25 or 30 years, than that of any other of the Australian States, excluding Tasmania. Many new records, and numerous new species, have been added during this period, through the labours of Mr. Thomas Whitelegge, the late Mr. W. Forsyth, and others. For many years, we have been indebted to Dr. V. F. Brotherus, of Helsingfors, for the determination of material collected from all parts of the State. Previously, the late Dr. C. Mueller, Mr. W. Mitten, Dr. Hampe and, in a less degree, Prof. Geheeb, had rendered invaluable service.

The position of New South Wales, lying, as it does, between Queensland, on the north, and Victoria and Tasmania, on the south, invests our flora with peculiar interest. Two distinct streams of moss-life can be traced within our borders; the one flowing upwards from the south, the other working downwards from the tropical and sub-tropical north. As would be expected, the southern stream is more in evidence in the far south of the State, where it exists with very little admixture of northern species. In the same way, the northern rivers reveal most distinctly the flow from the tropics, but in this case there is a considerable representation of southern species, though often in an enfeebled form.

It is from the south that there come the species that belong to the northern hemisphere. *Leptobryum pyriforme* has been found as far north as Sydney. *Pohlia nutans* and *P. cruda* occur in the south and on the Blue Mountains. *Polytrichum commune* and *P. juniperinum* are here; the latter the more frequent and widespread. *Tortula muralis*, in its typical form, comes from Mount Kosciusko, and it is found elsewhere in a form named by Dr. Mueller, *T. austro-muralis;* it gradually disappears north of Sydney. Other European species which come under the same rule are: *Ceratodon purpureus*, *Distichium capillaceum*, *Gymnostomum calcareum*, *Tortula princeps*, *Grimmia apocarpa*, *Rhacomitrium lanuginosum*, *Bryum bimum*, *Mnium rostratum*, *Hedwigia* *albicans*, *Hedwigidium imberbe*, *Aulacomnium palustre*, *Zygodon intermedius*, *Leptodon Smithii*, *Brachythecium plumosum*, *rivulare*, *rutabulum*, and *salebrosum*, etc. Their occurrence as part of the stream from the south is a problem of much interest.

From the south come also numerous species known in Tasmania or Victoria, or both, some of them with a New Zealand range. Without any attempt to give an exhaustive list, the following species may be mentioned: *Dicranoloma Billardierii*, *Menziesii*, and *Sullivani*, *Fissidens rigidulus*, *pallidus* and *ligulatus*, *Tortella Knightii*, *Barbula pseudo-pilifera*, *Zygodon Brownii*, *Funaria tasmanica* and *apophysata*, *Campylopus clavatus* and *bicolor*, *Barbula calycina*, *Breutelia affinis*, *Pterygophyllum nigellum*. *Acrocladium chlamydophyllum*, *Campylium relaxum*, and *decussatum*, *Papillaria flavo-limbata*, *Echinodium hispidum*, *Hypnodendron spininervium*, *Mniobryum tasmanicum*, *Oxyrrhynchium austrinum*, *Bartramia Mossmanniana* and *papillata*, *Calyptopogon mnioides* (only recently recorded, from Mount Wilson), *Tridontium tasmanicum*, *Rhizogonium mnioides* and *Novæ Hollandiæ*, *Eriopus apiculatus*, and many more.

The northern stream carries with it a considerable number of *Macromitria*, which gradually blend with those from the south, many *Fissidentes* and *Brya*, and much besides. Many of our most beautiful mosses come from the north, some of them reaching well to the south, while others do not seem to have got below the Northern Rivers. Among these northern species may be mentioned *Braithwaitea sulcata*, *Endotrichella Dietrichiæ* and *lepida*, *Beschcrellea Cyrtopus*, *Barbella trichophoroides*, *Euptychium cuspidatum*, *Hampeella pallens*, *Syrrhopodon fimbriatulus*, *Fabronia Scottiæ*, *Thamnium eflagellare*, and many more. The collector on the Northern Rivers is in quite a different Moss atmosphere from that of the far south, and it is most interesting to tap the coast flora at different points and note the trend of species.

Among the noblest of our Mosses, stand the *Dawsoniæ*, of which *D. polytrichoides* and *longiseta* appear to have northerly relations.

Great interest attaches to the considerable number of small ground mosses to be found in different parts of the State, especially on the south-west tablelands. Among these may be mentioned *Gigaspermum repens*, *Goniomitrium enerve* and *acuminatum*, *Acaulon Sullivani*, *robustum*, *crassinervium*, *Ephemerum cristatum*, *Eccremidium pulchellum*, *Nanomitrium brisbanicum*, *Ephemerum Whiteleggei*, *Trachycarpidium Novæ Valesiæ*, *Pleuridium nervosum*, *brachycaulon*, etc.

Even from this necessarily meagre sketch, it will be gathered that the Moss Flora of this State is of the most varied and interesting character, the blending of the northern and southern streams, in particular, having a fascinating attraction for the student.

Hepatics.

Only the briefest reference can be made to the Hepaticæ. These plants, very beautiful and interesting though many of them are, have not had the attention given to them that has been bestowed upon the mosses. We have a large number of species; and what applies to the mosses applies also to the hepatics; the northern species differ much from the southern. Many years ago, Messrs. Carrington and Pearson described several new species that had been collected by Mr. Whitelegge; but nearly all the later work has been done by Dr. F. Stephani, the well-known expert in hepaticology. A large number of new species have been set up by him, and many species recorded that had not previously been found in this State. This field awaits workers, and collectors may be assured that many new species are likely to reward their labours.

Ferns.

The Ferns of New South Wales, like the Mosses and Hepatics, present both northerly and southerly relations, but the species show, for the most part, a wider range of geographical distribution. We have about 125 species, with a few varieties, belonging to the following families:—

I. Hymenophyllaceæ.—Ten species of *Trichomanes* and seven of *Hymenophyllum* are recorded. Most of the Trichomanes come from the north, while the Hymenophylla come mostly from the south. T. vitiense, parvulum, and rigidum are found on the Northern Rivers, where apparently T. omphalodes (peltatum, Bak.) and T. Bauerianum have also been collected. T. caudatum, common in the north, ranges southward to Illawarra. T. javanicum also occurs here and there. T. venosum, humile, and digitatum belong to the south and to the Blue Mountains. H. flabellatum and australe range from Tasmania to North Queensland. H. tunbridgense is frequent. H. pumilum is found on Mount

Tomah and at one or two other places; it grows in profusion on Mount Gower, Lord Howe Island. H. rarum and bivalve have both been collected as far north as Illawarra. And recently the elusive H. marginatum has been found at three places on the Blue Mountains; it also comes from the south.

II. CYATHEACEÆ.—Among the tree-ferns *Dicksonia* antarctica, with its thick stem and narrow pinnæ, reaches as far north as southern Queensland; it is plentiful on the Blue Mountains. D. Youngiæ, a handsome species, occurs on the Northern Rivers and Mount Lindsay, and reaches south as far as the Hawkesbury River. Our only *Cyathea* is C. Lindsayana, from Mount Lindsay. Our *Alsophilæ* are the prickly A. Leichhardtiana, common in the coastal districts and the Blue Mountains; the softer A. australis; and A. Cooperi, with its scarred stem.

III. POLYPODIACEÆ.

1. WOODSIEÆ.—*Cystopteris* fragilis, the little "Bladder Fern," from Tasmania, has been found on the Snowy Mountains in the far south.

2. ASPIDIEÆ.—This tribe is represented by nine species of *Dryopteris*, whose affinities lie mostly in the north, and four species of *Polystichum*, which, with the exception of the tropical P. aristatum, belong to the south. The species are Dryopteris decomposita, tenera, setigera (tenericaule, Thw.), punctata, Baileyi (Polypodium aspidioides, Bail.), gongylodes (unitum, Sw.), parasitica (Aspidium molle, Sw.), truncata, and prolifer; Polystichum aculeatum, which reaches to Queensland, aristatum, adiantiforme (Aspidium capense, Willd.), and hispidum. The last two species (Tasmanian) have been collected on Mount Wilson.

3. DAVALLIEÆ.—The two climbing Ferns, *Arthropteris* tenella (Polypodium, Forst.) and obliterata (Aspidium ramosum Palis.) are northern species. Bailey's var. Eumundi of A. obliterata has been found on the Richmond River. *Nephrolepis* cordifolia is common throughout the State. *Dennstædtia* davallioides is frequent along shady watercourses. *Davallia* pyxidata ("Hare's Foot) has northern affinities; D. dubia ("Mountain Bracken") occurs throughout Australia and Tasmania. The genus *Lindsaya* is represented by five (or six) species, viz., L. linearis, microphylla, cuneata, incisa, dimorpha, and perhaps cultrata, which has been recorded for the Northern Rivers. All these, except L. linearis, link themselves with the north. L. microphylla is common about Sydney, but is limited in its southern range.

L. cuneata has been found near Bulli and Mount Kembla, and even as far down as the Clyde River.

4. Asplenieæ.—*Athyrium* umbrosum and *Diplazium* maximum, both handsome species, come from the north. Diplazium japonicum has been recorded from the Richmond River. Ten species of *Asplenium* are found in the State, of which A. nidus, adiantoides (falcatum, Lam.), attenuatum come apparently from the north, travelling far to the south; while A. trichomanes, flabellifolium, obtusatum, Hookerianum, præmorsum (furcatum, Thunb.), bulbiferum and flaccidum are southerly species with a good northerly range. *Pleurosorus* rutifolia is found throughout the State. The genus *Blechnum* (including Lomaria) gives us B. cartilagineum, lævigatum, serrulatum, Patersoni, discolor, lanceolatum, penna-marina (alpina, Spreng.), capense and fluviatile. Nearly all these have a southern range, but some of the southern species reach as far as Queensland. B. serrulatum is a northern species, and B. Patersoni ranges from Tasmania to the tropics. *Doodia* aspera and caudata are widespread species, while D. maxima (D. aspera, var. blechnoides F. v. M.) appears to be limited to the Northern Rivers.

5. Pteridieæ.—*Pellæa* falcata and P. paradoxa (a striking form) reach, from the north, well to the south. *Doryopteris* concolor (Pteris geraniifolia Raddi), a tropical species, has been found in New England. *Anogramma* leptophylla, widespread in the south, has been collected on the Shoalhaven River, and on the Warrumbungle Ranges. *Cheilanthes* tenuifolia and *Hypolepis* tenuifolia are common north and south. The genus *Adiantum* gives us A. æthiopicum, formosum, diaphanum, hispidulum, and affine, most of them with a wide range. *Pteris* longifolia, umbrosa, tremula, tripartita (marginata Bory) and comans occur, with *Histiopteris* incisa ("Batswing") and *Pteridium* aquilinum. Pt. comans is a southern, and Pt. tripartita a northern, species, the latter rare in New South Wales.

6. Vittarieæ.—*Vittaria* elongata is our only species of this section. It is fairly frequent in the scrubs of the Northern Rivers, or what is left of them.

7. Polypodieæ.—*Hymenolepis* spicata (Acrostichum, L.), a northern species, has been found on the north coast of this State. The genus *Polypodium* gives us P. australe and P. grammitidis, southern ferns with a good reach to the north, P. Brownii (attenuatum, R. Br.), a northern species some-

what rare in New South Wales, P. pustulatum from the south, and P. diversifolium (scandens, Labill.), which is very plentiful and has a wide range. This last species Christensen, in his Index Filicum, erroneously identifies with P. pustulatum. *Cyclophorus* serpens and confluens are frequent species and are found both north and south. *Drynaria* rigidula is a Queensland fern, but it reaches to the Blue Mountains.

8. ACROSTICHIEÆ—*Acrostichum* aureum, common in the coastal swamps of Queensland, is found on the Northern Rivers. *Platycerium* alcicorne and P. grande are among the most characteristic ferns of Australia. Both are northern species, P. alcicorne having the most southerly range.

IV. PARKERIACEÆ.—This family is represented by the northern *Ceratopteris* thalictroides, "an annual aquatic or sub-aquatic tufted fern" (Bailey). It appears to have been found on either the Northern Rivers or the Northern Tableland.

V. GLEICHENIACEÆ.—The genus *Gleichenia* is represented by six species: G. platyzoma (Platyzoma microphyllum), a tropical species, has found its way across the northern border. G. circinata and dichotoma (linearis) occur in many parts of the coast districts, the former having the widest distribution. G. flabellato and dicarpa are also found both north and south; and G. flagellaris has been collected in two or three localities, including Mount Lindsay. G. circinata, var. microphylia has been collected on Mount Wilson.

VI. SCHIZÆACEÆ.—We have four species of *Schizæa*. S. dichotoma and bifida are fairly plentiful; both have a tropical range, and S. bifida is also found in Victoria and Tasmania. G. rupestris occurs on the Blue Mountains, in Illawarra, etc. S. fistulosa is recorded for the south. Lygodium scandens, an immigrant from the north, is to be met with occasionally on the edges of swamps on the Northern Rivers, climbing over bracken and bush.

VII. OSMUNDACEÆ.—*Todea barbara* and *Leptopteris* Fraseri are our representatives of this family, the former ranging from Tasmania to north Queensland; and the latter, one of our most graceful ferns, growing in the deep gullies of the Blue Mountains, at Belmore Falls, and in New England. It has also been found as far north as Bellenden Ker.

VIII. MARATTIACEÆ.—The tropical *Angiopteris* evecta has been found on the Tweed River, but it is rare indeed in New South Wales.

IX. Ophioglossaceæ.—*Ophioglossum* vulgatum has generally been regarded as occurring in this State, but we are now credited with O. coriaceum and O. costatum instead, and there may be other species. O. pendulum has found its way from the far north into the northern districts of this State. *Botrychium* australe (B. ternatum of Hook and Bak.) occurs on the Northern Rivers and elsewhere, and B. lunaria on the southern Dividing Range.

SOME FUNGI AND LICHENS OF NEW SOUTH WALES.

By Edwin Cheel (National Herbarium).

The Fungus Flora of New South Wales is of special interest to those concerned in nature study, because of the varied climatic conditions, as well as the vast areas of forest lands with numerous deep gullies or gorges, which are usually strewn with rotten logs and rich leaf mould, on which most of the larger and most conspicuous epiphytic and saprophytic fungi live.

In addition to the vast area of forest lands, we have very extensive areas of land under cultivation with fruits and cereal crops, as well as enormous tracts of pasture land, in which numerous species of microscopic fungi, as well as the larger kinds, are found, a large number of which are of economic importance, owing to the ravages caused to the crops, which are frequently of serious consequence to the commercial industries.

If we review the "Handbook of Australian Fungi" published by M. C. Cooke in 1892, it will be seen that the names and descriptions of upwards of 2,000 species are given for Australia; and of this number, representatives of about 38 families, 150 genera, and 418 species and varieties are recorded for this State. In the adjoining States of Victoria and Queensland, however, there are, according to McAlpine's "Systematic Arrangement of Australian Fungi," published in 1895, 1,070 and 1,060 species respectively, for these two States.

Since the publication of the above-mentioned works, a considerable number of species have been recorded for this State which had previously only been recorded for the other States, so that we may reasonably expect that when the Census which is now being prepared is completed, that the known species will be not only as large as that of Victoria, but probably larger, owing to the number of sub-tropical species found in the northern parts of the State, which will not be found in Victoria.

In the following brief review, only a few of the most common, as well as the most conspicuous, can be mentioned, as space will not permit of much detail matter.

Agaricineæ.—This family, popularly known as "Mushrooms" or "Toadstools," is particularly rich in individual specimens, as well as in species, and includes a number of forms common in Europe, which have become naturalised in our pasture lands throughout the State. The most common species in the neighbourhood of Sydney are the "Shaggy Mane," *Coprinus comatus;* "Common Mushroom," *Agaricus campestris;* "Parasol Mushroom," *Lepiota procera;* "Inky Agaric," *Coprinus atramentarius;* and a number of coprophilous species, including *Stropharia stercorarius* and *S. semiglobata*, which are both more or less common everywhere on horse droppings.

On fallen logs in the dense "brush" lands in the neighbourhood of Otford, Stanwell Park, and Bulli, on the South Coast, as well as at Gosford and Wamberal, on the North Coast, there are quite a number of beautiful rich-coloured species of endemic Agarics.

In the Tea-tree scrub around Sydney, some fine specimens of *Lepiota ochrophylla* and *Russula emetica* are frequently seen, and in the deep gullies at National Park and the Blue Mountains and Southern Tablelands, the most common species are *Paxillus paradoxa* and *Volvaria speciosa.* In the gardens and parks of the Metropolitan District, the "Honey-coloured Agaric" (Armillaria melleus) and *Psathyrella disseminata* are frequently seen; the former, chiefly are at the base of willows and other cultivated shrubs; and the latter, at the base of *Erythrina spp.* Both of these are destructive parasites. On the trunks of *Casuarinas* and other trees with rough bark, some beautiful minute white or yellowish-coloured Agarics of the genus *Mycena* are frequently found. On fallen logs of *Melaleuca* several species may be found, chiefly of *Pholiota* or closely-allied genera. Our stately *Eucalyptus* tree-trunks are frequently invested with clusters of *Pleurotus candenscens*, which during a dark night gives off a pale, livid light, sufficiently powerful to enable the time on a watch to be seen by it.

In "brush" forests in the neighbourhood of Richmond and Tweed Rivers, the mossy trunks and branches of trees are sometimes over-run with the sterile rhizomorphs of the so-called "Horse-hair Fungus," *Marasmius equi-crinis.*

Polyporaceæ.—This family is very rich in species, and is of special economic importance owing to the harmful effects of several species which destroy the heart wood of our best timbers. *Polyporus eucalyptorum* is a fairly common species, and is frequently found on various Stringybarks. The sporophore is of a whitish colour, and of a soft nature, and the sterile mycelium is in thin whitish sheets in the centre of the trunks, wrapped around the heart wood, which is more or less decayed.

Several species of *Fomes* are also found on the trunks of various Eucalypts, and bushmen frequently find small sheets of brownish, felt-like mycelium in the heart wood, which it is reasonably supposed to be the sterile mycelium of the brownish bracket-like sporophores. In former days the felt-like masses of mycelium were known under the name *Xylostroma gigantea*, but quite recently the writer has succeeded in getting a specimen of timber with the sterile mycelium and sporophore *in situ*.

On fence rails, and occasionally on stacked timber exposed to weather, quite a number of specimens of *Trametes lactinea*, *T. ochroleuca* and *Polystictus cinnabarinus* may be gathered. The latter species is very common, and fallen branches of *Melaleuca* spp. are frequently penetrated with the cinnabar-coloured mycelium of this species.

Polystictus oblectans is also very common in the coastal districts and on the Tablelands, and is chiefly found on the ground amongst decaying branches.

The Sclerotia of *Polyporus Mylittæ*, which is commonly known as "Blackfellow's" or "Native Bread," is occasionally collected by orchardists when tilling their land, but the sporophores are of very rare occurrence.

Several species of *Boletus* are found in the neighbourhood of Sydney, the most common is *B. granulatus*, which is usually found under Pine Trees, which seems to indicate that a symbrotic relation exists between this species and *Pinus* spp. *Boletus lacunosus* is found on the Blue Mountains and the Southern Tablelands. The closely-allied genus, *Strobilomyces*, of which there are two species, is also found on the Southern Tablelands, and, occasionally, nearer the coast.

THELEPHORACEÆ.—Several species of this family are to be found in the "brush" forests; the most common species is *Stereum lobatum*, and several species of *Hymenochæte*.

In the "brush" forests on the northern rivers, some fine specimens of *Thelephora caperata* are occasionally collected.

GASTROMYCETES.—This tribe is well represented, and includes a large number of species of the families *Lycoperdaceæ*, *Sclerodermataceæ*, *Hymenogastreæ*, *Nidulariaceæ*, and *Phalloideæ*. The last-mentioned family is particularly interesting and rich in species.

During the rainy weather in January and February, the bizarre characters of these fungi are peculiarly attractive. The two most common species are *Aseröe rubra*, which somewhat resembles a sea-anemone, and *Clathrus cibarius* and the variety *gracilis*. The latter variety is very common, and is familiarly called the "Lace-ball Fungus." *Lysurus australiensis* is sometimes called "Dead-man's Finger." It is not quite so common as the two previous species, but some very interesting variations have been found. Specimens of the genera *Dictyophora* and *Jansia* are occasionally found in Port Jackson.

UREDINEÆ.—This family embraces a large number of microscopic parasitic fungi, which are so destructive to our cereal crops, as well as a number of other cultivated plants. A number of weeds and native plants are also infested with the æcio-uredo or telia stage of these "Rusts."

USTITAGINEÆ.—This family includes the fungi which caused the disease known as "Smuts," and like the "Rusts" causes an immense amount of damage to various crops.

About 97 species of "Rusts" and "Smuts" are recorded for New South Wales, and are included in "The Rusts of Australia" and "The Smuts of Australia," published by D. McAlpine.

These two works are illustrated, and the particulars concerning them are so good that there is no need to make any further mention of them here, except to say that 61 species of the 97 records, are now represented in the National Herbarium collection.

ASCOMYCETES.—This group is very plentiful, but very little has been done in working out the species. Some fine specimens of *Peziza vesiculosa*, *Morchella conica*, *M. esculenta* and *Hirneola polytricha* are frequently collected.

MYCETOZOA OR MYXOMYCETES.—Under the above names are included a number of species of minute organisms, which are generally considered an independent group, holding an intermediate position between plants and lower forms of animal life, and have in consequence been termed *Mycetozoa* or Fungus-animals. By some people they are called "Slime Fungus," while others prefer the pet name, "Myxies."

They are extremely interesting, and occasionally some very fine specimens are collected in the Port Jackson District or on the Blue Mountains and Southern Tablelands.

The most common species is *Physarum cinereum*, which, during the months of December, January, and February, is found in many parts of the State, over-running grasses and various weeds in patches varying from one to four feet in diameter.

Stemonites fusca and *S. ferruginea* are occasionally seen in decaying logs in the neighbourhood of Parramatta and the Sydney Botanic Gardens.

Arcyria punicea, a pretty little reddish-coloured species, and *A. nutans*, a yellowish-coloured species, are both fairly common on decaying vegetable matter.

Fuligo varians, the so-called "Flowers of Tan," is occasionally seen over-running the beds of tan bark in glass-houses and also on tea leaves thrown on the rubbish heap in back yards.

In the National Park, one occasionally sees specimens of *Lycogala epidendron* on the trunks of trees, which at first sight very much resembled a small brownish-coloured "Puff-ball."

Entomogenous Fungi.

Several species of fungi are known to attack insects, and in this State some remarkable forms have been found, and may be of economic importance when properly studied.

The largest and most conspicuous form in this State is *Cordyceps Gunnii*, which is found in the neighbourhood of the Kurrajong Heights and various other localities. It is usually found on caterpillar and pupa of a large moth, *Pielus sp.* Another species also found in the same locality is *C. Selkirki.* This species has also been found at Willoughby, and very closely resembles the New Zealand species, *C. Robertsii*, which is sold there in curiosity shops under the name "Awheto." Other species of economic importance are the so-called "Brown Fungus" (Myriangium sp.) and Microcera sp., both of which are found in the Port Jackson District. At the present time these are receiving special attention in the United States of America on account of their parasitic nature on scale insects which attack Citrus crops.

LICHENS.

Owing to the dryness of the climate and the crumbling nature of the sandstone rocks, the Lichen Flora in the neighbourhood of Sydney is not very rich in individual specimens, but although the individual plants are not so numerous, they represent a considerable number of species.

Along the foreshores of the harbour and at Long Bay and other pleasure resorts, some specimens of *Xanthoria parietina* may be gathered, and on twigs of Tea-tree bush, *Kunzea corifolia;* some specimens of *Theloschistes chrysopthalma* may also be gathered. Both these species are of a rich-golden or orange-yellow colour.

On the ground of the Wianamatta shale series in the neighbourhood of Hurstville, Bankstown, and Flemington, some fairly large patches of *Heterodea Muelleri, Clathrina aggregata and Cladonia diffissa* may be found. On charred logs partially buried in the soil, some very fine specimens of *Thysanothecium hyalinum* and *Cladonia bacillaris* are seen.

The latter species is very interesting and pretty, as the apothecia somewhat resemble the red heads of a wax match. On old fence rails some fine specimens of *Parmelia placorhodioides* and *Anzia augustata* and *Usnea scabrida* may be collected.

On the Manly heights, via The Spit, a fine patch of *Clathrina retipora* may be seen. This is a most beautiful lichen, and well worth a special visit.

In the deep gullies and creeks of National Park and the deep gorge at Waterfall, some specimens of *Sticta* (*Stictina*) *Weigeli*, *S. cinammomea*, *S. cyphellulata*, and *S. endochrysea* var. *flavicans* may be collected. Several species of *Physcia*, *Pseudophyscia* and *Pannaria* may also be collected, as well as a rich harvest of specimens of various species of *Parmelia*. Individual specimens of *Parmelia tinctoria* are occasionally very fine, and also *P. limbata*.

On the mossy rocks are numerous species of *Cladonia*, including *C. furcata* and its varieties as well as several forms of *Cladonia pyxidata*. Quite a number of *Lecideas*. *Lecanoras* and *Pertusaria* may also be collected, as well as a number of *Graphideeas*.

On the Blue Mountains and Southern Tablelands above 2,000 feet altitude, some interesting specimens of *Amphiloma* and *Rhizocarpon geographicum* may be obtained, as well as some specimens of *Peltigera polydactyla* and *Leptogium tremelloides* in the deep, moist creeks.

MARINE ALGÆ.

By A. H. S. Lucas, M.A., B.Sc., Hon. Curator of Algæ, National Herbarium.

The Coast of New South Wales, lying between the parallels of 38° and 28°, is found in the warm Temperate Zone, and is, in consequence, by no means so rich in Algæ as the coasts of Tasmania or the Bass Straits, while the forms are considerably more varied than those of the tropical seas to the north. Facing the Pacific Ocean, it is, however, so far removed from the opposite coasts of America that the flora is linked closely with those of Victoria and South Australia, and has very little in common with the marine flora of South America. A few tropical forms extend down along the northern half of the coast, and quite a number of species found in Japan have also been met with. With so great a stretch of coast it is not surprising that a few apparently endemic species are comprised in the flora. Victorian species occur in the extreme south.

The Algæ of New South Wales have been less extensively studied than those of the south, and even those of the west coast of Australia. Very few enthusiastic collectors have sent collections to the workers in Europe, and, until late years, no one has worked at the Algæ on the spot. The list of known described species is, therefore, not great, totalling only some 160 altogether. Under Mr. Maiden's auspices, the Algæ have found a home in the National Herbarium, and there we have quite a representative collection of the known forms, while a number of others await determination.

The coast is broken here and there by harbours and river-mouths, so that the comparative monotony of the ocean rock and cliff flora is relieved by the variety of the species which prefer less open and exposed waters, and grow among the *Zostera* and *Posidonia* of the sheltered flats.

Very little dredging for Algæ has been accomplished. It was hoped that useful scientific and practical results would have accrued from the cruises of the "Endeavour," but so far practically nothing has been done to show what and how much algal food is present on the continental shelf of our fish supply.

No great use is made of our Algæ by the people. The seaweeds serve, doubtless, as elsewhere, to purify the waters near the shore, and as food directly or indirectly, for the fish, but there are no harvests like those in Scotland, Ireland, and Brittany, of the coarser Fucoideæ or Varech to be used as a most efficient manure, or like those in Japan of such kinds as are useful as food or for the preparation of Agar-agar. In the first place, the growth is not luxuriant; and in the second, the collection of the weed is too dangerous and difficult from the steep slopes running into deep water, and from the turbulence of the waves. Even a scientific collector has to be very wary when gathering on the open ocean coast.

On the great rocks over which the waves are bursting at or near low water are, however, a number of Algæ which flourishes in the turmoil. Colonies of *Wildemania* (*Porphyra*) *laciniata*, *Splanchnidium rugosum* and *Hormosira banksii* are exposed at low water, growing on the tops and shelves of the rocks. Fringing the sides as they slope into deeper water, are masses of *Pterocladia capillacea*, *P. lucida* and bright red clusters of Corallines, *Cheilosporum wardii*, *Amphiroa anceps* and *Jania rubens*. Below these again are attached the fronds of *Ecklonia exasperata* and *Phyllospora comosa* and the various species of *Sargassum* and *Cystophora*. These occupy what would be termed the Laminarian Zone of Europe. Above low-water mark are mostly the green weeds, *Ulva*, *Enteromorpha*, *Cladophora* and *Chætomorpha*. These will be the forms most readily met with on the outer coast, near Sydney.

In the sheltered waters of the Harbour, Twofold Bay, Jervis Bay, Port Hacking, Botany Bay, Port Jackson, and Port Stephens, we find more delicate forms, species of *Nitophyllum*, *Grateloupia*, *Hypoglossum*, *Dasya*, *Ceramium*, and others in fair abundance. In rock pools, *Martensia elegans* is now and again seen. On the mud-covered rocks of the Parramatta River are found species of *Bryopsis*, *Cladophora*, *Bostrychia*, *Catenella*, *Polysiphonia*, as also the Fucoids, *Cystophyllum muricatum*, *Haliseris acrostichoides*, *Dictyota dichotoma*, *Spathoglossum cornigerum*. Here, too, was dredged the remarkably delicate *Sonderia* (*Claudea*) *bennettiana*.

To proceed to a more systematic account of our Algæ. Amongst the *Chlorophyceæ*, the most interesting are *Microdictyon umbilicatum*, a charming network of star-grouped, green filaments, and the "unicellular," multinuclear, *Siphoneæ*, *Bryopsis*, *Caulerpa* and *Codium*. There are at least two species of Bryopsis, *B. plumosa* (very variable) and *B. baculifera;* three species of *Caulerpa*, of which *C. parrifolia* is endemic; and six species of Codium.

The Fucoideæ are numerous. No fewer than 15 species of *Sargassum* are known, the commonest about Sydney being *S. leptopodum*, *S. lophocarpum*, *S. polyacanthum*, *S. neurophorum* and *S. erosum*. Seven species of *Cystophora* occur; *C. uvifera*, in the south; while common about Sydney are *C. spartioides*, *C. retroflexa*, *C. monilifera*, *C. polycystidea* and *C. paniculata*. The genus is interesting as being confined to Tasmania, Australia and New Zealand. Other vesicle-bearing Fucoids are *Cystophyllum*, *Phyllospora*, *Hormosira* and *Macrosystis purifera*, a southern plant. *Notheia anomala* is a remarkable true parasite, using frequently *Hormosira*. The black fronds of *Gymnosorus nigrescens* intermingle with the delicate shapes of *Homœostrichus sinclairii* and the curly fans of *Padina paronia*. There are several Dictyotas, some not yet determined. *Sporochnus moorei* is a local form, the fruit supported on very long peduncles; it is found in the harbours in deeper water. The very finely divided *Spermatochnus leiolisii*, previously only known in the North Sea of Europe, occurs in Port Stephens. *Myriocladia sciurus* is rare. It consists of long, dark-olive tassels, and flourishes on exposed rocks. *Colpomenia sinuosa* and *Asperococcus bullosus* are inflated forms; the former growing to the size of a man's head, and credited with lifting oysters from their beds. Lastly, small kinds of *Sphacelaria* grow on the larger Algæ, and numbers of *Ectocarpus* are found in the rock pools.

Occasionally one comes across wide-spread ruddy carpets composed of the delicate filaments of a *Bangia*, one of the varieties of *B. atro-purparea*. Sometimes these cover the surface of the walls of the baths at Bronte, only laved at high water by the waves which renew the waters of the baths. Outside occurs *Wildemania laciniata* in abundance. It is of an olive-green when growing, but assumes a purplish tinge on drying.

Of the *Nemalioninæ*, *Brachycladia marginata* and *Galaxaura umbellata* extends up the coast to the north of Sydney. Both have large, sponge-like fibrous attachments. *Wrangelia plumosa* is abundant in Middle Harbour. *Gelidium* *australe* and the two above-mentioned species of *Pterocladia* are more characteristic of the ocean surf-flora.

Gigartininæ are scarce. I have not found a single *Gigartina*, though the genus is common in the south. *Callymenia tasmanica* occurs unexpectedly in Botany Bay, where fruiting specimens are not uncommon. A large fronded form of *Catenella*, which grows in the Parramatta River, has been marked off by J. Agarth as a distinct species, *C. procera*. A *Rhodophyllis*, possibly a form of *R. gunnii*, is common in Twofold Bay, but extends at least as far north as Wollongong. The *Rhabdonia*, separated by Harvey as *Solieria*, is common in two or more varieties in the harbours.

Of the *Rhodymeninæ*, *Phacelocarpus alatus* is found, though never luxuriant, on the southern half of the coast. *Gracilaria* is represented by four or five species. *G. lucasii* is endemic, a bushy form growing in Port Jackson. *G. secundata* grows in the most exposed situations on the outer rocks. *G. textorii* is a Japanese species, abundant in Botany Bay. We have it also from Moreton Bay. *Hypnea musciformis* grows in great masses in the harbours. *Rhodymenia australis* lives below the level of low water. *Champia parvula* is very variable in size, common in Botany Bay and Port Stephens. *Chylocladia gelidioides* is a typical Port Jackson species. *Erythrocolon muelleri* is a handsome species occurring in Botany Bay. *Plocamium leptophyllum* and *P. angustum* are frequently met with all up the coast. *Martensia elegans* is found in rock pools. It does not assume its beautiful carmine colour while growing; it is then of a rather dull, but often iridescent brown. *Nitophyllum sinuosum* is a very handsome species lately described, from Botany Bay. Here also *N. ciliolatum* is, perhaps, the commonest plant. In the same assemblage we have the magnificent *Hypoglossum serrulatum* and its congener, *H. spathulatum*. The little *Caloglossa leprieurii* is found in the estuaries. *Sonderia bennettiana* is a unique genus and species, dredged long ago in Port Jackson, but not seen for many years. *Delisea pulchra* is at its best in New South Wales, becoming depauperated the further it grows from its centre. *Asparagopsis armata* grows about low-water level in pools and channels.

The *Rhodomelaceæ* comprise several species of *Laurencia*; *Chondria curdieana*, an irridescent form; a number of species of *Polysiphonia*, mostly four-tubed; *Pterosiphonia pennata*, *Dasya capillaris*, *Heterosiphonia australis*, and one or two

Bostrychias. Among *Ceramiaceæ*, *Griffithsia ovalis* and undetermined species of *Monospora* or *Griffithsia* and *Callithamnion*, *Spyridia filamentosa* and several species of Ceramium.

Among *Cryptonemineæ*, two species of *Grateloupia*, *G. filicina* and *G. australis* flourish luxuriantly in Port Jackson. *Peyssonnelia* has *P. gunniana*, *P. multifida* and some rock-encrusting forms. *Thamnoclonium seminerve* occurs from Sydney northwards. The most conspicuous Corallines are *Amphiroa anceps*, *A. ephedræa*, *Cheilosporum wardii* and *C. sagittatum*, *Jania rubens* and *J. micrarthrodia*, and *Corallina officinalis*, *C. chilensis* and *C. cuvieri*.

Chapter III.

THE ABORIGINES OF NEW SOUTH WALES.

By W. W. Thorpe, Ethnologist, Australian Museum, Sydney. Abridged, for the most part, from Dr. John Fraser's work.*

Origin.

There is not, as yet, and perhaps there never will be, any definite, reliable, or satisfactory answer to the question: Whence came the first inhabitants to Australia?

In 1769 Captain Cook landed at Botany Bay, and took possession of Australia on behalf of the British Empire. He was preceded by Dampier and others many years previously, and was followed by other travellers and explorers from civilised countries. These pioneers found tribes of blacks living in a state of savagery. In later times, scientific expeditions have been made and a great deal ascertained about them, but where the black folk sprang from originally is still an open question.

Although only writing of the aborigines of New South Wales, it may be found not uninteresting to bring forward some of our best hypotheses as to the origin of the race as a whole.

In Mr. Curr's valuable work, "The Australian Race," an ingenious theory is advanced that they are descended from African negroes. The author supports this view by references to similaries in language, manners and customs, and superstitions of the two races.

Professor Baldwin Spencer says:—"There is still some considerable doubt as to the origin of the Australian race, but it appears to be almost certain that in past times the whole of the Australian Continent, including Tasmania, was occupied by one people. This original, and probably 'negritto' population, was almost certainly at an early period widely spread over Malaysia and the Australian Continent, including Tasmania, which at the time was not completely separated off by Bass Strait. There is no doubt but that the Tasmanians had no boats capable of crossing the latter, and must, therefore, have walked over on land, or at most have

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* Fraser (John), B.A., LL.D., Sydney, "The Aborigines of New South Wales," Government Printer, Sydney, 1892.

paddled every now and then across narrow arms of still water in the frailest of canoes. Subsequently there came a time when what was at first low-lying land with peaks, now represented by King Island on the west, and the Kent, Furneaux, and Flinders Islands on the east, sank beneath the sea, leaving part of this original 'negritto' population stranded in Tasmania. On the Continent an immigration of what Sir W. H. Flower and Mr. Lydekker have suggested was a low type of dark-complexioned Caucasians produced a blend with the original inhabitants resulting in the formation of the present Australian people, so that, in the words of these two authors, the latter is not a distinct race at all, that is, not a homogeneous group formed by the gradual modification of one of the original stocks, but rather a cross between the two already formed branches of these stocks.

"The Tasmanians, isolated from the mainland, may be regarded as having retained the physical structure and the low level of culture of the old 'negritto' stock. Their hair had the frizzly character of the negroid races, in contrast to the wavy nature of the present Australians."

The somewhat similar opinion expressed by the Rev. J. Mathew:—"The ancestors of the now-extinct Tasmanians were the original inhabitants of Australia; they were a short, black, or very dark-brown, curly-haired race. At a time when Tasmania formed part of the mainland, or was much more easily accessible from it than in historic times, it was occupied by the then Australian race. Owing to the formation or enlargement of Bass Strait by a subsidence of the land, Tasmania and its inhabitants became isolated from the mainland and its people, and the Tasmanians remained physically and mentally in their primitive condition. A superior race—straight-haired and of a dark complexion—akin perhaps to the Dravidians of India, the Veddahs of Ceylon or the Ioalas of Celebes, migrated into Australia from the north-east and over-ran the whole continent. The vestiges of the Tasmanians are more pronounced in Victoria.

"The Australians of historic times are, therefore, a hybrid race, constituted mainly of the Tasmanian and old Asiatic elements, with a comparatively recent and slight infusion of the Malay blood in the northern half of the Continent."

Age of Man in Australia.

Up till the present there has been very little geological data discovered bearing on the antiquity of the human race in Australia. The primitive state of culture is considered by many as evidence of antiquity. The following factors have been suggested as proof in this direction:—No cultivation of the soil; no domestic animals excepting the dog; neither possessing or manufacturing any pottery; unacquaintance with the bow and arrow; and as a rule very poor examples of domestic architecture.

The geological factors as already stated are very sparse. The facts obtained by the cutting of Shea's Creek Canal, near Sydney, is the best direct evidence hitherto obtained to show the presence of man on the South-eastern sea-board, and probably claim something approaching to a geological antiquity, "as is implied by the fact that the Pacific Ocean and the Australian land have changed their respective levels by as much as fifteen feet since the existence of Neolithic man at Botany Bay." Australian Crania has also been offered as a test of antiquity. Marked resemblances between the Aboriginal Crania and Continental skulls, such as the Neanderthal, Spy, and others, including Pithecanthropus of Java.

Traditions of the aboriginals themselves have also been quoted as evidence to this question. The aborigines of Victoria have many stories regarding their ancestors and the times in which they lived. According to the testimonies given by reliable natives certain now-extinct volcanoes were far from quiescent in this ancestral period. Also legends, imaginary or otherwise, of the large game pursued by their forbears, immediately bring to mind the extinct gigantic marsupials of this Continent.

Other writers affirm that the present or historic culture was preceded by a period in which there lived a more highly-civilised people.

The period of the first arrival of man in Australia is, therefore, at its best only conjectural, until further and fuller data is brought forward.

Physical Appearance.

The general appearance may be described as follows:—The average height of the males is a little under five feet six inches, and that of the females five feet one inch. As a general rule they are well proportioned in physique. Whilst in some districts the limbs are somewhat attenuated; in others, natives have been met with possessing stout legs and arms, and presenting a manly and even athletic appearance.

The colour of the skin seems to be a dark-copper or sooty-brown. Most of the men are very hirsute, some boasting long, flowing beards, and indulging in whiskers and moustaches.

Birth and Childhood.

The children of an aboriginal household have a pleasant time of it, but not so the mother. Married at an early age, her lot seems to be one of hardship and responsibility. Beside bearing and rearing children it is expected of her to do all the heavy work for the family. In camp it is her duty to erect shelters, keep some smouldering fire always available and cook the food for the household. On the march she is the beast of burden; beside the incubus of a child, all the portable property is given to her to carry. The wife, as a rule, has very little consideration at the hands of her spouse and cruelty to the weaker sex is a common episode in camp life. And yet the man is often kind and affectionate to his wife, and both of them indulgent to their children; if any of the younger ones is injured by an accident, or diseased, or sick, he is carefully tended till well, and if deformed or otherwise helpless his parents may carry him about for years, and his brothers must hunt for him, and thus supply him with the necessaries of life.

At obvious periods it is deemed imperative that a woman should absent herself from the society of the camp. She must not cook food for others, for everything she touches is said to be defiled; she lies on the other side of the fire, away from her husband; and a blackfellow moving about in the bush, will go a long way around to avoid her tracks in such a case; if she sees him approaching her, she must call out to warn him, lest contact should bring calamity upon him.

Parturition is easy and no assistance is required. If a band is on the move, the woman, when her time draws nigh, goes aside into the bush alone or with a female companion, and ere long she rejoins them, either with or without her child; for infanticide is common. If a mother thinks the child would interfere with her domestic arrangements she buries it in the sand, chokes it with a pebble or simply abandons it at the place of birth. Or, if the father thinks that the care of the little one will impair his wife's usefulness he takes a club, and, notwithstanding the resistance of the mother (for she is not always forsaken by her natural affection) he kills the child. It is curious that in some places the maternal uncle is expected to do the deed. Girls especially are not spared. Infanticide is regarded by them only from a standpoint of convenience.

If the band happens to be in camp when a birth is imminent, the father absents himself for several days, and the mother is assisted in her post-natal weakness by other married women; the sick mother is kept warm, with hot stones, if necessary; she drinks only tepid water, and very little solid food is given her; in a very short time she is well again. There are very few deaths from childbirth and no idiot children.

The newly-born child is not black, but somewhat fair in colour; the blackness appears first on the forehead and then gradually spreads. The soles of the feet and the palms of the hands remain white for some time, and these, even in a grown man, are of a light, pinkish colour. The new-born babe is not washed or swaddled; it is simply rubbed all over with grease and charcoal, and laid near a fire, or committed to the nurse's arms, if there is one present; the placenta is buried. The mother suckles the child, and continues to do so for a very long time, perhaps two years or more; the indigestible nature of the native food and the uncertainty of supply renders this necessary for the rearing of the child. From the hardness of her lot in these and other respects, a black woman is barren and old at thirty. During the period of gestation there is a custom which restricts the woman to certain foods, on the other hand, such fare as eels, kangaroos and birds she must abstain from.

As to the naming of the child, this is a very simple affair. Any circumstance or place associated with the child's first entry on life will provide a name for it. The screech of an owl at the time, the passing by of an animal, or failing that, the birth locality name may be given to the infant. The aborigines have also words to describe the different stages of a man's life; for instance, a baby, a boy, a youth, a lad (three stages of initiation), a man and an old man.

Training for bush life begins very early. As soon as the little one is able to toddle about, the father makes for the boy a small spear to practise with at a mark; the girl gets a stick and is taught to recognise food-roots and to dig them out, to find the larvæ of insects under tree-bark and to kill lizards; and the parents take as much delight in this tuition as civilised people do in teaching the alphabet. If the camp is near a lagoon or river the young ones soon learn to be amphibious, and, when they become a little older and stronger, they have much of their amusement in the water. The boy at an early age accompanies his father on hunting expeditions, thereby learning much bushcraft. Nor is the girl's education neglected. Under the mother's eye she is taught to make string for nets and bags and ultimately learns to make these and other articles herself.

Natural Affection.

The aborigines are not devoid of feeling, though often it is asserted otherwise. They are very kind to the old and infirm and treat the children with great indulgence. If a man is old he is honoured and respected, and his word will often suppress strife. Although from the pressure of life the parents kill their babes, in the event of a child dying naturally after a few weeks of life, mourning is worn in the camp as if for an adult; the mother and other relatives raise at times during the day, and especially at sundown, those wailing cries only to be associated with death.

They are also kind to the dog, the only domestic animal they possess. It is a common occurrence for the women to suckle at the breast a pup which has lost its mother; but this is carrying kindness to excess. The dogs are in every camp. The approach of a stranger to a native encampment is always heralded by the barking of these animals, and they often outnumber the human population of the locality.

Maturity.

The approach to maturity is a very important era in the life of the aboriginal male. It means that the period has arrived when he must lay aside the state of pupilage as his mother's boy and enter the tribe through initiation and take his place as a fully-fledged man. These ceremonies are general throughout the Continent. Though differing in ritual, each has for its aim the teaching of the obligations of manhood and its accompanying expectations, such as fortitude, the laws and penalties of the tribe, and the esoteric wisdom of his elders. This ceremony is known generally amongst the whites as the "Bora," though this term, like many others, is of local application only. The rites of initiation are important, numerous and prolonged; and as the admission to the status of the neophyte to manhood does not concern himself or his family merely, but the whole tribe, these observances call together large assemblages and are the occasion of general rejoicing.

The following is a typical description of the New South Wales "Bora":—The elders of a tribule know that some boys are of an age to be initiated; they accordingly summon to them the public messenger or herald, and instruct him to inform the other sections of the tribe that a "Bora" will be held at a certain time and place, the time being near the full moon, and the place being usually a well-known "Bora"-ground; they also send him to invite the neighbouring tribes to attend. This invitation is readily accepted and for the time being all feuds are forgotten. The notice is usually of a month or more, in the meantime preparations are being made by those who are to conduct the ceremonials. A suitable locality is chosen, near water if possible, and level for convenience in sitting or lying on. Two circular enclosures are then formed and cleared of all timber, even of every blade of grass—a larger and a smaller, with a straight track connecting them. The smaller and sacred circle is about a quarter of a mile distant and out of sight of the other. The trees that grow around the smaller circle may be carved with curious emblematic devices and figures. The circuit of each ring is defined by a slight mound of earth laid around, and, in the centre of the larger one, a short pole is fixed surmounted with a tuft of emu-feathers. The ceremonies are started in the larger ring. Females are permitted at this stage to be present and lay covered in this large enclosure. The neophyte is painted red all over and, being brought forward, is made to lie down in the middle of the ring and covered with a rug. The master of ceremonies now begins to terrify the lad by swinging the bullroarer (see page 483). When the performers think that the novice is sufficiently impressed, the bullroarer ceases. The roaring is attributed to a dreaded evil spirit. They then raise the boy from the ground and set him with his face towards the smaller and distant circle. An old man then comes forward, breathes strongly in the lad's face and makes him look down; for in this attitude he must remain for several days. Two other old men next take the boy by the arms and lead him along the track and set him in the middle of the smaller enclosure. As soon as this is done the women rise from their prostrate attitude and begin to dance and sing. The Murringgari tribe on the south-east coast place along the track some figures moulded in earth, of various totemic animals, and one of a revered spirit-god. Before each of these the devotees have a dance; and a Karaji or "doctor" brings up, through his mouth, apparently from his stomach, the "joea" or magic of the totem before which they stand. Meanwhile the boy has been sitting in the smaller circle with downcast eyes. He is told to rise, and is led in succession to each of the carved trees and has their significance explained. When this is done he is invested wth a new name which must not be revealed to the uninitiated, and they hand him a little bag containing one or more small stones of crystal quartz. This bag he will always carry with him and on no account must it be shown to the uninitiated, the penalty for a breach of this rule is death. This concludes the first section of the performance.

A fire is kept constantly burning in the centre of the upper ring. The boy is made to lie for weeks within this enclosure, getting only a little food and water now and then. When he wishes to go outside he is carried over the raised margin. When the men in charge of the sacred circle at last bid him to rise from his recumbent position he is conveyed, blindfolded, to a large camp, at a distance of several miles, no woman being near, and food given to him, which he eats, still with his eyes cast down; here they keep him for eight or ten days, and teach him the tribal lore by showing him dances and songs; these songs, which are attributed to Bayemai, the great creator, he learns. At night the candidate is set alone in a secluded spot; during which hideous noises are made by the men with the sounding bullroarer, at which he must not betray the least sign of fear.

Another conspicuous part of the inner "Bora" customs is the avulsion of one or more of the upper incisors of the novice. This is effected by a smart blow on a wooden punch applied to the tooth. As to the removed tooth, it may be given to the lad's mother, who burns it, or after being passed around the circuit of the whole tribe, is given to the owner or retained by one of the head-men. In some tribes circumcision or hair-cutting takes the place of the tooth-breaking custom. All these formalities being now completed, the boy's probation is at an end. They now proceed with much merriment to some waterhole and remove all traces of the ceremonial decorations, and when they come out of the water they paint themselves white. Meanwhile the women who are called to resume their attendance, have kindled a fire not far off, and are lying around it with their faces on the ground and their bodies covered up as at first; the two old men who were the original initiators bring the boy at a run towards the fire, followed by all the others, striking their boomerangs together; the men then join hands and form a ring around the fire, and one old man runs around the inside of the ring beating a shield. A woman, usually the boy's mother, then steps within the ring, lifts him up, sets him down and retires; every man present, the boy included, now jumps upon the decaying red embers, until the fire is extinguished.

After all this is over the two sponsors to whom the boy has been committed, take him away into the thick forest, and here he is kept for weeks. In this seclusion he is trained and tested as for fitness for tribal occupations. He is at last permitted to rejoin his kindred and thus ends the "Bora."

The Corrobboree.

Karabari or Corrobboree is an aboriginal name for those dances which take place at night. It has usually been regarded as a form of amusement or dance to while away the time on moonlight nights. The men alone engage in it, a few women sit around to beat time to their movements. Some of these dances are in reality of a semi-religious nature, connected with the food supply. For them the men will prepare themselves with great care and sometimes dance all night. Other performances are undoubtedly pantomimic and only a repetition of some traditional or current event of interest.

Gesture Language.

This art is highly developed amongst the aborigines. Necessity for silence and caution when approaching game and the frequent presence of hostile parties has caused this mode of communication to be typical of our blacks. It is quite possible that this accomplishment is taught during the "Bora" ceremonies.

Astral Observations.

Our native tribes are attentive observers of the stars; as they sit or lie around the camp-fire after nightfall, their gaze naturally turns towards the starry vault above and there see many things with which they are conversant in daily life—young men dancing a corrobboree (Orion), and a group of damsels looking at them (Pleiades), and making music to their dance—the opossum, the emu, the crow, and so on. The appearance of a comet sometimes produces the need of a special corrobboree, which is evidence in favour of astral or religious exorcism.

Counting and Enumeration.

The power of counting is limited. Any numbers in advance of the units is usually indicated by the term for a multitude or quantity.

Betrothal and Marriage.

Female children are often betrothed at a very early age. Occasionally they are prenatally bound to a husband, usually an old member of the tribe. As the girl grows into womanhood it frequently happens that she may fancy a youthful member of the tribe, and this leads to complications. It is true that to escape from the betrothed man, the girl may elope with her young lover and hide for a time until the storm is over. This method is not always successful as the girl's family are bound to go after her and bring her back to fulfil the engagement made for her. If pursued and found she will be beaten and brought back again, but if she continues to repeatedly elope they let her have her own way. A wife, too, may run away from her husband alone in order to escape from misery, or in company, if she thinks better treatment may be given her; but this is dangerous, for the enraged husband may kill her paramour and compel her to return. Cruel as this may seem this question must be judged from the aboriginal standpoint that the wife is the personal property of the husband just as his weapons or implements, and he may go so far as to kill her without any challenge from social or tribal law.

As all girls are not betrothed at birth or infancy, it follows that many grow up to maturity mingling with the young men in their daily life and amusements. A young man cannot marry until he has passed the "Bora" ceremonies incidental to manhood. If suitable and not within the "forbidden degrees" the youth makes representations to the parents of the girl, or employs an emissary for the purpose, and demands the hand of the girl in marriage. If the girl is not already betrothed the suitor has marital rights *en posse* over her, providing all things be equal and regular. No purchase value is offered or paid. The father usually consents and in some cases the sanction of the head man and tribal council has to be obtained. The marriage ceremony is then fixed for a certain day. If there is no father to consult the girl's eldest brother or uncle gives consent. The young man's suit is more likely to prosper if he has a sister whom he can use as barter with the girl's guardian to be a wife of his. Meanwhile if there has been no courtship, the young woman's wishes have not been considered and she may also dislike the man chosen or may prefer another. In that case as soon as she hears of the arrangement, she runs away from her father's control, and tries to find concealment and refuge in some far-distant part of the tribe, where she may have friends. The male suitor then takes with him several of his companions of the same tribal division as himself, and pursues; if he finds the girl, he beats her into submission, no one hindering; and if she refuses to return, they all unite in carrying her by force back to the camp. As a reward for their assistance they are all allowed to share with the husband the *jus primæ noctis*.

The aborigines have also a kind of marriage by capture. When a tribesman, from one cause or another, has a difficulty of getting a wife in his own tribule, he takes with him a few of his comrades and, making an incursion into the neighbouring territory, he carries off a woman of that tribe to be his wife. He does not seize the first that comes to hand; for here the tribal restrictions as to intermarriage of certain classes prevent; and, however much the names of these intermarrying classes may vary throughout the Continent, a black man invariably knows which class of females he may have in marriage.

Another form of marriage by capture the Australians have—it is also common amongst all savage people. A war band invades a territory, kills the men and carries off the women. Each woman then becomes the property of the individual captor.

The Marriage Ceremony.

When the match has been arranged with the full consent of all concerned, a day is fixed for the marriage ceremony. For the appointed day guests are invited and a large store of food prepared. A great fire is kindled and the guests arrange themselves on opposite sides of it; meanwhile the bride's mother has built a shelter of sticks and leafy boughs; and the bride has built a fire there; the husband-to-be is highly decorated with white and red pigment; the bride is brought in; she is seen to be similarly ornamented; or, as in some districts, she is merely adorned on the head with white feathers; the girl is led to the shelter by her mother, or is told to go there by her husband, and she goes or is compelled to go. The young couple sit there all night and do not speak to each other; at daybreak she goes to her father's home, but at night she returns, and then the whole proceedings are brought to an end. This is the usual routine of a set marriage ceremonial, but the details vary amongst different tribes.

A peculiar custom is observed regarding the husband's relation with his mother-in-law, and *vice versa*. Neither hold speech or even look at one another, but must communicate through a third person. If at any time they are liable to meet *vis a vis*, the man must hide and avoid crossing her track. It is thought that any communication between the parties may bring calamity on either or both.

Exogamy.

Throughout Australia, a tribe is, for the purpose of marriage divided into two, four, or sometimes six, classes, and within each of these no marriage is possible. Every man in a given class must take a wife from another class and the group into which he must marry is fixed for him. Intermarriage with a woman of his own class is incest and a heinous offence.

The law of descent amongst the aborigines is that the children take the classification and totem of their grandparents usually on the mother's side.

Marriage Fidelity and Widowhood.

The rule which governs all marital matters is the recognised fact that a wife is the personal chattel of the husband. For infidelity the husband can maim or injure his wife, or he can appeal to the elders of the tribe and they can, on cause shown, decree a divorce; but not if she has children.

When a man dies, the widow becomes the property of his next brother, even if the latter is already provided; for polygamy is recognised in the tribes, but it exists chiefly in the households of the chief elders. If from any cause this refuge fails she goes to the dead man's paternal cousin, avoiding the sister relationship as usual, or she returns to her father's home, and remains there until her brothers give her away in barter; or, failing that, she becomes the property of the community.

Inheritance of Property.

There is not much scope in Australia for any principles regarding the disposal of property. Usually the "estate" is buried with the deceased, if it has not been made over verbally to a son or relative prior to the final dissolution.

The Tribe.

In Australia there are only two things to be considered when we proceed to locate a tribe—its territorial limits and its language. Each tribe has its own "taurai"—territory or hunting ground—usually determined by natural boundaries, such as mountain ridges and rivers; any transgression of these limits was regarded by the adjacent people as a *casus belli*, and would at once lead to hostilities. As a consequence of this isolation, and from the operation of a principle, which caused the name even of a common thing to be changed as soon as any man died who had that name, the dialect of each tribe has diverged considerably from the original stock. Thus it is that each tribe has come to be distinguished, both by its dialect and by the limits within each member of the tribe might wander, without encountering enemies who would drive him back. The tribe is further divided into sub-tribes or tribules each self-contained in regard to boundaries. These sub-tribes are called by the name of some local feature of their "taurai" or territory.

Notwithstanding these restrictions a man going on business or on a visit may pass freely from any one locality within the tribule boundaries to any other, and wherever he comes he is received with hospitality. It is only a war party or a band of blood-avengers that will cross the boundary and enter on the land of another tribe.

Tribal Government.

There is nothing of the nature of kingly rule in any one of the tribes, nor is there an over-chief for the whole of the tribe; but the affairs of each section are administered by a number of elders, amongst whom one is considered the leader or chief, because of his superior wisdom and influence. On his demise he is buried with special honour, and the chiefs of adjoining sub-tribes attend his funeral ceremonies. At first the government goes on without a successor being appointed; at last the council meets and agrees to recognise the eldest son of the deceased as head man, provided that he has the necessary qualifications. If not suitable he is passed over and the next son's chance may be considered; if the late chief has left no sons, the succession passes to his brother and his sons. If there are two rivals competing for the position the matter is settled by single combat.

Quarrels and Punishment.

The council of elders has the power to decree punishment for tribal offences. Many personal grievances are settled without the intervention of the council. Inter-tribule differences are often brought to a termination by a duel between picked champions from each camp.

Public Messengers.

The council of elders appoint the "herald" or tribal messenger. He passes in safety between and through hostile tribes, for his person is inviolable, and he is known to be a messenger by the red net which he wears around his forehead. Charged with the message from his tribe he approaches the journey's end and makes his presence known by a peculiar cry. He then sits down and remains silent for a long time; at length his tongue is loosed and he then delivers the message. He is listened to with the greatest attention; the chiefs consult, and he waits there for several days to receive their reply. This public messenger, *inter alia*, carries information as to "Bora" arrangements; he is generally provided with a message stick, whereon is incised various devices to assist his memory (see "Message Sticks").

Personal Adornment.

Cicatrising the trunk and limbs was a wide-spread custom. The incisions were made with a shell or piece of flint and while the wound was still open charcoal or some other foreign substance was rubbed in; this treatment caused the ridges to remain permanently on the site of the wounds.

The ornaments worn were simple and few. The nose-stick was assumed only by the men, the nasal septum being pierced in youth.

The hair was allowed to grow wild and cut from time to time and used for human-hair belts and twine. Sometimes it was gathered in a bunch on the head and tied; to the knob were added feathers and kangaroo-teeth pendants.

Necklets were worn by the women and girls; strings of grass-tubes or bugles being much in favour.

The articles of actual clothing were both few and scanty. The most important was a skin cloak worn by the women and made of pelts of the opossum or wallaby. This garment is now a thing of the past so far as New South Wales is concerned. It would take probably upwards of thirty skins to make one of these cloaks. After preparatory treatment the pelts were sewn together with sinew.

The only other article of clothing was the loin-cloth, worn by men, and consisting of a strip of hide, with a furry flap depending from the back, front and sides.

The young females wore a girdle of opossum-fur string, and at dances the women put on a deeper apron formed of the neck-feathers of the emu.

A man, when travelling, also wore a fibre waist-belt to hold his tomahawk, crystal amulet, etc. The hunger-belt of hide was also donned when on an expedition; it was not always possible to obtain food; so, when pressed by hunger, he need only tighten the belt and hurry on.

To fortify the body against the influences of weather and climate, it was anointed frequently with fat and ruddle; emu-fat for preference. The hair was also smeared with the same substance.

Shelters and Dwellings.

A people whose circumstances compel them to wander about from place to place are deterred from making dwellings of a permanent nature. If settled at any spot they must move on when the food-supply is about exhausted. When about to sojourn for a time at a given locality the women set to work and raise wind-shelters or "gunyas." These are very simple structures. Two strong sticks are fixed upright in the ground, each about four feet high, and having a fork at the upper end; across these forks a ridge-pole is laid; then leafy boughs are laid aslant from the ground to this cross-pole; and thus the black woman's house is complete. The back of it is placed facing the weather side, the family sheltering under the lee. A fire is made in the open front, and with dry grass for a bed within, and a log, it may be, for a pillow, the blacks lie with their feet towards the fire, and sleep the darkness of the night away.

The foregoing refers only to the temporary type of habitation. Should the food-supply be of a more or less permanent nature, better dwellings are erected, in the building of which the men take a part.

Food.

The food of the aborigines is as varied as it is strange; many kinds of berries, seeds and gums are collected and eaten; roots and piths also go towards swelling the menu. Grass seeds are pounded and made into a kind of bread. Other vegetable foods have to be macerated for some time to remove poisonous elements before cooking. There are many kinds of esculent bulbs known to the whites under the general name of "yams." It is the duty of the women and girls to collect this fare by digging in the ground with the bevel-pointed implement known as the "yam-stick" (see page 481).

The aborigines are expert fishers and have many modes of obtaining food in that way. Fish are taken by spearing, netting, by hook and line, damming the water-courses and stupefying with deleterious foliage.

Other articles of food are eggs, grubs, snakes, lizards, turtles and insects, and even frogs are partially cooked and devoured. Bird and fowl of every kind are caught, cooked and eaten, from the emu to the smallest feathered creature. These are either caught in nets, snared or knocked with the boomerang or club. Almost every animal in the bush or on the plains is killed and eaten. But an animal which is the totem of any man's class is never touched by that man; to him it is sacred or taboo. In addition to the totem animals certain restrictions as to food are also imposed by tribal law. To a lad who has not passed through the "Bora" ceremonies, foods of certain kinds are absolutely prohibited.

Most of the animal food is eaten when only partly cooked. Meal prepared from nuts and seeds is ground, mixed into a doughy condition, and baked in the ashes (see "Seed-grinding Stones").

Although not a common custom, the eating of human flesh was occasionally indulged in.

Production of Fire.

Fire was produced by two methods:—

By the Drill.—A stick or flat board with a partly-made hole was laid horizontally on the ground and held in position by one or both feet of the operator. In the hole was twirled a second stick in a vertical position. The friction produced fine dust particles in the hole or "cup." The hole becomes enlarged, smoke and finally sparks appear. These latter are caught in some already prepared tinder consisting of grass or teased bark. This material, on taking fire, is quickly swung around in the air, or blown up, and so made to burst into flame.

By the Sawing Method.—A cleft stick is usually employed; to keep it open a small pebble is placed in the opening. Teased bark is loosely inserted in the aperture, and contiguous to the bark a wedge-shaped piece of wood is rubbed across the grain, the friction ultimately producing fire and igniting the tinder.

Daily Life.

Before daylight all the camp is astir and begin the day with the morning meal. After breakfast the men set out to hunt, and are probably away all day; if there is enough food at home they lounge about or make weapons. The women are not idle. They go out to seek yams, fruits, berries or eggs. Within doors, if one may so speak, they busy themselves in spinning into threads and cords the bundles of opossum fur or making nets and bags. They also plait rushes into baskets or sew skins together to make rugs.

The young children play about while the elder ones either of their parents and learn the various duties incidental to savage life.

Trade.

Various products, such as pipe-clay, ruddle, flint, wood for weapons, gum-cement, etc., were bartered with neighbouring people for manufactured articles, such as cloaks, rugs, baskets, bags, nets, weapons and tools.

Signals.

The usual method for communicating at a distance was by medium of smoke. The fire was so manipulated that the smoke could be sent upward in such a manner as to convey to a distant tribe, or portion of a tribe, different messages.

Weapons.

Spears.—The spear was used both in hunting and warfare. These weapons were made of either one length of hardwood, or a reed shaft with a hardwood point. Barbs were cut in the solid or laterally inserted. The fish spear was an implement of more than one prong. These latter were lashed to the foreshaft and used for impaling fish.

Womerah or Spear Thrower.—A lath-like implement with the necessary spear peg at the distal end. The proximal end of the spear was provided with a socket into which the peg of the womerah was shipped when about to be thrown. The use of the spear-thrower gave to the arm a greater radius, thereby exceeding the distance and force that a spear could be thrown without this adjunct.

Clubs.—There were many varieties of these weapons, from the ordinary bulbous-headed stick to the leaf-like Yachi which approaches the boomerang in shape. Clubs were used in hand-to-hand fighting, and also as missiles.

Shields.—Of two kinds—the parrying and the true shield. The former was smaller, of hardwood, and narrower, whilst the large variety were usually of soft wood, and also formed an ample protection against spears and other missiles. Shields were sometimes decorated with carvings and pigments.

Boomerangs.—The boomerang is found in some form or other throughout the Australian Continent, with the exception, perhaps, of the northern portion of Cape York and Northern Territory. Boomerangs may be sharply divided into two classes—the returning and non-returning. The latter are usually heavier and straighter, and used more for offensive purposes. The returning type are generally lighter and more geniculate, with a sharper bend, approaching to a right angle in some examples; its essential character was a twist or warp at both extremities, but in opposite directions. The non-returning or offensive weapons were used as missiles, and are intentionally made on the one plane. The returning boomerang was used more as a hunting implement than in actual warfare, and if dexterously thrown amongst a flock of birds would commit great havoc.

Some of the aboriginal weapons merge so one into the other that a series would show the transition from an ordinary cudgel to a rectangular boomerang. This fact has induced some writers to affirm that the returning property of the boomerang was brought about by accident; others lean towards the theory that the gyrations of a falling gum leaf gave the idea to the aborigines. The Tasmanians were unacquainted with the use of this implement. The name "Boomerang" is derived from "bumarin," of the Botany Bay tribe.

Utensils.

To enumerate and describe all the articles of domestic utility manufactured by the aborigines would require a much greater space than that allotted for this subject. Some of the more important will be mentioned in brief:—

The Yam-Stick.—A bevel-ponted hardwood stick about four feet long, used by the women for unearthing vegetable roots, lizards, etc. This is the only instrument approaching what could be called an agricultural implement.

Grinding-Stones.—Two stones used in conjunction, the lower, or nether, being larger, flat, concave or double-concave. The upper stone, or rubber, was usually thin and flat. Both implements are made of sandstone, and used in grinding grass seed, pigweed or nardoo spores. They are frequently called "Nardoo-" or "Mealing-" Stones.

In grinding, a little water is sprinkled in with the left hand, the seeds being ground with the rubbing-stone held in the right. This process forms a kind of porridge which is gathered into a trough or on a sheet of bark; it is afterwards roasted in the ashes.

The large stones are not carried about, but left for future use at known camps. Their distribution is a restricted one, being chiefly confined to the valleys of the Lachlan and Darling Rivers.

Wooden Troughs.—The manufacture of these vessels is invariably the work of the man. The wood used is one that splits readily; the subsequent hollowing is done by picking, charring or gouging.

Skin Water-Bags.—In the interior and arid districts skins of marsupials are used for holding water. The body of the animal was extracted through the neck; the natural apertures and limb stumps were twitched or bound with sinew.

Chisel-Adze.—An important device or tool used by the aborigines; it is usually double-ended, and may be described as a bent stick with a flake of siliceous stone fixed at one or both ends. This working edge or blade is embedded in gum-cement, and, according to the size of the stone blade, the instrument is a cutting, shaving or scooping tool, and responsible for the flutings found on all objects in wood, such as water-vessels, shields, spears, boomerangs, clubs, etc. The requisite stone flake forms an object of barter often between remote districts, the tribe in whose territory the stone occurs trading it to others.

Baskets and Bags.—The former were built up of grass, rushes or split cane, the latter of bark-fibre string. These receptacles are made by the women-folk.

Stone-Axes.—Aboriginal stone-axes, celts, or tomahawks, as they are frequently called, are of various shapes and sizes. They can be classified according to their outline and general appearance as oval, deltoid, gad-shaped, etc., but in the native mind any pebble or fragment that suited the purpose intended was availed of. As indicated above, they were frequently prepared from flakes broken off a larger stone and reduced by chipping and subsequent rubbing to produce a cutting-edge.

The unhafted type were grasped in the hand by the butt-end. When a handle was employed, a flexible withy was passed around the stone, and the implement was completed with lashing and gum-cement; one or two ties were sometimes made along the haft.

On the Darling River a "grooved for handle" type occurs which may be considered of a higher development than the ordinary axe.

The stones utilised for axes were chiefly rocks of volcanic origin, and also quartzite.

Stone-axes were used for various purposes, such as cutting and splitting timber, bruising or chopping food, scraping skins, as weapons, tree-climbing, and other work incidental to savage life.

"Whirlers" or "Bullroarers."—Leaf-shaped slabs of hardwood ornamented or incised with various idealistic designs, the same being understood by the initiated members of the clan to whom the objects belong, or in whose presence they are put to use. The smaller forms of "whirlers" are invariably swung over the head, and are provided at one end with a small perforation to which is tied a cord, the latter frequently connected with a stick. The roaring sound emitted is attributed to some spirit or mythical personality, and serves to awe both the women and the candidates for initiation. In many tribes it was believed that fatal results would follow to a female who may happen to gaze on one of these objects, hence, when not in use, they were guarded by an elder, or group of elders, of the tribe into whose custody they were entrusted.

"Message" or "Memory Sticks."—Pieces of wood diverse in shape, bearing crude markings in the form of transverse and oblique cuts, nicks, wavy lines, etc. When in use they are carried by a messenger on a trading journey, to call together tribes or individuals to corrobborees, councils, or to warn others of the approach of a hostile tribe.

For a long time it was thought by Europeans—and in some quarters maintained to this day—that the markings could be interpreted as the message carried by the messenger. This theory is correct in so far as being an aid to the memory of the messenger in question, but as to the "stick" bearing a "written message," it is quite erroneous. If on a trading journey, the "stick" serves to indicate to the distant trader the *bona fides* of the bearer acting for his "principal." The trader, recognising the markings of his customer, had no hesitancy in handing over to the messenger the commodities desired. These "sticks" also act as a passport for a messenger through otherwise hostile territory.

Death and Burial.

When an aboriginal is killed in battle, or is so severely wounded that he dies, or is crushed to death by a falling tree, or dies from some other visible cause, his comrades do not wonder, because the manner of his death is manifest; but it is quite otherwise when a man sickens and dies from no obvious influences. Then the cause of the death is ascribed to some hidden malevolence on the part either of evil spirits or of some wicked wizard or "doctor," who, at his own will, or hired thereto by others, has, by magic arts, put something into the sick man's body sufficient to make him pine away and die. In the firm and universal belief of our natives, a man amongst them dies, not because the vital machinery has got clogged or worn out, but because he has been bewitched by an enemy.

As soon as the death occurs, the wail for the dead is raised, and the body prepared for burial or disposal while it is still warm.

There are several methods of treating the dead, but the commoner custom is to double the body into a sitting or squatting posture and bury it in that position. As an alternative the body may be buried at full length; laid on the side with the legs doubled back; trussed into a bundle; buried erect in the grave; laid in a side cavity at the bottom of a pit; placed in a hollow tree; desiccated over a slow fire; laid on the ground and a mound built over it; eaten or incinerated.

Two necessary sequences following on the death of an individual, particularly one of any social standing or importance, was the observance of mourning and an expedition for the purpose of avenging the death.

Widows' Caps, "Pa-ta" or "Kopi."—Plaster caps of the Darling River area, worn during the time of mourning by the deceased man's widow or nearest female relative, and occasionally by old men of a tribe, or even by the whole community. In some tribes the hair of the mourner is first removed by a glowing stick. In others a net is placed over the hair, then burnt gypsum or the latter mixed with pipeclay or clay and ashes is plastered on until the head is enclosed in a covering two inches thick; pipe-clay is smeared over the body, and often renewed daily. The cap is worn from one to twelve months, the weight being from eight to fourteen pounds. After removal it is sometimes baked and placed on the deceased man's grave.

Conical masses of the same material as the caps are often placed on the sepulchral site.

Statistics.

I am indebted to Mr. R. Beardmore, the Secretary to the Board for Protection of the Aborigines of New South Wales, for the following figures:—

Census Returns, 1912.

Comparisons with Year 1911.

Full-Bloods.

	Adults. Males.	Adults. Females.	Children.	Total.
By Return, 1911 ..	935 ..	564 ..	577 ..	2,076
,, ,, 1912 ..	831 ..	540 ..	546 ..	1,917
Decrease	104 ..	24 ..	31 ..	159

Half-Castes.

	Adults. Males.	Adults. Females.	Children.	Total.
By Return, 1911 ..	1,238 ..	1,059 ..	2,956 ..	5,253
,, ,, 1912 ..	1,234 ..	1,039 ..	2,844 ..	5,117
Decrease	4 ..	20 ..	112 ..	136

Total Decrease, Full-Bloods	159
,, ,, Half-Castes	136
Total	295

Births and Deaths, 1912.

Full-Bloods.

Births Reported	42
Deaths Reported	81
Increase, Deaths over Births	39

Half-Castes.

Births Reported	159
Deaths Reported	85
Increase, Births over Deaths	74

Chapter IV.

PHYSICAL GEOGRAPHY.

THE PHYSICAL GEOGRAPHY OF NEW SOUTH WALES.

By C. A. Süssmilch, F.G.S. (Technical College).

The physical geography of New South Wales is similar in all its essential features to that of the whole of Eastern Australia, which, as demonstrated by Mr. E. C. Andrews, has acted as a single geographical unit throughout Tertiary and Recent times. This present account is intended to give merely a general review of the physical geography of this State as a whole, while a more detailed description of certain portions will be given in subsequent chapters.

1.—The Topography.

The topography of New South Wales is such that the State may be conveniently divided into the following three geographical divisions:—

(*a*) The Coastal Region;
(*b*) The Tableland Region;
(*c*) The Western Plains.

These form three parallel belts with their longer axes parallel with the coast, and with a general NNE and SSW trend. The first has an average width of about 20 to 30 miles, the second 200 to 250 miles, while the third has a width of from 400 to 450 miles.

(*a*) *The Coastal Region.*—This is a relatively narrow strip of country lying between the tablelands and the coast. It is sometimes referred to as the coastal plains, but, as much of the area included is rugged and mountainous, the name is somewhat misleading. Geographically, most of the coastal region really belongs to the adjoining tableland belt, it being merely, for the most part, the much-dissected eastern portion of the main tableland. Further details will be given in a separate chapter.

(*b*) *The Tableland Region.*—This is a practically continuous belt of tablelands adjacent to and parallel to the coast, and extending the whole length of the State from Victoria to Queensland; these highlands are continuous with those of the two States mentioned. This belt of tablelands has a width in an east and west direction of from 200 to 250 miles, while the altitude ranges up to 7,300 feet—the average, however, being from 2,000 to 3,000 feet.

Nearly all the published maps of New South Wales indicate these highlands as consisting of a definite narrow mountain range which they call the Main Dividing Range. Much of the highest land is not directly on the line of this so-called Dividing Range at all; in New England, for example, the highest land lies to the east of the main divide. This so-called Main Dividing Range is really the water-parting between the eastern and western river systems, and would be better called the Main Divide.

This north and south belt of tablelands has been produced by the uplift of an extensive peneplain at the close of the Tertiary Period. The time when this epeirogenic uplift took place is generally referred to as the Kosciusko Epoch. In an east and west section across the tableland belt it is seen to be in general highest along the main axis, and to slope away to the shore-line on the one hand, and to the western plains on the other; the western margin is often referred to as the "Western Slopes." When these tablelands were uplifted the amount of movement was not everywhere the same, and this differential uplift developed stresses which were relieved by faulting and monoclinal folding, and the consequent development of great fault escarpments. The great majority of these faults, and the escarpments which accompany them, have a more or less meridional trend, *i.e.*, parallel to the main axis of the tableland belt; some few, however, strike approximately east and west. These faults divide the tablelands, particularly in the southern part of the State, into a series of fault-blocks, many of which have their upper surface more or less tilted and warped. In some localities lower fault-blocks are wedged in between high fault-blocks, and thus form typical "rift-valleys" or "senkungsfelder." The fault escarpments offer a serious impediment to travel, and the road and railway engineers have had to exercise much skill and ingenuity in surmounting these natural barriers.

There are two prominent gaps which break, to some extent, the north and south continuity of the tableland belt, and divide it into three divisions as follows:—

(*a*) The Northern or New England Tableland;
(*b*) The Central Tableland;
(*c*) The Southern or Monaro Tableland.

For such breaks in a main divide the name geocol has been proposed by Mr. T. G. Taylor. The break which separates the Northern from the Central Tableland is called the Cassilis Geocol, and corresponds in position to the pronounced westerly bend of the so-called Main Dividing Range west of Newcastle, between the headwaters of the Hunter and Peel Rivers. This break is primarily a tectonic one, but has been accentuated by differential erosion in the weak strata of the Permo-Carboniferous Coal Basin. The general level of the tableland in this geocol is under 2,000 feet, while the tablelands north and south of it are 3,000 feet and upwards in altitude. This natural break in the tableland belt provides the easiest means of communication between the western and eastern parts of the State, but so far has not been availed of for any of the main lines of communication.

The geocol which separates the Central and Southern Tablelands occurs near the town of Goulburn. Here we have a fairly level tableland, 1,800 to 2,000 feet in altitude, extending in an east and west direction across the Main Divide, and flanked by much higher tablelands to the north and south; this tableland is called the Yass-Canberra Tableland. Lake George lies on this tableland, and the use of the name Lake George Geocol has been proposed for this second break in the tableland belt. The main southern railway line crosses the Main Divide through this break. The Lake George Geocol, with its floor 2,000 feet above sea-level, is by no means a complete break in the tableland belt, the approach from the coast being both steep and difficult.

The three divisions of the tableland belt already mentioned will be described in detail in separate chapters.

(*c*) *The Western Plains.*—These also will be described in another chapter, so only brief mention is necessary here. Under this heading is comprised all that part of the State which lies to the west of the main tableland belts, and includes about two-thirds of the State. This region consists partly of low plateaux and partly of alluvial plains. The former includes the Cobar Plateau, 700 to 800 feet in altitude, which stretches from the western margin of the Central Tableland westwards to the Darling River, where it joins on to the Mount Brown and Barrier Plateau, which extends thence to the western boundary of the State. To the north and south of this low tableland extensive alluvial plains occur.

II.—The Rivers.

As the main divide of New South Wales runs approximately north and south, the rivers fall naturally into two groups—an eastern group and a western group; and, as the main divide is relatively close to the coast, the eastern rivers are relatively short, with steep grades, while the western streams are much longer and with much flatter grades. From the nature of the highlands and their position with regard to the coast, one would expect the eastern rivers to be short, and flow as consequent streams direct to the coast. This is not always the case, as nearly all of the larger eastern streams, such, for example, as the Hawkesbury River, flow parallel to the shore-line for long distances. A detailed study of such rivers shows that they are revived (rejuvenated) streams, and that their courses, for the most part, antedate the existing topography. The north and south courses of these rivers were determined, therefore, before the great uplift took place which produced the present tablelands, and had resulted largely by an adjustment of the stream channels to the prevailing rock structures; these north and south courses follow, in many cases, the strike of the geological formations over which they flow. Some stream piracy has, however, taken place during the existing cycle, as, for example, the capture of a large part of the one-time watershed of the Snowy River by the Murrumbidgee River.

The eastern rivers have developed fairly extensive flood-plains along the lower part of their courses, but these flood-plains quickly give place to deep valleys and profound gorges as they are followed headwards. None of them are navigable for any great distance from their mouths, and all are subject to sudden and destructive floods.

The western group of rivers may be grouped into two subdivisions—a north-western and a south-western division; the former includes the Upper Darling, with its tributaries, the latter the Murray River and its tributaries. Those tributaries of the Darling River which flow from the main tableland belt, such as the Bogan, Macquarie, Castlereagh, Namoi and Gwydir Rivers, have a general north-westerly direction of flow, and their courses appear to have been determined during the Cretaceous Period, when they flowed as consequent streams direct to the shores of the Cretaceous epicontinental sea. The headwaters of these streams flow in deep valleys and gorges, but where they leave the tableland belt and flow out on to the western plains, their courses for long distances are in level country (a "piedmont" plain), which has a semi-arid climate, they consequently lose much of their water by exaporation and soakage, and may for long periods fail to junction with the Darling River at all. The Macquarie River, for example, only reaches the Darling River in time of flood; at other times it ends in a series of swamps. This northern group of westerly-flowing streams is separated from the southern group by the low Cobar Tableland already referred to. The southern group includes the Murray River and its two tributaries, the Murrumbidgee and Lachlan Rivers, all of which flow in a general westerly direction, gradually converging and joining as the western part of the State is approached. The Murray-Darling River system is an example of an engrafted river system; during the early part of the Tertiary Period, an arm of the sea covered the south-western corner of New South Wales; into this sea the Murray, Murrumbidgee and Darling Rivers entered by separate mouths, but, as the Tertiary Sea retreated southwards, they followed the advancing shore-line until they united to form one river system. The Murray and Darling Rivers are navigable for long distances along their lower courses during wet seasons, lasting generally, in the case of the Darling River, at most for a few months of the year.

III.—The Lakes.

The lakes of New South Wales are few and unimportant; they belong to several different types, as follows:—

(*a*) Lake Basins of Tectonic Origin;
(*b*) Glacial Lakes;
(*c*) River Lakes;
(*d*) Coastal Lakes or Lagoons.

During the uplift which produced the existing tablelands, the surface of the land was warped, tilted and faulted; this led to the damming of some of the smaller streams, and, as a result, small lakes were formed. Most of these occur at or near the main divide, and the amount of water flowing into these depressions is too small to produce an out-flow. The only lake of this type of any size is Lake George. This lake, when at its maximum size, is the largest lake in New South Wales, but its size varies with the seasons, and at present it is almost non-existant. The Lake George basin has been formed by the tilting of one fault-block against another, its western margin being marked by a normal fault which has produced a fault escarpment about 500 feet in height; this escarpment is called the Cullarin Range.

The lakes of glacial origin are few in number and so small as to be not really worthy of the name of lakes; their occurrence is confined to a small area in the Kosciusko Tableland. They will be referred to again in the chapter in which the Southern Tableland is described.

The River Lakes occur in considerable number along the lower courses of the Murray River and its tributaries. These western rivers have, as a result of the aggradation of their banks during time of flood, raised their channels above the level of the surrounding country, so that there is a grade away from the main stream channels. Many of the weaker tributaries, in consequence of this, are now prevented from joining the trunk stream, and the damming back of their waters forms lakes. Such lakes receive considerable volumes of water from the trunk stream when it overflows its channel during flood-time. Lake Cowal, near the Lachlan River, Lake Menindie, in the lower Darling county, and Lake Victoria, on the lower Murray, are typical examples of this type of lake.

The coastal lakes or lagoons are, as the name implies, limited in their occurrence to the coastal area. The coast of New South Wales, in common with that of the whole of Eastern Australia, suffered a relative subsidence of about 200 feet in Recent times (it may have been a positive raising of sea-level), with the result that the lower courses of the coastal rivers were "drowned;" many of the inlets of the sea so produced have since been cut off from the sea by the development of sand-spits, thus forming coastal lagoons. Lake Illawarra, to the south of Sydney, is a typical example. Very many examples occur along the New South Wales coast.

IV.—Volcanoes and Volcanic Action.

No active volcanoes occur in New South Wales, nor have any occurred probably since the close of the Tertiary Period. Many of the Tertiary volcanoes, however, still remain, but in a more or less dismantled condition; the most important of these are (*a*) the Canoblas Mountains; (*b*) the Warrumbungle Mountains; (*c*) the Nandewar Mountains. The Canoblas Mountains are a group of extinct volcanic cones situated within a few miles of the town of Orange, on the western edge of the Central Tableland. The highest point in this group is Old Man Canoblas, with an altitude of 4,610 feet, but, as the tableland upon which it stands is 3,000 feet high, the actual height of the volcano itself is only 1,600 feet. The lavas here consist mainly of alkaline trachytes and andesites. The Warrumbungle Mountains are a similar group situated near the town of Coonabarabran, 100 miles to the north of the Canoblas Mountains. They cover a roughly circular area with a diameter of about 30 miles, and range up to a height of 4,200 feet. The Nandewar Mountains occur still further to the north, and lie between the towns of Narrabri, Barraba and Bingara; they range up to 5,000 feet in altitude. The Warrumbungles and Nandewars are built up of similar alkaline lavas and tuffs to those of the Canoblas Mountains, and, like the latter, stand on the western edge of the main tableland belt, which, at their bases, has an altitude of about 2,000 feet. All of these old volcanoes have suffered considerable denudation since they were last in activity.

Many of the Tertiary volcanic eruptions did not bring about the formation of volcanic cones at all, but produced great floods of basic lavas from fissure eruptions; these buried many of the Tertiary stream channels, and now occur capping the surface of the tablelands over large areas, forming extensive basaltic plains.

V.—Earthquakes.

New South Wales does not lie within the great belt of seismic and volcanic activity which engirdles the Pacific Ocean. Severe volcanic phenomena are absent at the present day, while earthquake shocks are few and unimportant. Eighty per cent. of the earthquake shocks which have occurred in New South Wales were located in a small area in the south-east corner of the State. It was in this region that the greatest amount of uplift took place during the Kosciusko Epoch, and where the greatest amount of faulting accompanied the uplift; absolute stability of the crust has apparently not yet been established here.

VI.—Climate.

The climate of Australia has been very fully treated in the handbook published by the Federal authorities for the British Association meeting in Australia, therefore only a brief mention of some special local features is necessary here.

The coastal belt has a comparatively warm climate, with mild winters and a fairly good rainfall; practically all of it falls within the isohyet of 30 inches. The North Coast District has a much higher rainfall, much of it having an annual rainfall of over 50 inches. Southward from Sydney the distribution of rain throughout the year is very erratic, and fairly long periods of dry weather occur.

The main tableland belt, particularly the higher parts, have, as would be expected, a much colder climate than the coastal regions, and have in general an abundant rainfall. The two gaps in the tableland belt previously referred to have a striking influence on the rainfall where they occur. The 20-inch isohyet in New South Wales is a simple curve running approximately parallel to the western margin of the main tableland belt, but the 25-inch isohyet shows a remarkable bulge eastwards where each of these gaps occur. At the Cassilis Geocol the 25-inch isohyet bends eastwards nearly to Newcastle, and the Hunter River Valley has a drier climate than regions of similar altitude lying to the north and south. At the Lake George Geocol the 25-inch isohyet bends eastwards across the Main Divide, and has also from here a pronounced bend southwards to Cooma along the Colinton Senkungsfeld. The rainfall of the Western Plains is much lower than that of the margin already referred to, being from 5 to 20 inches, and getting progressively less westwards.

The most interesting local wind which occurs in New South Wales is the "Southerly Burster," which affects the coast to as far north as Port Stephens. It generally occurs in summer after a hot day, when one anti-cyclone or high-pressure area has just left our coast, and the front isobars of the succeeding high pressure are approaching. As this second high-pressure area advances, the winds in front of the eddy sweep in a northerly direction, and, aided by the smaller friction of the ocean surface, and the shelter which the adjoining tablelands afford from other winds, the southerly becomes more vigorous, and rushes northwards in a squall. Professor David has suggested that the elevated westerly air drift (anti-trade wind) may carry one of the supporting columns, *i.e.*, an anti-cyclone, forward over the Main Divide, while the column next in succession is blocked and retarded in some degree by the same obstruction. One may imagine a "stretching" of the isobars connecting the two anti-cyclones until the accumulated pressure behind the Main Divide rises beyond bounds, and the second anti-cyclone sweeps over the divide with a temporarily accelerated velocity, the winds in the forefront blowing for a time with abnormal intensity, thus giving rise to the "Southerly Burster."

Another local wind of some importance is the "north-easter," which blows on the coast during the greater part of summer. This is a typical sea-breeze, due to the more rapid heating of the land than the sea. It generally begins about 10 a.m. in the morning, gradually freshens during the afternoon, and dies away soon after nightfall. It does much to mitigate the summer heat along the coast, but its influence does not reach far inland.

THE VALLEY OF THE GROSE RIVER.
The rounded hill just to the right of the centre of the picture is Mount Hay.

THE CENTRAL TABLELAND REGION OF NEW SOUTH WALES.

By C. A. Süssmilch, F.G.S. (Technical College).

The Central Tableland Region of New South Wales is the central portion of that great tableland belt which parallels the coast of New South Wales from Queensland to Victoria. Its western boundary lies at an average distance of about 150 miles inland from the coast; northwards it extends to the valley of the Hunter River, and southwards, approximately, to a line joining Nowra and Cootamundra; the region thus included has an area of about 9,000 square miles. The greater part of this region east of the main divide is drained by the Hawkesbury River and its tributaries, the western portion is drained by the Lachlan and Macquarie Rivers.

The altitude of the Central Tableland is variable, ranging in amount from a few hundreds to over 4,000 feet, being greatest along a north and south-central line, from which there is, in general, a slope to the shore line on the one hand, and to the western plains on the other. Its general altitude may be stated as being about 3,000 feet.

The region included above is not really a single tableland, but is rather a group of tablelands of different altitudes, which are separated from one another by a more or less abrupt change in altitude in each case. The more important of these may be referred to as follows:—

	Altitude.
1. The Blue Mountain Tableland	700 to 4,000 ft.
2. The Bowral-Moss Vale Tableland ..	2,000 ..
3. The Yass-Canberra Tableland	1,800 to 2,000 ,,
4. The Crookwell-Wombeyan Tableland ..	2,600 to 3,000 ,,
5. The Orange-Blayney Tableland	3,000 ,,
6. The Hargraves-Hill End Tableland ..	2,700 to 3,900 ..

The surface of each of these tablelands is part of a once-continuous peneplained surface developed during the Tertiary Period, and elevated to its present position at its close; this period of elevation is known as the Kosciusko Epoch. The uplift which produced the present tablelands was very unequal in amount over the region now referred to as the Central Tableland, as shown by the figures already given, with the result that the one-time level peneplain has been gently tilted in some places, steeply warped (monoclinal folding) in other places, and actually broken and dislocated (faulted) in still other places. This uplift has, as a result, produced a series of crustal blocks or fault-blocks separated from one another, in most cases by normal faults or by steep monoclinal folds, and with an abrupt change in elevation where such blocks adjoin. The edge of the higher of two adjoining blocks (tablelands) may present a steep escarpment to the lower block, such an escarpment being due either to steep monoclinal folding or to faulting, as the case may be. The eastern escarpment of the Blue Mountain Tableland immediately west of Penrith, near Sydney, is a typical example.

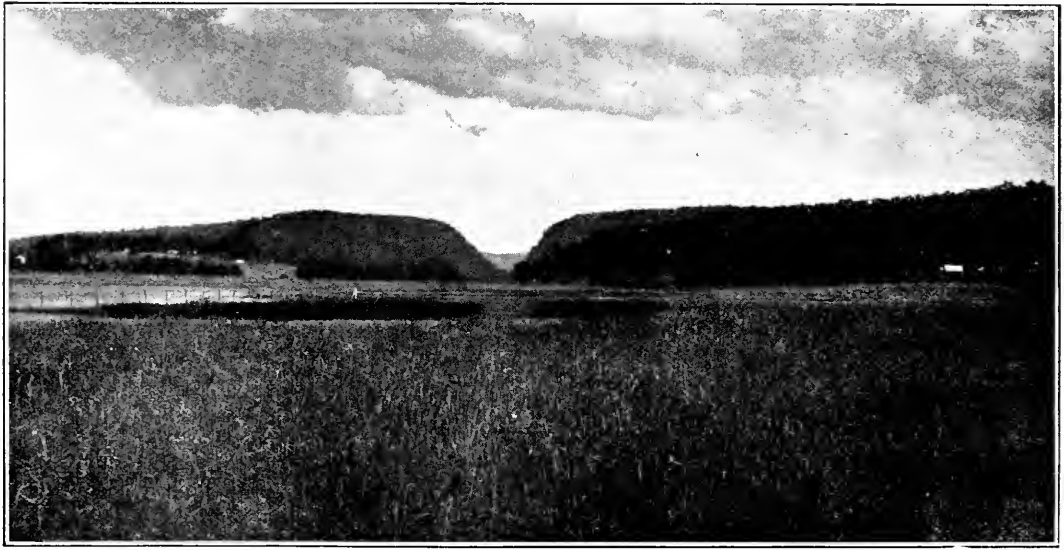
A fault-block may be wholly or partly surrounded by higher blocks, and thus appear as a relatively depressed area or senkungsfeld (Rift Valley); two interesting examples occur, (*a*) the Bathurst Senkungsfeld and (*b*) the depression in which the city of Sydney lies; these will be referred to later.

All of the fault-blocks have suffered considerable dissection since their uplift, the amount of dissection varying mainly according to the height, position, and geological structure of the block; speaking generally, the dissection has reached the early mature stage.

A.—The Tablelands or Fault-Blocks.

The general topographical features of the tablelands listed above are, in general, similar, but vary considerably in detail, according to the varying conditions of geological structure, altitude, etc. Unlike the Southern Tableland, glaciation has played no part in producing or modifying the topography of this region. It will be convenient to describe some of the more important of these blocks separately.

1. The Blue Mountain Tableland.—This lies to the west of Sydney, and includes the highest parts of the Central Tableland, it is, in addition, the largest of the separate units into which the Central Tableland Region is divided. Its surface has a general easterly tilt, being highest along its western margin, where it has an altitude of 4,000 feet, while at Glenbrook, on its eastern margin, the altitude is only 700 feet. Its eastern margin is marked by a monoclinal fold dipping steeply to the east and forming the well-known escarpment near Penrith. The western margin of this Tableland is marked by a great normal fault, striking



EASTERN ESCARPMENT OF THE BLUE MOUNTAIN TABLELAND, from near Penrith.

approximately north and south, and with a down-throw to the west; this gives a sudden drop of 1,000 feet to the Bathurst Senkungsfeld, and a less marked drop to the Orange-Blayney Tableland, both of which lie immediately to the west. The actual northern and southern limits of the Blue Mountain Fault-Block have not yet been investigated, but the area included here is far larger than that usually assigned to the Blue Mountains proper, which form only one part of this crustal block.

The surface of the north-eastern part of the Blue Mountain Tableland is occupied, for the most part, by massive Triassic sandstones; it is the bold vertical escarpments given by the out-cropping edges of these sandstones which forms such a characteristic feature of the Blue Mountain Valleys. In the south-western part of this region, however, the tableland consists of a lower palæozoic complex, and here typical V-shaped valleys characterise the scenery, such as those, for instance, at the Jenolan Caves.

This region has suffered considerable dissection since its uplift, and relatively little of the original flat-topped surface now remains. The Valleys are for the most part still in the youthful stage of development, but in the western part of the region where weak horizontal Permo-carboniferous and Triassic strata rest upon the Lower Palæozoic complex, much benching has taken place high above base-level, as, for example, in the Kanimbla and Capertee Valleys, with the development of typical valley in valley forms.

At the eastern margin of the Blue Mountain Tableland a typical example of a "Horst" occurs, which is known as the Kurrajong Mountain. It has a meridional trend, and at Kurrajong is bounded on the east by a monoclinal fold, and on the west by a normal fault. The western railway line crosses it at Glenbrook, where its height has very much diminished, and the fault on the western side has given place to a monoclinal fold with a throw of about 170 feet to the west; southwards from here it dies away and merges into the general level of the tableland.

Rising above the surface of the Blue Mountain Tableland are isolated basalt-capped Hills, such as Mounts Hay, Banks, Tomah, Wilson, Irvine, and Tooty. These are from 300 to 500 feet higher than the general level of the tableland at their bases, and are residuals of the older plateau, out of which the peneplain which forms the surface of the present tableland was cut.

2. The Bowral-Moss Vale Tableland.—This lies to the south of the Sydney Senkungsfeld. The railway line from Sydney to Goulburn has to climb a steep scarp as it approaches Hill Top, where it reaches an altitude of just over 2,000 feet. The traveller is now on top of an extensive flat-topped tableland, about 2,100 feet in altitude, which extends southwards to Goulburn, where it merges into the Yass-Canberra Tableland; westward lies the higher Crookwell-Wombeyan Tableland, 2,700 to 3,000 feet in altitude. Eastward, the Bowral-Moss Vale Tableland extends to the coast with a diminishing altitude, particularly towards the north-east; it breaks off suddenly at the shore line. This eastern edge is called the Illawarra Range, and is probably due to faulting not far east of the present shore line, but the steep escarpment facing the coast plain is due to the back of the weak strata of the upper coal measures benching.

The surface of this tableland is a peneplain, cut out of Triassic, Permo-Carboniferous, Silurian and Ordovician strata; it has suffered considerable dissection since its uplift, but large undissected areas still remain.

3. The Yass-Canberra Tableland.—This is more or less continuous with the Bowral-Moss Vale Tableland, and has about the same altitude (1,800 to 2,000 feet). It trends east and west, and forms a break in the main north and south tableland belt; to the south lies the great group of fault-blocks known as the Southern or Monaro Tableland, and from which it is separated by great fault escarpments. To the north lies the high Crookwell-Wombeyan Tableland, 2,700 to 3,000 feet in altitude. Eastwards, it extends to the coast, with a diminishing altitude; westward, the surface is gently warped, gradually decreasing in altitude, and finally merging into the western plains. The general level of this tableland is interrupted in places by north and south faults, and the blocks formed by such faults are tilted, the upstanding angle of the fault-block producing low mountain ranges, such as the Cullarin Range, along the western margin of Lake George. This lake itself lies in a depressed region, produced by the tilting of one fault-block against another. Much of this tableland, stretching as it does, across the Main Divide, has suffered but little dissection since its uplift, and here the general features of the Great Eastralian Peneplain, which forms its surface, may be studied to the best advantage. It has a gently-rolling (down-like) surface, above the general level of which rises, here and there, isolated hills or monad-

nocks; these are from 600 to 800 feet higher than the peneplain level, and are residuals of an older tableland. Mount Ainslie and Black Mountain, on the Federal Capital Site, are typical examples, as also is Bowning Hill, close to the Main Southern Railway Line, near Yass.

This relatively low tableland forms a natural break in the main tableland belt of New South Wales, between the Southern and Central Tablelands, and, as has already been pointed out, is called the Lake George Geocol.

4. THE ORANGE TABLELAND.—This lies to the west of the Blue Mountain Tableland, and has a general altitude of about 3,000 feet. Its surface features are similar to the other parts of the Central Tableland, and possess no features of special interest. At Orange, near its western margin, stands a group of extinct volcanic cones, known as the Canoblas Mountains, which rise about 1,600 feet above the tableland level. The Crookwell-Wombeyan and Hargraves-Hill End Tablelands also possess no feature of special interest.

B.—THE SENKUNGSFELDER OR RELATIVELY DEPRESSED REGIONS.

I. THE SYDNEY SENKUNGSFELD.—In whatever direction the traveller leaves Sydney, by road or railway, a fairly steep climb has to be faced. The Illawarra Railway Line, soon after leaving Sydney, begins to climb steadily up a warped surface, until, at Waterfall, an altitude of nearly 700 feet is reached. The Main Southern Railway Line follows a low-lying, more or less level, but slightly rising, surface, until Picton is reached; immediately beyond is a sudden jump up to Thirlmere, which is on a tableland, nearly 1,000 feet high; beyond this, again, is the sudden rise to Hill Top (2,000 feet), previously referred to. The Main Western Railway Line follows a level surface for thirty-six miles, until Emu Plains is reached. It then has to climb the steep escarpment of the Glenbrook Monoclinal fold. The Northern Railway Line, after crossing the Parramatta River, rises quickly until, at Hornsby, an altitude of 600 feet is reached. The Sydney Basin is surrounded on all sides, except the east, by high tablelands, whose surfaces are warped, gently or steeply, towards it; in some places, as at Hill Top, actual faulting appears to have taken place. During the uplift which closed the Tertiary Period and produced the existing tablelands, the region surrounding Sydney persistently lagged behind, and was elevated but little, so that it now appears as a relatively depressed region. It may, therefore, be called a senkungsfeld, although it is not by any means a typical example.

2. The Bathurst Senkungsfeld.—This lies between the western part of the Blue Mountain Tableland (4,000 feet) and the Orange-Blayney Tableland (3,000 feet). Its surface has a general altitude of 2,200 to 2,400 feet, and forms what is known as the Bathurst Plains, and is part of the same peneplain which forms the surface of the higher adjoining tablelands. A magnificent fault escarpment separates the Bathurst Senkungsfeld from the Blue Mountain Tableland.

THE SOUTHERN TABLELAND.

By C. A. Süssmilch. F.G.S. (Technical College).

The Southern or Monaro Tableland occurs in the south-eastern part of the State. It is the smallest of the three divisions of the highlands of New South Wales, but contains the highest land in Australia, much of it being upwards of 4,000 feet in altitude, its culminating point being Mount Kosciusko, 7,306 feet in altitude. The Southern Tableland of New South Wales is continuous with the highlands of eastern Victoria, and it is a significant fact that the highest land in Australia occurs at the point where the general north and south trend of the great tableland belt of eastern Australia changes to the east-west trend of the highlands of Victoria.

The altitude of the Southern Tableland varies so much in its different parts that it must be considered rather as a group of distinct tablelands. The more important of these may be referred to as follows:—

	Altitude.
The Kiandra Tableland	4,000 to 4,800 ft.
The Yarrangobilly Tableland	4,000 ,,
The Tinderry Tableland	4,000 ,,
The Berridale Tableland	2,800 to 3,000 ,,
The Kosciusko Tableland	6,000 to 6,500 ,,
The Coastal Tableland	1,000 to 2,000 ,,

The height given is the general altitude of the tableland surface; on each tableland, however, there are higher points rising above the general level; these are residual mountains, remnants of an older tableland.

Each of these subdivisions is separated from its neighbours by abrupt changes in elevation, and each constitutes a fault-block, such as was referred to in the description of the Central Tableland. As the surface features of all these tablelands are similar, the description already given of the Yass-Canberra Tableland may be taken as the general type.

The Fault-Blocks.

The whole of the region now occupied by the Southern Tableland was, at an earlier stage of its history, a peneplain but little elevated above sea-level (The Monaro Peneplain).

It was then subjected to a slow upward movement, a movement which varied much from place to place, being greatest along a north and south axial line, and decreasing in amount towards the coast on the one hand and towards the west on the other. The tendency of the uplift was to produce a broad flat arch, with an average height at the centre of the arch of about 4,000 feet. The strains developed in this arch during uplift caused it to collapse, and instead of an even curved surface inclining to the east and the west, the result has been the production of a series of relatively flat-topped blocks separated from one another by breaks or faults.

The majority of the faults in the Southern Tableland trend approximately north and south, as also do the fault-blocks which they border; there are, however, some faults which trend east and west, as, for example, those which separate the Kiandra Tableland from the Yass-Canberra Tableland.

The highest of the fault-blocks is the Kosciusko Tableland, which has a general altitude of about 6,000 to 6,500 feet. Mount Kosciusko itself, the highest mountain in Australia (7,306 feet), is a residual mountain rising above the general level of the tableland.

THE FAULT ESCARPMENTS.

Where one fault-block has been pushed up above its neighbour, the side of the block is exposed, and is called a fault escarpment. In travelling across the lower fault-block one would see this escarpment rising above the general level, and appearing in the distance like a mountain range. After climbing up this supposed mountain range one arrives on a level tableland similar in all respects to the one below. A number of such fault escarpments are passed over in travelling from Cooma to Mount Kosciusko; the first occurs quite close to Cooma; a second is ascended near Lake Coolamatong; a third is descended just before reaching Jindabyne; while the fourth and largest lies between Jindabyne and the Hotel Kosciusko. This latter represents a vertical displacement of about 3,000 feet. Such fault escarpments are quickly modified by denudation, and so much resemble mountain ranges that they are often so named. A fine example may be seen when travelling to Cooma, on the right-hand side of the railway line between Michelago and Bredbo.

Such fault escarpments, owing to their steepness, are a great hindrance to transport, and have taxed all the re-

FAULT ESCARPMENT between Michelago and Bredbo.

source and ingenuity of the railroad engineers and road engineers in trying to surmount them.

The Rift Valleys.

During the uplifting of a tableland in the manner already described, there is sometimes produced a fault-block, which lies between two other fault-blocks higher than itself; when such a fault-block is relatively long and narrow it resembles a river valley, and is called a Rift Valley or Senkungsfeld. Several such rift-valleys occur in the Southern Tableland. One of the most striking of these lies between the Kiandra and Tinderry Tablelands, and is traversed by the Cooma Railway line. The floor of this rift-valley is about 2,400 feet in altitude, while the tablelands on either hand are 4,000 feet in altitude; it averages about 15 to 20 miles wide, and is about 100 miles long; northward it merges into the Yass-Canberra Tableland. The Murrumbidgee River flows along the western side of this rift-valley, and its straight north and south course here has been determined by the fault escarpment on this side.

This rift-valley, which has been called the Colinton Senkungsfeld, is remarkable for the dryness of its climate as compared with the surrounding region; the higher tableland to the east cuts off the moisture-laden winds from the Pacific, while the high tablelands to the west act in a similar way in blocking moisture-laden winds from that direction. That part of the Snowy River Valley in which Jindabyne lies is a similar rift-valley. The surface of this senkungsfeld is tilted up stream, and for a time the river had been dammed back, and formed a lake; some of the lake deposits then formed still remain. The river has since cut a gorge through the projecting edge of the fault-block, and the lake has, therefore, been drained.

River Capture.

Some striking examples of river capture occur in the Southern Tableland region, the most notable being the capture of a large part of the one-time catchment area of the Snowy River by the Murrumbidgee River. To any student of physiography who follows the course of this river on a map, that course must appear to be strikingly anomalous. This river has its course on the southern side of Peppercorn Hill, in the County of Buccleugh. For about 80 miles it flows in a south-south-easterly direction; within a few miles of Cooma, where it cuts across the fault escarpment which separates the Kiandra Tableland from the Colinton Senkungsfeld, it suddenly turns due north and flows in this direction for upwards of 80 miles, following along the foot of the above-mentioned fault escarpment, it then turns westward, and maintains this direction, more or less, for the rest of its course. That part of the main divide separating the present watersheds of the Snowy and Murrumbidgee Rivers is relatively low; where the road from Cooma to Berridale crosses it, it is really an almost level plain, and one can hardly realise that it is a divide separating two important drainage areas. Standing on the top of Bunyan Hill, near Cooma, one sees what appears to be a continuous chain of hills standing athwart its course and apparently blocking any drainage in that direction. Looking south, on the other hand, one sees the Monaro Plains stretching west and south, and bounded in the distance by a low range of hills—the main divide. In this range, and due south from the observer, there is a gap, many miles in width. No stream flows through this gap—it is a "wind gap." Anyone unfamiliar with the direction of flow of the streams, would, from this point of observation, certainly come to the conclusion that all the drainage of the surrounding district was flowing south and through this "wind gap." Yet this same gap forms part of the present main divide. That part of the present Murrumbidgee River which flows from Peppercorn Hill to Cooma, as well as the northerly course from Cooma to Tharina, did at one time flow through this gap as part of the Snowy River, but, owing to the warping and faulting of the tableland as it was uplifted, has been captured by the Murrumbidgee River.

The Glacial Topography.

The Southern Tableland is unique in possessing the only evidences of Pleistocent glaciation, which occurs on the mainland of Australia, and here it is confined to one small part, that known as the Kosciusko Tableland. This is the only surface of any extent on the Australian mainland which has an altitude exceeding 5,500 feet—the downward limit of ice-action in this region during the Glacial Period. A few other points in the neighbouring parts of New South Wales and Victoria project above this level, but are too small in area to have afforded any considerable gathering ground for snow and ice.

One of the first things which impresses an observant visitor to the Kosciusko Tableland is the remarkable difference of the topography of this region, as compared with that of any other part of the State. Elsewhere the topography is such as has been produced by the combined action of the atmosphere and running water—what might be called a normal topography. On the Kosciusko Tableland occur all those distinctive topographical features associated with glacial erosion, such as U-shaped glaciated valleys, hanging valleys, truncated spurs, glacial lakes; nor is direct evidence wanting, for we find smoothed and striated rock surfaces, lateral and terminal moraines, glacial erreties, etc. When the Glacial Epoch was at its maximum, an ice-sheet covered an area of 80 to 100 square miles, and with a maximum thickness of not less than 1,000 feet. The downward limit of this ice appears to have been about 5,500 feet in altitude. During this time the snow-line must have been fully 3,000 feet lower than it is now, which would mean a lowering of the mean annual temperature by about 10° Fah.

The glacier lakes include: The Blue Lake, Lake Albina, and Lake Cootapatamba. The two latter are moraine lakes. but the former lies in a true rock basin, with a terminal moraine at its lower end.

THE NEW ENGLAND TABLELAND.

By E. C. Andrews, B.A., F.G.S.

New England may be defined as the plateau area in North-eastern New South Wales, which is bounded on the east by the narrow coastal district, on the south by the low-lying valley of the Hunter River, on the west by the Great Plains, while to the north it is geographically continuous with the plateau of south-eastern Queensland.

Thus defined, the region embraces three upland areas, namely, New England proper, forming a continuous highland surface; the Upper Manning and Hunter River "Tops," detached from the main mass by the erosive action of the headwaters of these streams; and the Nandewar Mountains, lying to the west, and separated from the main mass by tributary valleys of the Namoi and Gwydir streams.

The area lies approximately between latitude 28° 30′ S. and 32° 20′ S. and longitude 150° 10′ and 150° 30′ E.

The extreme length of the plateau proper is 220 miles, while if the high southern "Tops" be included, this length may be increased to 260 miles. The extreme width of the plateau proper, namely, from the Dorrigo to the vicinity of Barraba, is nearly 130 miles, while if the Nandewars be included, such extreme width may be increased to 175 miles. The average length of the plateau proper is about 200 miles, and its average width about 80 miles. Such restricted area varies from 2,000 to 5,300 feet in height, and averages about 3,500 feet above sea-level.

Relation to Other Plateaux in Eastern Australia.

New England is merely a portion of the great plateau area which forms the periphery of Eastern Australia.

Climate and Vegetation.

The area is generally well forested, but large open plains also occur. On these exposed heights the fierce winds from the western quarter are desiccating in summer, and of desolating nature in winter. Extreme shade temperatures as high as 105°, with readings as low as 10° or 11°, Fahrenheit, have been recorded for the plateau. The rainfall is good, ranging from 20 to 25 inches on the extreme west, to about 60 inches at Guy Fawkes, and 70 inches per annum at the Dorrigo. An average of 35 inches per annum appears to be a fair estimate, the eastern margin being one of heavy and continued precipitation, and showing a gradual decrease on a western traverse. Varying plateau heights produce local variations in the rainfall.

New England is separated from the coast-line by a district averaging 50 to 60 miles in width. To this narrow coastal strip the plateau presents a wild and rugged front, 250 miles in length, such front forming an area of great escarpments and profound ravines. Along the whole distance there is no place at which the plateau can be approached except with difficulty from the coast. Moreover, the escarpments intercept the moisture-laden winds from the Pacific, and bring about the investment of these fastnesses by dense jungle growths. Examples: the Hastings and Bellinger Valleys. For many years the upland areas remained unknown to the English pioneers, and this for no other reasons than the height and ruggedness of the eastern escarpments, the denseness of the jungle growths, and the absence of food supplies along the route. This eastern portion of the plateau is frequently also the highest. The plateau falls away more gently to the north-west than to the east.

Broadly speaking, the plateau proper may be divided into two portions, a southern and a northern, the one extending from the heads of the Namoi, Hunter, and Manning Rivers, to Armidale, with a gradual decrease in height from 4,500 to 3,500 feet above sea-level, the other rising as a step 4,500 feet above sea-level to the north of Armidale, and extending thence to Queensland, the height meanwhile decreasing. Each plateau division appears to dip gently in a north-westerly direction, passing under the Inland Plains, at an average height of about 700 feet above sea-level.

These greater divisions of New England may be again subdivided into other units. The various plateaux herewith enumerated occur in order on a north to south traverse of the area under consideration:—

	Altitude.
Wilson's Downfall Tableland	3,200 to 3,600 ft.
Boonoo Boonoo Tableland	3,500 to 4,400 ,,
Tenterfield Tableland	3,000 to 3,500 ,,
Mole Tableland	3,500 to 4,000 ,,
Deepwater-Emmaville Tableland	3,200 to 3,500 ,,
Glen Innes Tableland	3,500 to 3,750 ,,

Tingha Tableland	2,600 to 3,000 ft
Guy Fawkes Tableland	4,500 to 5,300 ,,
Dorrigo Tableland	2,500 to 3,000 ,,
Guyra Tableland	4,300 to 5,000 ,,
Armidale-Hillgrove Tableland	3,300 to 3,750 ,,
Walcha Tableland	3,500 to 3,750 ,,
Macdonald Tableland	4,300 to 4,750 ,,

To these may be added the "Tops" of the Upper Manning and Hunter Rivers, of an average height of 4,300 to 4,500 feet, and the Nandewar Mountains, reaching an extreme height of 5,000 feet in Mount Lindsay.

The heights supplied in the left-hand column are those of the average heights of the tablelands, considered here as the low divides to the broad, shallow valleys, so characteristic of the undulating tableland, while the heights indicated in the right-hand column are those of the highest residuals of the various plateau blocks. The Boonoo Boonoo, Mole, and Macdonald Plateaux are examples of uplands overlooking the general level, or lower, plateau of New England. No towns of importance lie on these higher broad residuals or plateaux. In the northern portion of New England, the lower plateau levels, almost without exception, occur in areas of crumpled Palæozoic sediments and basic plutonic rocks, while the partially dismantled plateau surfaces rising above these lower blocks are almost wholly contained in siliceous granites or rhyolites. The peculiar disposition of the plateaux and plateau remnants in the siliceous and basic plutonics strongly suggests that the several plateau surfaces arranged vertically above each other are the results of differential erosion during various cycles of erosion. This idea receives additional support from the known distribution of the rock structures. Thus the siliceous granites have intruded the basic and other weaker rock structures in a most complicated manner, nevertheless, the lower, or general plateau surface is developed but sparely at the expense of the siliceous types, and, furthermore, the higher plateau surfaces occur within the most resistant structures. This certainly suggests the excavation of one surface level out of another, and not the excavation of various levels simultaneously with one another.

Relative Areas of Upper and Lower Plateau Surfaces.

The upper plateaux are more dismantled than the lower examples, but due regard being had to this fact, it may be stated that in the acid granites the upper plateau surface is larger in area than the lower one, while the opposite condition obtains in the slate areas.

Several other interesting topographical features may be mentioned at this stage.

The plateau is a geographical unit, and the history of one of its valley systems is, in the main, the history of all others draining the highland.

At varying distances from the sea the coastal streams enter upon torrent tracks, the valley walls close in, and the valley itself becomes a profound canon, or ravine, varying in depth from 1,000 to 2,500 feet, according to the height of the plateau traversed. Such forms are of the "valley-in-valley" type, and their sides are clothed with dense forest and jungle growths. In certain districts, as those of the Hastings, Macleay, and Clarence, a gigantic waterfall terminates the torrent track, the torrent track, in extreme cases, being sunken as much as 1,500 feet into the plateau at the base of the falls. Above the falls the stream paths are confined for short distances to narrow and steeply-inclined valleys, but these features pass up-stream quickly into shallow valleys of decided width and of gentle grade. Such a type is often ascertained to be enclosed within another shallow, but broader valley. From the divides of such valleys the country may be observed to consist of a succession of the types here described, the inter-valley ridges rising to the same general height, and thus presenting the appearance of a peneplain dissected to the stage of maturity, but with valleys so shallow as to present the appearance of an undulating surface. Sometimes, indeed, these mature valleys are of such breadth as to suggest the excavation of one peneplain surface out of another. Above these, again, rise the many residual plateaux mentioned before. These consist of much more resistant rock types than the lower plateau surfaces.

After crossing the Main Divide the western aspect of the plateau is entered upon. This, as in the case of the eastern portion, consists of a varying width of unreduced plateau passing inland into a deeply-dissected area; valley-in-valley forms frequently occur; the valleys grow broader; the mountain piles become more and more separated, and dwindle away into insignificance until they disappear under the far-stretching expanse of alluvium known as the North-West Plains.

In the absence of palæontological criteria of age it is impossible to supply a definite statement as to the geological history of the province under consideration. Enough is known, however, of the outstanding facts to suggest that New England was built from east to west; that the plateau proper is composed of dense, crumpled Palæozoic rocks, buttressed by bathyliths and bosses of siliceous granites, and covered in part with Tertiary basalts; and flanked by the Mesozoic sediments on all sides. The plateau appears to owe its existence to the presence and arrangement of the dense siliceous granites and allied rock types.

The Tweed River and Woolgoolga schistose rock types appear to be the oldest in the area, while immediately westward occurs the peculiar complex of eastern and central New England. This may be coeval with, but appears to be younger than, the schistose types farther east. The slates of the Macleay and Manning River areas are of unknown age, but the lithology suggests an age less than the altered complex to the north-east. Sediments of definite Devonian age form a wide fringe on the western and southern portions of New England, while the Carboniferous sediments form a parallel and contiguous are farther west. A later and remarkable stage in the building of New England was the strong compression of the Permo-Carboniferous sediments in northern New England, with a later stage of successive granitic intrusions, and the weak compressive movement affecting the Permo-Carboniferous sediments to the south. The Post-Palæozoic history of New England consists of the repeated uplift and erosion of the plateau area and the deposition of weak Mesozoic sediments around the plateau margins. At least one, if not two, great peneplanation periods are indicated for the area, and these are here referred provisionally to the Cretaceous and pre-Cretaceous respectively, while another, but only incipient, period of peneplanation is indicated for the Tertiary, the formation of many deep leads and the extension of great basalt flows taking place within the area during this period of partial peneplanation. During the Kosciusko Period, or what appears to be the close of the Tertiary, the region was uplifted in several stages to its present position, and the deep cañons with which it is dissected afford a measure of the time which has elapsed since the inception of this pronounced uplift, while the mature valleys which mildly roughen the upland itself afford a measure of the time which has elapsed since the basalts were extruded over the incipient Tertiary peneplain.

The main structures of New England are disposed approximately in a meridional manner, and the larger streams have followed the main lines of weakness in a surprising degree. If New England had been composed entirely of ordinary slates, shales and allied rock types, there would have existed little or no traces of levels, even as old as the Tertiary peneplain, and the geographer would have had no clue as to the Mesozoic and the earlier Tertiary History of New England, except by inference from the sedimentation in adjacent regions. On the other hand, the disposition and extent of these older levels indicate that the periods of time during which the surfaces of erosion under consideration were successively formed in New England became decidedly less and less, while the vertical movements grew more pronounced as the cycles became less in duration. Thus the levels now about 3,500-3,600 and from 4,000-4,300 feet in height in Northern New England amounted almost to complete planation, while the general lower level of New England, upon which the main towns are situated, has been excavated only in the weaker rock structures.

The situations of the siliceous granites are those where the least stream erosion takes place, and this not by accident, but by a beautiful selective action continued throughout several cycles of erosion. Thus, when the granites were first exposed, the streams avoided them as much as possible, because of their strength and insolubility, gradually leaving them in the inter-stream areas during the progress of the cycles of erosion. Thus they became established as the headwaters of the New England streams. Each successive slight uplift merely accentuated the process, until at present the siliceous granites and rhyolites are in such positions that they are relatively immune from stream attack. In other words, the streams have been merely revived with each slow, gentle uplift, and the hard structures have become more and more revealed with each uplift. This statement needs modification, because the flooding of the low-lying Tertiary level by basalts changed the direction of many streams; but these basalts, however, did not materially affect the history of New England as a whole. The strike of the New England structures, moreover, is characteristically meridional in disposition, and the granites themselves appear to have formed no real exception to this rule. This has had a peculiar reaction on the courses of the Eastern Australian streams. The Clarence River may be taken as a single example out of many others. In its early Tertiary history this stream excavated long valleys, both in the slates, basic granites, weak sandstones and shales, so as to avoid attacking the north-and-south line of acid-granites lying farther east. As the later and successive periods of erosion resulted only in incomplete reductions to the plain stage, so the meridional trend of these streams became more emphasised. Upon the Kosciusko Uplift the streams were rejuvenated, and the cañons still receded along their old valley bases in the weaker rocks. In this way the old consequent courses of the major streams appear to have become changed to subsequent ones in great measure. The old course of the Clarence was probably somewhat east and west, whereas now its main tributaries have approximate north-and-south directions of flow. Similarly, the Namoi course is a compromise between subsequent and consequent drainage. This stream revival is an interesting phenomenon, and suggests that, under the influence of periodic uplifts, the land has swelled upwards in the form of a very flat, but warped, surface, but so slowly as not to have deflected the streams from their main courses. Even during the great uplift of the Kosciusko Period, the streams found it easier to follow the old channels than to carve new tracks across the "grain" of the country.

Faults and Monoclinal Folds.—The high plâteau of Guyra and Ben Lomond appears to be either faulted or sharply warped-up from the Armidale plateau. Reasons for this have been given elsewhere by the writer. The Dorrigo is a continuation of the Guy Fawkes Plateau, the latter having been warped down gently to the east-north-east through a vertical height of about 2,000 feet. The high mountains forming the seaward front of the Dorrigo are suggestive of either faulting or monoclinal folding. The enormous eastern scarp of the Guy Fawkes plateau may be explained either by erosive or by tectonic forces. Similarly, for the great eastern scarp overlooking the South Arm of the Clarence.

In a word, the main features of New England appear to be its continued existence as dry land since the momentous

Permo-Carboniferous Period, its wealth of siliceous granites, the meridional character of its rock structures, the resistance of its siliceous rocks to the forces of erosion, the beautiful adjustment of its streams to their associated structures during repeated periods of stream revival, the youth of the present plateau, the inability of the great uplift of the Kosciusko Period to materially deflect the streams from their old courses, and the predominating action of erosion in producing the present surface relief.

THE WESTERN PLAINS.

By E. C. Andrews, B.A., F.G.S.

The geographical divisions into which the State of New South Wales naturally falls are the Coast, the Plateaux, and the Western or Inland Plains. Of these the Inland Plains possess by far the largest area, for, whereas the remaining divisions have an aggregate width of from 200 to 250 miles, the Western Plains are from 450 to 500 miles wide westwards of Narrabri and Moree. The Inland Plains, however, are but a portion of the Great Central Plain of Australia which extends from the Gulf of Carpentaria in the north to south-western Victoria in the south. This large area in turn admits of a division into three principal portions, namely, Northern, Central and Southern. Of these the first-mentioned overlies the Artesian Basin in New South Wales; the second consists of two great plains of erosion separated from each other by the alluvium of the Darling River, and from the Eastern highlands by the alluvial plains of the Bogan and Lachlan Rivers, while the third consists, in the main, of an alluvial plain formed by the silting or aggrading action of the Murray, Murrumbidgee, Lachlan and Darling Rivers.

The Northern division of the Plains is drained by the Darling River, and members of that stream system have excavated their valleys within the intake beds. Its area is about 60,000 square miles, and its altitude varies from 350 to 700 feet above sea-level.

In the Western Plains the alluvial plains occur at levels lower than the great surfaces of erosion with which they are associated. The alluvium has been brought down from the highlands by the Murray River and its tributaries, the Darling and the Murrumbidgee, during periods of flood. Extensive surfaces have been formed thus, which show a gradual fall from about 500 feet above sea-level near Mungindi in the north of the State, to about 100 or 200 feet above the same datum near the junction of the Murray and Darling streams in the south-western portion of the State. The height above the sea of the zone at which the alluvial plain intersects the Western Slopes of the Highlands, as at Moree, Narrabri, Dubbo, Wyalong, Wagga and Albury, varies from 500 to about 800 feet.

The plains of erosion which rise above the alluvium are low plateaux which rarely attain a height of 1,000 feet above sea-level, with the exception of the numerous residuals dotting their surfaces, and which attain a maximum height of about 1,800 feet above the sea. The most noticeable exception to this statement is furnished by the case of the Warrumbungle Mountains, which form a volcanic pile rising above the plains to a height of between 3,000 and 4,000 feet above sea-level.

In general appearance, the plains of erosion, as at Broken Hill and Cobar, are undulating in nature, being traversed by numerous broad and shallow valleys, whose bases are covered with shallow alluvium which, in turn, overlies deposits of coarse stream drift. The plains dip away thence in almost every direction to the alluvial plains, and this gives the appearance of a low, flat shield to the Great Cobar Plain.

Climate.

The maximum and minimum shade temperatures recorded are 127° and about 20° Fahrenheit respectively, while the average rainfall for the whole area may be taken as about 10 inches annually in the extreme west, and from 18 to 19 inches in the eastern portions. The seasons consist mainly of summer and winter.

The Alluvium.

In the more eastern portions of the Western Plains the alluvium often occurs at two levels, the upper one being, in places, as much as from 20 to 25 feet above the lower one. In the regions receiving a precipitation of from 18 to 20 inches annually, that portion of the alluvium, which undergoes periodic flooding, is generally black or dark-grey in colour, and, in wet weather, it is almost impassable by reason of its adhesive nature, while in droughty periods it opens in great gaping cracks. In the Western Districts, "Red Soil" Plains are developed typically in areas with a rainfall less than 17 inches annually, as in the region west of the Bogan, or as terraces situated above the lower black-soil level, as in the Forbes district, or as waste sheets of gentle slope. In the more eastern portions of the plains such "Red Soil" slopes are highly prized for wheat farming, nevertheless, in the western portions of the plains the science of Agriculture has not advanced sufficiently in New South Wales to permit this class of land being used for Closer Settlement purposes, except in limited amounts.

Other interesting features are the "Sandhills and Claypans" recorded by Mr. E. F. Pittman, from the Artesian Basin. The sandhills vary from small mounds to fifty feet in height, while the claypans, which are invariably associated with the sandhills, are in the nature of shallow and flat-bottomed depressions varying in depth from a few inches to a few feet. The floors of the claypans are covered with fine clay, which retains the water for a considerable period after rain. These may be circular in shape, or they may assume the form of long, regular channels.

The gilgais of the Black Soil differ in many respects from those of the Red Soil terraces which overlie the general level of the alluvial plains. For example, the Black (or Grey) Soil examples appear to be almost impervious to water, and they form marshy areas for long periods after heavy rains. Those of the upper Red Soil terraces are porous in their upper portions, while their basal portions are naturally puddled, the gilgais being full immediately after periods of heavy rain, but being subject to drainage immediately after the cessation of rain, except in their basal portions. The sinuous rims of such gilgais as these are often covered with concretions.

In conclusion, the leading points in the geographical evolution of the Inland Plains may be set forth here as illustrating the harmonious adjustment of the fauna and flora of the Plains to their geographical environment.

In the later portion of Cretaceous time a great plain of erosion had been formed across New South Wales. An inland sea existed in the north-west, which possibly had a connection with the Southern Ocean.

During the succeeding Tertiary Period the Cretaceous Sea was drained, while the eastern portion of the State was raised moderately, and another, but quite immature, plain of erosion was formed in the east. Floods of basaltic lava also buried much of the eastern area. Most of the stream waste was carried on to the Plains.

At the close of the Tertiary the low-lying land of the eastern portion of the State was upraised slowly and intermittently to heights ranging from 2000 to 7000 feet above sea-level. A zone of weakness existed at the head of the Hunter, and here over a considerable width the elevation did not exceed 1,750 to 2,000 feet above sea-level. By reason of increased stream velocity caused by the uplift, deep cañons were rapidly formed in the plateaux, and the material removed in the excavation of the cañons discharging to the west was laid down by the Murray River system to form the Alluvial Plains of the Interior. After the formation of the gorges in the plateau, the streams lost their first strength, hence they now carry along smaller loads, and the old plain at present is being cut up by the streams which formed it. Hence have originated the terraced alluviums such as may be seen in the Forbes district.

With the formation of the plateaux during the Kosciusko Period, the Western Plains gradually underwent desiccation, and the gigantic marsupials of the plains became exterminated.

THE TERTIARY AND POST-TERTIARY HISTORY OF NEW SOUTH WALES.

By E. C. Andrews, B.A., F.G.S.

The Upper Cretaceous was, in the main, a period of protracted erosion in Eastern New South Wales, and in part an area of sedimentation in the western portions. The erosive activities continued so long as to have produced a lowlying, undulating plain dotted with residuals of limited area. This surface of erosion appears to have been formed along the whole eastern side of the Continent and Tasmania.

At the close of the great Cretaceous denudation the more peripheral portions of the State (as also of Eastern Australia) were uplifted moderately, and the Inland Cretaceous Sea was drawn off New South Walse, excepting in a relatively small area at the south-western portion, where marine fossils of earlier Tertiary age occur, according to Tate and Etheridge. The sediments comprise sands, calcareous sandrock and shales. Later Tertiary sediments also occur in this area. According to Tate, "Further deep-seated Eocene strata extend into New South Wales, as proved by the occurrence of *Trigonia semiundulata* at a depth of 647 feet in the Arumpo bore, situate in the angle formed by the junction of the Darling and Murray Rivers.

Tareena and Mindarie are situated at about 50 miles to the eastward of the meridian of Overland Corner, which, so far as known, demarks the eastern escarpment of the River Murray plateau, composed above the riverway of Eocene calciferous sandstone capped by Miocene sands and oysterbanks. Between Overland Corner and the confines of South Australian territory, Newer Tertiary lacustrine beds occupy the surface. Therefore, the fossiliferous beds beneath these at Tareena and Mindarie should be older than the River Murray Eocene-limestones (on the assumption that surface levels are approximately the same, and that the Eocene beds have little or no inclination, which I believe to be the case), or it may be that extensive erosion has removed the Eocene strata, which have been replaced by a younger deposit, similar to the Tintinarra section, where a Pleistocene deposit (containing a great variety of recent species) fills a north and south trough in the Eocene beds to a depth beneath the surface of 154 feet."

No traces of Tertiary marines have been found along the present seaboard of the State, and the Tertiary and Post-Tertiary history is to be found in a study of its physiography and its continental deposits rather than in that of its marine sediments.

New South Wales, as, indeed, the whole of Eastern Australia, appears to have formed a geographical unit during the Tertiary and Post-Tertiary Periods. The plateaux which form the peripheral zone of the eastern side of the Continent were already outlined at the commencement of Tertiary time, and their present height is merely the result of a pronounced, but intermittent, revival of the epeirogenic movements which have affected the continental margin in a varying degree since Cretaceous, or, maybe, even earlier time. Thus sections taken at right angles to the coast show a remarkable similarity in the sequence of the topographic forms when traced in like directions. Stated in other words, the main valley systems of the State show similar profiles when observation is limited both to the same great geographical division and to the same types of rocks. This suggests that the four great and sub-parallel regions, namely, the Coast, the Plateaux, the Western Slopes and the Great Plains, have had similar tectonic and erosive histories in later geological time, when considered individually.

During the deposition of the marine Eocene sediments already mentioned, a partial reduction to the peneplain stage had been effected by the streams in the more eastern portion of the State. A rejuvenescence of the uplift occurred subsequently, and defined stream channels were excavated in the uplifted surface, but while yet these channels were in the youthful or early-mature stage the land sank, and the channels gradually became filled with stream debris. As a final result of this group of activities, basaltic flows deluged the low-lying lands and buried many of the channels which had been filled already with riverwash. This sequence of activities with the production of leads or placers and their subsequent burial by successive flows of basalt was repeated after another period of erosion. The time occupied in the formation of the leads and their burial by basalts appears to have been small as compared with the erosion interval separating the two periods of lead formation. This double set of complex movements was closed by a period of erosion productive of wide, shallow valleys having a plain-like appearance in places. The lead formations are so important as to deserve more detailed description.

They occur frequently within the Coastal and Plateau provinces. Some lie above, while others lie buried beneath the general level of the plateau or plain surfaces. In most cases the river gravels are covered and protected by basalts. Physiographically, the leads thus naturally fall at least into a twofold division, namely, a higher and a lower, or an older and a younger, separated by a long erosion interval. David describes a fine set of these variable physiographic lead forms in the famous Emmaville district. In one locality he mentions at least three distinct and successive levels at which river gravels occur capped by basalts, and situated vertically above the other.

Some difficulty arises, however, when the fossil plants of the leads themselves are examined. In general, it has been customary to consider the peculiar fruits, to be mentioned hereafter, as belonging to the younger leads, and the leaves of the cinnamomum and associated types as belonging to the older leads.

In the following notes the several groups of plateau leads will be considered together:—Silicified sandstones or quartzites, full of fern and dicotyledonous leaves, occur near Yass (Jerrawa Creek). Clay, sand and marl characterise the Dalton leads, and excellent plant impressions of dicotyledonous and other types occur therein. According to Benson, the Hanging Rock leads have a maximum thickness of 300 feet. Ferruginous beds, full of leaves, have been found in quantity. Deposits of a white magnesitic material occur on the Richmond River, in which eucalyptus and other leaves occur. At Lucknow, Uralla, and Home Rule, fine examples of basalt-covered leads occur, containing lignite and woody matter. The Bala Hill (Hill End) also contains well-preserved plant remains. In the Nandewar Range, near Barraba, Tertiary continental deposits occur which Mr. E. F. Pittman has shown to contain a bed of infusorial earth, eight feet thick, as also a seam of bituminous coal from one to twelve inches thick. The coal is accompanied by fossil leaves.

Perhaps the most interesting types are the Kiandra (5,000 feet above sea-level), the Forest Reefs (3,000 feet), Gulgong (1,700 feet), Hanging Rock (4,000 feet), Emmaville (2,900 feet), and Wingello deposits.

The Kiandra deposits underlie basalt and form residuals on the uplifted Tertiary plain of erosion. The basal layers of the deposits are coarse and confined in a channel, while the lignite layers underlying the basalt are half-a-mile wide in places. The succession of sediments from the base upwards in one section is as follows:—

Auriferous gravel with sand	14	feet
Earthy lignite and sand	7	,,
Lignite and black shales, with plant remains ..	25	,,
Clay and sand (red and yellow .. (approx.)	50	,,
Lignite with tree stems	8	,,
Red and yellow clays and sands .. (approx.)	30	,,
Earthy lignite	8	,,

The sediments are capped with basalt, and the channel structures are of older Palæozoic slates, claystones, tuffs and syenites.

The fossils found comprise dicotyledonous leaves of moderate size, with fragments of wood.

The associated Round Mountain Lead lies several hundreds of feet vertically lower, and is also capped by basalt. The latter lead contains numerous leaves of large, luxuriant types, very different from the Kiandra types.

The Gulgong and Home Rule sediments reach thicknesses of 200 feet. These, in common with the Forest Reefs types, are covered by basalt, but underlie the general level of the plain of erosion. The auriferous gravels of these types contain numerous fruit remains rather than leaf impressions, and Baron von Mueller describes the following extinct genera from these localities:—Ochthodocaryon, Eisothecaryon, Illicites, Pentacoila, Pleiacron, Acrocoila, Phymatocaryon, Plesiocapparis, Spondylostrobus, Wilkinsonia.

According to Jaquet and Harper, the Wingello beds near Mittagong "comprise beds of ferruginous shale, sandy claystones, and coarse-grained sandstones." They are covered by basalt in places, while in others they have no lava covering. The plant remains belong to various luxuriant types, some of the genera apparently being extinct at the present day.

The older Emmaville Leads, according to Professor David, consist of beds of white, grey, and black clays and silts associated with coarse, well-worn sand and gravel, overlain by basalts. The average width of the beds is about 50 yards, and in thickness they vary from a few feet to 79 feet, the average thickness of the coarse gravels, with tin, being four feet. Great numbers of leaves occur in these beds, the majority of them, according to Ettingshausen, being extinct at the present time in Australia.

The basalts which buried these leads have in turn been greatly denuded, wide valleys having been formed within them prior to the formation of the present plateau.

The vexed question then arises, "What is the age of these leads?" McCoy, von Mueller and others have referred the Gulgong, Home Rule, Forest Reefs types, as also the Ballarat, Haddon, Nintingbool and other types in Victoria, to the late Pliocene, while the Dalton, many of the Emmaville, the Uralla and other similar types have been referred to Miocene and even Eocene Periods. Difficulties arise, however, from such a classification. Murray himself calls attention to the fact that some of the species of fossil fruits, at one time supposed to be characteristic of the younger types, have been found in the older leads. Again, these numerous fossil fruits recorded for leads supposed to be upper Pliocene in age, are almost all of extinct genera—a circumstance at variance with this conclusion as to age. It must be remembered also in this connection that von Mueller was not dealing with leaves, but rather with fairly well-preserved fruits. So high a percentage of extinct genera suggests at least a Lower Pliocene age. The physiography also strongly suggests that the great erosion which has affected the basalts must have occupied a considerable portion of the Tertiary, seeing that such erosion belongs to the pre-Kosciusko Period, to be presently mentioned. The Wingello beds, however, according to Dun, are of very late Tertiary age, and may be younger than the Forest Reefs and Gulgong types.

The climate of the early and middle Tertiary was doubtless mild and genial, as evidenced by the luxuriant plant growths suggested by fossil leaves. Depauperate types are practically absent in these river gravels.

The oscillatory movements of the continental periphery during which the leads had been formed and covered with basalts, culminated during the Kosciusko Period in a slow, but grand and intermittent, movement of uplift. Important, however, as was the sum total of the elevations, they appear to have been but a series of individual revivals of the earlier Tertiary oscillations. During and after each rejuvenescence of movement the streams cut their tracks into the rising land. The earlier uplifts of the period were the more important, as evidenced by the width and depth of the upper valley-in-valley structure. Thus the Upper Hunter at Belltrees occupies a channel excavated several hundreds of feet below an older and very wide valley floor, the upper and older enveloping valley appearing to be about 2,000 feet deep. The Lower Hunter near Singleton flows in a valley of moderate width, which has been excavated within a valley floor of great width, the surfaces of whose residuals lie from 200 to 300 feet above the present floor, the railway passing over a portion lying between Singleton and Liddell. The walls of the upper and older valley are steep and high, and lie many miles apart. Wide valleys of the Kosciusko or Post-Plateau Period occur only in the weak geological structures of the State. Good examples of this valley-in-valley appearance occur along the Murrumbidgee a little distance above its junction with the Yass River. The Clarence, the Gwydir, the Tweed, the Cox and other streams are also excellent examples showing valley-in-valley forms. At Parkes the traces of as many as four dismantled floors may be detected in one valley.

So slowly were the uplifts of the period carried out that the courses of the main streams do not appear to have been deflected thereby. Remarkable examples of such revivals, or non-deflection, of stream courses are the Shoalhaven at the Tallong bend, the course of the Hawkesbury from Richmond to the sea, of the South Arm of the Clarence, and of the Rocky or Timbarra River between Bald Nob and Tabulam. Fine examples of such stream revival occur also along the Mole, Gwydir, Namoi, Lachlan and other streams.

On the other hand, the plateau rose more rapidly than the streams were enabled to carve their cañons throughout the whole width of the plateau. This is evidenced by the wealth of waterfalls existing in the uplands.

The Kosciusko Period has been referred by the writer to the close of the Tertiary in Eastern Australia.

Along the coast the activities of the Kosciusko Period appear to have caused a faulting or bending down below the sea of the old land area now indicated in part by the Continental shelf. Inland, however, deposition of waste was proceeding as a result of the excavation of the western gorges and valleys during the long-continued Kosciusko period, and by such process the great plains of the interior of the State attained their present grand development. During the earlier stages, when the streams were in their period of greatest strength and load, the plains were built up rapidly because of the overburdening of the streams as they emerged from the plateau on to the lowlands with much-decreased channel slopes, but at a later period, when the gorges had been cut far back into the plateaux and the channel slopes of the streams within the plateaux themselves had been reduced greatly by such action, the streams were no longer overburdened, and found opportunity to cut wide and shallow valleys into the alluvial plains, thus giving the latter a terraced appearance, the higher and older portions in the regions of less rainfall than 20 inches per annum being changed to reddish colours by reason of peroxidation of the iron contents under dry conditions, while the lower portions, subject to periodical floodings, remained darker, sometimes almost black in colour. Both higher reddish and lower blackish alluviums possess gilgais, those of the higher alluvium being large and porous in the upper portions, and non-porous at the bases by reason of puddling by silting action, while those of the black soil are sunken in the surface of the lower plain, and hold water for long periods. The upper portions of the gilgais are often covered by small pebbles, often apparently of recent chemical origin.

To the Kosciusko Period belong "leads" such as the Forbes-Parkes examples in New South Wales and the Chiltern types in Victoria. In these buried watercourses fossil plants are found, apparently differing but little from the vegetation growing to-day in the vicinity.

A study of these younger leads and the topographic forms of the plateau region leads to the conclusion that the climate of Eastern New South Wales has been strongly differentiated in post-Cretaceous time. The Cretaceous appears to have been mild and genial, so also the greater portion of the Tertiary Period. With the uplift during the Kosciusko Period a marked division into climatic zones was initiated. The endemic flora of the colder regions of Australia, which had been gradually developing during the pre-Kosciusko Period, appears to have gradually found its way north during the Kosciusko Period along the slowly rising plateau. This northward migration of the colder types was also accentuated during the Pleistocene glaciation. The extinction of the peculiar Tertiary animals, such as Diprotodon and Nototherium, appears also to be referable, in the main, to this gradual differentiation of climate in late and post-Tertiary time.

The choked channel bases of the streams in the western districts, the gilgais of the red-soil plains and of the higher terrace, or terraces, of alluvium, as well as other features, suggest also that the climate of the State has been gradually becoming more arid since the Kosciusko Period.

The shore-line topography with its wealth of harbours, estuaries, islands, lagoons, cliffs and beaches strongly suggests a drowning of the shore-line at a period post-dating the excavation of the cañons and deep valleys of the warped plateaux, the drawing movement being fairly rapid, as indicated by the presence of deep harbours, such as Port Jackson and the lower portion of the Hawkesbury River. The numerous coastal plains, raised beaches and rock benches along the shore-line also suggest an apparent elevation of the shore-line to the extent of a few feet during still more recent time. Examples of these rock benches in contorted sediments occur at Tweed Heads and Carumbin Rocks.

Typical instances of the coastal plains are those at Tarro, along the Raymond Terrace-Hexham Road, and Woy Woy. Excellent examples of raised beaches are those recorded by Professor David at Maitland, the beds being associated with estuarine deposits from which 33 species of shells were obtained. The heights of these beds above high-water mark vary from one to 15 feet. Similar indications of the apparent elevation of the shore-line for a few feet are to be found along the whole eastern side of Australia.

The action of great storms from the south-east quadrant is also interesting in that they appear to have determined the main outlines of the present beaches and the deflections of the mouths of certain large streams, such as the Richmond and Tweed.

THE COASTAL AREA.

By E. C. Andrews, B.A., F.G.S.

The shore-line of New South Wales forms a simple curve presenting a slight convexity to the ocean, especially in its northern portion. Neglecting irregularities, the length of this line is about 600 nautical miles. The extremes are Point Danger and Cape Howe, and the positions of these respectively are given approximately by Latitude 28° 9′ S, and Longitude 150° 34′ E, and Latitude 37° 30′ S, and Longitude 150° E.

The trend of the coast is almost NNE and SSW, but the simplicity of the flat curve facing the ocean formed by the intersection of land and sea planes is somewhat broken between Forster and Newcastle, where it has a trend about N 40° E for a length of 50 miles.

The coastal area passes beneath the surface of the sea as the continental shelf, the latter being submerged by the sea to depths reaching an extreme of about 600 feet. Beyond this limit the shelf is warped rather rapidly to ocean depths. This continental platform is narrow and is composed of an inner and outer portion, the inner being very narrow and somewhat roughened by islands and reefs in certain places, whereas the outer portion is wider and presents only smooth profiles to the overlying sea surface. The maximum breadth, about 35 miles, appears to occur in the vicinity of Newcastle, while the greatest contraction lies to the south of Sydney, where the width at various points rarely exceeds twelve miles.

An ocean current follows the shore-line down from the north. According to Halligan, "In the offing the average speed of this current is about one-half to one knot, so that *per se* it is not a powerful stream. Its surface-speed is increased by a northerly or north-easterly wind; and a southerly gale lasting for more than twenty-four hours will often temporarily reverse the direction for a period depending upon the force of the gale and its duration." According to Hedley, the outer portion of the shelf is due to sedimentation by this southward-flowing current.

Adverting to the consideration of the coastal area proper, it may be noted that it is wider in the northern areas than in those south of Sydney. Thus between the Tweed Heads and Coff's Harbour the average width of the coastal area is about 50 miles.

At Coff's Harbour the eastward prolongation of the Guy Fawkes plateau takes a sudden dip under the sea surface and appears to be the result of two crustal bucklings of gentle curvature which give the differential elevations attained at the Dorrigo and Guy Fawkes. The Bellinger-Nambucca Valley is a deep amphitheatre heading under the Guy Fawkes escarpment, the view from which is probably unexcelled in New South Wales or even Australia. The coastal areas drained by the Macleay and Hastings Rivers are only of slight width, but those traversed by the Manning and Hunter streams have a considerable extension, the reason for which will be given later. Between Newcastle and Sydney a low abutment of the main upland extends almost into the sea, only broken by the valley of the Lower Hawkesbury, where it traverses the sandstone plateau in a grand cañon hundreds of feet in depth. The Sydney District itself is a low point from which the plateaux increase in height in three directions, reaching elevations of about 2,500 feet 100 miles south of the metropolis, and nearly 4,000 feet about 60 miles west of the same locality. At Illawarra and still farther southwards the plateau advances boldly almost to the shore-line, and is only broken by the valley and cañon of the Shoalhaven, which attains a depth of about 1,700 or 1,800 feet in the dense Palæozoic rock structures near Tallong. Still farther south the plateau rises to great heights and advances almost to the sea in abutment form, as at Bateman's Bay, Moruya and Tilba, the intervening low-lying coastal strips never exceeding a width of 20 miles. In all this it may be seen that the wider portions of the continental shelf coincide fairly well with the broader portions of the coastal area. This suggests that the tectonic movements which determined the main features of the coastal and adjacent plateau areas stand in some casual relation to the general form of the narrow continental shelf.

An examination of the coastal strip and the associated plateaux also strongly suggests that the coastal area represents the dissected extensions to the eastward of the main plateau which forms the peripheral portion of Eastern Australia. These smaller plateau units do not rise uniformly to one height, but, on the contrary, they mark the differential uplift of a low-lying surface, the uplift being broadly regular, but exhibiting marked irregularity in detail. All appear to be referable to a series of movements acting simultaneously right along the east side of Australia, each successive elevatory or depressing action merely representing a revival of the earlier movements. A long-established zone of weakness is thus indicated for this region.

DEPRESSED AREAS.

Three remarkable examples of such occur along the coastal area, namely, in the Sydney or County Cumberland, the Hunter, and the Lower Clarence districts. In the first-mentioned the Triassic rocks attain a thickness of about 3,000 feet; these have a slight dip inland at the shore-line and a dip towards Sydney district from almost every point in the depression, the area being flanked by a large monoclinal fold and fault, as shown by Professor David. In this instructive area the peneplain of Tertiary age may be seen to have been uplifted unevenly. The elastic limit of the rocks affected was exceeded a little to the west of Penrith, and rupturing ensued along a direction approximately parallel to the trend of the shore-line.

In the Hunter River, or central-coastal area, the Permo-Carboniferous sediments occupy a depression separating the Northern and Central Tablelands. The coastal strip is here very wide, and it appears to have lagged behind somewhat during the general uplift of the eastern margin of Australia in the Kosciusko Period. Here the actual Main Divide is distant about 130 miles from the coast, and it is less than 2,000 feet in height; moreover, its origin is mainly tectonic, although erosion has also been remarkably pronounced in this locality since the uplift, owing to the decided relative weakness of the sediments of the Permo-carboniferous. As will be evident by a comparison with the Sydney and Grafton districts, the Hunter River depression has not been so pronounced in later geological times because the Triassic rocks do not here occur below sea-level.

Along the lower portion of the Clarence drainage system Professor David has shown that there is a basin in the Clarence Series with one of its deepest points near Grafton. At Grafton itself the Clarence Measures are 3,400 feet thick, as proved by boring. At Maclean the sandstones dip inland at angles varying from 10 to 15 degrees, while the conglomerates along the Tyringham-Grafton Road, on the eastern fall of the New England Plateau, appear to dip towards Grafton at an angle possibly as high as 15 or 20 degrees. These western members of the group appear to be of similar age to the Clarence Series outcropping farther to the north. As in the Sydney district, the low-lying land of the Lower Clarence basin is terminated to the west by a high plateau rising abruptly for about 4,000 feet above sea-level, while the Clarence at the foot of the plateau is probably not more than 400 or 500 feet above the same base. The upland is composed mainly of siliceous granite, and it is doubtful whether folding phenomena, even if present, could be ascertained by stratigraphic methods. Nevertheless, the striking topographic features of the plateau escarpment, through whose margin the South Arm of the Clarence passes before taking its easterly course to the sea, is strongly suggestive of an important fold or fault paralleling the coast and formed during the Kosciusko Period. This idea receives additional strength from the fact that a similar topography occurs to the west of the depressed region of Sydney, as already stated. The river, however, practically follows the junction of the resistant siliceous granites with the weaker slates and the Clarence Series.

Another highly important point in connection with these remarks on the coastal depressions under consideration is the marked absence there of resistant rock buttresses in comparison with the great development of such buttresses in the high plateaux away from the sunken areas. Thus siliceous granites are characteristically absent from the area separating the Northern (New England) and Southern (Monaro and Bathurst) Tablelands. In the southern portion of the coast the granite plateaux, or their abutments, extend practically to the sea, but in such region there is no sign of sinking area such as at Sydney, Newcastle or Grafton.

RIVERS.

The main streams flow for the greater parts of their courses in directions approximately parallel to that of the shore-line. The major geological structures also have dispositions practically parallel to the shore-line, and it is an adjustment of streams to structure which has permitted of this peculiar arrangement of the drainage. Nevertheless, such adjustment of streams to the structure of the country is not the outcome of one period, but rather of many periods, of stream action. The formation of the great plateaux during the Kosciusko Period allowed the streams to cut the profound ravines of the Shoalhaven, the Wollondilly, the Macleay, the Manning and the Clarence, nevertheless, the present directions of flow of these streams were not determined during the great uplift because the cañons may be seen to be receding along the bases of valleys formed in a period prior to the main uplift. It has been considered by some physiographers that a stream, such as the Shoalhaven, has captured the upper waters of the Hawkesbury during the great uplift, but it can be definitely shown that the principal streams have courses practically identical with those they followed during the peneplain stage in the later Tertiary. As such, it is preferable to consider that the more powerful stream, namely, the Hawkesbury, worked its way headwards during the early or middle Tertiary, and gradually captured a portion of the Shoalhaven, otherwise we are faced with the difficulty of finding an explanation for the absence of a stream course continuous with the lower east-and-west trend of the Shoalhaven. The Hawkesbury, Hunter, Macleay and Clarence all appear to possess such continuations of their east-and-west courses beyond the point of junction with the main subsequent streams, but the east-and-west direction of the Shoalhaven is cut clean off at the mighty bend of the stream at Tallong, and such course is independent of the Kosciusko Uplift, as the stream has been simply revived by that epeirogenic movement.

SHORE-LINE.

The topography of the shore-line is interesting, but simple. Deep harbours, drowned river mouths, high cliffs, small beaches under the cliffs, long sigmoidal beaches tying together headlands otherwise well separated, bars backed up by lagoons and by lagoon-marsh meadows, sunken reefs and infrequent small islands are among the most conspicuous features of the zone at which land and sea meet in New South Wales. Such an association of forms indicates a moderate amount of drowning by the sea in quite recent times, and it also indicates that the drowning was carried out with relative rapidity, otherwise the harbours and river mouths would have been silted up concomitantly with the drowning movement. The stage which the shore-line has attained may be described as that of late youth.

Along the shore-line also one may see the indications of either an apparent rise of the land, or a retreat of the sea, to the extent of a few feet. The evidence exists in the nature of high and dry plains or terraces of coarse sand, as at Manly, Woy Woy, Raymond Terrace, Lady Robinson's Beach, or rock benches in crumpled sediments near high-water mark, as at the Carumbin Rocks, the Tweed Heads and other places. Thus the shore-line, simple though it is, is somewhat puzzling upon casual inspection. For to the one who confines his observations to the mere meeting-place of land and sea planes the coast appears to be in a stage of elevation; while to the other, who takes a slightly broader view of the case without looking carefully into the details, the coast appears to be passing merely through a period of submergence; nevertheless, to the observer viewing the long sweep of coast from some commanding elevation, the dominant action of the great, but differential elevation of the peneplain (with its details of faulting and sagging) in the Kosciusko Period is at once evident. Under an inspection such as this, the epicycle of apparent subsidence is seen to be merely a feature of minor importance and of much later age than the great uplift, nevertheless, one whose peculiar forms appear to have been modified in recent historical time by a vibratory movement of apparent elevation. Nevertheless, in the future, when the traces of both present drowning and apparent elevation shall have disappeared from the landscape, the dominating influence of the elevatory movement of the Kosciusko Period will still be the main feature of the coastal region.

THE MINERAL INDUSTRY.

By E. F. Pittman, A.R.S.M., Under-Secretary for Mines and Government Geologist.

The occurrence of gold in Australia was first recorded in 1823 by Surveyor McBrien, who discovered it while making a survey of the Fish River, between Bathurst and Rydal. It was not until 28 years later, however, that Mr. E. H. Hargraves demonstrated that the precious metal occurred in payable quantities. The exact date of his letter notifying the fact was April 30th, 1851. By the 25th May not less than 1,000 persons were working the alluvial drifts of Summerhill Creek, Ophir. The news of the discovery spread with amazing rapidity, and prospecting operations were immediately commenced all over the country, with the result that a number of the principal goldfields were discovered the same year. On the 1st July, 1851, the Colony of Victoria was separated from New South Wales, and almost immediately afterwards the goldfields of Ballarat, Mount Alexander, etc., were found within the new Colony.

Such, briefly, was the beginning of the Mineral Industry of New South Wales; the early successes of the gold-miners had the effect of attracting to our shores a large number of adventurous people from Europe and America, and for a time money was made easily and everything went well. Subsequently when the richer surface deposits of gold were exhausted, bad times were experienced; still many of the immigrants remained, the country became settled, other useful minerals, such as copper, tin, silver-lead, and zinc were successively discovered, and mining became one of the established industries of the country.

The alluvial gold deposits of the Mother State, although they were very rich, were not nearly so extensive as those of Victoria. The principal alluvial fields in New South Wales were Forbes and Parkes, Young, Sofala, Wattle Flat, Kiandra, Rocky River, Hill End, Hargraves, Gulgong and Temora. The gravels in which the gold occurred at these places were of Tertiary and Post-Tertiary age, and in some instances, as at Kiandra, Rocky River, and Gulgong, the Tertiary drifts were overlain by basalt. On a much smaller scale, auriferous gravels of Cretaceous age occurred at Mount

Browne and Tibbooburra in the north-west of the State, whilst still older (Permo-Carboniferous) deposits of a similar character were worked at Tallawang, near Gulgong.

In the earlier stages of mining the shallow alluvial deposits were worked with primitive washing or sluicing appliances; more complicated machinery became necessary as the deep leads were developed, and still more recently, large quantities of gold have been recovered from the beds of rivers, which had previously been regarded as unpayable, by means of Bucket Dredges and Centrifugal Pump Dredges.

Auriferous lodes or reefs have been worked on a number of fields of which the principal are Hill End, Hargraves, Forbes, Parkes, Grenfell, Gundagai, Temora, Wyalong, Lucknow, Cobar and Hillgrove. At Hill End in 1872-3 amazingly rich returns were obtained from the reefs, which were worked down to a depth of about 700 feet. At Gundagai a reef was worked with payable results down to a depth of 1,000 feet. As a general rule, however, successful mining operations have not been carried deeper than 600 or 700 feet in New South Wales. The gold almost invariably occurs in "chutes," and it generally happens that when the upper chutes have been exhausted, sufficient capital is not forthcoming to perform the dead work necessary to determine whether other payable chutes occur below. Hence the question as to how deep the payable auriferous deposits extend in this State has not been satisfactorily settled.

The quantity of gold won in New South Wales varies greatly from year to year. As a rule, when general industrial conditions are prosperous the gold yield is low, but when employment is not easily obtainable in other directions, more people turn their attention to prospecting, and the yield of gold improves.

Coal.—The discovery of coal in New South Wales antedated that of gold by about 54 years, but was not attended by the same excitement. However, although the finding of gold led to the populating of this country, the coal deposits have had far more to do with its development, and will doubtless have still more to do with its future prosperity.

As the coal and kerosene shale resources of the State have been dealt with in a separate article, it is unnecessary to say more about them here.

Platinum.—Traces of platinum have been found in the Broken Hill district. A certain amount of platinum has been recovered from the beach sands of the North Coast (near the Richmond River), where it occurs associated with other platinoid metals, gold, and tin. The most important deposit, however, is at Fifield, west of Parkes, where it is found, associated with gold in alluvial leads. The largest platinum nugget obtained here weighed 27 dwt. The chief difficulty in connection with the platinum mining industry in this district is the scarcity of water.

Silver-Lead-Zinc.—Silver mining in New South Wales practically dates from the discovery of Broken Hill in 1883; that mine was "pegged out" and applied for under the Mining Regulations by Charles Rasp, who believed that the cap of the lode consisted of tin-ore. In 1884 chloride of silver was found in Rasp's shaft at a depth of 100 feet. The story of the subsequent development of the mine reads almost like a fairy tale. There were seven shares in the original Broken Hill Proprietary Syndicate, and several of these were sold for less than £100 each; they were afterwards worth £2,500,000 each! In less than 30 years the lode has produced metals of the value of £70,182,124, and the sum of £16,177,580 has been paid in dividends. The present value of the mines, estimated from the market price of the shares, is £5,930,174.

The rocks in which the Broken Hill lode occurs consist of gneisses, schists, quartzites, and garnet sandstones, with pegnatites and amphibolites. The sedimentary series is believed to be of Lower Cambrian Age. The lode occupies a saddle-shaped cavity formed by the folding of the schists, gneisses and quartzites; it therefore belongs to the same class of deposit as the Bendigo saddle reefs, but is developed on a very much larger scale. In its oxidised zone the Broken Hill lode had a width of 300 feet of highly payable ore, while in the sulphide zone its width, in one position, amounted to no less than 450 feet. The cap of the lode consisted of manganiferous ironstone, and formed a low range, two and a half miles long. Under the cap extremely valuable oxidised ores were met with, consisting of cerussite, rich in silver, and kaolin ore containing native silver and embolite. Below the oxidised zone mixed sulphides of lead and zinc with high silver values were found, and as greater depth was attained there was a gradual decrease in the metal values of the ore, together with a development of rhodonite in the gangue, which, on account of its toughness, increases the cost of reduction. However, owing to improvements in the methods of treatment, and particularly the adaptation of the flotation process, the mining industry at Broken Hill is in a flourishing condition.

Another field where the silver-lead mining industry is in a healthy state is Yerranderie, which is situated about 80 miles south-west of Sydney. The field is on a much smaller scale than Broken Hill, the lodes, which occur in quartz porphyry, being from a few inches up to four feet in thickness, and consisting of argentiferous galena with a little gold. Notwithstanding the fact that freight by horse team to Camden costs £2 5s. per ton, the returns from this field have been steadily progressive.

Copper.—Lodes of copper-ore have been found in widely separated parts of New South Wales, and many mines have been opened and worked intermittently, owing to the fluctuations in the price of the metal. Amongst the most important mines may be mentioned Cobar, Nymagee, Shuttleton, Mount Hope, Girilambone, Burraga, Blayney, Cow Flat, Orange Plains, Gulf Creek, and Cangai.

Of these the most important is unquestionably the Great Cobar Mine, which is the terminus of a Government Railway 464 miles west of Sydney. There are three lodes in the property, known respectively as the Main lode, the Middle lode, and the Eastern. Of these only the Main lode has been prospected, and it is possible that the other two may yet prove valuable deposits. The Main lode really consists of three ore lenses which have replaced the country rock, viz., slate of Pre-Silurian Age. These lenses vary in width from an inch up to 100 feet, and, although copper-ore was visible at one point at the surface, there was nothing to indicate that such enormous ore-bodies occurred below. In the upper levels of the mine the ore was extremely rich and contained a notable proportion of gold associated with the copper. In the early days of the mine's history many difficulties had to be contended with, the principal one being the cost of freight. The copper had to be conveyed by bullock teams for a distance of 300 miles to the nearest railway station, and that the mine could be worked at a profit under these circumstances is eloquent testimony to the value of the ore. As the mine was worked to greater depths, the ore beame poorer in both copper and gold, and at the present time at a depth of 1,500 feet it contains, on an average, about 2½ per cent. of the former, and rather less than 1 dwt. of the latter per ton.

The Great Cobar ore, being of a basic character, is suitable for partially-pyritic smeltings, and as the Company possesses three other mines (the Cobar Gold Mine, the Chesney Mine, and the Great Peak Mine) in which siliceous ores, containing a little copper and gold, occur, these are smelted in conjunction with the former.

The Great Cobar field has already produced about 100,000 tons of copper, 500,000 ounces of gold, and 1,250,000 ounces of silver, the aggregate value of which amounts to about £8,000,000.

Tin.—Tin mining in the State dates from 1872, when considerable deposits of stream tin were discovered in the Inverell and Emmaville districts. Tinstone occurs in alluvial deposits, as grains and crystals scattered through greisen, and as lodes and pipes in intrusive granite close to its junction with slate. Fissure lodes are not very numerous, the most important examples being the Ottery lodes at Tent Hill, and Butler's lode about eight miles north of Emmaville. Tin-bearing pipes are somewhat remarkable; they are cylindrical in section, a few feet in diameter, and they have an irrgular downward course, few of them being worked for more than 40 feet in depth. The tinstone is disseminated through a gangue of felspar, quartz, and chlorite, and is frequently present in the proportion of 50 per cent.

Alluvial tin also occurs at Dora Dora, 40 miles east of Albury, and, associated with wolfram, at Tabletop, near Wagga. Lodes containing tin and wolfram occur in granite at Jingellic, on the Murray above Albury. Tinstone is also found in coarse crystals disseminated through dykes of pegmatite at Euriowie, north of Broken Hill.

Recently lenticular chutes of tinstone have been found at Ardlethan, a railway town 40 miles west of Temora. The deposits occur in granite close to its junction with slate. Remarkable blocks of ore, of as much as a ton in weight, and containing 50 per cent. of tin, were obtained on the surface, and there has been considerable activity there since. The question as to the depth to which the deposits will continue payable has still to be solved.

Iron.—Ores of iron occur in numerous localities, but the most important for smelting purposes are those of Coombing Park, Carcoar, and Cadia, near Orange. The first-named deposit consists of a mixture of hematite and limonite, and has been estimated to contain 2,571,000 tons of ore. It has been rather extensively worked by Hoskins Brothers, and smelted at their furnace at Lithgow. The Cadia deposit is much larger, and has been estimated to contain about 39,000,000 tons of ore. It consists of beds of hematite and magnetite, and much of it is believed to be suitable for the production of steel by the Bessemer process.

Iron smelting works are now in course of erection at Newcastle by the Broken Hill Proprietary Silver Mining Company, but they propose to use ore from their Iron Knob Mine in South Australia.

Aluminium.—The mineral bauxite, consisting chiefly of alumina, occurs in considerable quantities in the Inverell, Emmaville, and Goulburn districts. No attempts have yet been made to manufacture aluminium from it, but it is suitable for the purpose and will doubtless be worked in the future.

Alunite.—A very large deposit of alunite or alumstone occurs at Bullah Delah, where it forms the summit of a mountain 900 feet high. The mineral has been derived from the decomposition of rhyolites which underlie the deposit. It is exported for the manufacture of alum.

Antimony.—Stibnite occurs in considerable quantity, associated with scheelite and gold, in quartz reefs intersecting granite at Hillgrove. Antimony mining, however, is only carried on intermittently, owing to the great fluctuations in the price of the metal.

Bismuth and Molybdenum.—At Kingsgate, 18 miles east of Glen Innes, at Pheasant Creek, 30 miles north-east of Kingsgate, and at Whipstick, 14 miles from Pambula, ores of bismuth are associated with molybdenite in pipes intersecting granite near its junction with slate. The pipes are roughly circular or oval in section, and descent irregularly. The gangue is quartz with sometimes felspar and a little mica and garnet.

Tungsten.—Scheelite occurs in quartz lodes, associated with stibnite and gold, in granite rocks at Hillgrove. The extent to which these deposits are worked depends upon the ruling price of the mineral.

Wolfram is found at many localities, but at Torrington it occurs, associated with bismuth, in deposits of considerable importance. The permo-carboniferous marine beds there have been intruded by granite, and both granite and slate have later been invaded by a granite rock which has been much altered (silicified), and now has the appearance of a quartzite. The wolfram occurs in crystals scattered through this altered rock (topaz greisen); also in quartz veins penetrating it, and again in pegmatite dykes associated with it.

Diamonds.—At Copeton, near Inverell, diamonds are recovered from alluvial drifts, and at Oakey Creek, in the same district, small diamonds occur in a matrix of dolerite.

Opal.—Precious opal occur as seams in a white siliceous rock in the Desert Sandstone (Upper Cretaceous) series at White Cliffs, north of Wilcannia, and at Lightning Ridge, near Walgett. At the last-named place the rare variety known as black opal is obtained.

TABLE SHOWING THE QUANTITY AND VALUE OF THE MINERALS WON DURING THE YEAR 1913, AND TO THE END OF 1913.

NEW SOUTH WALES.

Minerals.	Production for Year Ending 31st December, 1913. Quantity.	Value.	Total Production to 31st December, 1913. Quantity.	Value.
Coal	10,414,165 tons	£3,770,375	192,010,145 tons	£72,858,063
Gold	149,657 oz. fine	635,703	14,148,432 oz. fine	60,098,678
Silver	2,194,871 oz.	244,321	28,389,373 oz.	3,371,238
Copper	9,461 tons	598,733	225,533 tons	12,382,835
Tin	3,020 ,,	421,292	108,164 ,,	9,748,901
Lead	23,554 ,,	365,742	161,745 ,,	2,366,653
Antimony	18 ,,	407	16,672 ,,	305,631
Opal	—	29,493	—	1,359,700
Wolfram	125 ,,	13,037	1,482 ,,	145,554
Manganese	—	—	576 ,,	1,662
Bismuth	8 ,,	1,202	549 ,,	129,739
Molybdenite	78 ,,	6,802	383 ,,	42,838
Limestone	42,663 ,,	10,686	1,167,334 ,,	713,500
Ironstone	—	—	106,917 ,,	81,618
Scheelite	44 ,,	4,457	1,174 ,,	105,305
Iron	46,563 ,,	186,252	384,008 ,,	2,300,038

Iron Oxide	3,204 ,,	3,563	26,900 ,,	34,311
Lime	33,272 ,,	41,428	340,825 ,,	319,355
Portland Cement	—	402,249	—	2,241,933
Shale (Oil)	16,985 ,,	7,339	1,668,419 ,,	2,330,171
Diamonds	5,573 cts.	5,141	184,543$\frac{3}{8}$ cts.	125,549
Alunite	2,235 tons	8,940	41,270 tons	128,483
Chrome	500 ,,	500	31,335 ,,	101,968
Marble	—	991	—	24,055
Platinum	442 oz.	3,135	13,432 oz.	32,145
*Stone (Building, etc.)	—	1,156	—	25,332
*Slates	—	—	79,234 No.	890
Cobalt	—	—	884 tons	8,065
Coke	298,612 tons	208,989	3,310,695 ,,	2,347,656
Quicksilver	—	—	1,010 lbs.	126
*Grindstones	—	170	—	3,012
Zinc (Metal and Concentrates)	506,660 ,,	1,547,987	3,326,384 tons	9,087,900
Silver-Lead Ore, Concentrates, etc.	391,261 ,,	3,563,804	7,833,268 ,,	58,657,876
Sundry Minerals	—	11,189	—	133,273
Totals		£12,095,083		£241,614,053

* Quantity and Value Exported.

ARTESIAN WATER.

By E. F. Pittman, A.R.S.M., Under-Secretary for Mines and Government Geologist.

The artesian water-bearing beds of New South Wales form the south-eastern portion of the main Australian artesian area, extending westward into South Australia, and northwards through Queensland to the Gulf of Carpentaria. The beds underlie the north-western portion of New South Wales, extending from longitude 151° east to the South Australian border, and from Queensland to latitude 32° south, an area of about 83,000 square miles. The eastern boundary of the New South Wales Basin runs along the western flank of the Main Dividing Range, near the towns of Moree and Narrabri; near the 32nd parallel of south latitude it swings to the west and sweeps in a curving line to the north of Dubbo and Bourke, whence it trends in a westerly direction to the South Australian border.

Along the western foothills of the Great Dividing Range, which gradually merge into the western plains, occur outcrops of a series of porous greyish-white sandstones and blue shales, belonging to the Trias-Jura (Ipswich) Coal Measures, containing the typical ferns, *Tæniopteris Daintreei* and *Thinnfeldia Odontopteroides*. These strata have an almost meridional strike, changing in parts to a little east of north, and extend almost continuously from the Queensland border to the southern boundary of the artesian basin.

The sandstones dip gently west under the waste sheet of the plains, which is derived from the denudation of the Palæozoic rocks and Tertiary basalts of the Divide. The intake beds have a probable maximum thickness of 2,500 feet in this part of the State, and form the base of the artesian basin, resting unconformably on a complex of Palæozoic beds and plutonic rocks which form an impervious floor to the water-bearing strata.

Above the Trias-Jura beds and apparently resting conformably on them lies a series of Lower Cretaceous Marine beds, consisting of shales, sandstones, and argillaceous limestones. This series was originally covered, also conformably, by the Upper Cretaceous (Desert Sandstone) series, consisting mainly of ferruginous sandstones, grits and con-

Photo by E. F. Pittman.

TENANDRA ARTESIAN BORE, NEAR WARREN
Depth, 1,038 feet: Flow, 600,000 gallons per diem.

glomerates. The Upper Cretaceous series has, however, been removed over vast areas by denudation and is now only represented there by isolated hills or low ranges, with local developments, as at White Cliffs and Lightning Ridge, of a white kaolin rock, containing the veins of precious opal.

The surface of the Western Plains, which was once covered by horizontal beds of Desert Sandstone, now consists of red or white sand (the local remnants of that rocky mantle) or of dark clays which have been distributed by unusually high floods of the Darling River and its tributaries. These clays, locally known as "black soil," become extremely tenacious after a comparatively small rainfall, and travelling by means of wheeled vehicles then becomes almost an impossibility, as the mud collects in great masses upon the tyres and spokes, while the horses are unable to obtain sure footing upon the slippery surface.

Attention was first drawn to the probable existence of supplies of underground water in the State in 1879, by H. C. Russell, at that time Government Astronomer, who stated that only a small proportion (1.46 per cent.) of the rainfall on the Darling River catchment area actually flowed past Bourke, whereas, he contended, in the case of the Murray, the "run-off" amounted to 25 per cent. of its rainfall.

He concluded that the great difference between the rainfall and the run-off of the Darling could not all be accounted for by evaporation, and that the only way of explaining it was on the assumption that some of the water was sinking into the ground "to flow at some lower level," and that it was in this way forming an unlimited underground supply of good water. These statements of Russell's led to boring operations being started in the following year, and in 1880 bores were sunk at Wee Wattah and Mullyeo, between the Darling and Paroo Rivers. Artesian supplies were obtained at shallow depths and this encouraged extensive drilling, both by the Government and by pastoralists.

Although Russell's estimates of the percentage run-off of the Darling and Murray Rivers respectively have proved, in the light of more recent gaugings, to be inexact, the important fact remains that the Murray carries away a much greater proportion of the rain which falls within its catchment area than does the Darling. As the first-named river passes over none but impervious rocks, whereas all the tributaries of the latter flow over the porous Trias-Jura sandstones before referred to, the low run-off of the Darling is accounted for by the absorption of the rainwater by these beds and its percolation into the artesian basin.

Up to the end of 1912 a total of 503 bores had been sunk in New South Wales—flowing wells numbered 384, and in 77 bores pumping had to be resorted to, while 42 bores were failures. Of this total 165 were put down by the Government and 338 were privately owned.

The distribution of the flowing wells is very even over the whole basin, but the depths at which the water is tapped varies between the limits of several hundreds of feet and 4,400 feet. The deepest bore was put down at Boronga (near Moree), 4,338 feet, and the flow per diem was 1,062,133 gallons. The greatest flow registered from a bore in the State was 1,900,000 gallons per diem from the Coonamble No. 1 Bore; this flow was measured 10th November, 1893. The great majority of the bores are characterised by high temperatures, the highest record in the State being from the Goondabluie private bore, near Walgett, which reached 148 degrees Fahr. from a depth of 2,800 feet. Speaking generally, the shallow bores appear to have lower temperatures than the deeper, although there are many notable exceptions.

A large number of analyses has been made by Mr. J. C. H. Mingaye, in the Departmental Laboratory—these all show the artesian water to be strongly alkaline, the principal constituent being $Na_2\ Co_3$, which usually represents about 80 per cent. of the total solid matter. Na Cl is next in abundance, as a rule ranging from 5 to 20 per cent. of the total solids. In isolated cases analyses show excessive salinity in comparison with the usual composition of the water, but this is evidently gathered from a strictly local source and does not truly represent the composition of the water passing through the strata. The water as it issues from the bores has a rather strong odour of H_2 S, but after standing for some time it becomes perfectly inodorous. Gases have been collected from the water issuing from most of the bores, but they consist almost entirely of nitrogen, although carbon dioxide, and oxygen are occasionally present in small quantities.

Analyses of water from several bores are set out for purposes of comparison. These bores are in widely separated localities, situated in the eastern, western, southern and central portions of the basin:—

ANALYSES MADE IN THE CHEMICAL LABORATORY, DEPARTMENT OF MINES, N.S.W.

	Coonamble No. 1 (Central).	Warren (Southern).	Gil Gil (Eastern).	Yantabulla No. 1 (Western).
Sodium Carbonate .. (Na_2 Co_3)	40.00	38.34	32.630	17.369
Potassium Carbonate (K_2 CO_3)	--	trace	1.701	6.615
Calcium Carbonate .. (Ca Co_3)	1.12	1.21	0.499	1.549
Magnesium Carbonate (Mg Co_3)	trace	0.26	0.127	1.930
Sodium Chloride .. (Na_2 Cl)	6.91	7.23	7.258	9.557
Potassium Chloride .. (K Cl)	—	—	—	—
Magnesium Chloride .. (Mg Cl)	—	—	—	—
Sodium Sulphate .. (Na_2 SO_4)	—	0.859	—	—
Potassium Sulphate .. (K_2 SO_4)	—	—	—	—
Silica .. .. .. (Si O_2)	—	1.960	1.764	1.456
Alumina & Ferric Oxide (Al_2O_3 Fe_2O_3)		trace	trace	trace
Total solids in grains per gallon ..	48.03	48.60	43.979	39.996
Total solids in 1000 parts	0.6861	0.6940	0.6282	0.5713

Analyses have proved that the mineral content is, in a majority of bore waters, well under the maximum which renders it unfit for consumption. Under these circumstances, it is of immense benefit in watering stock routes that traverse the arid western districts of New South Wales. It is also largely availed of for household purposes, and occasionally for irrigation, though its continuous use for this purpose is found to be inimical to plant life on account of the carbonate of soda contained in it, which ultimately saturates the soil with alkali.

It is worthy of notice that in the extreme north-west of the State the water in the Urisino Bore exhibits the singular phenomenon of rising and falling to a varying extent, viz., from 3 to 4 feet, while the periods of its oscillation also varied from 9 to 17½ hours, according to observations made with a tide recorder during a period of nearly two months. No completely adequate explanation has yet been offered, and the irregularity of the periods of ebb and flow is opposed to the suggestion of lunar attraction. Urisino is the only tidal well at present observed in the State, though there may possibly be others.

Diminution of Flow.—One of the most serious facts in connection with the artesian water supply is the steady decrease in the flow from all bores.

Periodical measurements are made by officers of the Public Works Department, and it has been ascertained that at present the mean annual decrease of flow from all the bores in the State amounts to seven per cent. Twelve bores have ceased flowing altogether, the supply having become sub-artesian, which necessitates pumping. As examples of individual losses the following may be cited:—

Warren	Bore	has	lost	91.0%	of its flow	in	14	years
Bourbah	,,	,,	,,	85.2%	,,	,,	4	,,
Three Corners	,,	,,	,,	84.9%	,,	,,	9	,,
Haddon Rigg	,,	,,	,,	76.1%	,,	,,	10	,,
Moramina	,,	,,	,,	74.8%	,,	,,	16	,,
Quabathoo	,,	,,	,,	66.7%	,,	,,	7	,,
Carwell	,,	,,	,,	62.0%	,,	,,	6	,,
Florida	,,	,,	,,	51.2%	,,	,,	10	,,
Lower Quambone	,,	,,	,,	45.1%	,,	,,	7½	,,
Brigalow	,,	,,	,,	38.6%	,,	,,	7	,,

These losses are only what might have been expected from the indiscriminate multiplying of bores and consequent overtaking of the reserve supply. The same thing has happened elsewhere, a notable instance being the artesian basin from which the City of Denver (U.S.A.) draws its water supply. In six years from the time when the first bore was put down, nearly 400 bores had ceased to flow, and pumping had to be resorted to.

Although the flow in individual bores is thus seriously diminishing, the figures for the total outflow for each year are at present but slowly receding, owing to the fact that more bores are continually being put down.

This is well shown by the following table:—

Date of Measurement Outflow.	No. of Bores Gauged.	Outflow in Gallons per Diem.
1 Jan., 1910	316	109,560,972
1 Jan., 1911	326	109,168,059
1 Jan., 1912	332	106,152,850

It is to be noted that only 332 bores were measured in 1912, so that these figures do not represent the actual total outflow from the total number of bores.

Maximum Usefulness of Artesian Water.—Under the Artesian Wells Act, 1897, and Water and Drainage Acts, of

1906 and 1911, many districts have been incorporated in bore trusts constituted for the purpose of sinking artesian wells and distributing drains for supplying water over several adjoining pastoral holdings.

It may be mentioned that in 1912 a conference of geologists and engineers representing the Governments of five of the Australian States was held in Sydney, and their report, which was unanimous, contains the following:—

"Experience has proved that results more important to the community at large can be obtained from artesian water in connection with pastoral pursuits than in connection with agriculture.

"We have been much impressed by the success of the operations under the New South Wales Water and Drainage and Artesian Wells Amending Act. These operations have resulted in obtaining the maximum usefulness of the water from each bore, and, at the same time, avoiding the waste which would ensue from the unnecessary multiplication of bores. Under this Act the value and productiveness of pastoral land have been enormously increased by reason of the permanence of the water supply, and already about 4½ million acres have been occupied with most successful results."

Source of the Water.—It is confidently believed, by those geologists who have had opportunities for carefully studying the features of the New South Wales artesian basin, that the water is derived from rainfall, and that hydraulic pressure is the principal cause of its rising above the surface when tapped by bores. The evidence in support of this belief may be summarised as follows:—

1. Water, under sufficient pressure to rise above the surface in bores, is found nearly everywhere within the limits of what has been proved to be a true geological basin.

2. The floor of this basin is composed of impervious rocks, such as granites and Palæozoic sediments.

3. Above these impervious rocks, and resting unconformably upon them, are beds, of considerable thickness, of porous Mesozoic sandstones, with interbedded shales

4. These porous sandstones are seen at the surface along the eastern margin of the basin, that is to say, along the western flanks of the Dividing Range, where their outcrop has an average width of about 30 miles. They dip in a westerly direction under the centre of the basin.

5. The continuous westerly extension of the porous sandstones under the basin has been proved by the finding of a typical fossil plant, *Tæniopteris Daintreei*, at a depth of about 1,400 feet in the Salisbury Downs bore, which is situated about 400 miles west of the intake beds.

6. The altitude of the area where the porous beds outcrop is everywhere considerably greater than that of the plains where the artesian bores are situated.

7. In the centre of the basin the porous sandstones are overlain by several thousand feet of shales, limestones and clays, forming an impervious covering to the water-bearing beds.

8. The exposed porous sandstones form a considerable portion of the catchment area of the Darling River, all the tributaries of which flow over these rocks.

9. The "run-off" of the Darling River is much lower, in proportion to the amount of rain which falls upon its catchment area, than that of the Murray River, the watershed of which is all composed of impervious rocks.

10. The mean annual temperature of the two watersheds is about the same, and therefore there can be little difference in the loss by evaporation to which each river is liable.

11. Water under sufficient pressure to rise above the surface in bores is found nowhere outside the limits of the porous sandstones.

In connection with this question, the report of the Interstate Conference on Artesian Water contains the following:—

"As there has been a considerable amount of controversy in regard to the origin of artesian water and the cause of its flow, we have given special consideration to the question, and have no hesitation in stating that, in our opinion, the ascertained facts indicate that the water is almost wholly, if not entirely, derived from rainfall; and that it percolates the porous beds under the influence of hydraulic conditions.

"The hydraulic surfaces which have so far been plotted, fragmentary though these are at the present time, show by their contours that the water is in motion, and that its rise to the surface is clearly controlled by the laws which govern the flow of liquids in channels which are more or less confined.

"The only additional information which has been obtained in recent years in connection with this question is the fact that the artesian waters appear to contain considerable proportions of nitrogen gas and carbon dioxide, particularly the former, which must undoubtedly to some extent assist in bringing the water to the surface. At the same time, we feel convinced that these gases are only to a slight extent responsible for the rise of the water; and it would appear that the amount of gas in the waters from new bores is larger than is the case in bores which have been flowing for some years. Further experiments, however, require to be made in order to definitely prove this statement, and in the meantime we can only express the opinion that the rise of the water is primarily due to hydraulic pressure, but that the presence of the gas to some extent assists it."

THE COAL DEPOSITS.

By E. F. Pittman, A.R.S.M., Under-Secretary for Mines and Government Geologist.

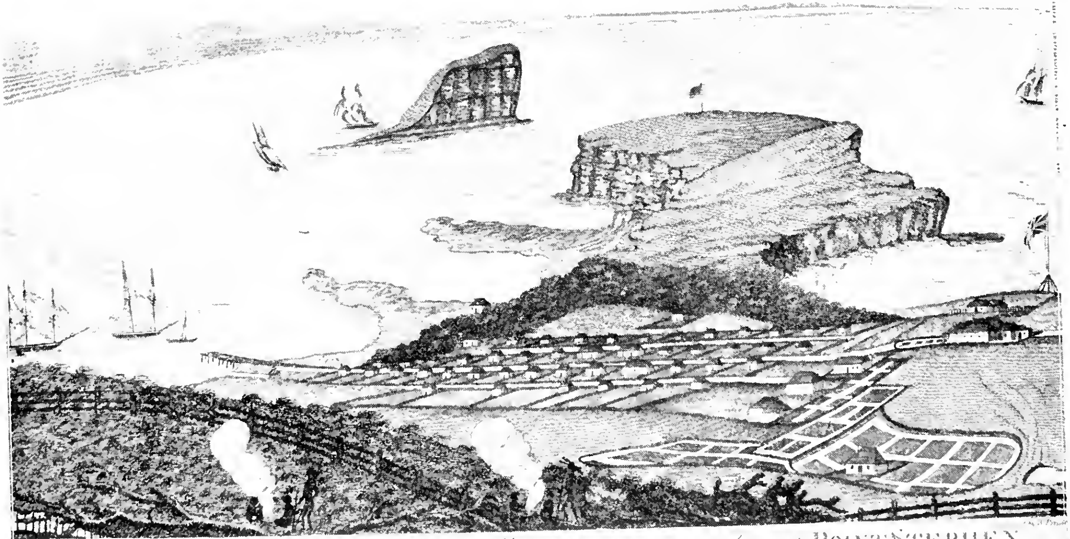
The coal deposits of New South Wales are the most important of the State's mineral resources, and are of greater extent, and as a whole of better quality, than those of any other Australian State. The possession of such large quantities of valuable fuel must ultimately cause New South Wales to become the chief centre of manufacturing industries of Australasia.

The coal from the different coalfields varies somewhat in character and composition, and, while in some districts the fuel is most suitable for steam-raising, in others it has a special value for gas-making, or for household purposes. One special advantage about these deposits is that, for a distance of about 200 miles, they extend along the seaboard, so that they are excellently situated for export purposes.

Coal was discovered in this State in August, 1797, at Coalcliff, on the coast to the north of Wollongong, in the Southern Coalfield. About a month later seams of coal were discovered in the cliffs at Newcastle, which has since become the centre of export for the Northern Coalfield. These two districts still remain the principal sites of coal mining activity. Several of the collieries near Newcastle have been worked out, and others are near depletion, but the recent discovery of the rich seams of the Greta Coal Measures between Maitland and Cessnock has resulted in the opening up of a number of new collieries which will supply the Australian and foreign markets with first-class coal for very many years to come, and Newcastle will certainly remain the port of shipment.

Geology of Coal Measures.

The general geology of the coal-bearing rocks of New South Wales was first worked out by the late Rev. W. B. Clarke, and his work has been elaborated by the officers of the Geological Survey of New South Wales. The Hunter River Coalfields were surveyed by Professor David; the Western by J. E. Carne, and the Southern by Messrs. J. B. Jaquet and L. F. Harper.



NEWCASTLE, in New South Wales, with a distant View of POINT STEPHEN.
(taken from Prospect Hill)
Dedicated to his Excellency Lachlan Macquarie Esqr. Governor of New South Wales, &c. &c.
Published Novr. 30th 1812, by A West, Sydney

NEWCASTLE IN 1812.

As a result of the investigations of the abovementioned workers, the coal-bearing rocks of New South Wales may be geologically classified as follows:—

Geological Age.	Maximum Thickness of Strata.	Locality.	Character of Coal.
I.—TERTIARY, *Eocene* to *Pliocene*.	About 100 feet.	Kiandra, Gulgong, Chouta Bay, etc.	Brown-coal or lignite.
II.—MESOZOIC, *Triassic*, or *Trias-Jura*.	About 2,500 feet.	Clarence and Richmond Rivers.	Coal suitable for local use only
III.—PALÆOZOIC, *Permo-Carboniferous*.	About 13,000 feet.	Northern, Southern, and Western Coal-fields.	Good coal, suitable for gas-making, and for household and steam-raising purposes.
IV.—PALÆOZOIC, *Carboniferous*.	About 10,000 feet.	Stroud, Bullah Delah.	Very inferior coal, with bands: of no value.

I.—Tertiary.

Lignite or brown coal has been found in limited quantities in deep leads at Kiandra, Gulgong, etc., the seams being from 3 to 4 feet thick, though at Kiandra there is a maximum thickness of 30 feet. No detailed examination has been made of these deposits.

II.—Mesozoic.

The Mesozoic coal measures may be regarded as of Trias or Trias-Jura age, and are principally developed in the Clarence basin (see geological map).

The rocks forming this basin have been divided into the *Upper, Middle,* and *Lower Clarence Series,* as under:—

Shales, possibly containing coal seams	Upper Clarence Series.
Thick bedded sandstones (about 100 feet)	Middle Clarence Series.
Shales and sandstones (300 to 1,000 feet) with coal seams	Lower Clarence Series.
Thick beds of coarse conglomerates	

These measures contain at least five seams of coal and shale bands varying in thickness from 2 to 37 feet, but in every instance shale forms the greater part of the seams. The Clarence River coal is, as a rule, remarkably free from sulphur, and is comparatively smokeless.

The Clarence basin extends far into Queensland, and at Ipswich thick and valuable seams of coal are worked on an extensive scale. These seams probably occur in the equivalents of the Lower Clarence Series.

In the Sydney and Blue Mountain area occurs a series of sandstones and shales—the Hawkesbury Series—in the main of freshwater origin, and made up of the Wianamatta shales, Hawkesbury sandstones, and Narrabeen shales. The coal seams of this series are negligible.

The dominant fossils of this series are of the cosmopolitan Mesozoic type—Thinnfeldia, Tæniopteris and Alethopteris.

Permo-Carboniferous.—These measures contain the productive coal seams of New South Wales, and occupy about 16,550 square miles.

The Permo-Carboniferous rocks have been classified, in descending order as follows:—

Photo by E. F. Pittman.

DOLERITE DYKE INTERSECTING THE UPPER COAL MEASURES, NOBBY'S, NEWCASTLE.

The course of the Dyke can be seen in the foreground, together with some masses of Coal which have been cindered by the heat of the intrusive lava.

	Thickness in feet.
1. *Upper or Newcastle Coal Measures*, containing twelve seams of coal. In the aggregate they contain 35 to 40 feet of workable coal	1,400 to 1,500
2. *Dempsey Series*, freshwater beds, containing no productive coal. This series thins out completely in certain directions	2,200
3. *Middle, or Tomago, or East Maitland Coal Measures*, containing six seams of coal, varying from 3 to 7 feet in thickness. In the aggregate they contain about 18 feet of workable coal	500 to 1,800
4. *Upper Marine Series*, containing an abundance of marine fossils, but specially characterised by the predominance of the Brachiopod, *Productus Brachythærus*	5,000 to 6,400
5. *Lower or Greta Coal Measures*, containing an aggregate of about 20 feet of coal ..	100 to 300
6. *Lower Marine Series*, containing an abundance of marine fossils, but specially characterised by the predominance of the Mollusc, *Eurydesma cordata*	4,800
Total Maximum thickness	17,000 feet.

The characteristic fossil plant genera of the Permo-Carboniferous Coal Measures are *Glossopteris*, *Vertebraria* (believed to be the root of *Glossopteris*), *Nœggerathia*, and *Gangamopteris*. *Gangamopteris* is most abundant in the Greta Coal Measures.

1.—The Upper or Newcastle Coal Measures.

These Coal Measures show the greatest surface development of any of the Permo-Carboniferous rocks. Their coal seams outcrop in the neighbourhood of Newcastle in the north, Lithgow in the west, and Bulli in the south, and, as will hereafter be shown, they extend continuously under the deep portion of the coal basin.

In the *Northern* or *Newcastle Coalfield* no less than twelve seams (which, with included bands, vary from 3 feet to about 20 feet in thickness) have been discovered in these Measures. They have been named as follows, in descending order: —

*1. The Wallarah seam	..	about 11 feet thick.
*2. The Great Northern seam		about 20 feet thick.
3. The Fassifern seam	..	up to 25 feet thick.

4. The Upper Pilot seam ..	not workable.
5. The Lower Pilot seam ..	not workable.
*6. The Australasian seam ..	from 7 to 20 feet thick.
*7. The Burwood seam ..	from 6 to 8 feet thick.
8. The Nobbys seam	not workable.
9. The Dirty seam	from 6 to 10 feet thick; splits into two seams in places.
10. The Yard seam	about 3 feet thick.
*11. The Borehole seam ..	from 4 to 22 feet thick; usually 8 to 9 feet thick.
12. The Sandgate seams .	from 4 to 6 feet thick.

* Seams worked at present.

In the *Southern* or *Illawarra Coalfield* these Coal Measures are known to contain five distinct seams which have been named as follow, in descending order:—

*1. The Bulli seam	2 to 11 feet thick; usually 6 to 7 feet thick.
*2. The Four-feet seam	about 4 feet thick.
3. The Thick seam, or Dirty seam	about 17 feet thick.
(Several small seams occur between the Thick seam and the Eight-feet seam.)	
4. The Eight-feet seam .	from 7 to 9 feet thick.
5. The Bottom seam	about 6 feet thick, including numerous bands.

* Seams worked.

In the *Western* or *Lithgow Coalfield* there are seven seams known to occur in the Upper Coal Measures, and of these only three have been proved to be of commercial importance; indeed, although coal has actually been won from three seams, by far the greatest proportion of it has come from the lowest of the series, viz., the Lithgow seam.

In descending order the seams in the Western Coalfield have been defined by Mr. J. E. Carne, Assistant Government Geologist, as follows:—

*1. The Katoomba or top seam	from 2 to 6 feet thick.
2. The Dirty seam	with bands attains a thickness of 18 feet.
4. 5. 3. } Thin, unimportant seams	
*6. Upper Irondale seam	from 5 to 8 feet thick.
*7. The Lithgow seam.	about 11 feet 6 inches thick; (lower 6 feet worked).

* Seams worked.

A feature of the Western and Southern Coalfields is the occurrence, in the Upper Coal Measures, of lenticular patches of deposits of kerosene shale, a variety of torbanite, cannel coal, or boghead mineral. It is used extensively for the manufacture of kerosene oil, and also for the production of gas. The lenticular patches vary considerably in extent; their thickness ranges from an inch or two up to 4 feet 6 inches, while in length or width they seldom exceed a mile. At the edges of the deposits the shale is found to pass into either bituminous or splint coal, or into earthy or stony carbonaceous shale. It is also frequently associated with coal seams either above or below it. Very rich deposits of kerosene shale occurred at Hartley Vale, near Mount Victoria, and at Joadja, near Mittagong, but both these deposits have been worked out. An extensive deposit is at present being worked by the Commonwealth Oil Corporation, at Newnes. The Corporation's leases cover a large area of ground, including the valleys of the Capertee and Wolgan Rivers, and kerosene shale outcrops in both these valleys, and possibly may underlie the greater part of the intervening tableland; the character of the shale, however, differs in the two outcrops, and hence the continuity of the deposit is open to doubt. The shale driven upon from the Capertee Valley is of decidedly better quality than that in the Wolgan Valley, and while the former attains a thickness of 4 feet 5 inches, the latter has a maximum of about 2 feet.

Deposits of kerosene shale, though much less extensive, have also been found in both the Upper and Greta Coal Measures of the Northern Coalfield.

2.—Dempsey Series.

The Dempsey Series consist of about 2,200 feet of mudstones, shales, sandstones and conglomerates, and contain no coal seams.

3.—The Middle or Tomago Coal Measures.

The Middle, or Tomago, or East Maitland Coal Measures outcrop in the neighbourhood of East Maitland, and their general dip is towards Newcastle and under the Dempsey freshwater series and Upper Coal Measures. The following are the principal coal seams of the Middle Coal Measures, in descending order:—

1. Top seam, or Donaldson's seam	4 to 6	feet thick
2. Big Ben, or Tomago thick seam	7 to 10	,,
3. Tomago thin seam	$2\frac{1}{2}$ to 3	,,
4. Scotch Derry seam	9 to $10\frac{1}{2}$	,,
5. Rathluba seam	$5\frac{1}{2}$ to 11	,,
6. Morpeth seam	$4\frac{1}{2}$ to 8	,,

It has been estimated by Professor David that the aggregate thickness of the coal in these Measures is about

40 feet, and the total thickness of coal actually worked is about 18 feet.

The Middle Coal Measures do not occur in the Western Coalfield; and, though they may occur under Bulli, do not outcrop in the Southern Coalfield.

4.—UPPER MARINE SERIES.

The Upper Marine Series occurs below the Middle Coal Measures, and above the Lower or Greta Coal Measures. In the Northern Coalfield it has a thickness of 4,700 feet, and in the Southern is represented by 1,720 feet of volcanic rocks and tuffs in the Upper Stage, and 3,000 feet of sediments in the Lower Stage.

5.—THE LOWER OR GRETA COAL MEASURES.

The Greta Coal Measures outcrop as a narrow belt of conglomerates, sandstones, shales, and coal seams. The total thickness of these beds never, apparently, exceeds 300 feet. In the neighbourhood of Maitland their outcrop follows a very irregular course, as they have been thrown into anticlines and subjected to considerable faulting. To the north of Maitland they have been traced, with intervening breaks, as far as Wingen, and they again occur as an isolated belt to the north of Inverell, and extending thence through Ashford to near the Queensland border. In their normal position they lie upon the Lower Marine beds, and are overlain by the Upper Marine Series, but they have been much intruded by igneous rocks in the northern parts of the State, so that it frequently happens that they are bounded on one side by either granite or quartz-felsite, and their angle of dip is often very considerable.

Two coal seams occur in these Measures, viz.:—

1. The upper seam, varying from 14 to 32 feet in thickness.
2. The lower seam, varying from 3 to 11 feet in thickness.

A few very small lenticular patches of kerosene shale were found to occur in the upper coal seam at Greta, and a seam of cannel, about 5 feet thick, in the same (upper) seam at Homeville, near West Maitland.

The coal from the Greta Measures is very hard, and can therefore be very economically worked, inasmuch as it makes a minimum quantity of "smalls;" it is, moreover, of exceedingly good quality, being useful for gas-making and household purposes, and also for steam-raising, though, on account of its large proportion of volatile hydrocarbons, it

Photo by E. F. Pittman.

TWENTY-TWO FEET OF FIRST-CLASS COAL WITHOUT A BAND.

Greta Coal Seam in the Stanford-Merthyr Colliery, Kurri Kurri, near Maitland.

has a tendency to burn rather too fast for use with a forced draught; moreover, it makes too much black smoke for navy purposes. Still it is undoubtedly the purest, and, generally, the most useful coal in the State, while the great thickness of the seams in which it occurs makes it an exceptionally valuable deposit of fuel. One disadvantage from which the Greta coal suffers is that it contains rather a high percentage of sulphur, and this is especially true in regard to the top bands of coal in the upper or thick seam. These are termed by the miners the "brassy tops," on account of the presence of so much iron-pyrites (marcasite) in them. They are usually left as a roof, and only the lower part of the seam is worked. When the "brassy tops" fall, in the pillar workings, they are very liable to spontaneous combustion, and many gob-fires have been traced to their agency.

The Greta coal seams are being very extensively worked between West Maitland and Cessnock, and it can safely be stated that this stretch of country, covering a distance of about 15 miles, is at the present time by far the most important coal-mining district in Australasia. The following ten collieries are now at work within this area, viz., South Greta, East Greta, Heddon Greta, Stanford Merthyr, Pelaw Main, Hebburn, Abermain, Neath, Aberdare, and Aberdare Extended; and their aggregate output for the year 1910 was 2,561,861 tons.

The Greta Coal Measures have also been recognised in the Clyde Valley in the extreme southern portion of the Illawarra Coalfield; but the seams there, so far as they have been prospected, do not appear to be workable under present conditions, the coal being somewhat inferior and the seams thin. Kerosene shale, of rather inferior quality, has also been met with in that neighbourhood.

6.—Lower Marine Series.

The Lower Marine Series are developed in the Northern Coalfield and have a thickness of 4,800 feet.

Volcanic Rocks.—In the Southern Coalfield about 1,700 feet of volcanic rocks and tuffs are developed near Kiama, and contemporaneous volcanic rocks (Andesites and Basalts) occur in the Lower Marines at Lochinvar. The Greta Coal Measures have been intruded by granites and felsites.

Later intrusions have destroyed the coal in various parts of the Main Coal Basin.

Carboniferous.—The Carboniferous coal seams of New South Wales are of no economic value.

QUANTITY OF COAL AVAILABLE IN NEW SOUTH WALES.

Any estimate of the quantity of coal in New South Wales must be based upon very uncertain data. For the purposes of an approximate estimate, however, we may assume the following:—

Palæozoic Coalfields.

	Sq. miles.
Area within which the Upper and Middle Coal Measures are productive within 4,000 feet of the surface	15,800
Area within which the Greta Coal Measures are productive in the Northern District, within 4,000 feet of the surface	250
Area within which the Greta Coal Measures are productive in the Southern District, within 4,000 feet of the surface	500
Total area	16,550

In their most productive areas the Upper Coal Measures contain about 40 feet of workable coal; the Middle Coal Measures contain about 18 feet of workable coal; the Greta Coal Measures contain about 20 feet of workable coal. There is, therefore, a maximum thickness of about 78 feet of workable coal in the Permo-Carboniferous rocks. It would, however, be very unsafe, in estimating our coal resources, to assume that anything approaching that thickness of coal is available under the area mentioned above, for reasons which have already been given.

It seems preferable, therefore, to base the calculation upon the assumption that a thickness of only 10 feet of workable coal underlies an area of 16,550 square miles. Taking 84 lbs. as the average weight of a cubic foot of coal, and deducting one-third of the gross weight for loss in working, impurities, etc., this would represent a total quantity of 115,346,880,000 tons of available fuel in the Permo-Carboniferous Coal Measures within a depth of 4,000 feet.

No estimate of the coal obtainable in the Middle and Upper Coal Measures between depths of 4,000 and 6,000 feet can be attempted, because the necessary data are not available, no bore or shaft having ever penetrated deeper than the uppermost seam of the Upper Coal Measures in the deeper parts of the basin. The Greta Coal Measures are of wide extent, but as they are separated from the Upper and Middle

Coal Measures by a thickness of about 6,000 feet of marine beds, and are, therefore, concealed for the greater part, the quantity of coal available in them between 4,000 and 6,000 feet below the surface can only be estimated under a limited area which has recently been surveyed by Professor David. Within this area, which is in the vicinity of Kurri Kurri and Cessnock (*vide* map), they are estimated to contain 1,893,000,000 tons of workable coal above a depth of 4,000 feet, under an area of 158 square miles, and an additional 1,200,000,000 tons between 4,000 and 6,000 feet, under an area of 100 square miles.

During 1912, 9,885,815 tons of coal were raised, valued at £3,660,015, and since the inception of coal mining, 181,559,980 tons have been put out, worth £69,087,688.

Composition of Coal.

With the object of obtaining reliable information in regard to the average composition of the coals at present being won in New South Wales, proximate analyses have been made of 194 thoroughly representative samples taken from all the collieries now working in the State. In all the larger collieries at least two samples were taken from working faces as far removed from one another as possible, and in many cases samples were taken from portions of the seams not at present being worked. The samples were taken by the Government Inspectors of Mines.

The analyses have all been made in the Geological Survey Laboratory (by Messrs. J. C. H. Mingaye, H. P. White, and W. A. Greig), and the details of these are appended.

The average composition of the coal from the Upper or Newcastle Coal Measures in the Northern Coalfield, as calculated from the analyses of seventy-eight samples, is as follows:—

Hygroscopic moisture	2.01
Volatile hydrocarbons	36.01
Fixed carbon	53.27
Ash	8.71
	100.00
Sulphur	0.468
Calorific value ..	12.7

The average composition of the coal from the Middle or Tomago Coal Measures in the Northern Coalfield, as calculated from the analyses of five samples, is as follows:—

Hygroscopic moisture	1.88
Volatile hydrocarbons	35.71
Fixed carbon	52.77
Ash	9.64
	100.00
Sulphur	1.185
Calorific value	12.5

The average composition of the coal from the Lower or Greta Coal Measures in the Northern Coalfield, as calculated from the analyses of fifty-one samples, is as follows:—

Hygroscopic moisture	1.84
Volatile hydrocarbons	41.61
Fixed carbon	49.52
Ash	7.03
	100.00
Sulphur	1.291
Calorific value	13.07

The average composition of thirty-one samples of the coal from Greta seams, as actually worked in the Northern Coalfield, is as follows:—

Hygroscopic moisture	1.89
Volatile hydrocarbons	41.35
Fixed carbon	50.51
Ash	6.25
	100.00
Sulphur	1.014
Calorific value .. .	13.2

The average composition of the coal from the Upper Coal Measures in the Western Coalfield, as calculated from the analyses of twenty-five samples, is as follows:—

Hygroscopic moisture	2.05
Volatile hydrocarbons	32.31
Fixed carbon	53.08
Ash	12.56
	100.00
Sulphur	0.672
Calorific value .. .	11.9

The average composition of the coal from the Upper Coal Measures in the Southern Coalfield, as calculated from the analyses of thirty-five samples, is as follows:—

Hygroscopic moisture	0.71
Volatile hydrocarbons	23.65
Fixed carbon	63.98
Ash	11.66
	100.00
Sulphur	0.470
Calorific value ..	12.68

THE GEM STONES.

By G. W. Card, A.R.S.M., Curator, Mining Museum.

Considering the variety of the gem stones that have been recorded from this State, it is somewhat disappointing that with the exception of opal and diamond, none are as yet of commercial importance. It is further regrettable that there is no adequate representation of these gems in any public institution in Sydney.

Precious Opal.—A striking feature of the Upper Cretaceous Sandstone of Eastern Australia is the extent to which they have been silicified, with the wide-spread production of quartzite and common opal, precious opal being an occasional concomitant. It would seem as if there has been a general uprise of heated silicated water under pressure. In New South Wales, precious opal has been found in commercial quantity at Whitecliffs, some 650 miles north-westerly from Sydney, and at Lightning Ridge, near Walget, 500 miles north. Mining is now going on at both localities, but the importance of the former is waning in favour of the latter (and newer) field. It is at Lightning Ridge that the famous black opal is procured.

The opal-fields afford opportunities for unskilled mining, since there are no known surface indications, and the finds have so far been made at no great distance from the surface —generally much less than 90 feet.

Of great interest, is the replacement of fossil organisms by precious opal, with the frequent production of objects of great beauty. In this way, molluscs, crinoids, belemnites, reptilian bones, and fossil wood have been opalised, and were sought after by foreign buyers at the Whitecliffs field. They are very seldom found at Lightning Ridge. It is greatly to be deplored that these unique specimens have for the most part gone to museums abroad.

Precious opal has also been found as amygdales in volcanic rocks at the Abercrombie River and in the Warrumbungle Mountains; at the first-mentioned locality stones of fine quality were obtained some years ago, but nothing of commercial importance has yet been found.

Up to the end of 1913, the winning of precious opal to the value of £1,359,700 has been recorded, but, owing to the ease with which it can be removed from the field, there can be no doubt that the amount actually produced is greatly in excess of this estimate.

Diamond.—Diamonds are occasionally found in the alluvial deposits and present water courses, of Tertiary to Recent Age, draining the Dividing Range from New England southwards. Mining has been spasmodically undertaken by companies for many years past at Bingera, Inverell, and elsewhere, and many stones are casually found by fossickers, or when sluicing for gold or tin.

As was the case in South Africa, and at an earlier date in Brazil, there have been many objections to Australian stones, and its is believed their sale has often been effected only by masquerading under another name. New South Wales diamonds are usually crystallised, bort being scarce, and carbonado almost unknown; they are consequently not generally suitable for drilling purposes. It must be conceded that they are exceptionally hard. Their size is also small on the whole, averaging, perhaps, about three to the carat. Some years ago, a 28-carat stone was found at Mount Werong, in the Oberon District, but it is rare to find them of more than one carat. The largest stone recorded from Inverell is 6½ carats.

With an exception of great interest, to be referred to immediately, New South Wales diamonds are of alluvial origin. They are associated, as elsewhere, with a variety of pebbles capable of resisting the abrasion to which water transport exposes them, and stress is laid in New England on an association with water-worn, rod-shaped tourmaline. The idea of tracing these alluvial deposits to pipes analogous to those at Kimberley has obsessed many people, and the Press sometimes announces the discovery of "yellow," or "blue," ground by some so-called South African expert, it not being generally realised that basic igneous rocks commonly weather in these colours. Yet the analogy has in one or two instances gone much further than this, and at two localities—near Bingera and near Delegate respectively—pipe-like masses of breccia, of which eclogite is a constituent, have been found. Mining operations have been carried on in each place, but have not as yet proved the presence of diamond.

At Copeton, in the Inverell district, a discovery of great interest was recently made by Mr. A. R. Pike. Underlying diamond-bearing alluvial wash-dirt, that gentleman noticed an altered basic intrusive rock, showing marked spheroidal weathering, which he considered bore resemblance to the surface diamond matrix at Kimberley. This he carefully prospected, and was rewarded by the discovery of a diamond *in situ*. Of the genuineness of this discovery there can be no possible doubt; but the question of genesis is, of course, open to discussion. Several other diamond splinters are believed to have been found in the débris from the rock. At the time of writing, this specimen is not in Australia, but it will perhaps be available for inspection during the Congress.

The market for Australian diamond has greatly improved of late, and it is understood they are now readily sold at prices well over 20s. a carat. Yet there seems no adequate reason for the lowness of this price, as compared with that of South African stones. An effort is now being made to establish cutting machinery in Sydney.

The total recorded value of diamond won in New South Wales to the end of 1913 is £125,549, but the actual amount is beyond doubt much greater.

Beryl.—Pebbles of beryl are occasionally found in the alluvial gold and tin wash-dirts, but are of no particular interest.

At Emmaville, in New England, beryl occurs in a granite dyke, and is sometimes of a sufficiently deep green colour to rank as a light-coloured emerald. It is associated with topaz, cassiterite, fluorite and mispickel. Several attempts have been made to work the deposit, and a good many stones have been cut in the past.

Massive beryl is a common gangue mineral at the Torrington wolfram mines, and some beautiful little crystals with perfect terminations have been found. The beryl seems to be always flawed, and is of very pale colour when cut.

A fine yellow beryl from New England was sold recently.

A thoroughly representative series of New South Wales beryl, cut, rough, and in the matrix, may be seen at the Mining and Geological Museum.

Corundum.—Beyond the exceedingly rare recovery of very small stones, ruby is practically unknown in New South

Wales; the writer has personally seen only two such stones. Reported rubies usually prove to be something else. On the other hand, sapphire is comparatively common in the Tertiary and Recent alluvials, and more particularly in the tin wash-dirt of New England. As a rule, the stones are either too green or too dark, and, although sometimes large enough and suitable for mechanical purposes, specimens of gem quality are rarely found.

An occurrence in basalt has been recorded.

Topaz.—Pebbles of colourless topaz are very common in the alluvial tin deposits of New England. Occasionally blue stone of good quality and colour is found, sometimes of considerable size, and from time to time are sold for good prices, but there is no regular market. Well-developed crystals are sometimes found and are of mineralogical interest.

Turquoise.—At Wagonga, on the South Coast, thin seams of green turquoise occur, and an unsuccessful attempt has been made to work it. The colour is unsatisfactory.

Zircon.—Zircon is widely distributed in gem gravels and alluvial deposits generally, but is usually of small size, and is hardly ever worth cutting. A. H. Church, in *Precious Stones*, specially refers to zircon from Mudgee, New South Wales, but the authority is not known.

Tourmaline.—Only the "schorl" variety is known.

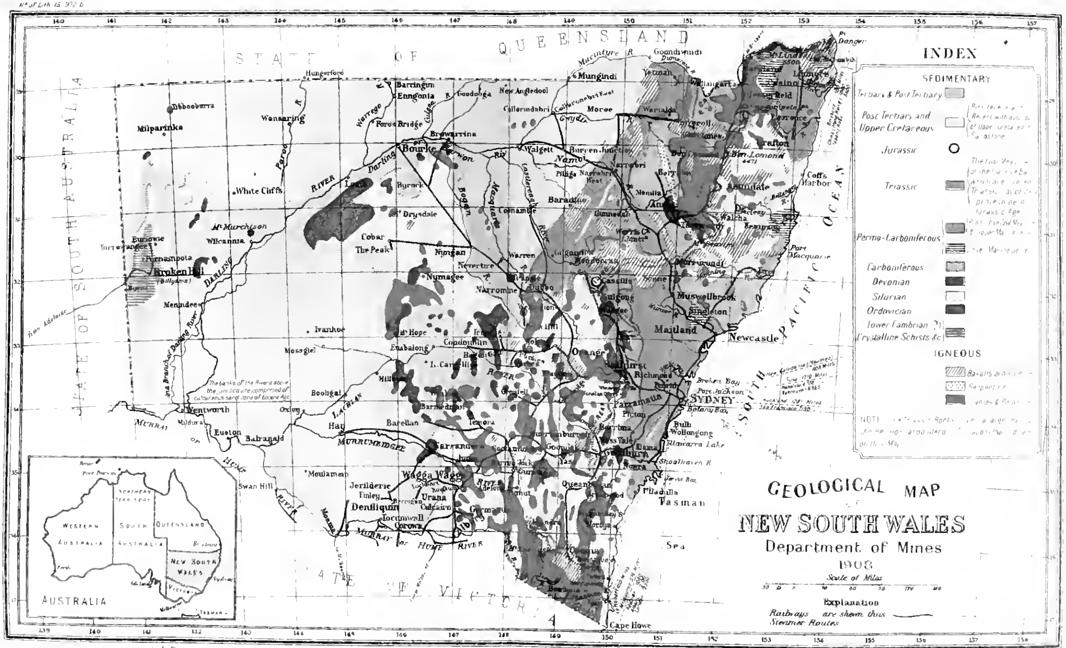
Garnet.—Large crystals of almandine and spessartite are found in the Broken Hill district, but nothing appears to have been done with them as yet.

Spinel.—Stones suitable for cutting occur now and then, but, with the exception of opaque pleonaste, spinel is rarely found.

Quartz.—Rock-crystal, smoky quartz, prase and jasper, are all known, but, since these stones are practically unsaleable, they are seldom cut. Agate is widely distributed and is sometimes beautifully marked. A pretty variety of clear smoky quartz enclosing golden coloured needles of rutile is obtained at Tingha, and is locally known as "grass-stones." From the molybdenite mines near Glen Innes, water-clear crystals of colourless quartz enclosing spangles of molybdenite are sometimes obtained, and are very pretty when cut.

In addition to the generally recognised gem-stones, other minerals found in New South Wales possess undoubted possibilities in this direction, and some of them have been cut by the Geological Survey. Among these may be instanced rhodonite, alunite, chlorite, fluorite, azurite, and jet.

Alunite is a regular article of commerce, and the pink variety looks very pretty when cut. The pseudophite variety of chlorite occurs at Nundle, and resembles New Zealand greenstone, but is, of course, much softer. Jet has been found as a great rarity in oil-shale. Mention might also be made of quartz containing free gold which can sometimes be cut with satisfactory effect.


GEOLOGICAL MAP
NEW SOUTH WALES
Department of Mines
1908
Scale of Miles
Explanation
Railways are shewn thus
Steamer Routes
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SEDIMENTARY
Tertiary & Post Tertiary
Post Tertiary and Upper Cretaceous
Jurassic
Triassic
Permo-Carboniferous
Carboniferous
Devonian
Silurian
Ordovician
Lower Cambrian (?)
Crystalline Schists &c
IGNEOUS
STATE OF QUEENSLAND
STATE OF SOUTH AUSTRALIA
STATE OF VICTORIA
SOUTH PACIFIC OCEAN
Tasman Sea
AUSTRALIA
WESTERN AUSTRALIA
SOUTH AUSTRALIA
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VICTORIA
SYDNEY
Newcastle
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Hay
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Port Macquarie
Muswellbrook
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Young
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Queanbeyan
Bombala
MURRAY
MURRUMBIDGEE
LACHLAN
DARLING RIVER
HUME RIVER

CHAPTER VI.

THE TECTONIC GEOLOGY OF NEW SOUTH WALES.

By T. W. EDGEWORTH DAVID, B.A., C.M.G., F.R.S.,
University of Sydney.

IN New South Wales there are three chief lines of trend:—(1) The old lines which run from Broken Hill first from SW to NE, then towards NNE to Mount Brown, and further E the trends of the Main Divide from Mount Kosciusko through Canberra to Parkes and Forbes, at first N by E, then N, then N by W, and NNW as the geosyncline is approached (see Section I.). In the New England Tableland these trends are mostly NNW and SSE, parallel to the trough axis of the coal basin which lies in the middle of the geosyncline. (2) The strong WNW to ESE lines of fracture which traverse the main coal basin. (3) The newer trends running parallel or subparallel to the present Pacific Coast, in a SSW to NNE direction.

Tectonically New South Wales may be divided up into the following units (see Section I.).

First.—The New England Tableland, with the Liverpool and Mount Royal Ranges, and the Nandewar Ranges.

Second.—The great syncline, in which lies the Permo-carboniferous coal basin, the main axis of which extends from Sydney to Gunnedah and Narrabri. This basin constitutes the second unit which divides the previous tableland from that of the Bathurst-Monaro Highlands or Tableland. In the New England Tableland the older trend lines are well shown by the direction of outcrop of the Devonian limestones and Radiolarian rocks. These strike from about south 30° east to north 30° west, and parallel with them is the remarkable belt of serpentine, at least 200 miles in length, and having a similar orientation. The direction of folding has here come from east-north-east and operated in a west-south-west direction tending to over-fold in the latter direction. The Carboniferous and Devonian rocks have been folded and powerfully fractured along this north-north-west to south-south-east tectonic zone. In the Emmaville district of New England the Permo-carboniferous and the older claystones, perhaps of Carboniferous age, are folded on lines trending about north 30° and south 30°. Recently Mr. A. B. Walkom has argued that there is a distinct Permo-carboniferous basin extending from near Kempsey in a north by west direction through Drake and on to Undercliff near the Queensland border. Lately Mr. J. E. Carne has identified in Queensland, in the neighbourhood of Warwick, a continuation of this Permo-carboniferous trough. Here again we see the north by west and south by east tectonic lines emphasised. On the other hand, if we study the long axes of the great intrusion of granites, which occupy so large an area of the country between Tamworth and Wallangarra on the Queensland border, we find that, while on its western side it curves sympathetically with the serpentine belt, on its east side it strikes about north 22° east (true bearing), and south 22° west. This direction is at variance with that of the two previously mentioned troughs, but it is almost exactly parallel with the adjacent coast line, and shows that in New South Wales the newer trend lines, which determined the orientation of the present coast line, were partly controlled by the granites. Mr. E. C. Andrews has shown that in the New England district the acid granites have strongly intruded the Permo-carboniferous rocks, whereas in tho Lithgow district of the Western Coalfield rolled pebbles of the Hartley and Bathurst granite are of frequent occurrence in the basal beds of the Upper Marine Permo-carboniferous rocks of that district. The long axis of the Clarence Basin, which is generally assumed to be of Jurassic age, is almost exactly meridional. Another important tectonic line in New England is that of the belt of alkaline lavas, which form such remarkable mountain masses in the Nandewar Ranges, in the McPherson Ranges, and in Queensland at points like Spicer's Peak, Mount Mitchell, Mount Roberts, Mount Flinders, etc. (see Section III.). This line of alkaline volcanoes is clearly connected with more recent tectonic disturbances, such as those which have been concerned in the late uplifts which have determined the exact position of our present coast, and it is noteworthy that they diverge very considerably from the older trend lines, having the north-north-west to south-south-east orientation. It would seem as though in the earlier stages of movement of the earth's crust during middle and late Palæozoic time, the line of the main coal basin between Sydney and Narrabri was a zone of weakness forming the axis for prolonged

CORRIGENDA.

Page 568, line 2.—For "north 30° and south 30°" read "north 30° west and south 30° east."

Page 571, line 19.—Omit "still later."

Page 573, line 22.—For "the cycle" read "the Post-Tertiary cycle."

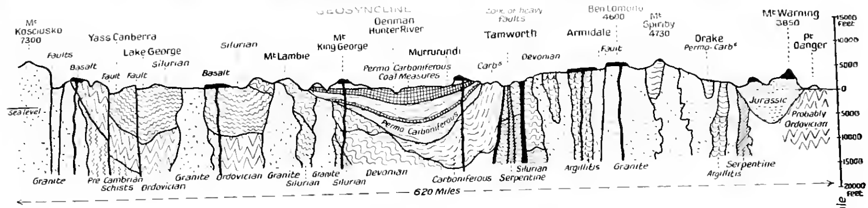
Page 575, line 31.—For "overflowing" read "over-folding."

Page 593, line 9.—For "64,000" read "6,400."

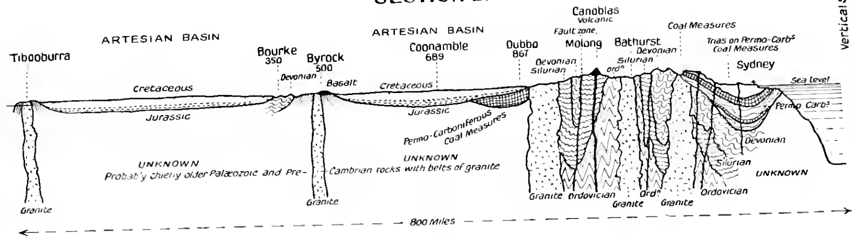
Page 597, line 7.—For "orthoclate" read "orthoclase."

Page 599, line 7.—For "L" read "G."

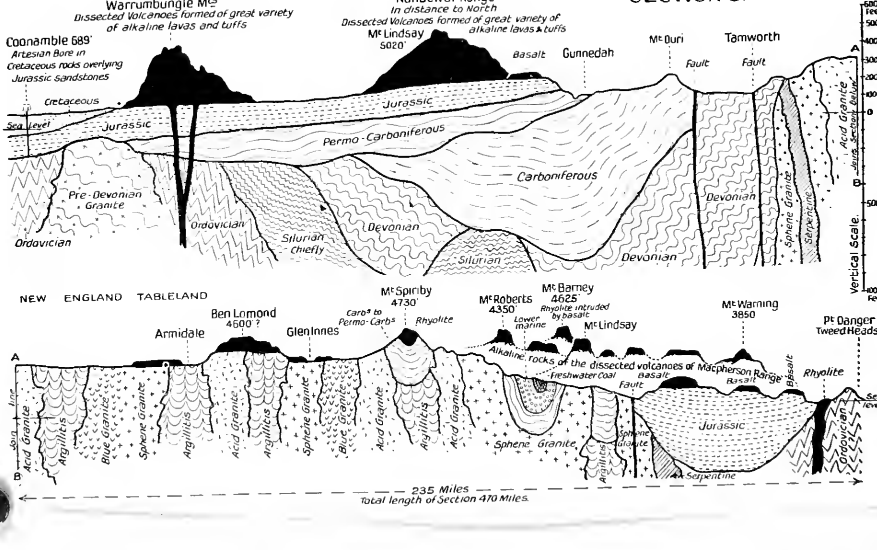
stones, perhaps of Carboniferous age, are folded on lines trending about north 30° and south 30°. Recently Mr. A. B. Walkom has argued that there is a distinct Permo-carboniferous basin extending from near Kempsey in a north by west direction through Drake and on to Undercliff near the Queensland border. Lately Mr. J. E. Carne has identified in Queensland, in the neighbourhood of Warwick, a continuation of this Permo-carboniferous trough. Here again we see the north by west and south by east tectonic lines emphasised. On the other hand, if we study the long axes of the great intrusion of granites, which occupy so large an area of the country between Tamworth and Wallangarra on the Queensland border, we find that, while on its western side it curves sympathetically with the serpentine belt, on its east side it strikes about north 22° east (true bearing), and south 22° west. This direction is at variance with that of the two previously mentioned troughs, but it is almost exactly parallel with the adjacent coast line, and shows that in New South Wales the newer trend lines, which determined the orientation of the present coast line, were partly controlled by the granites. Mr. E. C. Andrews has shown that in the New England district the acid granites have strongly intruded the Permo-carboniferous rocks, whereas in the Lithgow district of the Western Coalfield rolled pebbles of the Hartley and Bathurst granite are of frequent occurrence in the basal beds of the Upper Marine Permo-carboniferous rocks of that district. The long axis of the Clarence Basin, which is generally assumed to be of Jurassic age, is almost exactly meridional. Another important tectonic line in New England is that of the belt of alkaline lavas, which form such remarkable mountain masses in the Nandewar Ranges, in the McPherson Ranges, and in Queensland at points like Spicer's Peak, Mount Mitchell, Mount Roberts, Mount Flinders, etc. (see Section III.). This line of alkaline volcanoes is clearly connected with more recent tectonic disturbances, such as those which have been concerned in the late uplifts which have determined the exact position of our present coast, and it is noteworthy that they diverge very considerably from the older trend lines, having the north-north-west to south-south-east orientation. It would seem as though in the earlier stages of movement of the earth's crust during middle and late Palæozoic time, the line of the main coal basin between Sydney and Narrabri was a zone of weakness forming the axis for prolonged



SECTION 2.



SECTION 3.



depression, which formed the great trough separating New England from the Bathurst-Monaro Highlands. The subsidence along this trough was prolonged all through Devonian, Carboniferous and Permo-carboniferous time, and was continued into Triassic time, but after the close of the Trias further downward sagging of the earth's crust ceased over this area, and the frame-work of the earth stiffened ready to meet the later uplift or movement of emergence which carried the modern Main Divide from the level of a peneplain, a little above sea-level, into tablelands from 3,000 to 4,000 and in places 5,000 (at Kosciusko 7,000) feet above the sea. In this last swaying up of the earth's crust, New England, the central geosyncline, and the Bathurst-Monaro Tableland moved upwards as a single rigid block, a movement in which, as Mr. E. C. Andrews has shown, the whole of the eastern coast of Queensland, as well as that of south-east Victoria and the whole of Tasmania participated. The fact that during this emergence the rocks of the geosyncline were less elevated than those of the tablelands to its north and south seems to imply that there was still a weakness in the geosyncline structure which prevented this part of the coast responding to the emergence to the same extent as the rest of the Main Divide. As regards the chief tectonic lines in the great central coalfield, there are two well-marked directions, the first set running more or less WNW and ESE, not diverging very considerably from the axis of the main basin. (In the lower Hunter district this is shown by the faults in the Greta and other coal measures, which run from between east 30° south and east 10° south to west 30° north and west 10° north, while in the southern coalfield they trend in a general east-south-east and west-north-west direction.) In this first set of faults the throw in each case is in towards the centre of the basin. The other set of faults runs more or less parallel with the coast line. The well-marked trend belonging to this set is the flat asymmetrical anticline forming the eastern escarpment of the Blue Mountains. The general trend of this ridge is north 15° west (true bearing). It should be noted that this structure makes an angle of nearly 35° with the coast and the edge of the continental shelf. It cannot, therefore, be correctly described as a structure parallel to the above shelf. The continental Shelf has already been ably described in detail by Mr. C. Hedley, but it may even yet be doubted as to how far the edge of the shelf, where the gradual slope changes to a steep declivity, plunging to depths of 2,500 fathoms, is due to actual folding in the earth's crust or to a heavy fracture on the one hand, or to what extent it has been built up by sedimentation on the other. Probably both factors have operated. Recently evidence has been obtained to show that in this extensive geosyncline there is a heavy overthrust fault bounding it on the north-east. This fault carries the Carboniferous rocks several thousands of feet above the level of the Greta Coal Measures and of the beds of the Lower Marine Series. It is particularly well seen about six miles to the north-east of Muswellbrook, and it probably becomes continuous (though this is doubtful) with the Elderslee fault and the Lachnagar fault north of Branxton on the north bank of the Hunter River. The trend of the Elderslee fault at its southern end is north and south true, while on the north side of the Hunter River it is nearly 9° west true. From this bearing it is obvious that the Elderslee fault, if it is continuous with that of Muswellbrook, must bend round considerably to the west of north. Mr. A. B. Walkom has, in a recently published paper, shown that there is a very strong fault trending nearly from east to west, cutting off completely the Permo-carboniferous coalfield of Tangorin on the north. This fault, if produced westwards, would probably run into that of Muswellbrook. In the central coalfield the tendency has been in the case of the older folds for the earth's crust to creep inwards towards this region of great depression. This is shown by the direction of the overthrust as well as by the direction of folding. In addition to this movement from east-north-east to west-south-west there has been a movement almost from due east to due west. This has thrown the rocks of the Permo-carboniferous system, together with the underlying Carboniferous strata (the former 13,000 feet thick, the latter 20,000 feet thick) into a series of immense folds, trending almost due north and south, true. Along these trend lines are situated the narrow fold basins of the Stroud-Gloucester coalfield, as well as of the Myall Lakes coalfield.

As regards the western boundary of the geosyncline, on account of the extensive overlapping of the Jurassic and Cretaceous rocks, it is not possible to say exactly where it is situated (see Section III.). It is bounded in a general way on the north-west by the great belt of alkaline lavas forming the extinct volcanoes of the Nandewar and Warrumbungle Mountains, which rise to altitudes of from 4,000 to 5,000 feet above sea-level, and form bold imposing masses, as viewed from the western plains when the observer looks eastwards, as they rise in abrupt peaks, sometimes so steep as to be unscaleable for about 3,000 feet above the general level of the plains (see Section III.). These lavas, together with the volcanic chimneys from which they were erupted, have a trend in a general north-east to south-west or south-south-west direction. Traced still further to the south-south-west, the Warrumbungle Mountains are prolonged into the volcanoes of the Canoblas, near Orange. These also are impressive peaks rising to over 4,000 feet above the sea.

An interesting feature, to which attention has been called by Mr. A. B. Walkom, in connection with the folding of the Carboniferous coal basin and the development of a shallow basin further to the west, in which later the Trias rocks were laid down, is that there is every evidence of the travelling of a great earth wave, which started with its trough situated at the spot where now we find the Carboniferous sediments thickest, still later the axis of depression, namely in the Clarencetown area. This being assumed to form the deepest part of the trough in late Carboniferous time, we find that in the succeeding epoch of the Permo-carboniferous, the bottom of the trough had moved in a west-south-west direction in Lower Marine Permo-carboniferous time. Later the axis of the trough migrated further west still at the time when the Bulli, Lithgow and Newcastle measures were being deposited, and still later, in Triassic time, we find the axis of main depression still further west, running approximately from the Hawkesbury River near the Hawkesbury Bridge towards the north-north-west. It would seem then that we have evidence here of a great earth wave rolling inwards against the resistant rocks of the Bathurst-Monaro Highlands and taking about three periods of geological times in which to complete its rolling and folding movements. The passage of the wave westwards raised a crest on its eastern side, and so we find that already, even in Permo-carboniferous time, the Carboniferous rocks of Clarencetown were uplifted, probably many thousands of feet above sea-level, and underwent a considerable amount of erosion before the Permo-carboniferous rocks were deposited on their west-south-western flanks.

Next is the *third unit* of the Bathurst-Monaro Highlands, together with the old rocks of Parkes, Forbes and

Cobar. In the Bathurst-Monaro Tableland the old trend lines are still shown by the direction of outcrop of the chief beds of limestone of Silurian age which there run north and south. Towards the northern edge of the plateau these fold lines swing more round west of north, the chief synclinal troughs in the Upper Devonian series lying along directions between north-north-west and north 30° west. Professor W. G. Woolnough has described and figured a strongly marked unconformity in the gorge of the Shoalhaven River, near Tallong, adjacent to Marulan, between the Ordovician slates containing graptolites and the Silurian limestones. The folding of the Ordovician rocks has also been much more intense than that of the Silurian. In the Yass district the general trend of the folds in Silurian and also Devonian rocks is north 15° west and south 15° east. As shown by Mr. L. F. Harper, the prevailing dip is about west 15° south-west. At Yalwal, Mr. E. C. Andrews has shown that the Upper Devonian rocks, lying in a long and narrow basin, trend about north 30° east (true bearing). If we examine the direction of strike of the elongated masses of intrusive granite from Delegate on the south to Bathurst on the north, we find that there is a slight tendency to virgation. The great mass of granite extending from Bombala to Braidwood runs north 15° east and south 15° west, but the mass extending from the Snowy River near Forest Hill to Adelong trends about north 8° west. In the Forbes-Parkes goldfield area, Andrews shows that the trend of the Silurian folds is towards north-north-east, with suggested overthrusts to the east-south-east. This trend is an approximation to that of the pressure directions at Broken Hill, where, too, the main over-folding seems to have come from the north-west and to have operated towards the south-east. In the Cobar region, Andrews finds the strike of the Silurian limestone and conglomerates and Devonian quartzites to be generally about north-north-west, with several major faults, apparently overthrusts, striking in the same direction, but the overthrusting being directed towards the west. Traced in the direction of Girilambone, the strike changes to north and even north-east, the rocks there being schists and quartzites, possibly Pre-cambrian in age. Possibly these latter rocks represent an off-shoot from the Pre-cambrian group of Broken Hill, which have prevalent north-easterly trends. Andrews is of opinion that there is very definite evidence at Cobar of an old Silurian shore line, as shown by very heavy conglomerate of the nature of coarse shingle. It has an approximately meridional trend. At the Jenolan Caves *Pentamerus* limestone, belonging to the Silurian rocks, strikes nearly due north and south, with a westerly dip. In the Canoblas region near Orange the folded Devonian and Silurian rocks have a trend of about north 30° west (true bearing).

If now the fractures be considered in this third unit, Mr. C. A. Süssmilch has recorded strong lines of faulting extending from Jindabyne and Cooma north-west, in the former case north-easterly, and in the latter case northerly. The Cooma-Colinton line of fractures is parallel to the upper course of the Murrumbidgee River, *i.e.*, about north 5° west. Mr. T. G. Taylor has further examined the zone of faults between Lake George and the Murrumbidgee River, near the site of Canberra, the Federal Capital. He refers to this Snowy-Murrumbidgee line of disturbances as a rift valley running northwards towards the volcanic region of the Canoblas, and thus by way of Wellington to the volcanic zone of the Warrumbungle necks. These faults, described by Süssmilch and Taylor, are of recent origin, for the most part belonging to the cycle of erosion; but they appear to be established along old lines of intense folding and major faulting. There can be no question that the highlands of Bathurst-Monaro (especially in the neighbourhood of Bathurst) have been very strongly folded. At present there is insufficient evidence to show exactly from what quarters the folding came on the north-eastern side of the Bathurst highlands. Such slender evidence as is available suggests that the pressure came from the direction of the Tasman Sea and operated in a westerly direction.

The *fourth Tectonic unit* is that of the Barrier Range and Grey Range region. The Barrier Ranges are part of an enormous trend line which runs through Kangaroo Island and Cape Jervis, and thence in a north-east direction to the Barrier Ranges, Milparinka, Mount Brown, and the Grey Ranges. These over-folds of the Barrier region are developed in gneiss and schists, and are over-folded towards the south-east. The lines of fold, which run through the Barrier Ranges proper, are only part of a great group, which virgate from the mainland opposite Kangaroo Island as a céntre. There are two other tectonic units in New South Wales. First, the Cretaceous basin (probably Lower Cretaceous), in which lies the artesian water of the northern and sub-central portions of New South Wales. The strata in this basin are disposed in long, very gentle folds; in fact, it may be said that the artesian basin is only very slightly folded. The only place, so far, in the whole of Australia, where sharp folds have been discovered in rocks as new as Cretaceous is in the region recently examined and closely studied by Mr. B. Dunstan, the Government Geologist of Queensland, in the Maryborough-Burrum Coalfield and Fraser Island areas of that State. The occurrence of these folds, which bring about in places a dip of the Cretaceous rocks of as much as from 50° to 60°, shows that, as on the whole the steeper slopes face inland, the folding pressure came from the east, forcing up the rocks in long ridges and deep troughs towards the west. Amongst more recent tectonic strikes in New South Wales are the lines of fault which run approximately parallel to the coast line. Typical examples of these have already been described by Mr. T. G. Taylor in his two works contributed to the Commonwealth Meteorological Bureau, namely, "The Geology of Yass-Canberra," and "The Physiography of Eastern Australia." The fault scarps, like the one that has given origin to Lake George, are still very fresh and unreduced, pointing to the recent character of the faulting. This same remark applies to portions of the block-faulted plateau of New England. Obviously the great escarpment, nearly vertical, overlooking the valley of the Thredbo River on the south-east side of the Kosciusko Plateau again shows distinct evidence of geological youth.

Summary.

If now we sum up these tectonic movements, it would seem that the oldest grain of the country in New South Wales was that of the Barrier region with its north-east to north-north-east trends. The meridional trend lines of the Parkes-Forbes group of rocks, as well as those of the Cobar area, are not much divergent from the Barrier Range to Grey Range directions. In the Cobar district splendid examples are found of original water-worn pebbles pulled out into elongated sausage-shape forms, as the result of intense pressure. This folding probably took place, partly in Cambrian and partly in Pre-cambrian time. Next we find a development of meridional folds in the extreme south-east of New South Wales, sympathetic with the long lines of granite-upheaval along the east coast of Tasmania. These folds affected both the Ordovician, Silurian and Devonian rocks. As the folds approached the south-western edge of the geosyncline they bent around so as to become almost parallel to its main axis, as is the case with the chief folds in the New England Tableland. The heavy faulting, trending west-north-west and east-south-east in the central coal basin, belongs, perhaps, to a later part of this epoch. All the succeeding features, indicating trends, are connected with the uplift of the eastern periphery of Australia, such as is shown by the Post-permo-carboniferous granites of eastern New England, by the Canoblas-Warrumbungle-Nandewar volcanic ranges, by the great fault lines of the Kosciusko Plateau, as well as by the steep scarps with flexures and probable faults bounding New England on the east, and facing the Pacific Ocean. A recent emergence from epeirogenic uplift has given origin to the present Main Divide and coast line, and has accentuated the continental shelf. The latter has a form of a gentle wave with its steeper side directed to the Pacific. Here the question suggests itself, has the eastern part of the continent of Australia spread or flowed under gravity eastwards, or has a wave in the ocean floor crept landwards? In the latter case it would probably have to be assumed that there was much heavier material in the ocean floor than in the adjacent coastal ranges, towards which the ocean floor moved by a series of inthrusts. On the whole, it would seem that the eastern coast of Australia has been inthrust from the direction of the Tasman Sea rather than that there has been a wholesale over-folding and over-thrusting into that sea. This is rendered probable first by the arrangement of the main subsidence basins, as shown on the section across New England, most of the other basins lying to east of the newer; next by the overflowing at Tamworth, at Tallong, near Marulan, at Cobar, and on the Queensland Coast, near Maryborough; also it seems probable, as Mr. Hedley has argued, that in very recent time there has been a slight uplift parallel to the coast, forming the chain of lakes from Myall Lakes northwards to Wallis Lakes, and numerous lakes and lagoons still further lying just inland of the coast (see Section II.). At the same time, the evidence in regard to the direction of thrust in the Sydney-Blue Mountain coalfield is not at all conclusively proved. On account of the recent uplift being most accentuated near to or about 100 miles inland from the coast line, the profile of New South Wales from east to west somewhat resembles the curve of a boomerang, as Mr. Andrews has pointed out, with the short arm directed eastwards and the long arm inland. These steeper slopes fronting the ocean accelerate the flow of river water, and this is leading to a rapid cutting back of the cañons in which the chief eastern rivers lie, and thus to their continued encroachment on the watershed of the western rivers. In fact, the Dividing Range is obviously tending to migrate westwards.

Still more recent than this broad epeirogenic uplift has been a slight downward joggle for considerable distances along the coast. This movement is very strongly marked along the eastward edge of the great coal basin, and perhaps responsible for the chain of coastal lakes, referred to above, extending from Port Stephens towards the Clarence District. The amount of this submergence is equal to about 200 feet. A very recent positive movement of the strand-line, to the extent of about 15 feet, is so general around Australia as to suggest that it may have been due to an eustatic negative movement of the whole ocean surface of the southern hemisphere. This may have been due to the locking up of sea-water in the snow-fields and glaciers of the Antarctic, following on after extreme deglaciation during an interglacial epoch. As the area of the Antarctic is about one-thirtieth of that of the whole surface of the ocean, it is easy to see that the removal by melting of 33 feet of ice and snow in the Antarctic would raise the level of the ocean all over the world by about one foot. The disappearance of 330 feet of ice would raise it about ten feet. In fact, evidence shows that probably at least 1,000 feet of ice and snow have recently been removed from the general surface of the Antarctic continent. If this is not an over-estimate the disappearance of this vast body of water-substance from the Antarctic continent and its incorporation with the waters of the ocean would tend to raise the sea-level all over the world by an amount equal to about 30 feet. If the glaciation of the northern hemisphere during the great Ice Age was synchronous with the recent maximum glaciation of Antarctica, and the area under ice was about 6,000,000 square miles, and the average thickness of the ice that has since disappeared be assumed to be 1,500 feet, its thaw-water would have raised sea-level by a further amount of about 60 feet; that is, sea-level all over the world may have been raised by an amount of the order of 90 feet since the close of the latest great glaciation. Conversely, the recrudescence of a glacial epoch would withdraw water from the ocean by that amount, and thus would lay high and dry all areas of Australia which are now not more than 90 feet below sea-level; in fact, it would have the effect of probably joining New Guinea to Australia by a narrow land bridge.

THE OLDER PALÆOZOIC SEDIMENTS OF NEW SOUTH WALES.

By E. C. Andrews, B.A., F.G.S., Geological Survey of New South Wales.

Sediments of Older Palæozoic have had an extensive development in Australia, nevertheless, over very large areas they cannot be definitely referred to any particular period, such as Cambrian, Ordovician or Silurian, owing to the absence of palæontological criteria of age. For example, the age, or the ages, of the sedimentary complexes occurring in the areas drained by the Tweed, the Upper South Clarence, the Upper Manning and the Upper Macleay are not known. In like manner the schistose types occupying large areas in the Cobar district are here tentatively placed in the Pre-silurian. So also certain sedimentary formations of great extent in central and south-eastern, included until recently under the Silurian, may probably be placed hereafter in the Ordovician.

It is impossible to appreciate the exact position occupied by the Older Palæozoics of New South Wales unless reference be made to the general laws governing their distribution and appearance in Australasia as a whole.

Four principal facts emerge upon such a broader, or Australasian, point of view, namely:—

(*a*) The building of Australia, up to the close of the Ordovician sedimentation appears to have been as far as from west to east in wide and subparallel zones.

(*b*) Silurian and Devonian history appears to have consisted of sedimentation transgressive with respect to the Ordovician and possibly also to the Eastern-Cambrian sediments. Orogenic activity closed each period of sedimentation.

(*c*) Strongly-compressive and mashing action has been confined to regions of enormous accumulation, indeed, mashing of sediments appears to bear a direct relation to the thickness of the sediments affected.

(*d*) Areas of decided orogenic activity in Australia appear to have contracted as from west to east and from south to north with progress of time. (New England appears to form an exception to this rule up to the Carboniferous, but to conform to the rule subsequent to Carboniferous time.) These statements need amplification.

PRE-CAMBRIAN.—Wherever observed, rocks of this age in Australia are strongly mashed and more or less recrystallised. Their distribution is practically confined to Tasmania, South and West Australia, with small and doubtful occurrences in the extreme south-east of Australia.

CAMBRIAN.—Strong "mashing" is characteristic of sediments of this age wherever found in Eastern and South Australia, and recrystallisation of minerals is very common. The distribution is very pronounced in a wide zone lying east of the great mass of Pre-cambrian rocks in Western and South Australia.

Other developments occur in Tasmania, and probably also in Victoria and Western New South Wales.

CAMBRIAN AND ORDOVICIAN.—Sediments of Cambrian age are recorded from the Broken Hill District by Mawson, but elsewhere in New South Wales their presence is only inferred without having been definitely proved. In Tasmania and South Australia, however, they are well developed. Howchin records great thicknesses of various sediments, the upper series is much less altered than the lower, with a preponderance of slates, shales and quartzites of purple colours. Numerous limestones, oolitic at times, occur in the upper members. In the lower series no purple rocks occur, and slates and phyllites preponderate. Massive quartzites and cherty limestones also occur in this lower series, the former being contiguous to the slates. At the base of the series conglomerates and grits occur, the latter at times arkose. Great shearing and drawing-out of pebbles has occurred, sometimes causing them to pass finally into horizontal quartz-veins. Glacial till and boulders are also common.

Cambrian sediments are well represented in Tasmania, and they are also doubtfully recorded from Victoria.

In New South Wales and Victoria there are several large areas of old rocks, which probably belong partly to Cambrian and partly to Ordovician sediments, but which, up till the present, have yielded no definite fossils. Such are the slates, phyllites, schists, claystones, sandstones, quartzites and conglomerates stretching from a point north of Cobar through the Condobolin District and thence through the Wagga and Albury Districts. The strike of these sediments, where observed, is almost NNW and SSE. They are closely folded, and are of enormous thickness. The conglomerates have been much altered, shearing, flattening and elongation of pebbles being very pronounced in places. Red, purple, white and yellowish-white slates are also common. Heavy quartzites are a common feature.

In the absence of fossils it has been considered advisable to place these among the Pre-silurian sediments, probably Ordovician and Cambrian, for the the following reasons:—

(1) Their lithology is somewhat similar to that described as Cambrian by Howchin for South Australia.

(2) The metamorphism to which they have been subjected is also suggestive of the South Australian Cambrian types.

(3) The general arrangement of the sediments in the same great geological province and occupying a position between sediments known to be Cambrian on the one side and Ordovician on the other.

(4) The presence among the sediments under consideration of Silurian rock types exhibiting only feeble metamorphism.

(5) Ordovician sediments are generally conformable upon Cambrian and mark great marine transgressions over Cambrian sediments in other parts of the world.

In the southern-eastern portions of the State the evidence for the widespread presence of Ordovician areas is gradually increasing. Some of the sediments, hitherto supposed to be of Pre-cambrian age in the Australian Alps, are now suggested to be of Ordovician age by Brown from certain intrusive phenomena observed there. According to Dun, these sediments are of Upper Ordovician age.

The distribution of sediments of this age is roughly parallel to, and eastwards of, the great Cambrian zone with doubtless much overlapping in more eastern areas.

Ordovician rocks occur in Tasmania and Victoria, but where of known age, they do not present "mashing" phenomena to nearly so great an extent as they do farther north and east. In New South Wales slates and sandstones of this age occur in the south-eastern portion, as shown by Mr. Carne, and extend to the coast as far north as Tallong, near the mouth of the Shoalhaven River, where Graptolite shales, cherts, slates and quartzites are represented. In the Bathurst and Orange area they have also a great development. The schistose slates, sandstones and quartzites of the Condobolin, Cobar and Girilambone areas have a strike a little west of north, and they are probably of Cambrian and Ordovician age. The Forbes-Parkes and Peak Hill districts contain large exposures of slates, shales, sandstones and phyllitic rocks of Ordovician age.

SILURIAN.—The commencement of the Silurian opened a new chapter in the history of New South Wales geology. The enormously thick sediments which had gradually accumulated between Western Australia and a point now east of Sydney and Cape Howe during the Cambrian and Ordovician (the undoubted Cambrian lying to the west and the Ordovician proper to the east) were wonderfully folded and much altered at the close of the Ordovician. Upon the truncated edges of the folds the Silurian sediments were laid down during long-continued marine erosion and transgression. The marine transgression affected the total area as far west at least as the Darling River. Claystones, sandstones and limestones were abundantly represented, the limestones being well developed in the more eastern portions, whereas conglomerates with sediments of cherty arenaceous and argillaceous types may be noted as being more emphasised as the examination is carried westward of the eastern portion of the State. This is suggestive of a transgression of the Silurian sea from east to west, with shore lines more marked in western than in eastern areas. The Silurian sediments in the great Cobar district are of great thickness and have been highly crumpled. A great development of cherts, apparently of radiolarian origin, occurs in this region.

No distinct break has been found between the Cambrian and Ordovician, but wherever the Ordovician and the Silurian occur together the former may be seen to have been strongly compressed before the deposition of the Silurian upon it. Orogenic movement closing the Silurian sedimentation was irregular in its action. In certain areas the beds are not strongly folded, while in others they are very strongly compressed. Compressive action, however, was pronounced where the Silurian has been nipped or folded within masses of Ordovician or older strata. In all such cases, the older sediments have been much altered by recrystallisation action, whereas the Silurian does not appear to have been thus affected.

DEVONIAN.—Sedimentation during two epochs is indicated for the Devonian period, the earlier types of sediments in the southern and western portions of the State—

for example, the Murrumbidgee beds—being highly folded, whereas those of the younger epoch, such as the Parkes-Forbes, Orange-Molong, and Cobar-Wilcannia beds are only gently folded except at points where they have been pinched up sharply within troughs of the Silurian or Pre-silurian basements. In New England, however, rocks, probably Upper Devonian (according to Dun), are highly folded. These again, according to Benson, show no unconformity with the overlying Carboniferous, both series having been highly folded at the close of the Carboniferous.

The sediments of the earlier types consist, in the main, of shales, tuffs, limestones and lavas. Harper describes them as of great thickness, and as having been strongly folded.

The Tamworth, as also the beds described by Professor David and Mr. Pittman, and the Bingara-Barraba beds, described by Benson, consist mainly of coralline limestones, radiolarian limestones and cherts, claystones and tuffs. These also are highly folded.

In the Upper Devonian of the central western portions of the State the main rock types are quartzites, sandstones with chocolate and greenish claystones, tuffs and shales.

A striking geological feature may be mentioned here in connection with the Devonian sediments. The New England province to the south and south-west terminates against the Permo-carboniferous and Triassic sediments in a long, convex arc of Carboniferous rocks which is paralleled a little to the east and north by the Devonian. The long, wide trough of these almost horizontally-bedded Permo-carboniferous and Trias-jura sediments has its long axis about NNW and SSE, and is terminated against the massif of the southern Tableland in a long and almost unbroken ring of Devonian sediments, which pass again into the older Palæozoic massif buttressed with granites and partly overlain by other Devonian patches. The absence of the Carboniferous on the southern boundary of the trough is very interesting (the Clyde Mountain sediments are recorded as Devonian by Dun), and strongly suggests that New South Wales is divisible into two grand geological provinces, within one of which, namely, the southern and western, the periods of compressive activity closed with the Devonian, while in the north the periods of compressive activity existed till the close of the Carboniferous, only retreating a little further north in Permo-carboniferous time. The trough of weakness between New England and the southern massif of the State was already outlined in the Devonian time, becoming gradually less in importance till the end of the Trias-jura, since the close of which period it has been dry land. The influence of this zone of weakness, however, has persisted to the present day, allowing a natural separation of northern from southern Tablelands, because of the relative sagging motion in this intermediate area ever since the Devonian.

The special case of the New England area needs separate mention. This region, as also Eastern Queensland, appears to belong to a province distinct from the rest of Australia, and apparently had a much greater extension eastward in late and post Palæozoic time than at present.

The Tweed River schists, a southern extension of the Brisbane schists, of unknown, but probably earlier Palæozoic, age, lie on the eastern portion of the area. With these the Woolgoolga rock types may be coeval. The South Clarence series parallel these to the west and are probably younger. Also of unknown age are the subparallel rock groups occupying the Upper Macleay, Manning and Namoi areas. The Devonian parallel these again to the west and present a curve convex to central New South Wales. Conformable with these the Carboniferous form a concentric and western arc.

It is thus evident that, in older Palæozoic time, the building of Australia generally appears to be from west to east, nevertheless a contiguous province, although now part of the same great geographical unit, appears to have had a very different history in Palæozoic time.

THE CARBONIFEROUS OF THE CLARENCE-TOWN AREA.

By J. B. Jaquet, A.R.S.M., F.G.S., Chief Inspector of Mines.

The Upper Carboniferous beds with *Rhacopteris* and *Lepidodendron veltheimianum* until quite recently were only known to be present in the vicinity of the Williams and Karuah River districts north of Port Stephens. During last year, however, Mr. R. H. Cambage found another occurrence of the beds at Currabubula, near Tamworth. The rocks at Currabubula consist of pale-yellow cherts and mudstones, which are lithologically similar to the Port Stephens beds, and yield impressions of the fern *Rhacopteris inequilatera*. They have a strong westerly dip, rest upon conglomerates, and have masses of augite andesite associated with them. So far very little has been done to determine their extent.

The earliest account of the Port Stephens rocks is that given by Count Strzelecki, in 1845. Subsequently they were examined by Messrs. F. Odernheimer and E. Herborn, who were employed by the Australian Agricultural Company, between the years 1855 and 1857, to examine and report upon the minerals contained in the Port Stephens Estate. A geological sketch map was prepared by Mr. Odernheimer, and distinguishes between three series of sedimentary beds which may respectively correspond to the Permo-Carboniferous and Upper and Lower Carboniferous.

Mr. J. Mackenzie, late Examiner of Coalfields, on behalf of the Australian Agricultural Company, had a series of trenches carried across the beds in the Stroud district. The section which he published includes seams of bituminous shale and inferior coal, and gives to the strata a total thickness of 10,000 feet. Dr. O. Feistmantel, when referring to this section, says: "Later, however, I received from Mr. John Mackenzie a more detailed section across the same ground in the length of 20,900 feet." I have reason to believe that this longer section was taken across a fold, and that the beds are duplicated. Professor T. W. E. David gives a section showing the beds to have a thickness of 11,241 feet, and subsequently, in 1893, he reduced this amount by 1,309 feet. He says: "These strata have been estimated by Mr. J. Mackenzie, F.G.S., the Government Examiner of Coalfields, to have a thickness of about 10,000 feet, as shown on his unpublished sections. The thickness was stated by me to be 11,300 feet, but I have since seen evidence which necessitates the removal of the upper 1,309 feet from the top of that section, and joining it to the Permo-Carboniferous System, which reduces the thickness of the Carboniferous rocks in the Stroud district to that originally mentioned by Mr. J. Mackenzie."

Mr. Jaquet, who made a geological survey of a portion of the district states that the Upper Carboniferous formation with the included sheets of volcanic rock must have a thickness of at least 19,000 feet.

The formation comprises sandstones, claystones, limestones, conglomerates, tuffs, cherty shales, and intercalated lava beds. The sedimentary rocks are in part marine and in part freshwater. The great bulk of the rocks consist of coarse-grained tuffaceous sandstones, which do not contain recognisable organic remains: so that one is unable to determine whether they are marine or freshwater. The claystones and more argillaceous rocks contain trilobites, crinoids, etc., and are undoubtedly marine, and the cherty shales with plant remains only would certainly seem to have been deposited in freshwater, probably in lakes.

Though locally the beds form well-marked horizons, yet these beds are not persistent throughout the series or even over considerable areas. As an example, the beds along the Glen William Road, near Clarence Town, may be referred to. Here claystones and argillaceous sandstones occur, which yield an abundant marine fauna, and are sharply defined from the coarse-grained arenaceous rocks and tuffs with which they are interstratified. These beds can be traced for a distance of rather more than four miles. They terminate near Stony Creek, upon the south, and beyond this point, upon the same horizon, there are sandstones, etc., devoid of fossils and altogether dissimilar in character. Upon the western slopes of Wallaroo Hill, Parish of Uffington, there is a bed of marine claystone which can be traced for about half-a-mile, and then abruptly gives place to other rocks. Other instances of a similar character may be cited from elsewhere.

The rapid changes of rock along one horizon, and the complex interstratification of marine and freshwater beds, would seem to indicate that during Upper Carboniferous times the land must have been alternately rising and falling while the presence of worm tracks and drift plant remains in the claystones go to show that the marine beds were deposited in shallow water.

That Upper Carboniferous time was marked by a period of intense volcanic activity is evidenced by the numerous beds of lava and volcanic ash which are interstratified with the other rocks. Some of these sheets of igneous rock can be traced for several miles, and they are far more useful as recognisable horizons than the majority of the sedimentary beds.

THE CARBONIFEROUS PERIOD IN NEW ENGLAND.

By E. C. Andrews, B.A., F.G.S., Geological Survey of New South Wales.

The Carboniferous sediments which lie to the north of the Lower Hunter River, form a long curve presenting a concave front to New England proper, sweeping from a point in the vicinity of Warialda in the form of an arc to the coast near Port Stephens by way of the Bingara, Barraba, Tamworth, Maitland and Nundle districts.

Magnificent curves, which are intimately related to the Carboniferous arc, are formed by both the Devonian sediments and the Serpentines of western and southern New England.

Carboniferous sediments of undoubted age are not known to exist in New South Wales south of the Hunter River, and the long area of weakness running throughout the main valley of that stream appears to mark the southern boundary, or meeting-ground, of two vast geological provinces in Eastern Australia, which may be called the South-eastern and North-eastern Provinces.

The Carboniferous sediments here considered dip under the later beds of the Hunter Basin, but do not reappear to the south of these beds, their place there being taken by Devonian sediments. Moreover, orogenic movements of great magnitude affected the North-eastern Province after this class of movement had ceased in the South-eastern Province.

From a study of the Devonian and Carboniferous sediments of New England, Benson has drawn the important conclusion that the Carboniferous sedimentation in that region succeeded the Devonian conformably, and that the great folding to which the Devonian of New England has been subjected was not accomplished until the close of the Carboniferous. This is in marked contrast with the indications in the South-eastern Province, where the Devonian appears to have been folded either at the close of, or both during and at the close of, the Devonian Period. The latter date for the folding of the Devonian beds is suggested by the absence of positive proof of the existence of folded Carboniferous sediments in the South-eastern Province. There is nothing inconsistent in these statements; they simply give support to the necessity for the separation of the North-eastern from the South-eastern Province.

The long discontinuous zone formed by the Serpentines which parallel the strike of the Devonian and Carboniferous sediments is referred by Benson to the rising of ultrabasic rocks along a plane of overthrust faulting, at the close of the Carboniferous.

According to the same authority, the Carboniferous sediments in the area under consideration aggregate 3,500 feet in thickness at least. Of these the Burindi Mudstones form the lower 1,500 feet, and the Rocky River Conglomerates the remainder of the beds.

These were deposited conformably upon a mass of Devonian sediments consisting of red jasperoids (?) containing radiolaria claystones, tuffs, spilites, radiolarian cherts, coarse agglomerates and mudstones. According to Benson, these beds, here named in ascending succession, exceed 26,000 feet in thickness. The mudstones alone exceed 13,000 feet of the whole mass, and contain abundant remains of *Lepidodendron australe*.

The Burindi Series consist of fine, dark, grey, fissile sediments, with bands of tuffs and an occasional coarse breccia. Benson's observations indicate the extreme difficulty attendant upon the separation of these mudstones from the subjacent Devonian types. Marine fossils occur throughout the sediments.

The Rocky River Conglomerates form the upper members of this conformable series. A noteworthy feature is the marked persistence of the conglomerates along the Carboniferous arc, and west of the serpentine curve, which runs parallel with them. The pebbles of the conglomerates consist, in the main, of granite, aplites, quartz-porphyries, rhyolites, trachytes, dacites and andesites. Lava flows also alternate with the conglomerate beds. From the contained plant fossils, Benson has referred these beds to the Lower Carboniferous. No Upper Carboniferous sediments have been recorded from the region.

In conclusion, the study of the Carboniferous in New England indicates a continuation of Devonian geographical conditions succeeding a considerable period of stable equilibrium. This is well brought out by a study of the mudstones, tuffs, and the persistent feature of the Rocky River Conglomerates. The enormous thickness of the sediments formed during the relatively short period of the Devonian and Lower Carboniferous was closed by a powerful orogenic movement attended by a marked overthrust faulting. The folding activities were followed by the rise of ultrabasic rocks along fault planes.

PERMO-CARBONIFEROUS SYSTEM.

By T. W. Edgeworth David, D.Sc., B.A., C.M.G., F.R.S., University of Sydney.

It has been stated by the writer elsewhere that, so far as rocks usually grouped under the above title in New South Wales and other parts of Eastern Australia are concerned, there is scarcely sufficient reason to consider them anything other than simple Permian.

The Carboniferous System is already well represented in New South Wales by a system, some 20,000 feet in thickness, in which reef-forming corals, such as *Michelinia*, *Cyathophyllum*, etc., are well represented. *Phillipsia* is also of common occurrence in Carboniferous rocks in Australia, but is never found in our Permo-Carboniferous strata. Moreover, *Lepidodendron* is quite frequent and characteristic in the local Carboniferous rocks, *L. australe* being found in their lower division, and *L. volkmannianum*, *L. veltheimianum*, and *L. dichotomum* in the middle division, while *Rhachopteris* occurs in enormous quantities in the upper 10,000 feet of the Carboniferous tuffs and shales. None of this flora, essentially Carboniferous for the most part, ascends into the so-called Permo-Carboniferous rocks.

On the other hand, the *Gangamopteris*, representative of the *Glossopteris-Gangamopteris Flora*, goes deep down into the Lower Marine Series of the system, occurring on a horizon about 2,000 feet below that of the Greta Coal. No single species of plant in New South Wales passes up from a Carboniferous into the Permo-Carboniferous horizon, and the same is perhaps true of the fauna, as far as at present known.

All through Carboniferous time the Hunter region in New South Wales was the scene of volcanic eruptions and injection of sills and bathyliths on a grand scale. The vulcanism became very intense towards the close of Carboniferous time, and considerable warping of the earth's crust was in progress. At Lochinvar, in the Hunter Valley, there is a distinct unconformity between the basal glacial beds of the Permo-Carboniferous rocks and those of the Carboniferous. The unconformity is still more strongly marked in the small outlying coalfield of Tangorin, to the NW of Lochinvar. On the other hand, near Kempsey the glacial beds appear to pass down conformably into tuffaceous rocks, just as at the Irwin River in Western Australia the horizon of the "Lyons Conglomerate," an important Permo-carboniferous glacial horizon, passes downwards quite conformably into a considerable thickness of brown shales devoid of fossils. As a rule, the main glacial horizon may be taken as the base of the Permo-Carboniferous (Permian) System in Eastern Australia, just as in South America the Orleans Conglomerate lies at the base of the Santa Catharina System, in South Africa the Dwyka at the base of the Karroo, and in India the Talchir boulder bed, or tillite at the base of the Gondwana System.

Upwards our Permo-Carboniferous System is bounded by the Triassic strata of the Sydney-Blue Mountain area, the upward passage being nearly conformable, but usually marked by contemporaneous erosion. Further west the Permo-carboniferous rocks at the base of the Warrumbungle Mountains are capped quite unconformably by the Jurassic beds forming the edge of the Great Artesian Basin. A similar unconformity marks the junction of the Jurassic rocks with the Permo-Carboniferous rocks at the Irwin River Coalfield in Western Australia.

As regards geographical distribution. The Permo-Carboniferous rocks lie in one main basin, with several subordinate basins. The main basin has a frontage to the coast, from Ulladulla on the south to near Port Stephens on the north, of about 200 miles.

Inland it extends in a general NNW direction for about a similar distance until it disappears under the covering of Jurassic rocks of the Great Artesian Basin. Its total area is estimated by Mr. E. F. Pittman to be about 16,500 square miles. It contains numerous coal seams. No outliers of Permo-Carboniferous age are known to be S or SW of the main basin. On the NE are several outlying basins.

(2) The Stroud-Gloucester Coalfield is a long, narrow and deep trough from one to two miles in width, and about 20 miles in length.

(3) To the east of this is the Myall Lakes Coalfield, also trough-shaped and of approximately the same size.

(4) An outlier of the Lower Marine Series extending from near Taree on the Manning to beyond Kempsey. This

is the furthest point north along the east coast of Australia to which undoubted glaciated boulders have been traced, the latter extending to about Lat. 31° S. A similar outlier of Lower Marine beds near Drake, in New England, where contemporaneous acid and basic lavas are interstratified with marine beds containing *Trachypora*.

(5) A narrow strip of graphitic shales intruded by acid granites at Undercliff.

(6) A small basin, also of Lower Marine sediments, on the west side of the Mole Tableland, to the west of Tenterfield.

(7) A very narrow fault trough existing at intervals for about 80 miles from near Inverell northwards to the Queensland border near Ashford.

As the main basin has been taken as the type district for Australia, it may be described first. The strata have been grouped provisionally in the following descending order, the thicknesses given being those for the type district, that of the Lower Hunter, near Newcastle:—

			Thickness in feet.	
Newcastle-Dempsey-Tomago Series.	Upper Coal Measures.	Newcastle Coal Measures containing in the aggregate about 120 feet of coal in seams varying from 3 feet up to 27 feet in thickness. *Glossopteris* greatly predominates over *Gangamopteris*. Fossil forests on several horizons.	1,200-1,500	1,700 to 5,300
		Dempsey Beds, freshwater beds, without productive coal seams, and very local in its development.	Up to 2,000	
	Middle Coal Measures.	Tomago or East Maitland Coal Measures, containing in the aggregate about 30 feet of coal in seams 3 feet to 10 feet thick. *Glossopteris* still dominates *Gangamopteris*. Fossil trees smaller than in Newcastle beds.	500-1,800	

		Thickness in feet.	
Upper Marine Series.	Crinoidal Shales, with *Trachypora*, etc., terminating upwards in cherty tuffaceous beds, with abundant *Chænomya Glendonite*. A large Pseudomorph after Glauberite is common and characteristic in the upper portion of these beds.	2,500-3,000	64,000 to 5,000
	Marine sandstones and mudstones interspersed with glacial *débris*, including small to large erratics and conglomerate. *Fenestellidæ* are very numerous near the erratic horizon.	2,500-3,400	
Greta Series	Greta Coal Measures, with 15 feet up to a maximum of 43 feet of coal, the thickness mostly aggregating about 20 feet, most of which is workable. *Gangamopteris* predominates over *Glossopteris*. Wood rare.	100-300	
Lower Marine Series.	Marine sandstones of the Farley Beds, including the Ravensfield sandstone.	1,000	4,770
	Shales with occasional Foraminifera.	800	
	Harper's Hill Conglomerates and andesitic tuffs and chloritic sandstones, with abundant *Eurydesma cordata*.	270	
	Marine shales with occasional thin flows of andesitic and basic lavas passing downwards into sandstones, with occasional plants. *Gangamopteris* occurs in the upper part of these beds.	2,400	
	Dark brown to purplish brown shales, with numerous erratics, mostly subangular to rounded, diorite, grano-diorite, greenish felsitic rocks. Devonian quartzites, with *Spirifera disjuncta*, etc. These erratics are sparsely distributed through the beds, many of them are striated or grooved, but the deposit cannot be termed a true tillite.	300	
	Total maximum thickness		16,770 feet

These strata rest with an unconformity in the dip of about 10° on the tuffs of the *Rhachopteris*-bearing Carboniferous strata.

If now the members of this system be briefly reviewed, the shales with glacial erratics at the base of the series may be described first. Lithologically, as regards the matrix of the rock, they bear a wonderful resemblance to the glacial beds at Bacchus Marsh in Victoria, but probably are a marine equivalent, as marine beds succeed almost immediately above the latest of these erratic-bearing beds. The source of the erratics appears to be two-fold. Those of serpentine have, perhaps, come from the New England district to the north, but this is not certain, as there are also serpentines to the south and west. On the other hand, the origin of the quartzites with casts of *Spirifera disjuncta* is clearer and significant. No such Upper Devonian quartzites are known excepting from high residuals, like Mounts Walker and Lambie, especially the latter, to the west of the Blue Mountains, and in the direction of Bathurst. It would seem, then, that the ice which carried these boulders, some of which are strongly ice grooved, came from local alpine glaciers developed on the highlands near Bathurst. If this conclusion is correct, ice in that region must have come down to sea-level in Lat. 33° 30′ S.

About half way up in the series, and just north of Lochinvar railway station, is the oldest horizon to which *Gangamopteris* has as yet been traced.

The next horizon worthy of comment is that of the Harper's Hill andesitic conglomerates and chloritic tuffs, with abundant and often exquisitely preserved marine fossils. These indicate contemporaneous eruptions of andesitic rock, very rich in natrolite in its amygdaloidal cavities. Members of the *Fenestellidæ*, especially *Polypora*, are extremely numerous on a horizon close to that of these lavas at Allandale. Between Pokolbin and Millfield, near the Kangaroo Grounds, at a point about 20 miles south of Harper's Hill, there is an extensive development of basic lava of a somewhat spilitic facies, with masses of natrolite and some datolite filling its large steam holes. The tuffs belonging to this horizon are charged with marine fossils, especially representatives of *Stenopora*. Similar lavas occur at three miles north of West Maitland.

Next it may be mentioned that in the Farley beds there are small erratics indicating a continuation of floating ice conditions. In the Greta Coal Measures the seams vary from a few feet up to a maximum of 32 feet in thickness. In places the seams, by addition of *Reinschia australis*, pass into cannel coal and occasionally contain patches, a few inches in thickness, of kerosene shale. This association of kerosene shale has also been observed 200 miles to the south near the southern end of the Greta coal basin at the Clyde River. *Gangamopteris*, *Glossopteris*, *Næggerathiopsis*, *Phyllotheca* and *Sphenopteris* have been found in the underclays of this seam. *Gangamopteris* predominates over *Glossopteris*. Fossil wood is conspicuously absent, and so far no erect stems of plants have been recorded from the roofs over these seams. The exact mode of origin of these Greta seams has not yet been ascertained. Probably they were formed close to a coast in brackish lagoons. Coarse conglomerates are associated with the seams in places. The coal, when weathering at the outcrop, is evidently liable to spontaneous combustion. A pre-historic fire, dating back about 1,000 years from the present, is still raging in the outcrop portion of this seam at Wingen, in New South Wales, 72 miles northerly from West Maitland, and near Cessnock; at intervals along the outcrop traces of rocks are met with which at first were taken for amygdaloidal andesite, but these have since proved to be shaly material actually smelted by the heat of the burning seam. The cause of this liability to spontaneous combustion through weathering is not known. The coal is a perfectly safe coal for carriage on board ship, and no complaints have been received as to its showing any tendency to spontaneous combustion when stored in ship's hold. On account of its hardness and toughness, it is very suitable for export.

The Greta Coal Measures are followed by a group of strata, known as the Upper Marine Series, formed of mudstones, sandstones and at the base a conglomerate. A well-marked horizon for glacial erratics occurs nearly half way up in this series. The erratics often weigh over a ton, and again belong to rock types like those occurring in the Bathurst district. They occur in sporadic groups, evidently dumped by small icebergs or floe ice, or both, probably the former, as some of them show well-marked ice scratches. At Branxton railway cutting is a good example of one of these dumped erratics resting on its thinnest edge, and showing evidence of having indented the shales upon which it has fallen. Members of the Family of *Fenestellidæ* are again very abundant on this horizon, and *Zaphrentis* is alse common. When one reflects that the waters of Ross Sea in Antarctica swarm with calcareous Polyzoa, and occasionally even as far as 74° S have small, simple corals, one can realise that there is probably a harmonic relation between the glacial erratics and the associated fauna. No reef-forming corals have ever been met with in any of the Permo-Carboniferous rocks of New South Wales. Large aviculopectens are abundant in these Upper Marine Beds, as well as in the Lower Marine. This, too, may have a relation to glacial conditions, for at the present time it is chiefly the pectens, such as *Pecten colbecki*, that form conspicuous littoral deposits.

The nearest approach to a reef-forming coral is *Trachypora*. A little over half way up in the Marine Series, as at Mount Vincent, 12 miles south of Maitland, this coral forms small clusters, but its slender branches do not form anything like a reef. Near the top of the Upper Marine Series, and usually above the Branxton erratic horizon, and the still higher remarkably persistent Bolwarra conglomerate, with its bold outcrop and numerous erratics, are the remarkable pseudomorphs, *Glendonite*. These are formed after a double sulphate of lime and soda, glauberite. They occur at the railway bridge near Singleton and Glendon in the same neighbourhood, but are best seen on the beach between tide marks, at Huskisson on Jervis Bay, nearly 100 miles south of Sydney. They occur either singly or in clusters, and are obviously monoclinic. Individuals are from a few inches up to nearly a foot in length. They have also been found, but more sparingly, in the Lower Marine Series. Here, too, there may be a casual connection between the wide-spread distribution of these remarkable pseudomorphs and glacial conditions. Certainly, in Antarctica, deposits of sulphate of soda, connected with ice deposits at or close to sea-level are very common.

Certain horizons in the Upper Marine Series are very rich in brachiopods, especially in members of the *Productida*, particularly *Productus brachytharus* and *Strophalasia Clarkei*. A fine shell bank of this kind is to be seen at the Bow-wow, near Mount Vincent, about 14 miles south of Maitland. Fine crinoids are there associated with Productidæ. The Upper Marine Series ends with tuffaceous strata. These become distinctly tuffaceous at Black Head, near Gerringong, in the Southern Coalfield, about 77 miles south of Sydney. At Black Head large idiomorphic crystals of augite and occasionally large blocks of an augite-rich basic amygdaloidal lava are scattered through the strata. These beds are particularly rich in the pelecypods, *Chænomya* and *Cleobis.*

In the Illawarra district a very interesting series of lavas and tuffs has been described by Messrs. J. B. Jaquet, L. F. Harper, and G. M. Card, with numerous analyses by Mr. J. C. H. Mingaye. It is about 1,000 feet in thickness.

The older lavas are chiefly orthoclate basalts of the nature of latites, followed by melanocratic types of trachyte. These rocks are subalkaline, and were followed later by intrusions of small bosses and sills of peralkaline rocks of the nature of nepheline syenites, tinquaites and monchiquites. Some of these peralkaline rocks are obviously newer than the Upper Marine epoch, and intrude the latite series, and are probably even newer than the Bulli Coal Measures. It is possible that the monchiquites, which occur chiefly in dykes, are related to, and perhaps even contemporaneous with, the analcite basalts, and analcite dolerites of the Sydney area, where these igneous rocks are certainly Post-Triassic and probably Cainozoic.

The sequence in Permo-Carboniferous time in this series of lavas has been described in this volume by Mr. C. A. Süssmilch.

The Tomago Coal Measures do not call for special comment. They are specially developed in the Lower Hunter area, varying in thickness from 500 to 1,800 feet, and containing in the aggregate about 30 feet of coal in seams not less than 3 feet in thickness. Trees fossilised in clay ironstone are of common occurrence, but they are notably smaller than those found in the succeeding Newcastle Coal Measures. The Dempsey Beds, as merely a local development of freshwater beds devoid of productive coal, may be also passed over. The Newcastle Coal Measures, continuous with those of Bulli on the south and Lithgow on the west, are full of interest. Their thickness varies in the Newcastle district from 1,200 feet up to 1,500 feet, while in the Illawarra and Lithgow districts it is much less as the southern and western margins of the field are approached.

The Newcastle stage of the Newcastle-Dempsey-Tomago Series is built up of sandstones, shales and conglomerates, with occasional groups of chert very thickly and evenly bedded, and at intervals are seams of coal from a few feet up to 25 feet in thickness. Altogether at least 12 seams, 3 feet, or exceeding 3 feet in thickness, can be recognised. There is clear evidence to show that these seams, as well, indeed, as those of the Tomago stage, were formed out of vegetation which grew on the spot. The floors of the seams are full of rootlets, and *Vertebraria*, which may have been the root of *Glossopteris*, is of very frequent occurrence, but more often it is seen penetrating the clay bands in the seams in a direction more or less at right angles to the bedding planes.

At Reid's Mistake, at the southern side of the entrance to Port Macquarie, the upper part of the "Pilot" Seam, exposed between tide-marks, is seen to consist largely of stumps of trees passing downwards into coal and upwards into Chalcedonic chert. Flattened oval roots or rhizomes radiate from the stumps to distances of at least 10 to 14 feet. The stems can be traced upwards through the cherts to a height of about 10 feet. These cherts are altered tuffs formed of fine dust of volcanic glass and minutely powdered felspar. It is just possibles that diatomaceous material may have contributed, the growth being stimulated by the silica dissolved out of the fine tuff, but evidence for this is of the slenderest description. Sponge spicules are absent. These resinous trees were evidently overwhelmed in position of growth by the showers of volcanic tuff. Numerous round black bituminous drops in the cherts speak of resin dripping from the fractured ends of branches snapped off by the tuff.

At Lake Macquarie, at Awaba, near Fassifern, there is a fossil forest of *Dadoxylon* also preserved in tuffaceous shale, passing into chert. Similar cherts, but on a lower horizon, are well seen at Nobby's, at the entrance to Newcastle, and are also well developed in the Western Coalfield as described by J. E. Carne.

At Bellambi, in the Illawarra Coalfield, on the shore at the jetty are numerous trunks of *Dadoxylon* converted into black chalcedony. They were apparently blown down by a strong southerly wind, an ancestor perhaps of the "Southerly Buster," so common and strong a wind upon our coast now in summer time.

The chief horizon for kerosene shale, the origin of which is ascribed by Bertrand and Renault chiefly to the alga *Reinschia australis* mixed with pollen grains, is in the Newcastle Coal Measures, and it occurs chiefly in the south-western and western parts of the field, a small patch also occurring near Kembla in the Illawarra Field. That kerosene shale was formed from the deposits of a quantity of finely divided material is clear from the occurrence in it of numerous leaves of *Glossopteris*, *Nœggerathiopsis*, etc., as well as of the remains of a labyrinthodont at Airlie in the Blue Mountains to which the name of *Bothriceps* has been given.

The chief fossils found in the Newcastle-Dempsey-Tomago series, in which *Glossopteris* is the dominating form, are as follows:—*Glossopteris browniana*, *G. ampla*, and L spp., *Gangamopteris*, *Sphenopteris*, spp., *Phyllotheca australis*, and *P. Etheridgei*, *Caulopteris*, and *Dadoxylon australe*.

As regards the other Permo-Carboniferous basins it may be mentioned that the fine seam of steam coal, about 27 feet thick at Ashford has associated with it *Gangamopteris* only and, therefore, probably belongs to the Greta horizon. At Undercliff certain graphite beds are ascribed to Permo-Carboniferous coal seams altered by intrusive acid granites. This age for intrusion of the acid granites, which are very important units in the geology of New England, has been fully explained by Mr. E. C. Andrews in his chapter on the Plutonic rocks in this volume. At Drake *Trachypora* and Lower Marine fossils are associated with contemporaneous rhyolite and basic rocks, the whole series intruded by the acid granites.

The Manning to Kempsey Basin is also Lower Marine, and it is to the west of Kempsey that Prof. Woolnough has lately discovered striated glacial boulders apparently on the same horizon as that of Lochinvar. This spot, in Lat. 31° S., is the furthest point north along the east coast of Australia to which the undoubted glacial boulders have as yet been traced. The fact should, however, be mentioned that small erratics are found in Queensland as far north as the Bowen Coalfield in Lat. 21° N.

As regards the climatological conditions under which the Permo-Carboniferous Coal Measures of New South Wales were formed, it would seem that if glaciers came down to sea-level at the beginning of Permo-Carboniferous time near Lat. 34° S., a fall of approximately 18° Fahr. in temperature, or at all events, a very considerable fall, would be needed to bring about these conditions. Probably at the time of Gondwana Land Continental climate was present on a far grander scale than now in the southern hemisphere, and refrigeration in part may have been due to the immense land mass, of which Australia then formed part, checking the transfer of heat by ocean currents from the Equator southwards. Later the climate became sub-Antarctic in its severity, and the Greta coal formed under climatic conditions, perhaps like those of Macquarie Island, with its dark mantle of peat to-day. Still later the climate became warmer still, but the torrential gravels forming the extensive conglomerate beds in the Newcastle stage perhaps resulted from melting snows on the highlands. The annual rings of growth in the fossil woods of the Newcastle Series led Prof. Lawson to the opinion that the seasons in late Permo-Carboniferous time were much more marked by extremes of temperature than they are now.

The world-wide character of these peculiar Permo-Carboniferous climatic conditions are well known and have been commented on by the writer in the Geology chapter of the "Federal Handbook."

Obviously a vast amount of most fascinating research, as yet only at the early initiation stage, lies before us in these great Permo-Carboniferous coalfields.

MESOZOIC STRATIGRAPHY OF NEW SOUTH WALES.

By J. E. CARNE, F.G.S., Assistant Government Geologist.

MESOZOIC.

Upper Cretaceous.—Desert Sandstone, North-western Plains.
Lower Cretaceous.—Rolling Downs, North-western Plains.
Trias-Jura (?).—Clarence Series, North-east Coast, Talbragar Beds.
Trias-"Hawkesbury Series".—Wianamatta Stage, chiefly County of Cumberland; Hawkesbury Sandstone Stage, Narrabeen Stage, Co-terminous with Upper Coal Measures.

NARRABEEN STAGE.—This Stage attains its maximum development in the Sydney Basin, a thickness of 1,743 feet being measured in the second diamond drill bore at Cremorne Point, Port Jackson.

Stratigraphically it succeeds the Permo-Carboniferous Upper Coal Measures without apparent break, save at Pokolbin, in the Hunter River Valley, but palæontologically an intervening lapse of time, during which sedimentation ceased and life conditions changed, is evidenced in the relative abundance and differentiation of the fossil floras. From the plentiful and well-preserved flora of the Coal Measures to the sparsely represented and commonly macerated plant remains of the Narrabeen, the transition is sudden and distinct. One remarkable exception to the prevailing palæontological discontinuity was observed in the second Cremorne Bore, where, immediately above the top coal seam, the Mesozoic Equisetum, *Schizoneura*, was associated with the distinctive Permo-Carboniferous fern (in Australia), *Glossopteris*. Above this restricted horizon the former is abundant, but no trace of the latter is seen.

The Pokolbin unconformity is represented by horizontal Narrabeen Beds resting on Permo-Carboniferous strata dipping at an angle of 30°.

The lower division of the Narrabeen in the type, or coastal, area consists of fine-grained sandstones and sandy shales, the latter predominating, with some greenish or reddish-purple tuffaceous shale containing minute particles of metallic copper.

Westward, in the Blue Mountain region, arenaceous characters become more pronounced and coarser grained, and the included cupriferous shales sensibly thinner.

Northerly and north-westerly in the Hunter and Goulburn River Valleys, the sedimentation is still coarser, conglomerates becoming increasingly prominent to the exclusion of fine sandstones and sandy shales, the trend of the finer sediments being thus indicated.

The upper portion of the Narrabeen consists of about 130 feet (maximum) of red and purple shales formed of fine volcanic tuff deposited in water. These conspicuously-coloured shales divide the Hawkesbury Sandstone from the underlying Narrabeen Beds, and form most persistent and reliable guides to the relative position of the first coal seam at the top of the Upper Coal Measures.

With due allowance for thickening or thinning in any given direction, the "Chocolate Shales," as they are termed, may be confidently used in estimating depths to coal where valley dissection or trial borings reveal their presence.

As the western margin of the coal basin is approached, the Chocolate Shales split into three well-defined bands separated by Sandstone.

The "Copper Shales," which occur about 500 feet above the top coal seam in the coastal region, decreasing to under 200 feet in the western, also constitute reliable stratigraphic indicators. Where exposed under shattering ledges, owing to differential weathering, in the vertical cliff sections of the mountain valleys, characteristically coloured copper salts render the outcrops conspicuous.

Owing to normal thinning and denudation combined of the Hawkesbury Stage on the western margin, the underlying Narrabeen is more prominent in the cliff sections. The bold, massive features and petrological characters that specially distinguish the former on the sea-coast and in the principal Blue Mountain cañons, are assumed by the latter in the picturesque mural escarpments and turrets that front the western valleys, and practically limit the Coal Measures in that direction.

Phyto-palæontological distinctions between the different members of the Hawkesbury Series are dependent more on modification and relative abundance of a comparatively few plant forms than on restricted range of individual genera.

Thus amongst ferns the long-pinnuled *Thinnfeldia* greatly preponderates in the Narrabeen over the ovate and reniformcordate form characteristic of the Hawkesbury Sandstone Stage. Again, in *Alethopteris* the typical Australian type —*Alethopteris* (*Cladophlebis*) of world-wide distribution in Jura-Oolite—is absent, but forms with smaller entire pinnules are present in the Narrabeen. *Sphenopteris* is comparatively rare. Of *Tæniopteris, Oleandridium* is fairly abundant, also a new species of *Macrotæniopteris.* No trace of *Tæniopteris* is present.

Equisetaceæ.—*Phyllotheca*, abundant, and *Schizoneura* particularly well developed in the basal portion of the Stage.

Coniferæ, represented by abundant cones referable to *Araucarites*, and others probably to *Brachyphyllum.*

Crustaceæ.—Perhaps one of the most distinctive fossils of the Narrabeen is the small crustacean, *Estheria Coghlani.* About eighty-two feet above the top coal seam in the Sydney Basin these typical fossils are so abundant as to form a definite geological horizon.

HAWKESBURY SANDSTONE STAGE.—This important division of the Trias is strikingly represented in the bold headlands of Port Jackson and the immediate coastline, and in the upper sections of the cañons and precipitous ravines which form the chief features of the Blue Mountains. Its maximum thickness approximates one thousand feet.

The rugged grandeur of the valley escarpments, in some instances exceeding a thousand feet in sheer descent, is the direct consequence of geological structure, and the different phases of weathering it induces. The massive jointed Hawkesbury Sandstone of the summit continuously presents mural faces to the valleys, as unstable underlying shales yield more rapidly to weathering and undermine the margin of the superincumbent mass back to vertical joints from which it falls away.

Persistent bands of soft shale alternating with massive beds of sandstone in the Hawkesbury Stage itself induces comparatively lateral degradation by "benching" or undercutting. Alternations of tectonic weakness and strength produce a series of step-like levels with bold marginal escarpments at upper valley levels, which in more mature dissection merge into stupendous vertical cliffs exposing the full thickness of the stage, and of the underlying Narrabeen.

A glance at the insignificant streams meandering through wide, vertically-scarped valleys, like that of Govett's Leap, near Blackheath, shows how small their part in lateral extension compared with benching or undercutting.

The highest stratum of the Hawkesbury Stage is a quartz-pebble conglomerate which weathers into fantastic turret-shaped pinnacles in western escarpments. Beneath it, a coarse grit developing remarkable concretionary structures in iron oxide is equally evident. Lower still a persistent bed of very aluminous, finely-laminated shale (the Mount Piddington) is traceable from Woodford to Mount Clarence.

The principal stratigraphic features of the Hawkesbury Stage are prevalent eastward inclination at low angles, and current-bedding. Throughout the Hawkesbury and Narrabeen there is abundant evidence of shallow water deposition in current-bedding, ripple marks, mud cracks, rain-prints, and worm tracks. To which may be added, no direct evidence of marine deposition save one doubtful instance, fish remains (allied to fresh or brackish-water forms) and land plants.

Save occasional gentle undulations, there is little disturbance of the prevailing easterly and north-easterly inclination of the Hawkesbury Series until the eastern face of the Blue Mountains is reached. Here the strata have been steeply folded down to a depth of about 900 feet in the Glenbrook-Kurrajong monocline. Warping, though less sudden, is also pronounced north and south of Sydney, as shown in the gradual rise of the strata in these directions. The metropolis, or more correctly the neighbourhood of Liverpool, marks about the centre of the warped area or wide trough-valley.

The Hawkesbury Sandstone, on which the City of Sydney stands, furnishes excellent building stone of handsome colour and great durability, and susceptible of artistic sculpture, as may be seen in the principal public and private buildings.

Palæontology.—Of the ferns, *Thinnfeldia odontopteroides* is probably the most characteristic, followed by *Ottelia præterita*. Other forms are: *Macrotæniopteris* (not the Wianamatta species); *Oleandridium lentriculiforme; Alethopteris*, and fructifications at Mount Piddington.

Equisetaceæ are represented by *Phyllotheca concinna* and *P. Hookeri*.

Mollusca, by the one doubtful loose specimen, *Tremanotus Maidenii*, which, if actually belonging to the Hawkesbury Sandstone, is a remarkable survival of Silurian form.

Pisces.—From an intercalated shale bed near the base of the Hawkesbury Stage at Woy Woy, near Gosford, a large collection of fossil fish was obtained, including fishes of the types of ceratodus and the Port Jackson shark, links between the present and Devonian times.

The Gosford Fish Beds furnished representatives of the following genera:—*Gosfordia*, *Myriolepis*, *Apateolepis*, *Dictyopyge*, *Belonorhynchus*, *Semionotus*, *Pristisomus*, *Cleithrolepis*, *Pholidophorus*, and *Peltopleurus*.

Labyrinthodontia, by *Mastodonsaurus robustus*, Stephens, and *Platyceps Wilkinsoni*, Stephens.

WIANAMATTA STAGE.—This division consists almost entirely of clay shales, with occasional bands of sandstone, occupying a slightly eroded basin in the Hawkesbury Sandstone. Though a few thin outliers occur on the Blue Mountains in County Cook and in the Bowral district in County Camden, it may be said to be practically confined to the County of Cumberland, where it has a maximum thickness of between six and seven hundred feet. The outliers in the elevated regions for the most part owe their preservation to the protection of Tertiary basalt flows.

The Wianamatta Shales—as they are termed from extensive development along the Wianamatta or South Creek—are of great commercial importance for brick and pottery manufacture and are extensively used in the Metropolitan area. The extremely fine sedimentation undisturbed by current bedding, and the nature of the included fossils, point to quiet deposition in fresh or brackish water.

Palæontology.—The Wianamatta ferns include *Thinnfeldia odontopteroides*, and a smaller variety of *lancifolia type*. *Cycadopteris scolopendrina*; *Macrotæniopteris Wianamattæ*; *Sphenopteris*; *Pecopteris* (?) *tenuiflora*; *Gleichenia dubia*; *Alethopteris australis*—rare.

Ginkoales.—*Baiera multifida* (=*Jeanpaulia? palmata*).

Cycadaceæ.—*Pterophyllum* (?).

Equisetaceæ.—*Phyllotheca Hookeri*.

Pisces.—*Palæoniscus*; *Myriolepis*; *Elonichthys*; *Pholidophorus*; *Pleurocanthus*; *Elpisopholis*; *Acentrophorus*. The Wianamatta fishes extend the range of European Carboniferous types to Upper Trias in Australian Labyrinthodontia.

Mollusca.—*Unionella bowralensis* and *Carnei*.

Crustacea.—*Crustacea-Ostracoda* (Cypris?).

An exception to the prevailing fresh or brackish-water conditions occurs at Grose Vale on the Kurrajong, where a small area of foraminiferal and ostracodal sandstone has been identified. Possibly in the upper beds of the Stage, about Camden and Picton, further remnants of similar marine deposition may be discovered.

This interesting fact affords direct evidence of hitherto suspected subsidence about the close of the Stage.

TRIAS-JURA-CLARENCE SERIES.—The Clarence Series occupy an extensive basin between the New England Tableland and the coast in the extreme north-east of the State, drained by the Clarence, Richmond and Orara Rivers. Passing into Queensland in the same relative coastal position it correlates with the Ispwich Coal-basin near Brisbane. It also skirts the western flanks of the New England Plateau. The basal beds consist of massive conglomerates in which ferruginous fossil-wood is conspicuously abundant. Fine laminated sandstones and shales with well-preserved fern impressions and several coal seams, overlie the latter. Massive current-bedded sandstones complete the section. Vertical scarps of the latter in favourable locations—as along the Orara River and the coast—are indistinguishable in appearance from the Hawkesbury Sandstone. On this close physical resemblance correlation was suggested, and for a time maintained, but the similarity is probably a natural coincidence of shallow-water deposition.

The presence of coal seams and the absence of the "Chocolate Shales," strongly differentiates the Clarence from the Hawkesbury Sandstone. The difference is further accentuated in palæontology; classification hinges on the range of *Tæniopteris Daintreei*, a distinctly characteristic fern—abundant in Clarence, Talbragar and Artesian Beds—but absent from the Hawkesbury Series.

Talbragar Fish Beds.—These occupy a small basin eroded in the Hawkesbury Series and consist of silicious cherty shales, horizontally bedded, jointed, and rendered ochreous by ferruginous infiltrations. Thickness, about ten feet. Well-preserved fish and plant remains are very abundant. Overlying the latter are about 15 feet of white siliceous shales, and these are succeeded by about seven feet of siliceous ironstone, and this again by well-waterworn rather coarse gravel of slight thickness, containing undoubted pebbles of the Hawkesbury Series.

Contemporaneous erosion might, perhaps, be considered, but the absence of *Tæniopteris Daintreei* in the eroded Triassic beds, and the association of fish of a *Jurassic* facies with that plant in abundance in the latter deposit, indicate inconformability both stratigraphical and palæontological.

The plants of the Clarence Series and Talbragar Beds establish the close relationship of these deposits to the Ipswich Coal Measures of Queensland, the Gippsland beds of Victoria and the Lake Eyre beds of South Australia, the flora of which shows very definite affinities to the old-world Jurassic.

In each case these beds are characterised by the relatively great abundance of *Tæniopteris Daintreei* (=*Spathulatum*), *Alethopteris australis* (=*Cladaphlebis denticulata*) and numerous types of Conifers and *Thinnfeldia*. This flora is more variable than in the rocks of the Hawkesbury Stage, the *Thinnfeldia* being much more variable, delicate, and more lanceolate as regards the pinnule form.

The abundant and well-preserved fish fauna of the Talbragar Beds, which are associated with *Tæniopteris Daintreei*, are distinct from, and palæontologically younger than, any of the numerous species discovered in the Hawkesbury and Wianamatta Stages.

The former comprise *Coccolepis australis*, *Aphnalepis australis*, *Aetheolepis mirabilis*, *Archæomæne tenuis*, and *robustus*, and *Leptolepis talbragarensis*, *Lowei*, and *gregarius*.

Lower Cretaceous, or Rolling Downs Formation.—Proved in New South Wales by boring, but not definitely known to outcrop, though occupying extensive areas of surface to the north in Western Queensland.

It comprises sandstones, shales and limestones containing characteristic marine fossils, such as *Maccoyella*, *Pinna*, *Belemnites*, etc., and rests on Trias-Jura rocks containing *Tæniopteris Daintreei* and coal seams.

Artesian water is obtained from this division in the north-west, but the larger flows from deeper bores are from freshwater beds, which at present are classed as Trias-Jura.

Upper Cretaceous, or Desert Sandstone Formation.—Well represented in north-western New South Wales and Queensland resting unconformably on the Rolling Downs division, as revealed in the latter State.

Typical sections in the White Cliffs opal-field rest upon Palæozoic rocks, having evidently overlapped the Lower Cretaceous in this direction. The lowest beds consist of coarse grits and sandstones; above these a considerable thickness of "Kaolin," with occasional boulders of quartzite containing Devonian Marine fossils.

The rock locally known as "Kaolin," consisting chiefly of finely divided silica, is the chief repository of the extensively mined precious opal of this locality. About twenty feet of coarse conglomerate complete the series. The latter to a lesser extent is also opal-bearing. Upper Cretaceous rocks outcrop towards the north-eastern boundary of the Artesian area in the Lightning Ridge Opal-field. The Upper Cretaceous division has furnished the following fossils, many of them opalised:—*Lucina*, *Platopsis*, *Belemnites*, *Natica*, *Modiola*, *Tellina*, *Maccoyella*, *Glycimeris*, *Cytherea*, *Cimoliosaurus leucoscopelus*, and Coniferous wood.

TERTIARY STRATIGRAPHY OF NEW SOUTH WALES.

By T. W. Edgeworth David, C.M.G., B.A., F.R.S., Hon. D.Sc. (Oxon.)

Reference to some of the Tertiary rocks has already been made by Mr. E. C. Andrews (*supra*, pp. 518-526). On account of the absence of marine strata of Tertiary age from the whole of New South Wales, except the extreme S.W. corner, it is much more difficult to classify the Tertiary rocks of this State than those of Victoria and South Australia.

The following classification is tentatively suggested, the order being descending:—

		Thickness in feet.
Probably Pliocene.	(7) Lower sands and gravels in part of the extensive Red Soil areas of the Western Plains of New South Wales.	100 to 200
	(6) Basalts such as those of Ben Lomond, Inverell, Gulgong, Blue Mountains.	100 to 350
	(5) Leads such as those of Gulgong, Home Rule, Emmaville, with lignites containing Pliocene fossil fruits, strata with fossil insects, *Meiolania*, the bird bones.	50 to 100
Upper Miocene.	(4) Series of alkaline lavas and tuffs. These build the extinct volcanoes of the Canobolas, Warrumbungle Mountains, Nandewar Ranges, Macpherson Ranges, etc., and are often associated with diatomaceous earths 4 to 5 feet in thickness. The latter are chiefly formed of *Melosira*, with some spicules of *Spongilla*. Possibly this volcanic series may in part be even newer than (6).	300 to 2,100
Oligocene (?)	(3) Calcareous Sandstones and marls, with marine fossils, in which *Trigonia semiundulata* seems characteristic.	900

		Thickness in feet.
Oligocene (?) to Eocene.	(2) Older basalts, with tuffs, laterites and bauxites. Remains of Unio and fossil leaves in the tuffs.	200 to perhaps 500
	(1) Older leads of stream tin and placer gold, such as those of Kiandra, Uralla, Emmaville, etc., with occasional beds of lignite and abundant fossil leaves.	50 to 350
	Total Maximum Thickness	4,500

(1) As indicated by Mr. Andrews, there has been much dispute as to the age of the fossil flora in the oldest leads.

Baron von Ettingshausen considered that it contains cosmopolitan forms, such as *Quercus*, *Alnus*, *Fagus*, *Cinnamomum*, *Laurus*, *Magnolia*, *Banksia*, etc., with *Eucalyptus* very sparingly represented. On the other hand, Mr. Henry Deane and others, who have reviewed Ettingshausen's work, deny the existence of European types, such as *Alnus*, *Magnolia*, etc., in this flora, referring the forms to purely Australian types.

Hitherto no fossil animals have been found in New South Wales in these older leads.

(2) The older basalts, with tuffs, laterites and bauxites, appear in Victoria to have been partly of submarine origin, though not showing pillow structure nor spilitic affinities. In New South Wales these rocks much resemble those of Victoria in being, for the most part, much decayed to the form of wacke; and in places they are capped by red pisolitic ironstone or laterite passing into bauxite. This ironstone results chiefly from the decomposition of basic tuffs.

The following is an analysis of the bauxite from Warialda Road, 9½ miles from Inverell:—

Al_2O_3	41.68
H_2O	26.34
Fe_2O_3	24.18
SiO_2	4.10
CaO	0.80
MgO	0.14
Soda and Potash	Nil
P_2O_5	0.23
TiO_2	2.05
	99.52

These older lavas and tuffs, as in the case of many of the areas in New England, have been derived from numbers of small cones and craters built up upon Palæozoic sediments or Palæozoic plutonic rocks.

(3) The Calcareous sandstones and marls penetrated to a depth of 900 feet at the south-western corner of New South Wales are to be probably correlated with the marine strata of Victoria known as the Janjukian Series, containing *Lepidocyclina tournoueri*, *Cellepora*, etc. These rocks are considered by Mr. Fred Chapman to be of Oligocene Age. They represent the latest known marine strata in New South Wales, apart from insignificant areas of estuarine beds in our recent drowned valleys along the coast.

(4) The series of alkaline lavas and tuffs which build up important volcanic chains in this State, as well as in Victoria and Queensland, is of great interest and importance. It is well developed in the Canobolas, the Warrumbungle and Nandewar Mountains, and in the Macpherson Ranges on the Queensland boundary.

The sequence seems to have been first leucocratic trachytes (sometimes preceded by rhyolites), commencing with riebeckite-arfvedsonite-comendites, passing upwards into pantellarites. These are followed by sölvsbergites, phonolitic trachytes and melanocratic trachytes. These in turn are succeeded by first alkaline andesites, then by either olivine basalts or olivine-fayalite-melilite basalts. Nepheline basalts and theralites associated with olivine basalts are well developed in the Liverpool and Mount Royal Ranges. Beds of diatomaceous earth, from 3 to 5 feet thick, in places containing fossil trees converted into wood opal, are so frequently associated with these tuffs as to suggest some casual connection between the presence of warm mineral waters and the growth of diatoms. *Melosira* is much the most abundant diatom represented. Occasional sponge spicules belonging to *Spongilla* may be observed. The following are analyses of the earth:—

	Cooma.	Wantialable Creek.
SiO_2	81.64	82.62
Fe_2O_3	0.40	5.20
Al_2O_3	3.20	
$CaCO_3$	1.50	9.53
$MgCO_3$	2.16	0.70
H_2O	10.95	—

The diatomaceous earth from Wantialable Creek in the Warrumbungle Mountains is capped by beds of snow-white to buff-coloured tuff formed of anorthoclase crystals.

(5) Leads such as those of Gulgong are formed of sands, gravels, clays and lignites, the aggregate maximum thickness of which is about 200 feet. The lignite beds are from about 10 to 14 feet thick. Remains of *Meiolania*, a large fresh-water tortoise, have been found in this lead, similar to the remains of this genus in the coral-dune rock of Lord Howe Island, and the later formations of South America.

Remains of fossil birds have been found in Tertiary caves in Palæozoic limestone underlying the adjacent Home Rule lead.

At Emmaville these drifts occupy shallow valleys eroded out of the older basalts. They there contain a number of fossil insects in ironstone, such as *Chironomus venerabilis*, a *Palæolycus* belonging to glow-worms, the *Lampyridæ*, and a representative of the Ephemeridæ (May-flies), *Ephemeris* sp.

At Mount Irvine, in the Blue Mountains, coarse river gravel belonging to an ancient river (now split into the Colo and Grose Rivers respectively) lies not far below the highest part of the plateau.

This feature of a basalt-filled Tertiary valley now forming a water-parting is very common in New South Wales, and can be seen conspicuously in the Nundle district. The Tertiary leads, older and newer together, have yielded over £30,000,000 of gold, and about £9,000,000 worth of tin.

(6) The so-called newer basalts, such as those of the Blue Mountains, Mount Hay, Mount Tomah, Mount King George, Mount Wilson, Mount Irvine, etc., probably belong to this age, as well as basalts like those of Gulgong, New England, etc. It is noteworthy that, while on the east side of the Main Divide, where the late Pliocene to Pleistocene uplift has been most pronounced, these basalts form some of the highest parts of the plateau, on the far Western Slopes, as near Inverell, they lie considerably below the level of the modern river channels, like that of the McIntyre.

In the Blue Mountains many scores of volcanic necks filled with volcanic breccia have been mapped by Mr. J. E. Carne; one of these, Tayan Pic, still retains part of a superincumbent crater.

Many of these later basalts, especially in the New England district, appear to have emanated from fissures. The age of these newer basalts is determined chiefly by the fossil fruits found at Gulgong. These are chiefly *Phymatocaryon*, *Plesiocapparis*, and *Spondylostrobus* (v. pp. 521-522). A Lower or Middle Pliocene Age may be suggested for these extinct genera. According to Mr. W. N. Benson, lavas of this age at Hanging Rock have been faulted by as much as 200 feet subsequent to their flow, and warped also several hundreds of feet.

(7) Lastly, there are to be found extensive sheets of quartz-gravel and sand belonging to the lower part of the Red Soil formations of the Western Plains, and situated to the west of the foothills of the Highlands. These represent wide-spread fluviatile and lacustrine deposits spread over the surface of the Cretaceous sediments. These are in places about 100 to 200 feet thick, as proved by boring. They are very pervious, and the water in them is saline. If water from an artesian bore forces its way outside the steel lining pipes driven into the Cretaceous marine shales, which seal the basin, it becomes lost in these gravels and fails to rise to the surface.

POST-TERTIARY STRATIGRAPHY OF N.S. WALES.

DEPOSITS of this age cannot be sharply differentiated into Pleistocene and Recent, so no attempt will be made to draw a line between them.

They may be grouped as follows:—

(9) Mound spring or mud spring deposits of the artesian basin and iron-ore deposits from chalybeate springs of Mittagong area, Travertine of Cooma, etc.

(8) Sand-dunes.

(7) Coral Reef, Lord Howe Island.

(6) Raised Beaches of Hunter District.

(5) Black Soil areas of Western Plains.

(4) Delta deposits with peat beds, filling in drowned valleys, such as those of Hawkesbury and Hunter Rivers, etc.

(3) *Cave Deposits*, such as those of Wellington, Jenolan, etc., with remains of *Thylacoleo*, *Thylacinus*, *Sarcophilus*, etc.

(2) Red Soil Plains and high-level fluviatile deposits, with peats and remains of *Diprotodon*, *Nototherium*, *Thylacoleo*, *Thylacinus*, *Sarcophilus*, etc.

(1) Glacial deposits, found only on the Kosciusko Tableland between altitudes of 7,300 and 5,500 feet. These are, moraines and erratics associated with rock moutonnees, lakes and tarns, and hanging valleys.

(1) After the uplift of the late Pliocene Kosciusko Epoch (pp. 523-525) glaciation developed on the highest part of the warped peneplain at Kosciusko. An older and a newer glaciation can be distinctly traced. The older was of the nature of a calotte or ice-cap glaciation, smothering the plateau under ice for an area of about 100 square miles, the maximum thickness of the ice being about 1,000 feet. This was far older in date than the small alpine glaciation which occurred later. These later glaciers, only one to two miles in length, were not more than 500 feet thick. The great freshness of the striated pavements left by them suggests that they survived probably to within a few thousands of years of the present day. The Calotte glaciation was probably at least ten times as old as the Alpine type of glaciation at Kosciusko.

(2) *The Red Soil Plains of the Western District.*—These strata cover an enormous area of the Western Plains, probably fully half of the whole area of the State, and creep for some distance up the valleys into the highland plateaux. At Myall Creek, near Bingara, fluviatile deposits of this age have yielded a large number of mammalian bones, as yet undescribed.

The red soils are particularly rich in plant foods, as is shown by the comparative analyses given by Mr. F. B. Guthrie below:—

Average of 19 soils from semi-arid regions far inland in New South Wales, compared with average analyses of 100 soils from the Coastal Plain of County Camden, near Sydney.

Capacity for Water	Volatile Matter	Nitrogen	Lime	Potash	Phosphoric Acid	
40 0	5·7	·08	·44	·33	·21	From Semi-Arid Regions, New South Wales.
49.7	11·2	·23	·11	·10	·17	From Costal Plains, New South Wales

Thus, while the coastal soils have more humus, nitrogen and capacity for water than the inland soils, the latter are about three times as rich in lime and potash, and distinctly richer in phosphoric acid than the former.

This differenco is, of course, due to the fact that in the coastal strip these valuable mineral plant foods are carried deep down by the good rainfall into the subsoil, whereas in the case of the soils from the semi-arid regions, where the rainfall is scanty, and the rainy days very few in proportion to the hot, sunny days, capillarity greatly predominates over leaching, and thus the surface soil is being continually enriched with mineral plant foods through the upward creep of the capillary waters. Their red colour suggests accumulation under arid conditions, but on the other hand, as they are far more extensive than the modern alluvials of our rivers, and so bespeak heavier floods than those of to-day, the presence of hæmatite in them may have to be explained otherwise. Their thickness is about 30-50 feet.

(3) *Cave Deposits.*—These are mostly of the nature of bone breccias in stalagmite. At the Jenolan Caves the complete skeleton of a *Thylacinus* was found on the floor of a cave, and not imbedded in the stalagmite. At one of the Wellington Caves a nearly perfect skull of *Thylacoleo* was found under similar circumstances. At Jenolan an extremely interesting skeleton of a primitive type of aboriginal is to be seen partly imbedded in the stalagmite at the Skeleton Cave. It is probably some thousands of years old. At the Wellington Cave a human molar tooth was found in the red stalagmite, and is also of considerable age.

(4) The recent downward movement of the crust has drowned our coastal valleys, but these are now being reclaimed by silting. Between Newcastle and Maitland these delta deposits are over 200 feet thick.

At the Hawkesbury River bridge fluviatile sands at least 70 to 80 feet thick, with trunks of large trees, underlie the surface estuarine beds. The same feature is met with in Sydney Harbour. At Shea's Creek canal an aboriginal stone axe was found imbedded in peat 15 feet below sea-level (v. p. 466).

(5) The black soil areas form narrow strips of flood loam rich in humus and covered by modern floods following the tortuous courses of the western rivers as they meander over the plains. The Nardoo (Marsilea) grows luxuriantly on these black soil flats.

(6) Raised Beaches have been described near Maitland, where they are 15 feet above sea-level. They may be due to an eustatic negative movement of the ocean.

(7) *Coral Reef, Lord Howe Island.*—In this island, which belongs to New South Wales, the coral reefs reach their southernmost limit. The reef is a small fringing reef. Remains of *Meiolania* were discovered there in a calcareous dune rock by Mr. R. Etheridge, jun.

(8) *Sand-dunes.*—Sand derived from marine erosion of cliffs and from pulverised shells, forms dunes and bars along the mouths of many of the drowned valleys. The strong south-east winds appear to do most work in controlling the movements of these dunes.

(9) Near the junction of the strata of the Great Artesian Basin with the Palæozoic rocks there are numerous mud or mound springs. These springs carry up with them mineral matter in suspension, such as clay, sand, etc., together with small flakes of granite and other rocks transported from the floor beneath the artesian basin, and build up conical or crateriform mounds. The height of these varies from 10 feet up to about 50 feet as a maximum. The shallow craters are filled in many cases with hot water, through which gas bubbles up to the surface. Much mineral matter is also brought up in solution, as soda, lime, silica, etc., and in some cases the older mound deposits are considerably consolidated thereby.

In the Mittagong and Picton district, to the south of Sydney, mounds of limonite and other hydrous oxides of iron have been formed by springs, mostly now extinct, which rise along fissures connected with the intrusions of syenite and essexite. The total quantity of ore brought up by them is estimated at over 4,000,000 tons.

At Cooma, at a soda spring in the vicinity, there is a considerable deposit of calcareous travertine.

PREHISTORIC MAN IN NEW SOUTH WALES.

Reference to the antiquity of Man in Australia is given on p. 466, and mention has already been made (1) of the stone axe, *in situ*, in a peat bed, part of a submerged forest, 15 feet below sea-level at Shea's Creek Canal, between Botany Bay and Sydney; (2) of the human molar tooth in the red stalagmite at the Wellington Cave; (3) the extremely interesting skeleton of the aboriginal who met his death by falling down a total distance of 230 feet in three drops, respectively of 65 feet, 90 feet and 75 feet, at the Jenolan Caves. This remarkable skeleton, partly imbedded in the stalagmite, is in quite a good state of preservation.

THE VOLCANIC ROCKS OF NEW SOUTH WALES.

By C. H. Süssmilch, F.G.S., Technical College.

No active volcanoes occur in New South Wales at the present day, nor is there any human record of any volcanic eruption having taken place; nevertheless there is abundant geological evidence to show that vulcanism has frequently, and for long periods of time, been an important factor in the geological history of this State. Nearly every period of the Palæozoic Era had its active volcanoes, from which extensive floods of lava were poured out. The Mesozoic Era, on the other hand, appears to have been comparatively free from volcanic displays. During the Cainozoic Era renewed activity took place; first came great floods of basaltic lava from fissure eruptions, while later on volcanic cones developed from the piling up of alkaline lavas and tuffs.[1] The late Tertiary cones, although they have suffered considerable denudation, still remain as evidence of the great eruptions which produced them.

The volcanic eruptions of the Palæozoic Era appear, in nearly all cases, to have occurred in or adjacent to subsidence areas, and to have, in the main, preceded the more important orogenic earth movements. The Carboniferous eruptions, for example, appear to have been confined to the north-eastern part of the State, the only part which was undergoing subsidence at the period.

In giving this brief summary of the volcanic rocks of New South Wales, it will be convenient to take them in chronological order. Nothing is yet known regarding vulcanicity in Pre-Cambrian times in New South Wales.

Cambrian Period.—No volcanic rocks of Cambrian Age have yet been described from New South Wales, and so far as our present knowledge goes, it indicates that the vulcanism which produced the vast basaltic sheets and tuffs of Northern Territory and Kimberley, in Western Australia, was not represented in New South Wales.

1. The relative age of the Cainozoic plateau basalts on the one hand, and of the alkaline volcanic cones and lavas on the other, can scarcely be considered to be definitely settled as yet. While the above view by Mr. Süssmilch may be correct, it should be mentioned that Dr. H. I. Jensen and Professor Woolnough consider the alkaline rocks to be older than the basalts.—Edit.

Ordovician Period.—Extensive deposits of andesitic lavas and tuffs are associated with the Ordovician strata of the Orange-Cadia district; these have a great thickness at Forest Reefs, near Orange, and the tuffs there are crowded with angular fragments a foot or more in diameter. Andesitic lavas and tuffs of Ordovician Age have also been described from the Parkes-Forbes district. No detailed descriptions of these rocks are available. The thick and extensive volcanic series of the Hargraves district may also be of Ordovician Age.

Silurian Period.—The lavas of this period are largely acidic in composition; rhyolite lavas and tuffs occur interstratified with Silurian strata at such widely separate localities as Jenolan Caves, Bowen Park, near Orange, Canbelago in the Cobar district, and in the Yass district. At the last-named locality they would appear to have a thickness of several thousands of feet, and appear to be dacitic. The published information regarding these occurrences is very scanty, and no detailed petrological investigations have been made. The occurrence of andesitic lavas and tuffs of Silurian Age has been described from the Parkes district.

Devonian Period.—The Silurian vulcanism continued on into the Devonian Period with apparently no intermission. At the beginning of the Lower Devonian Epoch stupendous outpourings of acid lavas and tuffs took place in southern New South Wales and in north-eastern Victoria. At Taemas, in the former State, these accumulated to a maximum thickness of 5,000 feet, and, in addition, the Lower Devonian marine strata, which overlie them, and which are some thousands of feet in thickness, are tuffaceous throughout. In the Tamworth district, also, vulcanicity was a pronounced feature during the Middle Devonian Epoch, when an extensive series of basic submarine tuffs and spilites were erupted. During the Upper Devonian Epoch, on the other hand, vulcanism appears to have been more or less dormant, except in the Yalwal district, where an alternating series of Rhyolites and Basalts of some magnitude was poured out.

Carboniferous Period.—Volcanic eruptions, so far as is known, were confined to the north-eastern part of the State, where they occurred on a grand scale more or less throughout the Carboniferous Period, but particularly towards its close. In the southern part of New England at least twelve distinct lava flows, as well as thick beds of volcanic ash, are interstratified with marine and freshwater sediments. These lava flows, which individually range up to 200 feet or more in thickness, consist mainly of Rhyolites and Rhyolite Glasses, and contain upwards of 70% of silica. Some Hypersthene Andesites also occur. Extensive deposits of Carboniferous Rhyolites and tuffs are also developed in northern New England, on the Drake Goldfield, and in the neighbourhood of Bolivia and Tenterfield.

THE PERMO-CARBONIFEROUS (PERMIAN) PERIOD.—During this period vulcanism was, on the whole, less pronounced and more local in its distribution than had been the case in the Carboniferous Period. During the early part of the Lower Marine Epoch, several basaltic and andesitic lava flows were poured out in what is now the Hunter River district, while at about the same time an extensive series of andesitic lavas and tuffs was erupted in Northern New England (Drake Goldfield). Then followed a considerable period of rest until towards the close of the Upper Marine Epoch a great centre of eruption developed in the Illawarra district. Submarine volcanoes here poured out a great series of lavas and tuffs on a subsiding sea-floor; these range in the aggregate to upwards of 1,000 feet in thickness, and vary from basic to intermediate in composition. They are all more or less alkaline in composition, and include some interesting orthoclase basalts or Latites; the alkali contents of the Latites range up to 9%. In the same district there are a number of hypabyssal intrusions (dykes and sills) of monzonite of somewhat similar composition to the Latites, and probably related to them. At Kiama there occurs also some sills of Nepheline Syenite and Tinguaite, intruding the Coal Measures; these are more alkaline in composition than the other rocks mentioned above (11% to 15% alkalies), and appear to be more nearly related to some of the Tertiary alkaline rocks to be referred to later.

The volcanic eruptions in the Illawarra district continued on into the Upper Coal Measure Epoch, but on a much reduced scale. At this time a new centre of eruption developed near Murrurundi, on the north-western margin of the coal basin, from which basaltic lavas, aggregating many hundreds of feet in thickness, were poured out.

THE MESOZOIC ERA.—No volcanic eruptions are definitely known to have occurred in New South Wales during Cretaceous time. Certain beds of chocolate-coloured shales, which belong to the Narrabeen Stage of the Triassic rocks of the Sydney Basin, are considered to be redistributed tuffs, and the occurrence of numerous bands of green basic tuff interstratified with them indicates that the Permo-Carboniferous vulcanism lingered on into the early part of the Triassic Period. Trachytic rocks are represented in the Jurassic strata of the MacPherson Ranges, rolled pebbles of which are associated with *Tæniopteris Daintreei* over the Queensland border. These Trachytes are no doubt connected with the volcanic epoch which produced the massive tuffs of the nature of quartz-trachytes so extensively developed at base of the Jurassic strata at Brisbane.

THE CAINOZOIC ERA.—The long period of rest which characterised the Cretaceous and late Jurassic time now gave place to renewed activity. This resulted in the outpouring of vast floods of basaltic lavas which filled and in many places overflowed the river channels and buried thousands of square miles of country, under a covering of basalt. These basalt flows still form the surface rocks over large areas, and have provided much rich agricultural land. There are reasons for thinking that these Tertiary basaltic lavas belong to two distinct periods of eruption—an older basalt now represented by cappings on the tops of isolated hills and ridges (residuals), which rise above the general level of the tablelands, though in places, as at Inverell, they lie in the deepest hollows of the Tertiary landscape, and a younger series which, over large areas, form a surface capping to the tableland itself. These latter may be referred to as the Plateau Basalts, as they are practically confined to the Eastern Tableland belt. These flows appear to have resulted from fissure eruptions; whereas the older lavas and tuffs were erupted from groups of small cones and craters. These older tuffs are largely converted into Laterite. The Plateau Basalts have a silica content ranging from 43% to 49%, and are sub-alkaline containing from 3½% to 8% of alkalies. The more alkaline varieties contain small quantities of Nepheline.

Towards the close of the Tertiary Period several isolated centres of eruption developed, from which a highly interesting series of alkaline lavas was erupted. These lavas and their associated tuffs built up groups of volcanic cones, such as the Canoblas Mountains, near Orange, the Warrumbungle Mountains, near Coonabarabran, and the Nandewar

For "G. B. Docker" read "E. B. Docker."

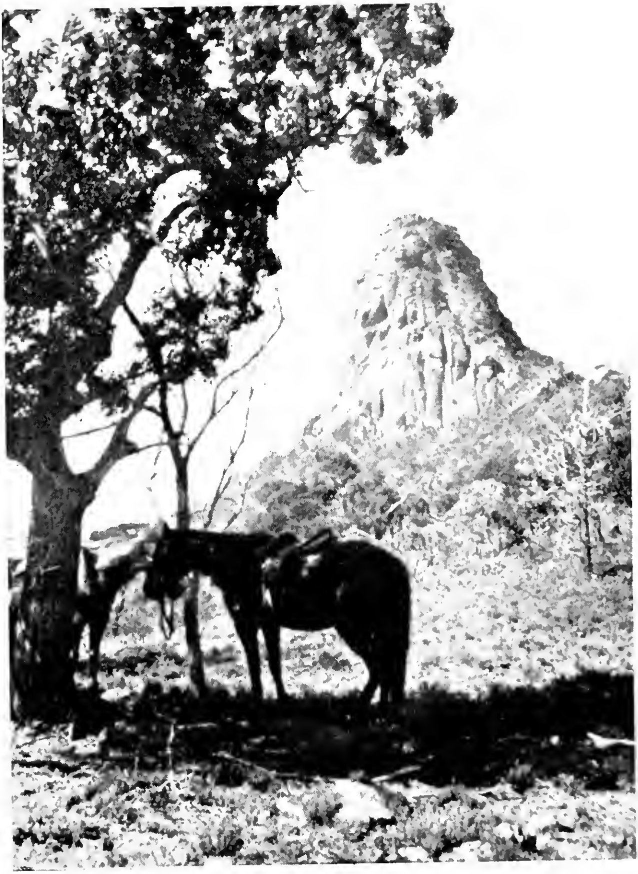


Photo by G. B. Docker.

"VERNON'S PIC" OR TONDEBURINE SPIRE,
WARRUMBUNGLE MOUNTAINS.

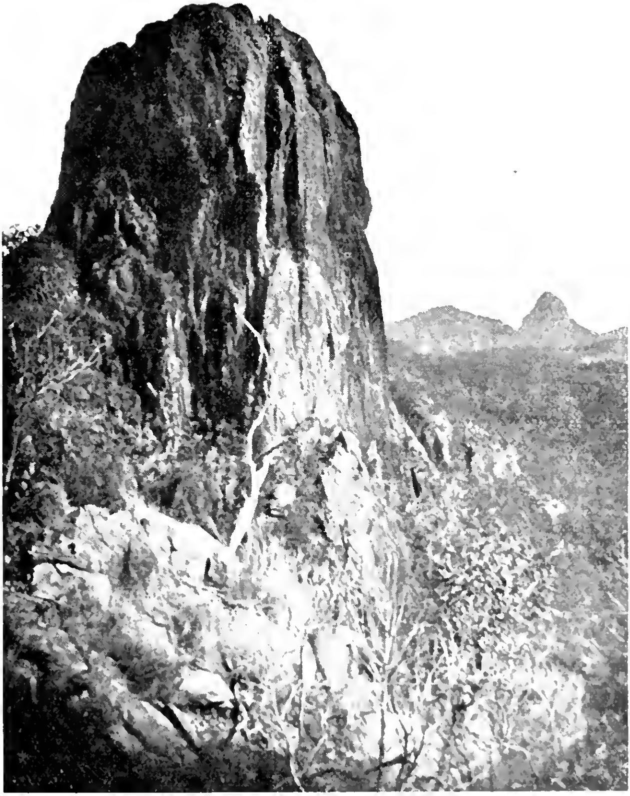


Photo by G. B. Docker

THE SPLIT ROCK, WARRUMBUNGLE MOUNTAINS.

Mountains, near Narrabri. If the first-named be taken as a type, they stand on the top of the tableland near Orange, adjacent to the fault (or series of faults) which marks its western edge. The first eruption brought to the surface a series of highly acid and alkaline viscous lavas, which built up a group of steep lava cones; then came great showers of volcanic ash, included in which were fragments up to several tons in weight. Further lava flows followed at intervals, becoming progressively more basic, the eruptions finally closing with the out-pouring of somewhat basic alkaline Andesites.

The order of extension of these lavas was as follows:—

1. Alkaline Rhyolites (Comendites).
2. Alkaline Trachytes and Quartz Trachytes.
3. Phonolitic Trachytes.
4. Basic Andesites.

The Nandewar and Warrumbungle Mountains consist of similar lavas and tuffs.

In the Mittagong-Bowral district two large cones of alkaline igneous rock occur, namely, the Gib Rock and Mount Jellore. These cones appear to be partly hypabyssal and in places are laccolitic, but as tuffs of the same age occur in their vicinity, they probably congealed close to the surface. The well-known Gib Rock rises about 1,000 feet above the surrounding country, and is a rock allied to Bostonite, and contains narrow segregation views consisting of sanidins, alkaline hornblende, and ægirine. This rock makes an excellent building stone, and is used to a considerable extent in the buildings of Sydney. Mount Jellore consists of alkaline Trachyte and Essexite. Similar alkaline Trachyte occurs at Dubbo and at various places in the Northern Rivers district.

HYPABYSSAL IGNEOUS ROCKS.

But little is known of the hypabyssal igneous rocks of New South Wales except those occurring in and about the main Permo-Carboniferous Coal Basin, and of these nothing definite is known regarding their geological age, except that in most cases it is post-Triassic. From the point of view of composition, they fall naturally into two groups:—(*a*) The Per-Alkaline Group, and (*b*) the Basic Sub-Alkaline Group. The monzonites of the Illawarra district have been already referred to.

(*a*) The Per-Alkaline Group.—Under this heading may be grouped the following occurrences:—

1. The Nepheline-Syenite and Tinguaite Sills of the Kiama district.
2. The Tinguaite Dykes of the Kosciusko region.
3. The Tinguaite Laccolites of the Capertee district.
4. The Dykes and Sills connected with the Alkaline eruption of the Canoblas, Warrumbungle and Nandewar Mountains.

These rocks have a silica contents ranging from 51% to 58%, and an alkali contents of from 10% to 16%, the soda in nearly every case preponderating. The sills of the Kiama district intrude the Upper Coal Measures; the laccolites of the Capertee district intrude Triassic strata, the youngest strata developed in that region. In composition, these rocks closely resemble the Tertiary alkaline lavas, already referred to, and are possibly directly related to them. In that case they would be of Tertiary age.

(*b*) The Basic Sub-Alkaline Group.—The rocks of this group occur as dykes, sills, volcanic necks and laccolites. They include Monchiquites, Essexites, Olivine-Dolerites and Olivine Basalts; their silica percentage ranges from 39% to 46%, and their alkalies from about 3½% to 6%. Many of them contain the mineral Analcite, apparently as an original constituent. One of the most interesting examples is the Essexite, which occurs at Prospect, near Sydney. It is a coarse-grained rock consisting of Labradorite, Augite, Biotite, Olivine, Ilmenite, Apatite and Analcite. It contains some interesting aplitic and pegmatitic segregation views, which are much more highly alkaline than the parent rock, the extreme differentiation product consisting almost entirely of Albite, Orthoclase and Analcite.

These basic Hypabyssal rocks are related in composition to the Tertiary basaltic lavas already described, and are probably of the same geological age.

THE PLUTONIC AND ALLIED ROCKS OF N.S. WALES.

By E. C. Andrews, B.A., F.G.S., Geological Survey of New South Wales.

GENERAL GEOLOGY.

The rocks under consideration are generally considered as granites, but they fall mainly into granite and granitoid types, with minor developments of forms, such as diorites, norites, gabbros, dolerites, serpentines, gneisses and crystalline schists. The main development is in three districts, namely, Broken Hill, the Southern Tableland and New England, the first-named being separated from the Eastern Tablelands by the plains of Riverina, the Bogan, and of the north-west, while New England and the Southern Tableland are separated by the weaker structures of the Mesozoic and the Permo-Carboniferous sediments which are almost horizontally bedded in the southern and western portions with a doming of the Permo-Carboniferous in the more northern and eastern portions. In this area of relatively weak structures many alkaline intrusive types occur. Similar types occur also in similar areas in South Illawarra and in the extreme north-eastern portion of the State.

Arrangement.

Broken Hill Types.—Unrecorded, but probably conforming, in the main, to the strike of the country.

Southern Tableland Types.—Almost meridional, and following the strike of the country in the main. This is well seen on the new 16-mile Geological Map of the State.

New England Types.—Often meridional in the northern and eastern portions. The western boundary of the granitoids forms a curve convex to the south-western portion of the State, and subparallel, if not parallel, to the strike of the Devonian and Carboniferous sediments. The serpentines of Bingara, Barraba and Nundle also form a discontinuous series arranged on an outer arc sympathising with the convex front presented to the west by the New England granitoids The serpentines of the Manning, the Hastings and the Clarence are arranged around the borders of the New England Plateau just beyond the granite curves, as in the case of the Bingara, Barraba and Nundle serpentines.

Ages of Groups.

Broken Hill.—Apparently Pre-Cambrian.

Upper Murrumbidgee and Murray.—Probably Pre-Cambrian or closing Ordovician.

Southern Tableland (north of Cooma).—Partly Post-Ordovician and Pre-Upper Devonian and partly Post-Devonian and Pre-Permo-Carboniferous.

Northern Tableland.—Close of Permo-Carboniferous. Benson, however, refers the outlying arc of the serpentines to the Carboniferous.

Areas of Triassic and Gently Folded Permo-Carboniferous Sediments.—Alkaline Syenites, Monzonites and allied types of Tertiary Age.

All these important groups are intimately related to periods of strong compressive activity, with the exception of the Alkaline intrusives recorded from the sunken areas. (The Canoblas intrusives rise, however, from the Palæozoic complex on the Orange Plateau.)

From the foregoing statements it is apparent that the Plutonics associated with periods of orogenic activity are arranged in belts which, as time progressed, contracted in area in directions from west to east, and from south to north

The vexed question of the origin of the Plutonics, namely, whether as injections along planes of weakness or as masses eating their way slowly upwards by a process of stoping and assimilation, is too great a subject to discuss adequately in a brief note, such as that here presented. The peculiar occurrences of the main Plutonic masses, however, show that the arrangement of the granitoids is generally conformable to the grain or structure of the country (strike a little west of north in western New England and a little east of north in Eastern New England), but, although arranged somewhat parallel to the axis of the sedimentary folds, they nevertheless frequently cut clean across the bedding planes. These facts suggest a following upwards of great planes of weakness by the granitoids during a process of stoping with an assimilation of the stoped and foundered blocks from the roof and sides of the granite chambers.

Description of Plutonics and Allied Rocks.

Pre-Cambrian.—Mawson reports a widely-spread intrusion of granitic magma in Pre-Cambrian time for the large Broken Hill area. The augen-gneiss, sillimanite-gneiss, garnet-gneiss and allied rocks are described as metamorphosed conditions of this granite. Pegmatites with tin and wolfram are also associates. Basic intrusive rocks of this period are also common, the ferromagnesian content being largely in the form of pyroxene. A later basic intrusive series is also indicated.

CAMBRIAN AND ORDOVICIAN.—These two periods may be considered as one from the point of view of Plutonic intrusions, because all over the world the Ordovician is generally conformable on the Cambrian, the sediments in areas of enormous thickness being intensely folded at the close of the Ordovician.

The crystalline schists, gneisses and granites of the large Cooma district, which appear to form a northern continuation of the Mitta Mitta series of Victoria, bear evidence of metamorphism as intense, in places, as those of the Broken Hill area. It has been customary to consider them as possibly of Pre-Cambrian age, but caution must be exercised for the following reasons:—

(*a*) Ordovician rocks occur in the area and the orogenic movement closing the Ordovician in New South Wales is known to have been by far the most intense in its history, with the exception of that which affected the Archean rocks in Pre-Cambrian time, and it is possible in an area of enormous sedimentation during Cambrian and Ordovician time that the subsequent folding stage was so pronounced as to have been accompanied by profound metamorphism.

(*b*) Certain observers incline to the belief that the crystalline rocks of the Cooma district may be traced into rocks of known Ordovician Age. No satisfactory mapping of this area has been attempted.

These oldest types of intrusives in New South Wales, namely, the Broken Hill and Cooma areas lie on the western and southern fringe of the State.

POST-ORDOVICIAN AND PRE-UPPER DEVONIAN.—The coarse acid and miarolitic granite of Parkes may be referred to this period, as it intrudes rocks apparently of Ordovician age and is overlain by the Upper Devonian quartzites.

POST-DEVONIAN AND PRE-PERMO-CARBONIFEROUS.—Yalwal, Kanimbla, Bathurst, Burrenjuck and other granitoids fall into this period. These types intrude the Upper Devonian, while the Permo-Carboniferous sediments, where present, lie on their eroded surfaces.

The Plutonic types commonly found in the Southern Tableland north of the large Cooma district appear to fall into these two periods. The rocks vary from serpentines and norites to highly acidic granites. Norites are recorded from Kiandra, serpentines from Lucknow and Gundagai, diorites from Kiandra, Kanimbla and other localities. The strike of the long line of serpentine at Gundagai is almost N 40° W and S 40°. Hornblende and biotite types of granitic rocks are more common than acid granite types.

Tonalites, granodiorites, quartz-mica-diorites and allied types are commonly classed as granites in this region. The basic granites or granodiorites appear to be related, in some measure, to the gold occurrences, while tin is intimately associated with the highly acid types. The occurrences are of the nature of composite bathyliths, stocks, bosses with the usual accompaniment of dykes and pegmatitic phases. From an examination of the 16-mile Map it is evident that the Plutonic rocks occupy a great portion of the Southern Tableland, especially in the more southern portion.

The Bathurst and Kanimbla bathyliths are good examples of the composite type, while the Burrenjuck granite is an example of the acid types. The Ardlethan, Whipstick, and Pulletop granites are examples of acid types.

Closing Palæozoic.—The district affected was New England.

The leading types appear to be granitoids of peculiar character, with a series of serpentine masses, arranged on an outlying curve. Benson refers these outlying basic occurrences to the Carboniferous.

The occurrences are mainly composite bathyliths, the older types being diorites, basic granites and allied types, while the younger members are of coarse acid and non-porphyritic granites, ranging from 70 to 80 in silica percentage, and intruded by aplites, pegmatites and quartz veins.

The older and basic rocks have been intruded by lamprophyric dykes which appear to be intimately related to the gold veins. The younger acidic members are famous for their tin contents.

Examples.

(*a*) Basic Granites and Granitoids.—Hillgrove, Tenterfield, Timbarra, Glen Innes, Tingha, Glen Elgin, Uralla, Bendemeer, Tamworth.

(*b*) Acid Types.—Boonoo Boonoo, Mole Tableland, Kingsgate, East Mount Mitchell, Tingha-Inverell, Giant's

Den, Moogem (about 80% SiO_2), Carrai, Bolivia, Guy Fawkes.

In the imperfect state of our present knowledge it is impossible to state clearly the relations existing between the New England serpentines and the enclosed granitoids. A definite relation is indicated on account of first, the peculiar manner in which the older Palæozoics of New England are arranged, namely, in sympathetic curves presenting a convexity towards the more southern and south-western portions of the State; secondly, the enclosure of the strongly compressed Permo-Carboniferous sediments within a disconnected ring of serpentines; thirdly, the sympathy of curvature of the western serpentines and the western New England granites, with the strikes of Devonian and Carboniferous sediments, and fourthly, the meridional trend of granites and serpentines in north-eastern New England.

Benson shows that the Carboniferous is conformable with the Devonian in New England, and he places the serpentines at the close of the Carboniferous. It will be highly important, in any study of New England Tectonics, to understand clearly the chronological relations of these two important manifestations.

Chapter VII.

THE SYDNEY OBSERVATORY.

By Professor W. E. Cooke, M.A., Government Astronomer.

The history of Astronomy in Australia is coeval with that of colonisation. Amongst the very first arrivals a young astronomer, Lieutenant Dawes, came for the purpose of observing one of Halley's comets (not the famous one) which were expected to be favourably situated for observation from the new Colony in 1788-9. He erected an observatory on what is now known as Dawes' Point, not far from the present site.

The next step was taken by Sir Thomas Brisbane, Governor of the Colony, who erected an Observatory of a more permanent character at Parramatta in 1821, and provided an assistant, Mr. Rumker, and a good set of instruments. Sir Thomas himself assisted in the work and for some time it was pushed on vigorously. Mr. Rumker resigned and was succeeded by Mr. Dunlop. When Sir Thomas left the Colony he sold the instruments to the Government and the work was continued by Mr. Dunlop. The Observatory was dismantled in 1847, leaving behind as one of its products the well-known "Parramatta Catalogue" of Stars.

In 1856, at the instance of Sir William Denison, then Governor of the Colony, a sum of £7,000 was voted for erecting the present Observatory and supplying it with instruments. The Rev. W. Scott was appointed Government Astronomer and Meteorologist. Twelve meteorological stations were established, and as soon as the building at Sydney was completed Mr. Scott began his astronomical work. Mr. H. C. Russell, B.A. (Sydney), obtained the position of assistant on January 1st, 1859.

In July, 1862, the Rev. W. Scott resigned and Mr. Russell was Acting-Astronomer until Mr. G. R. Smalley, B.A., arrived from England and took charge in January, 1864.

In July,1870, Mr. Smalley died and Mr. Russell was appointed Government Astronomer. At that time there were only six meteorological stations, and the astronomical instruments were becoming obsolete. Mr. Russell threw himself heartily into the work of reorganisation. A Transit Circle by Troughton & Simms, of $6\frac{1}{2}$ inches aperture and 7 feet focal length, two equatorials ($11\frac{1}{2}$ and 6 inches aperture), an astrograph (13 inches), chronographs, etc., were gradually added; and tho meteorological department progressed very rapidly.

After a period of great activity, during which he published many valuable astronomical and meteorological memoirs, Mr. Russell retired on November 1st, 1903, and Mr. Lenehan was appointed his successor.

Mr. Lenehan died rather suddenly in May, 1908, and the Observatory remained in charge of Mr. W. E. Raymond, F.R.A.S., until August, 1912, when Mr. W. E. Cooke, M.A., former director of the Perth Observatory, was appointed Government Astronomer and Professor of Astronomy in the Sydney University.

The Meteorological Department, which had grown not only here but throughout Australia, to large dimensions, was transferred to the Commonwealth and converted into a Weather Bureau of Australasia on January 1st, 1908.

The Observatory is co-operating with 17 other observatories throughout the world in the formation of an International Star Catalogue and Photographic Chart of the Skies. The instruments and site, however, are not now suitable for modern observations of sufficient accuracy, and the Government has determined to remove the Observatory to Wahroonga (12 miles from Sydney), and equip it with modern instruments. Its most obvious work of immediate practical importance, however, is in connection with local time, and a time-ball has been erected on its tower, 220 feet above sea-level, and visible from nearly all parts of the harbour. This is dropped daily at 1 p.m. New South Wales Standard Time, or 15 hours Greenwich Mean Time.

A time-gun is also fired at Fort Denison at the instant the ball is seen to drop, but this is not under the Astronomer's control.

The Observatory is open to the public every Monday afternoon from 2 to 4 p.m., and admission at night may be obtained by special arrangement.