JOURNAL AND PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

NEW SOUTH WALES

FOR

1921.

VOL. LV.

With Appendix containing the complete Minutes of the Philosophical Society of Australasia 1821 – 1822.

EDITED BY

THE HONORARY SECRETARIES.

SYDNEY
PUBLISHED BY THE SOCIETY, 5 ELIZABETH STREET, SYDNEY.

1922.

CONTENTS.

VOLUME LV.

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JOURNAL AND PROCEEDINGS OF THE ROYAL SOCIETY OF N. S. WALES.

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AND

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OF THE

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(INCORPORATED 1881.)

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THE AUTHORS OF PAPERS ARE ALONE RESPONSIBLE FOR THE STATEMENTS MADE AND THE OPINIONS EXPRESSED THEREIN.

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NOTICE.

The Royal Society of New South Wales originated in 1821 as the "Philosophical Society of Australasia"; after an interval of inactivity, it was resuscitated in 1850, under the name of the "Australian Philosophical Society," by which title it was known until 1856, when the name was changed to the "Philosophical Society of New South Wales"; in 1866, by the sanction of Her Most Gracious Majesty Queen Victoria, it assumed its present title, and was incorporated by Act of the Parliament of New South Wales in 1881.

TO AUTHORS.

Authors of papers desiring illustrations are advised to consult the editors (Honorary Secretaries) before preparing their drawings. Unless otherwise specially permitted, such drawings should be carefully executed to a large scale on smooth white Bristol board in intensely black Indian ink, so as to admit of the blocks being prepared directly therefrom, in a form suitable for photographic "process." The size of a full page plate in the Journal is $4\frac{1}{4}$ in. $\times$ $6\frac{3}{4}$ in. The cost of all original drawings, and of colouring plates must be borne by Authors.

PUBLICATIONS.

The following publications of the Society, if in print, can be obtained at the Society's House in Elizabeth-street:—

Transactions of the Philosophical Society, N.S.W., 1862-5, pp. 374, out of print.

Vols. I—XI Transactions of the Royal Society, N.S.W., 1867—1877, ,,

,,	XII	Journal and Proceedings			,,	,,	1878,	,, 324,	price 10s.6d.
,,	XIII	,,	,,	,,	,,	,,	1879,	,, 255,	,,
,,	XIV	,,	,,	,,	,,	,,	1880,	,, 391,	,,
,,	XV	,,	,,	,,	,,	,,	1881,	,, 440,	,,
,,	XVI	,,	,,	,,	,,	,,	1882,	,, 327,	,,
,,	XVII	,,	,,	,,	,,	,,	1883,	,, 324,	,,
,,	XVIII	,,	,,	,,	,,	,,	1884,	,, 224,	,,
,,	XIX	,,	,,	,,	,,	,,	1885,	,, 240,	,,
,,	XX	,,	,,	,,	,,	,,	1886,	,, 396,	,,
,,	XXI	,,	,,	,,	,,	,,	1887,	,, 296,	,,
,,	XXII	,,	,,	,,	,,	,,	1888,	,, 390.	,,
,,	XXIII	,,	,,	,,	,,	,,	1889,	,, 534,	,,
,,	XXIV	,,	,,	,,	,,	,,	1890,	,, 290,	,,
,,	XXV	,,	,,	,,	,,	,,	1891,	,, 348,	,,
,,	XXVI	,,	,,	,,	,,	,,	1892,	,, 426,	,,
,,	XXVII	,,	,,	,,	,,	,,	1893,	,, 530,	,,
,,	XXVIII	,,	,,	,,	,,	,,	1894,	,, 368,	,,
,,	XXIX	,,	,,	,,	,,	,,	1895,	,, 600,	,,
,,	XXX	,,	,,	,,	,,	,,	1896,	,, 568,	,,
,,	XXXI	,,	,,	,,	,,	,,	1897,	,, 626,	,,
,,	XXXII	,,	,,	,,	,,	,,	1898,	,, 476,	,,
,,	XXXIII	,,	,,	,,	,,	,,	1899,	,, 400,	,,
,,	XXXIV	,,	,,	,,	,,	,,	1900,	,, 484,	,,
,,	XXXV	,,	,,	,,	,,	,,	1901,	,, 581,	,,
,,	XXXVI	,,	,,	,,	,,	,,	1902,	,, 531,	,,
,,	XXXVII	,,	,,	,,	,,	,,	1903,	,, 663,	,,
,,	XXXVIII	,,	,,	,,	,,	,,	1904,	,, 604,	,,
,,	XXXIX	,,	,,	,,	,,	,,	1905,	,, 274,	,,
,,	XL	,,	,,	,,	,,	,,	1906,	,, 368,	,,
,,	XLI	,,	,,	,,	,,	,,	1907,	,, 377,	,,
,,	XLII	,,	,,	,,	,,	,,	1908,	,, 593,	,,
,,	XLIII	,,	,,	,,	,,	,,	1909,	,, 466,	,,
,,	XLIV	,,	,,	,,	,,	,,	1910,	,, 719,	,,
,,	XLV	,,	,,	,,	,,	,,	1911,	,, 611,	,,
,,	XLVI	,,	,,	,,	,,	,,	1912,	,, 275,	,,
,,	XLVII	,,	,,	,,	,,	,,	1913,	,, 318,	,,
,,	XLVIII	,,	,,	,,	,,	,,	1914,	,, 584,	,,
,,	XLIX	,,	,,	,,	,,	,,	1915,	,, 587,	,,
,,	L	,,	,,	,,	,,	,,	1916,	,, 362,	,,
,,	LI	,,	,,	,,	,,	,,	1917,	,, 786,	,,
,,	LII	,,	,,	,,	,,	,,	1918,	,, 624.	,,
,,	LIII	,,	,,	,,	,,	,,	1919,	,, 414,	,,
,,	LIV	,,	,,	,,	,,	,,	1920,	,, 312,	price £1 1s.
,,	LV	,,	,,	,,	,,	,,	1921,	,, 418,	,,

Royal Society of New South Wales.

OFFICERS FOR 1921-1922.

FORM OF BEQUEST.

I bequeath the sum of £   to the ROYAL SOCIETY OF NEW SOUTH WALES, Incorporated by Act of the Parliament of New South Wales in 1881, and I declare that the receipt of the Treasurer for the time being of the said Corporation shall be an effectual discharge for the said Bequest, which I direct to be paid within   calendar months after my decease, without any reduction whatsoever, whether on account of Legacy Duty thereon or otherwise, out of such part of my estate as may be lawfully applied for that purpose.

[*Those persons who feel disposed to benefit the Royal Society of New South Wales by Legacies, are recommended to instruct their Solicitors to adopt the above Form of Bequest.*]

LIST OF THE MEMBERS

OF THE

Royal Society of New South Wales.

P Members who have contributed papers which have been published in the Society's Transactions or Journal. The numerals indicate the number of such contributions.

‡ Life Members.

Elected.		
1908		Abbott, George Henry, B.A., M.B., Ch.M., 185 Macquarie-street; p.r. 'Cooringa,' 252 Liverpool Road, Summer Hill.
1877	P 5	Abbott, W. E., 'Abbotsford,' Wingen.
1918		Adam, George Hyslop, 'Lintrose,' Warren Road, Marrickville.
1904		Adams, William John, M. I. MECH. E., 175 Clarence-street.
1898		Alexander, Frank Lee, William-street, Granville.
1905	P 2	Anderson, Charles, M.A., D.Sc. *Edin.*, Director of the Australian Museum, College-street.
1909	P 8	Andrews, Ernest C., B.A., F.G.S., Government Geologist, Department of Mines, Sydney. *President.*
1915		Armit, Henry William, M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, B.M.A. Building, Elizabeth-street.
1919		Aurousseau, Marcel, B.Sc., Geophysical Laboratory, 2801 Upton Street, Washington, D.C.
1878		Backhouse, His Honour Judge A. P., M.A., 'Melita,' Elizabeth Bay.
1921		Baker, Rev. Harold Napier, M.A. *Syd.*, St. Thomas' Rectory, North Sydney.
1919		Baker, Henry Herbert, 15 Castlereagh-street.
1894	P 26	Baker, Richard Thomas, The Avenue, Cheltenham.
1894		‡Balsille, George, 'Lauderdale,' NE. Valley, Dunedin, N.Z.
1919		Bardsley, John Ralph, "The Pines," Lea Avenue, Five Dock.
1896		Barff, H. E., M.A., Warden of the University of Sydney.
1908	P 1	Barling, John, L.S., 'St. Adrians,' Raglan-street, Mosman.
1918		Barr, Robert Hamilton, Australasia Chambers, 2 Martin Place.
1895	P 9	Barraclough, Sir Henry, K.B.E., B.E., M.M.E., M. INST. C.E., M. I. MECH. E., Memb. Soc. Promotion Eng. Education; Memb. Internat. Assoc. Testing Materials; Professor of Mechanical Engineering in the University of Sydney; p.r. 'Marmion,' Victoria-street, Lewisham.
1894		Baxter, William Howe, L.S., Chief Surveyor, Existing Lines Office, Railway Department, Bridge-street.
1877		Belfield, Algernon H., 'Eversleigh,' Dumaresq.
1909	P 2	Benson, William Noel, D.Sc. *Syd.*, B.A., *Cantab.*, F.G.S., Professor of Geology in the University of Otago, Dunedin, N.Z.
1919		Bettley-Cooke, Hubert Vernon, 225 Castlereagh-street.
1916		Birrell, Septimus, 'Florella,' Dunstaffnage-st., Hurlstone Park.

Elected		
1920		Bishop, Eldred George, Belmont-street, Mosman.
1915		Bishop, John, 24 Bond-street.
1913		Bishop, Joseph Eldred, Killarney-street, Mosman.
1905		Blakemore, George Henry, 4 Bridge-street.
1888		‡Blaxland, Walter, F.R.C.S. *Eng.*, L.R.C.P. *Lond.*, 'Gundaroo,' Wallaroy Road, Double Bay.
1893		Blomfield, Charles E., B.C.E. *Melb.*, 'Woombi,' Kangaroo Camp, Guyra.
1898		Blunno, Michele, Licentiate in Science (Rome), 'Havilah,' No. 1, Darlinghurst Road, Darlinghurst.
1907		Bogenrieder, Charles, M.A., No. 2 Little's Avenue, Balmain.
1879		‡Bond, Albert, 64 Wentworth Court, Elizabeth-street.
1917		Bond, Robert Henry, 'Elfindale,' Croydon Avenue, Croydon Pk.
1920		Booth, Edgar Harold, M.C., B.Sc.. Lecturer and Demonstrator in Physics in the University of Sydney.
1910		Bradley, Clement Henry Burton, M.B., Ch.M., D.P.H., 'Nedra,' Little-street, Longueville; 203 Macquarie-street.
1876		Brady, Andrew John, L.K. and Q.C.P. *Irel.*, L.R.C.S. *Irel.*, 175 Macquarie-street, Sydney.
1916		Bragg, James Wood, B.A., c/o Gibson, Battle &Co. Ltd.,Kent-st.
1917		Breakwell, Ernest, B.A., B.Sc., Headmaster Agricultural School, Yanco.
1891		Brennand, Henry J. W., B.A., M.B., Ch.M. *Syd.*, 203 Macquarie-street; p.r. 'Wobun,' 310 Miller-steet, North Sydney.
1919		Bretnall, Reginald Wheeler, 'Dardanella,' Bowral, N.S.W.
1919		Briggs, George Henry, B.Sc., Lecturer and Demonstrator in Physics in the University of Sydney.
1914		Broad, Edmund F., 'Cobbam,' Woolwich Road, Hunter's Hill.
1906		Brown, James B., Resident Master, Technical School, Granville; p.r. 'Aberdour,' Daniel-street, Granville.
1913	P 2	Browne, William Rowan, B.Sc., Lecturer and Demonstrator in Geology in the University of Sydney.
1921		Bull, James Towers, 148 Fort-street, Petersham.
1898		‡Burfitt, W. Fitzmaurice, B.A., B.Sc., M.B., Ch.M. *Syd.*, 'Wyoming,' 175 Macquarie-street, Sydney.
1919	P 4	Burrows, George Joseph, B.Sc., Lecturer and Demonstrator in Chemistry in the University of Sydney; p.r. Watson-street, Neutral Bay.
1909		Calvert, Thomas Copley, ASSOC. M. INST. C.E., Department of Public Works, Sydney.
1904	P 18	Cambage, Richard Hind, L.S., F.L.S., Under Secretary for Mines, Department of Mines, Sydney; p.r. Park Road, Burwood. (President 1912). *Hon. Secretary.*
1907		Campbell, Alfred W., M.D., Ch.M. *Edin.*, 183 Macquarie-street.
1921		Campbell, John Honeyford, M.B.E., Deputy Master of the Royal Mint, Macquarie-street, Sydney.
1876		Cape, Alfred J., M.A. *Syd.*, 'Karoola,' Edgecliff Road, Edgecliff. Australia Chambers, George and Margaret-streets.
1920		Carleton, George Brabason, B.E. *Syd.*, ASSOC. M. INST. C.E., Public Works Department, Sydney.
1891		Carment, David, F.I.A. *Grt. Brit. & Irel.* F.F.A., *Scot.*, 4 Whaling Road, North Sydney.

Elected		
1909		Carne, Joseph Edmund, F.G.S., 'Dimlands,' Dickson-street, Homebush.
1920		Carruthers, Sir Joseph Hector, M.L.C., M.A., *Syd.*, LL.D., *St. Andrews*, 'Highbury,' Waverley.
1903	P 3	Carslaw, Horatio S., M.A., Sc. D., Professor of Mathematics in the University of Sydney.
1913	P 3	Challinor, Richard Westman, F.I.C., F.C.S., Lecturer in Chemistry, Sydney Technical College.
1909	P 2	Chapman, Henry G., M.D., B.S., Professor of Physiology in the University of Sydney. *Hon. Treasurer.*
1913	P 10	Cheel, Edwin, Botanical Assistant, Botanic Gardens, Sydney.
1909	P 20	Cleland, John Burton, M.D., Ch.M., Professor of Pathology in the University of Adelaide. (President 1917.)
1876		Codrington, John Frederick, M.R.C.S. *Eng.*, L.R.C.P. *Lond.* and *Edin.*, 'Roseneath,' 8 Wallis-street, Woollahra.
1906		Colley, David John K., Pennant Hills Road, Normanhurst viâ Wahroonga.
1896	P 2	Cook, W. E., M.C.E. *Melb.*, M. INST. C.E., Burroway-st., Neutral Bay.
1920		Cooke, Frederick, c/o Meggitt's Limited, Parramatta.
1913	P 1	Cooke, William Ernest, M.A., F.R.A.S., Government Astronomer and Professor of Astronomy in the University of Sydney, The Observatory, Sydney.
1913		Coombs, F. A., F.C.S., Instructor of Leather Dressing and Tanning, Sydney Technical College; p.r. Bannerman Crescent, Rosebery.
1882		Cornwell, Samuel, J.P., 'Beechworth,' Lane Cove Road, Pymble
1919		Cotton, Frank Stanley, B.Sc., Lecturer and Demonstrator in Physiology in the University of Sydney.
1909	P 5	Cotton, Leo Arthur, M.A., D.Sc., Assistant Professor of Geology in the University of Sydney.
1919		Cowdery, Edward Henry, L.S., 6 Castlereagh-street, Sydney.
1892	P 1	Cowdery, George R., ASSOC. M. INST. C.E., Blashki Buildings, Hunter-st.; p.r. 'Glencoe,' Torrington Road, Strathfield.
1886		Crago, W. H., M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, 185 Macquarie-st.
1921		Cresswick, John Arthur, 101 Villiers-street, Rockdale.
1912		Curtis, Louis Albert, L.S., 'Redlands,' Union-street, Mosman.
1920		Daněs, Jiri Victor, Ph.D. *Prague*, Consul General for Czecho-Slovakia, 40 Bayswater Road, Darlinghurst.
1890		Dare, Henry Harvey, M.E., M. INST. C.E., Commissioner, Water Conservation and Irrigation Commission, Union House, George-street.
1876	P 3	Darley, Cecil West, M. INST. C.E., 'Longheath,' Little Bookham, Surry, England, Australian Club, Sydney.
1886	P 22	David, Sir Edgeworth, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S., F.G.S., Professor of Geology and Physical Geography in the University of Sydney; p.r. 'Coringah,' Sherbrooke-street, Hornsby. (President 1895, 1910.)
1885	P 3	Deane, Henry, M.A., M. INST. C.E., F.L.S., F.R. MET. SOC., F.R.H.S., 'Campsie,' 14 Mercer Road, Malvern, Victoria. (President 1897, 1907.)
1919		de Beuzeville, Wilfrid Alex. Watt, Forestry Assessor, Forest Office, Tumut.

Elected		
1921		Delprat, Guillaume Daniel, C.B.E., 'Keynsham,' Mandeville Crescent, Toorak, Victoria.
1921		Denison, Hugh Robert, 701 Culwulla Chambers, Castlereagh-st.
1894		Dick, James Adam, C.M.G., B.A. *Syd.*, M.D., Ch.M., F.R.C.S. *Edin.*, 'Catfoss,' Belmore Road, Randwick.
1915	P 1	Dick, Thomas, J.P., Port Macquarie.
1916		Dixon, Jacob Robert L., M.R.C.S., L.R.C.P., Demonstrator in Physiology in the University of Sydney.
1906		Dixson, William, 'Merridong,' Gordon Road, Killara.
1876		Docker, His Honour Judge E. B., M.A., 'Mostyn,' Billyard Avenue, Elizabeth Bay.
1913		Dodd, Sydney, D.V.Sc., F.R.C.V.S., Lecturer in Veterinary Pathology in the University of Sydney.
1913	P 2	Doherty, William M., F.I.C., F.C.S., Second Government Analyst, 'Jesmond,' George-street, Marrickville.
1920		Downing, Reginald George, B.Sc., (Agr.) Field Branch, Department of Agriculture, Sydney.
1908	P 4	Dun, William S., Palæontologist, Department of Mines, Sydney (President 1918.) *Vice-President.*
1919		Earp, The Hon. George Frederick, C.B.E., M.L.C., 8 Spring-st.
1918		Elliott, Edward, c/o Reckitts' (Oversea) Ltd., Bourke-street, Redfern.
1916	P 2	Enright, Walter J., B.A., High-street, West Maitland, N.S.W.
1908		Esdaile, Edward William, 42 Hunter-street.
1896		Fairfax, Geoffrey E., *S. M. Herald* Office, Hunter-street.
1887		Faithfull, R. L., M.D., *New York*, L.R.C.P., L.S.A. *Lond.*, c/o Iceton, Faithfull and Maddocks, 25 O'Connell-street.
1902		Faithfull, William Percy, 'The Monastery,' Kurraba Road, Neutral Bay.
1921		Farnsworth, Henry Gordon, 'Rothsay,' 90 Alt-street, Ashfield.
1910		Farrell, John, Riverina Flats, 265 Palmer-street, Sydney.
1909	P 5	Fawsitt, Charles Edward, D.Sc., Ph.D., Professor of Chemistry in the University of Sydney. (President 1919). *Vice-President.*
1920		Ferguson, Eustace William, M.B., Ch.M., 'Timbrabongie,' Gordon Road, Roseville.
1881		Fiaschi, Thos., M.D., M.Ch. *Pisa*, 'Beanbah,' 235 Macquarie-st.
1920		Fisk, Ernest Thomas, Wireless House, 97 Clarence-street.
1888		Fitzhardinge, His Honour Judge G. H., M.A., 'Red Hill,' Beecroft.
1921		Fletcher, Joseph James, M.A., B.Sc., 'Ravenscourt,' Woolwich Road, Woolwich.
1879		‡Foreman, Joseph, M.R.C.S. *Eng.* L.R.C.P. *Edin.*, 'Wyoming,' Macquarie-street.
1920		Fortescue, Albert John, 'Benambra,' Loftus-street, Arncliffe.
1905		Foy, Mark, Elizabeth and Liverpool-streets.
1904		Fraser, James, C.M.G., M. INST. C.E., Chief Commissioner for Railways, Bridge-street; p.r. 'Arnprior,' Neutral Bay.
1907		Freeman, William, c/o A. Freeman, Byron Arcade, Inverell.
1881		Furber, T. F., F.R.A.S., L.S., c/o Dr. R. I. Furber, 'Sunnyside,' Stanmore Road, Stanmore.

Elected		
1917		Galbraith, Augustus Wm., M. INST. C.E.I., F.S.E., F.R.San.I., City Engineer, Perth, W.A.
1918		Gallagher, James Laurence, B.A. *Syd.*, 'Akawa,' Ellesmere Avenue, Hunter's Hill.
1921		Godfrey, Gordon Hay, M A., Lecturer in Physics in the Technical College, Sydney; p.r. 262 Johnston-street, Annandale.
1897		Gould, The Hon. Sir Albert John, K.B., V.D., 'Eynesbury,' Edgecliff.
1916		Green, Victor Herbert, 7 O'Connell-street, Sydney.
1899	P 1	Greig-Smith, R., D.Sc. *Edin.*, M.Sc. *Dun.*, Macleay Bacteriologist, Linnean Society's House, Ithaca Road, Elizabeth Bay. (President 1915.)
1912		Grieve, Robert Henry, B.A., 'Langtoft,' Llandaff-st., Waverley.
1912		Griffiths, F. Guy, B.A., M.D., Ch M., 'Woolgan,' Lane Cove Road, Killara.
1919		Grutzmacher, Frederick Lyle, F.C.S., Church of England Grammar School, North Sydney.
1891	P 16	Guthrie, Frederick B., F.I.C., F.C.S., Department of Agriculture, 137 George-street. (President 1903).
1919		Hack, Clement Alfred, Collins House, 360 Collins-street, Melbourne.
1880	P 5	Halligan, Gerald H., L.S., F.G.S., Avenue Road, Hunter's Hill.
1912		Hallmann, E. F., B.Sc., 75 Hereford-street, Forest Lodge.
1892		Halloran, Henry Ferdinand, L.S., 82 Pitt-street.
1919		Hamblin, Charles Oswald, B.Sc., Biological Branch, Agricultural Museum, Department of Agriculture, Sydney.
1919		Hambridge, Frank, 58 Pitt-street.
1916	P 1	Hamilton, Arthur Andrew, 'The Ferns,' 17 Thomas-st., Ashfield
1912		Hamilton, Alexander G., 'Tanandra,' Hercules-st., Chatswood.
1887	P 8	Hamlet, William M., F.I.C., F.C.S., Member of the Society of Public Analysts; 'Glendowan,' Glenbrook, Blue Mountains. B.M.A. Building, 30 Elizabeth-st. (President 1899, 1908).
1909		Hammond, Walter L., B.Sc., High School, Broken Hill.
1916		Hardy, Victor Lawson, 'The Laurel,' 43 Toxteth Rd., Glebe Pt.
1912		Hare, Arthur J., 'Booloorool,' Monte Christo-st., Woolwich.
1905	P 3	Harker, George, D.Sc., Lecturer and Demonstrator in Organic Chemistry in the University of Sydney.
1913	P 1	Harper, Leslie F., F.G.S., Geological Surveyor, Department of Mines, Sydney.
1919		Harrison, Launcelot, B.Sc., *Syd.*, B.A. *Cantab.*, Acting Professor of Zoology in the University of Sydney.
1918		Hassan, Alex. Richard Roby, c/o W. Angliss & Co. Ppty. Ltd., 64 West Smithfield, London, E.C.
1884	P 1	Haswell, William Aitcheson, M.A., D.Sc., F.R.S., Emeritus Professor of Zoology and Comparative Anatomy in the University of Sydney; p.r. 'Mimihau,' Woollahra Point.
1919		Hay, Alexander, M.H.R., Coolangatta, N.S.W.
1916		Hay Dalrymple-, Richard T., L.S., Chief Commissioner of Forests, N. S. Wales; p.r. Goodchap Road, Chatswood.
1914		Hector, Alex. Burnet, 481 Kent-street.

Elected.		
1891	P 3	Hedley, Charles, F.L.S., Australian Museum, Sydney. (President 1914.)
1899		Henderson, James, F.R.E.S., 'Wahnfried,' Drummoyne.
1916		Henderson, James, 'Dunsfold,' Clanalpine-street, Mosman.
1919		Henriques, Frederick Lester, 56 Clarence-street.
1919		Henry, Max, D.S.O., B.V.Sc., M.R.C.V.S., 'Coram Cottage,' Essex-street, Epping.
1884	P 1	Henson, Joshua B., ASSOC. M. INST. C.E., Hunter District Water Supply and Sewerage Board, Newcastle.
1918		Hindmarsh, Percival, M.A., B.Sc. (Agr.), Teachers' College, The University, Sydney.
1921		Hindmarsh, William Lloyd, B.V.Sc., M.R.C.V.S., D.V.H., Linden Park, Revesby, via Bankstown.
1920		Hinds, Herbert Henry, 484 Kent-street, Sydney.
1916		Hoggan, Henry James, 'Lincluden,' Frederick-st., Rockdale.
1901		Holt, Thomas S., 'Amalfi,' Appian Way, Burwood.
1905	P 3	Hooper, George, Assistant Superintendent, Sydney Technical College; p.r. 'Nycumbene,' Nielson Park, Vaucluse.
1920		Hordern, Anthony, c/o Messrs. A. Hordern & Sons Ltd., Brickfield Hill.
1919		Horsfall, William Nichols, M.B., B.S. *Melb.*, Lecturer and Demonstrator in Physiology in the University of Sydney.
1919		Hoskins, Arthur Sidney, Eskroy Park, Bowenfels.
1919		Hoskins, Cecil Harold, Windarra, Bowenfels.
1891		Houghton, Thos. Harry, M. INST. C.E., M. I. MECH. E., 63 Pitt-st. (President 1916), *Vice-President.*
1919		Houston, Ralph Liddle, 'Noorong,' Cooper-street, Strathfield.
1906		Howle, Walter Cresswell, L.S.A. *Lond.*, 'Lugano,' 244 Military Road, Mosman.
1913		Hudson, G. Inglis, J.P., F.C.S., 'Gudvangen,' Arden-st., Coogee.
1920		Hulle, Edward William, Commonwealth Bank of Australia.
1919		Hunt, Charles James, B.A., Trinity Grammar School, Dulwich Hill.
1921		Jackson, Frederick Henry, 22 Carrington-st., Wynyard Square.
1904		Jaquet, John Blockley, A.R.S.M., F.G.S., Chief Inspector of Mines, Department of Mines, Sydney.
1917		Jenkins, Richard Ford, Engineer for Boring, Irrigation Commission, 6 Union-street, Mosman.
1905	P 8	Jensen, Harold Ingemann, D.Sc., Treasury Chambers, George-street, Brisbane.
1918		Johns, Morgan Jones, A.M.I.E.E. *Lond*, M.I.E. *Aust.*, M.I.M. *Aust.*, Mount Morgan Gold Mining Co., Mount Morgan, Queensl'd.
1916	P 1	Johnston, Stephen Jason, B.A., D.Sc., Professor of Zoology in the University of Sydney.
1909	P 15	Johnston, Thomas Harvey, M.A., D.Sc., F.L.S, C.M.Z.S., Professor of Zoology in the University of Adelaide.
1911		Julius, George A., B.Sc., M.E., M. I. MECH. E., Culwulla Chambers, Castlereagh-street, Sydney.

Elected		
1883		Kater, The Hon. H. E., J.P., M.L.C., Australian Club.
1876	P 4	Keele, Thomas William, L.S., M.INST.C.E., Llandaff-st., Waverley.
1914		Kemp, William E., A.M. INST. C.E., Public Works Department. Coff's Harbour Jetty.
1887		Kent, Harry C., M.A., F.R.I.B.A., Dibbs' Chambers, 58 Pitt-st.
1919	P 1	Kesteven, Hereward Leighton, D.Sc., M.D., Ch.M., Bulladelah, New South Wales.
1901		Kidd, Hector, M. INST. C.E., M. I. MECH. E., Cremorne Road, Cremorne.
1896		King, Kelso, 14 Martin Place.
1920		Kirchner, William John, B.Sc., 'Clyde,' Cavendish-street, Concord West.
1919		Kirk, Robert Newby, 25 O'Connell-street.
1881	P 23	Knibbs, G. H., C.M.G., F.S.S., F.R.A.S., L.S., Director, Commonwealth Institute of Science and Industry, Member Internat. Assoc. Testing Materials; Memb. Brit. Sc. Guild, 314 Albert-street East Melbourne. (President 1898).
1877		Knox, Edward W., 'Rona,' Bellevue Hill, Double Bay.
1911	P 3	Laseron, Charles Francis, Technological Museum.
1913		Lawson, A. Anstruther, D.Sc., F.R.S.E., F.L.S., Professor of Botany in the University of Sydney.
1906		Lee, Alfred, 'Glen Roona,' Penkivil-street, Bondi.
1920		Le Souef, Albert Sherbourne, Taronga Park, Mosman.
1916		L'Estrange, Walter William, 7 Church-street, Ashfield.
1909		Leverrier, Frank, B.A., B.Sc., K.C., 182 Phillip-street.
1883		Lingen, J. T., M.A. *Cantab.*, K.C., University Chambers, 167 Phillip-street, Sydney.
1921		Lloyd, Warwick, 188 Kent-street.
1906		Loney, Charles Augustus Luxton, M. AM. SOC. REFR. E., Equitable Building, George-street.
1884		MacCormick, Sir Alexander, M.D., C.M. *Edin.*, M.R.C.S. *Eng.*, 185 Macquarie-street.
1887		MacCulloch, Stanhope H., M.B., Ch.M. *Edin.*, 24 College-street.
1878		MacDonald, Ebenezer, J.P., c/o Perpetual Trustee Co., Ld., Hunter-street, Sydney.
1876		Mackellar, The Hon. Sir Charles Kinnaird, K.C.M.G., M.L.C., M.B., C.M. *Glas.*, Equitable Building, George-street.
1921		McDonald, Alexander Hugh Earle, Department of Agriculture, Sydney.
1903		McDonald, Robert, J.P., L.S., Pastoral Chambers, O'Connell-st; p.r. 'Lowlands,' William-street, Double Bay,
1891		McDouall, Herbert Crichton, M.R.C.S. *Eng.*, L.R.C.S. *Lond.*, D.P.H. *Cantab.*, Hospital for the Insane, Gladesville.
1920		McDowall, James Campbell, B.Sc., *N.Z.*, c/o Austral Bronze Co., Ltd., O'Riordan-street, Alexandria.
1919		McGeachie, Duncan, 'Craig Royston,' Toronto, Lake Macquarie.
1919		McGlynn, William Henry, 'Koora,' Iredale Avenue, Cremorne.
1906		McIntosh, Arthur Marshall, 'Moy Lodge,' Hill-st., Roseville.

Elected		
1891	P 2	McKay, R. T., L.S., M. INST. C.E., Commissioner, Sydney Harbour Trust, Circular Quay.
1880	P 9	McKinney, Hugh Giffin, M.E., Roy. Univ. *Irel.*, M. INST. C.E., Sydney Safe Deposit, Paling's Buildings, Ash-street.
1917		McLean, Archibald Lang, M.C., M.D., Ch. M., B.A., 'Gartfern,' North Road, Abbotsford.
1901	P 1	McMaster, Colin J., L.S., Chief Commissioner of Western Lands; Box 20, G.P.O. Sydney.
1916		McQuiggin, Harold G., B.Sc., Lecturer and Demonstrator in Physiology in the University of Sydney; p.r. 'Berolyn,' Beaufort-street, Croydon.
1909		Madsen, John Percival Vissing, D.Sc., B.E., Professor of Electrical Engineering in the University of Sydney.
1883	P 44	Maiden, J. Henry, J.P., I.S.O., F.R.S., F.L.S., F.R.H.S., Hon. Fellow Roy. Soc. S.A.; Hon. Memb. Roy. Soc, W.A.; Netherlands Soc.for Promotion of Industry; Philadelphia College Pharm. Southern Californian Academy of Sciences; Pharm. Soc. N.S.W.; Brit. Pharm. Conf.; Corr. Fellow Therapeutical Soc., Lond.; Corr. Memb. Pharm. Society Great Britain; Bot. Soc. Edin.; Soc. Nat. de Agricultura (Chile); Soc. d'Horticulture d'Alger; Union Agricole Calédonienne; Soc. Nat. etc., de Chérbourg; Roy. Soc. Tas.; Roy. Soc. Queensl.; Inst. Nat. Genévois; Hon. Vice-Pres. of the Forestry Society of California; Diplomé of the Société Nationale d'Acclimatation de France; Linnean Medallist, Linnean Society; N.S.W. Govt. Rep. of the "Commission Consultative pour la Protection Internat. de la Nature"; Corr. Memb. National Acclimatisation Society of France; Government Botanist and Director, Botanic Gardens, Sydney. (President 1896, 1911.) *Vice-President.*
1880	P 1	Manfred, Edmund C., Montague-street, Goulburn.
1920	P 1	Mann, Cecil William, 'Pentreath,' Fairview-street, Arncliffe.
1920		Mann, James Elliott Furneaux, Barrister at Law, 163 Phillip-street.
1908		Marshall, Frank, C.M.G., B.D.S., 151 Macquarie-street.
1914		Martin, A. H., Technical College, Sydney.
1912		Meldrum, Henry John, p.r. 'Craig Roy,' Sydney Rd., Manly.
1905		Miller, James Edward, Albury, New South Wales.
1889	P 8	Mingaye, John C. H., F.I.C., F.C.S., Assayer and Analyst to the Department of Mines; p.r. Campbell-street, Parramatta.
1879		Moore, Frederick H., Union Club, Sydney.
1921		Morris, Albert, 74 Cornish-street, Railway Town, Broken Hill.
1879		Mullins, John Francis Lane, M.A. *Syd.*, M.L.C., 'Killountan,' Double Bay.
1915		Murphy, R. K., Dr. Ing., Chem. Eng., Lecturer in Chemistry, Technical College, Sydney.
1893	P 4	Nangle, James, O.B.E., F.R.A.S., Superintendent of Technical Education, The Technical College, Sydney; p.r. 'St. Elmo,' Tupper-st., Marrickville. (President 1920.) *Vice-President.*
1917		Nash, Norman C., 'Ruanora,' Lucas Road, Burwood,
1891		‡Noble, Edward George, L.S., 8 Louisa Road, Balmain.

Elected		
1920		Noble, Robert Jackson, B.Sc., (Agr.), Division of Plant Pathology, University Farm, St. Paul, Minnesota, U.S.A.
1919		Oakden, Frank, C.E., 33 Hunter-street.
1903		‡Old, Richard, 'Waverton,' Bay Road, North Sydney.
1921		Olding, George Henry, 47 Parramatta Road, Glebe.
1913		Ollé, A. D., F.C.S., 'Kareema,' Charlotte-street, Ashfield.
1896		Onslow, Col. James William Macarthur, B.A., LL.B., 'Gilbulla,' Menangle.
1919		Orams, Hector, c/o R. Orams, State Electricity Commission of Victoria, Hartley's Buildings, Flinders-street, Melbourne.
1917		Ormsby, Irwin, 'Caleula,' Allison Road, Randwick.
1891		Osborn, A. F., ASSOC. M. INST. C.E., Water Supply Branch, Sydney, 'Uplands,' Meadow Bank, N.S.W.
1921	P 2	Osborne, George Davenport, B.Sc., 'Belle-Vue,' Kembla-street, Arncliffe.
1920		Paine, William Horace, State Abattoirs, Homebush Bay, N.S.W.
1880		Palmer, Joseph, 96 Pitt-st.; p.r. Kenneth-st., Willoughby.
1921		Parkes, Varney, Royal Chambers, Castlereagh-street.
1920	P 7	Penfold, Arthur Ramon, Economic Chemist, Technological Museum, Harris-street, Ultimo.
1899		Peterson, T. Tyndall, F.C.P.A., E.S. & A. Bank Building, King and George-streets.
1918		Petrie, James Matthew, D.Sc., F.I.C., Research Fellow of the Linnean Society in Biochemistry, The University, Sydney.
1909	P 2	Pigot, Rev. Edward F., S.J., B.A., M.B. *Dub.*, Director of the Seismological Observatory, St. Ignatius' College, Riverview.
1879	P 8	Pittman, Edward F., ASSOC. R.S.M., L.S., c/o The Bank of New South Wales, 29 Threadneedle-street, London, E.C.
1881		Poate, Frederick, F.R.A.S., L.S., 'Clanfield,' 50 Penkivil-street, Bondi.
1919		Poate, Hugh Raymond Guy, M.B., Ch. M. *Syd.*, F.R.C.S. *Eng.*, L.R.C.P. *Lond.*, 225 Macquarie-street.
1887	P 12	Pollock, J. A., D.Sc., F.R.S., Corr. Memb. Roy. Soc. Tasmania; Roy. Soc. Queensland; Professor of Physics in the University of Sydney. *Hon. Secretary.*
1917		Poole, William, B.E., (Civil, Min. and Met.) *Syd.*, M. INST. C.E., M.I.M.M., M.I.E., Aust., M.Am. I.M.E., M. Aust. I. M.M., L.S., Memb. Intern. Assoc. Testing Materials, 906 Culwulla Chambers, Castlereagh-street.
1896		Pope, Roland James, B.A., *Syd.*, M.D., C.M., F.R.C.S., *Edin.*, 185 Macquarie-street.
1910		Potts, Henry William, F.L.S., F.C.S., c/o Lindley Walker & Co., Ltd., Mark Lane, Sussex-street, Sydney.
1921	P 2	Powell, Charles Wilfrid Roberts, A.I.C., c/o Colonial Sugar Refining Co., O'Connell-street.
1918		Powell, John, 170-2 Palmer-street.
1919		Pratten, Herbert E., M.H.R., 26 Jamieson-street.
1918		Priestley, Henry, B.Sc., M.D., Ch. M., Associate-Professor of Physiology in the University of Sydney.
1893		Purser, Cecil, B.A., M.B., Ch.M. *Syd.*, 193 Macquarie-street.

Elected		
1912	P 2	Radcliff, Sidney, F.C.S., Department of Chemistry, The University of Sydney.
1919	P 3	Ranclaud, Archibald Boscawen Boyd, B.Sc., B.E., Lecturer in Physics, Teachers' College, The University, Sydney.
1916	P 1	Read, John, M.A., Ph.D., B.Sc., Professor of Organic Chemistry in the University of Sydney.
1909		Reid, David, 'Holmsdale,' Pymble.
1914		Rhodes, Thomas, 'High Coombe,' Carlingford.
1920		Richardson, John James, A.M.I E.E. *Lond.*, 'Kurrawyba,' Upper Spit Road, Mosman.
1921		Robertson, Frederick Arnold, Science Master, Sydney C. of E. Grammar School, North Sydney.
1915		Ross, A. Clunies, B.Sc., c/o G. R. W. McDonald, 32 Elizabeth-st.
1884		Ross, Chisholm, M.D. *Syd.*, M.B., C.M. *Edin.*, 225 Macquarie-st.
1895	P 1	Ross, Herbert E., Equitable Building, George-street.
1897		Russell, Harry Ambrose, B.A., c/o Sly and Russell, 369 George-street; p.r. 'Mahuru,' Fairfax Road, Bellevue Hill.
1915		Sach, A. J., F.C.S., 'Kelvedon,' North Road, Ryde.
1917		Sawkins, Dansie T., M.A., B.A., 'Brymedura,' Kissing Point Road, Turramurra.
1920		Sawyer, Basil, B.E., 'Birri Birra,' The Crescent, Vaucluse.
1920		Scammell, Rupert Boswood, B.Sc., *Syd.*, 18 Middle Head Road, Mosman.
1913		Scammell, W. J., Mem. Pharm. Soc. *Grt. Brit.*, 18 Middle Head Road, Mosman.
1892	P 1	Schofield, James Alexander, F.C.S., A.R.S.M., Associate-Professor of Chemistry in the University of Sydney.
1919		Sear, Walter George Lane, 14 Roslyndale Avenue, Woollahra.
1921		Sellers, Alfred Edward Oswald, M.I.M.E., M.A.I.E., Bellambi.
1904	P 1	Sellors, Richard P., B.A. *Syd.*, 'Mayfield,' Wentworthville.
1918		Sevier, Harry Brown, c/o Lewis Berger and Sons (Aust.) Ltd., 38a Pitt-street.
1883	P 4	Shellshear, Walter, M. INST. C.E., Mitchell-street, Greenwich Point, Greenwich.
1917		Sibley, Samuel Edward, Mount-street, Coogee.
1900		Simpson, R. C., Lecturer in Electrical Engineering, Technical College, Sydney.
1910		Simpson, William Walker, 'Abbotsford,' Leichhardt-street, Waverley.
1882		Sinclair, Eric, M.D., C.M. *Glas.*, Inspector-General of Insane, 9 Richmond Terrace, Domain; p.r. 'Broomage,' Kangaroo-street, Manly.
1893	P 56	Smith, Henry G., F.C.S., 'Dunbourne,' Shirley Road, Roseville. (President 1913.)
1916		Smith, Stephen Henry, Department of Education, Sydney.
1919		Southee, Ethelbert Ambrook, O.B.E., M.A., B.Sc., Principal, Hawkesbury Agricultural College, Richmond, N.S.W.
1921		Spencer-Watts, Arthur, 'Araboonoo,' Glebe-street, Randwick.
1917		Spruson, Wilfred Joseph, Daily Telegraph Building, King-st.
1921		Starr, George Henry, Engineer Commander, Royal Navy, Garden Island, Sydney.
1916		Stephen, Alfred Ernest, F.C.S., 801 Culwulla Chambers, 67 Castlereagh-street, Sydney.
1921		Stephen, Henry Montague, B.A., LL.B., 167 Phillip-street.

Elected		
1914		Stephens, Frederick G. N., F.R.C.S., M.B., Ch.M., 13 Dover Road, Rose Bay.
1920	P 1	Stephens, John Gower, B.Sc, St. Andrew's College, The University, Sydney.
1913		Stewart, Alex. Hay, B.E., 165 Wardell Road, Dulwich Hill.
1900		Stewart, J. Douglas, B.V.Sc., M.R.C.V.S., Professor of Veterinary Science in the University of Sydney; 'Berelle,' Homebush Road, Strathfield.
1903		Stoddart, Rev. A. G., The Rectory, Manly.
1909		Stokes, Edward Sutherland, M.B. *Syd.*, F.R.C.P. *Irel.*, Medical Officer, Metropolitan Board of Water Supply and Sewerage, 341 Pitt-street.
1916	P 1	Stone, W. G., Assistant Analyst, Department of Mines, Sydney.
1919		Stroud, Sydney Hartnett, F.I.C., Lecturer in Pharmacy in the University of Sydney.
1918		Sullivan, Herbert Jay, c/o Lewis Berger and Sons (Aust.) Ltd., Rhodes.
1920		Sulman, John, Warrung-st., McMahon's Point, North Sydney.
1918		Sundstrom, Carl Gustaf, c/o Federal Match Co., Park Road, Alexandria.
1901	P 9	Sussmilch, C. A., F.G.S., Principal of the Technical College, Newcastle, N.S.W.
1919		Sutherland, George Fife, A.R.C.Sc., *Lond.*, Lecturer in Mechanical Engineering, in the University of Sydney.
1920		Sutton, Harvey, O.B.E., M.D., D.P.H. *Melb.*, B.Sc *Oxon.*, 'Lynton,' Kent Road, Rose Bay.
1912		Swain, E. H. F., Director, Forestry Department, Brisbane.
1919		Swain, Herbert John, B.A. *Cantab.*, B.Sc., B.E. *Syd.*, Lecturer in Mechanical Engineering, Technical College, Sydney.
1917		Tate, Herbert, Bridge Road, Stanmore.
1915	P 1	Taylor, Harold B., B.Sc., Kenneth-street, Longueville.
1893		‡Taylor, James, B.Sc, A.R.S.M. 'Cartref,' Brierly-st., Mosman.
1921		Taylor, John Kingsley, 16 Ferrier-street, Rockdale.
1905		Taylor, John M., M.A., LL.B. *Syd.*, 'Woonona,' 43 East Crescent-street, McMahon's Point, North Sydney.
1921		Taylor, Thomas Griffith, D.Sc., Associate-Professor of Geography in the University of Sydney.
1920		Tebbutt, Arthur Hamilton, B.A., M.B., D.P.H., 185 Macquarie-st.
1899		Teece, R., F.I.A., F.F.A., Wolseley Road, Point Piper.
1878		Thomas, F. J., 'Lovat,' Nelson-street, Woollahra.
1919		Thomas, John, L.S., Chief Mining Surveyor, Mines Department Sydney; p.r. 'Remeura,' Pine and Harrow Roads, Auburn.
1913		Thompson, Joseph, M.A., LL.B., Vickery's Chambers, 82 Pitt-street, Sydney.
1879		Thomson, The Hon. Dugald, Carabella-st., North Sydney.
1919		Thorne, Harold Henry, B.A. *Cantab.*, B.Sc. *Syd.*, Lecturer in Mathematics in the University of Sydney; p.r. Rutledge-st., Eastwood.
1913		Tietkens, William Harry, 'Upna,' Eastwood.
1916		Tilley, Cecil E., c/o The Department of Geology, The University, Sydney.
1916		Tillyard, Robin John, M.A., D.Sc., F.L.S., F.E.S., Biological Branch, Cawthron Institute, Nelson, New Zealand.
1879		Trebeck, P. C., 'Wiyella,' Burradoo-street, Bowral.

Elected		
1900		Turner, Basil W., A.R.S.M., F.C.S., Victoria Chambers, 83 Pitt-st.
1919	P 4	Turner, Eustace Ebenezer, B.A. *Cantab.*, D.Sc. *Lond.*, A.I.C., Lecturer and Demonstrator in Organic Chemistry in the University of Sydney.
1916		Valder, George, J.P., Under Secretary and Director, Department of Agriculture, Sydney.
1883		Vause, Arthur John, M.B., C.M. *Edin.*, 'Bay View House,' Tempe.
1890		Vicars, James, M.E., Memb. Intern. Assoc. Testing Materials; Memb. B. S. Guild; Challis House, Martin Place.
1921		Vicars, Robert, Marrickville Woollen Mills, Marrickville.
1892		Vickery, George B., 78 Pitt-street.
1903	P 5	Vonwiller, Oscar U., B.Sc., Associate-Professor of Physics in the University of Sydney.
1919		Waley, Robert George Kinloch, 63 Pitt-street.
1910		Walker, Charles, 'Lynwood,' Terry Road, Ryde.
1910		Walker, Harold Hutchison, Vickery's Chambers, 82 Pitt-st.
1879		Walker, H. O., Commercial Union Assurance Co., Pitt-street.
1899		‡Walker, The Hon. J. T., F.R.C.I., Fellow of Institute of Bankers *Eng.*, 'Wallaroy,' Edgecliff Road, Woollahra.
1919		Walkom, Arthur Bache, D.Sc., Linnean Society's House, 23 Ithaca Road, Elizabeth Bay.
1903		Walsh, Fred., J.P., Consul-General for Honduras in Australia and New Zealand; For. Memb. Inst. Patent Agents, London; Patent Attorney Regd. U.S.A.; Memb. Patent Law Assoc., Washington; Regd. Patent Attorn. Comm. of Aust.; Memb. Patent Attorney Exam. Board Aust.; George and Wynyard-streets; p.r. 'Walsholme,' Centennial Park, Syd.
1901		Walton, R. H., F.C.S., 'Flinders,' Martin's Avenue, Bondi.
1918		Ward, Edward Naunton, Superintendent of the Botanic Gardens, Sydney.
1913	P 4	Wardlaw, Hy. Sloane Halcro, D.Sc. *Syd.*, Lecturer and Demonstrator in Physiology in the University of Sydney; p.r. 87 Macpherson-street, Waverley.
1883	P 17	Warren, W. H., LL.D., WH. SC., M. INST. C.E., M. AM. SOC. C.E., Member of Council of the International Assoc. for Testing Materials, Professor of Engineering in the University of Sydney. (President 1892, 1902.)
1921		Waterhouse, Gustavus Athol, Royal Mint, Macquarie-street.
1919		Waterhouse, Lionel Lawry, B.E. *Syd.*, Lecturer and Demonstrator in Geology in the University of Sydney.
1919	P 1	Waterhouse, Walter L., B.Sc. (*Agr.*), 'Cairnleith,' Archer-st., Chatswood.
1919		Watkin-Brown, Willie Thomas, 24 Brown's Road, Kogarah.
1876		Watkins, John Leo, B.A. *Cantab.*, M.A. *Syd.*, Selbourne Chambers, Phillip-street.
1910		Watson, James Frederick, M.B., Ch.M., 'Midhurst,' Woollahra.
1911		Watt, Robert Dickie, M.A., B.Sc., Professor of Agriculture in the University of Sydney.
1920	P 1	Welch, Marcus Baldwin, B.Sc., A.I.C., Economic Botanist, Technological Museum.
1907	P 1	Welch, William, F.R.G.S., 'Roto-iti,' Boyle-street, Mosman.
1920		Wellish, Edward Montague, M.A., Lecturer in Applied Mathematics in the University of Sydney.

Elected		
1921		Wenholz, Harold, 29 Palace-street, Petersham.
1881		‡Wesley, W. H., London.
1909		White, Charles Josiah, B.Sc., Lecturer in Chemistry, Teacher's College; p.r. 'Kooringa,' Robinson-street, Chatswood.
1918		White, Edmond Aunger, M.A.I.M.E., c/o Electrolytic Refining and Smelting Co. of Australia Ltd., Port Kembla, N.S.W.
1892		White, Harold Pogson, F.C.S., Assistant Assayer and Analyst, Department of Mines; p.r. 'Quantox,' Park Road, Auburn.
1921		Willan, Thomas Lindsay, B.Sc., Geological Survey, Department of Mines, Sydney.
1920		Williams, Harry, A.I.C., Challis Flats, Phillip-street.
1917		Willington, William Thos., O.B.E., King-street, Arncliffe.
1890		Wilson, James T., M.B., Ch.M. *Edin.*, F.R.S., Professor of Anatomy in the University of Cambridge, England.
1891		Wood, Percy Moore, L.R.C.P. *Lond.*, M.R.C.S. *Eng.*, 'Redcliffe,' Liverpool Road, Ashfield.
1906	P 8	Woolnough, Walter George, D.Sc., F.G.S., c/o Geological Department, The University, Sydney.
1916		Wright, George, c/o Farmer & Company, Pitt-street.
1917		Wright, Gilbert, Lecturer and Demonstrator in Agricultural Chemistry in the University of Sydney.
1921		Yates, Guy Carrington, 184 Sussex-street.
1916		Youll, John Gibson, Water Conservation and Irrigation Commission, Leeton, N.S.W.
1918		Young, John Anthony, c/o Lewis Berger and Sons (Aust.) Ltd., 38a Pitt-street.

Honorary Members.

Limited to Twenty.

M.—Recipients of the Clarke Medal.

1914		Bateson, W. H., M.A., F.R.S., Director of the John Innes Horticultural Institution, England, The Manor House, Merton, Surrey, England.
1918		Chilton, Charles, M.A., D.Sc., M.B., C.M. etc., Professor of Biology, Canterbury College, Christchurch, N.Z.
1911		Hemsley, W. Botting, LL.D. (*Aberdeen*), F.R.S., F.L.S., Formerly Keeper of the Herbarium, Royal Gardens, Kew; Korresp. Mitgl. der Deutschen Bot. Gesellschaft; Hon. Memb. Sociedad Mexicana de Historia Natural; New Zealand Institute; Roy. Hort. Soc., London; 16 Osborne Road, Broadstairs, Kent, England.
1914		Hill, James P., D.Sc., F.R.S., Professor of Zoology, University College, London.
1908		Kennedy, Sir Alex. B. W., Kt., LL.D., D. ENG., F.R.S., Emeritus Professor of Engineering in University College, London, 17 Victoria-street, Westminster, London S.W.
1908	P 57	*Liversidge, Archibald, M.A., LL.D., F.R.S., Emeritus Professor of Chemistry in the University of Sydney, 'Fieldhead,' George Road, Coombe Warren, Kingston, Surrey, England. (President 1889, 1900.)

* Retains the rights of ordinary membership. Elected 1872.

Elected.		
1915		Maitland, Andrew Gibb, F.G.S., Government Geologist of Western Australia.
1912		Martin, C. J., C.M.G., D.Sc., F.R.S., Director of the Lister Institute of Preventive Medicine, Chelsea Gardens, Chelsea Bridge Road, London, S.W.I.
1894		Spencer, Sir W. Baldwin, K.C.M.G., M.A., D.Sc., F.R.S., Emeritus Professor of Biology in the University of Melbourne.
1900	M	Thiselton-Dyer, Sir William Turner, K.C.M.G., C.I.E., M.A., LL.D., Sc.D., F.R.S., The Ferns, Witcombe, Gloucester, England.
1915		Thomson, Sir J. J., O.M., D.Sc., F.R.S., Nobel Laureate, Master of Trinity College, Cambridge, England.
1921		Threlfall, Sir Richard, K.B.E., M.A., F.R.S., lately Professor of Physics in the University of Sydney.

Obituary 1921-22.

Ordinary Members.

1875		Dangar, Fred. H.
1899		French, Sir J. Russell
1878		Knaggs, Samuel T.
1876		Quaife, F. H.
1893		Rygate, Philip W.
1919		Sandy, James Montague
1892		Statham, Edwyn Joseph
1917		Wallas, Thomas Irwin
1891		Walsh, Henry Deane

AWARDS OF THE CLARKE MEDAL.

Established in memory of

The Revd. W. B. CLARKE, M.A., F.R.S., F.G.S., etc.,

Vice-President from 1866 *to* 1878.

To be awarded from time to time for meritorious contributions to the Geology, Mineralogy, or Natural History of Australia. The prefix * indicates the decease of the recipient.

Awarded	
1878	*Professor Sir Richard Owen, K.C.B., F.R.S.
1879	*George Bentham, C.M.G., F.R.S.
1880	*Professor Thos. Huxley, F.R.S.
1881	*Professor F. M'Coy, F.R.S., F.G.S.
1882	*Professor James Dwight Dana, LL.D.
1883	*Baron Ferdinand von Mueller, K.C.M.G., M.D., Ph.D., F.R.S., F.L.S.
1884	*Alfred R. C. Selwyn, LL.D., F.R.S., F.G.S.
1885	*Sir Joseph Dalton Hooker, O.M., G.C.S.I., C.B., M.D., D.C.L., LL.D., F.R. .
1886	*Professor L. G. De Koninck, M.D.
1887	*Sir James Hector, K.C.M.G., M.D., F.R.S.

Awarded

1888 *Rev. Julian E. Tenison-Woods, F.G.S., F.L.S.

1889 *Robert Lewis John Ellery, F.R.S., F.R.A.S.

1890 *George Bennett, M.D., F.R.C.S. *Eng.*, F.L.S., F.Z.S.

1891 *Captain Frederick Wollaston Hutton, F.R.S., F.G.S.

1892 Sir William Turner Thiselton Dyer, K.C.M.G., C.I.E., M.A., LL.D., Sc. D., F.R.S., F.L.S., late Director, Royal Gardens, Kew.

1893 *Professor Ralph Tate, F.L.S., F.G.S.

1895 *Robert Logan Jack, LL.D., F.G.S., F.R.G.S.

1895 *Robert Etheridge, Jnr.

1896 *The Hon. Augustus Charles Gregory, C.M.G., F.R.G.S.

1900 *Sir John Murray, K.C.B., LL.D., Sc. D., F.R.S.

1901 *Edward John Eyre.

1902 *F. Manson Bailey, C.M.G.. F.L.S.

1903 *Alfred William Howitt, D.Sc., F.G.S.

1907 Walter Howchin, F.G.S., University of Adelaide.

1909 Dr. Walter E. Roth, B.A., Pomeroon River, British Guiana, South America.

1912 *W. H. Twelvetrees, F.G S.

1914 A. Smith Woodward, LL.D., F.R.S., Keeper of Geology, British Museum (Natural History) London.

1915 Professor W. A. Haswell, M.A., D.Sc., F.R.S., The University, Sydney.

1917 Professor Sir Edgeworth David, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S., F.G.S., The University, Sydney.

1918 Leonard Rodway, C.M.G., Honorary Government Botanist, Hobart, Tasmania.

1920 Joseph Edmund Carne, F.G.S., late Government Geologist, N.S.W. 'Dimlands,' Dickson-street, Homebush.

1921 Joseph James Fletcher, M.A., B.Sc., 'Ravenscourt,' Woolwich.

AWARDS OF THE SOCIETY'S MEDAL AND MONEY PRIZE.

Money Prize of £25.

Awarded.

1882 John Fraser, B.A., West Maitland, for paper entitled 'The Aborigines of New South Wales.'

1882 Andrew Ross, M.D., Molong, for paper entitled 'Influence of the Australian climate and pastures upon the growth of wool.'

The Society's Bronze Medal and £25.

1884 W. E. Abbott, Wingen, for paper entitled 'Water supply in the Interior of New South Wales.'

1886 S. H. Cox, F.G.S., F.C.S., Sydney, for paper entitled 'The Tin deposits of New South Wales.'

Awarded .

1887 Jonathan Seaver, F.G.S., Sydney, for paper entitled 'Origin and mode of occurrence of gold-bearing veins and of the associated Minerals.'

1888 Rev. J. E. Tenison-Woods, F.G.S., F.L.S., Sydney, for paper entitled 'The Anatomy and Life-history of Mollusca peculiar to Australia.'

1889 Thomas Whitelegge, F.R.M.S., Sydney, for paper entitled 'List of the Marine and Fresh-water Invertebrate Fauna of Port Jackson and Neighbourhood.'

1889 Rev. John Mathew, M.A., Coburg, Victoria, for paper entitled 'The Australian Aborigines.'

1891 Rev. J. Milne Curran, F.G.S., Sydney, for paper entitled 'The Microscopic Structure of Australian Rocks.'

1892 Alexander G. Hamilton, Public School, Mount Kembla, for paper entitled 'The effect which settlement in Australia has produced upon Indigenous Vegetation.'

1894 J. V. De Coque, Sydney, for paper entitled the 'Timbers of New South Wales.'

1894 R. H. Mathews, L.S., Parramatta, for paper entitled 'The Aboriginal Rock Carvings and Paintings in New South Wales.'

1895 C. J. Martin, D.Sc., M.B., F.R.S., Sydney, for paper entitled 'The physiological action of the venom of the Australian black snake (*Pseudechis porphyriacus*).'

1896 Rev. J. Milne Curran, Sydney, for paper entitled 'The occurrence of Precious Stones in New South Wales, with a description of the Deposits in which they are found.'

PRESIDENTIAL ADDRESS.

By JAMES NANGLE, O.B.E., F.R.A.S.

[*Delivered to the Royal Society of N. S. Wales, May 4, 1921.*]

Gentlemen,—The year just ended has been one of steady progress by the Society. The papers read have been of a high standard, and, in all cases, valuable contributions to science. The membership has been slightly increased, and a state of soundness financially has been maintained.

During the year five members of the Society have been removed by death.

FREDERICK HOLKHAM DANGAR, who joined this Society in 1875, was born in this State on 23rd October, 1831, and died in London at the end of March 1921. Mr. Dangar was a son of one of the pioneers of this State. His two brothers, the late H. C. Dangar, M.L.C., and A. A. Dangar, were very well-known pastoralists. Though he too was interested in pastoral pursuits he turned his attention mostly to commercial affairs. He founded the firm of Dangar, Gedye and Company, and participated in the shipping and general business of that firm until 1882, when he decided to retire and live in England. Apart from a visit to Australia about fifteen years ago, he lived continuously at Ealing, a suburb of London, up to the time of his death.

SAMUEL THOMAS KNAGGS, M.D., Aberdeen, F.R.C.S. Ireland, was a member of this Society for forty-three (43) years, having been elected a member in 1878. He was born in Ireland in July 1832, but came to this State when six years of age. His father, a medical practitioner, settled in Newcastle. He returned to the Old Country in his 'teens,' and studied medicine at the Universities of Dublin, London, Aberdeen, Vienna, and Paris. He became a Fellow by examination of the Royal College of Surgeons, Ireland, in 1871, and took the degree of M.D. at Aberdeen in 1873 Returning to New South Wales in the Seventies, he practised his profession in Newcastle for some years. In 1884, he removed to Sydney and practised here up to the time of his retirement only a few years since. His career was one of great activity, and amongst other appointments he was medical officer to the Public Instruction Department; fleet surgeon (volunteer) to the New South Wales naval volunteer forces, and a member of the Board of Health, as well as lecturer in clinical surgery at Sydney University, an honorary surgeon at Royal Prince Alfred Hospital, an examiner in anatomy and physiology for the Board of Technical Education from 1887 to 1892, and an honorary surgeon at St. Vincent's Hospital. He also edited the "Australasian Medical Gazette," and in 1887 was editor of the "Australian Practitioner." He frequently contributed to the Press, and was the author of "Recreations of an Australian Surgeon," "Human Fads, Foibles and Fallibilities," "Spiritualism of the Present Day," and "Dr. de Lion, Clairvoyant." He died on the 6th April, 1921.

Bertram James Smart, B.Sc., London, whose untimely death occurred on 4th September, 1920, at the early age of thirty-eight, became a member of this Society in 1912. He was born in England on 27th November, 1881. His studies in chemistry were commenced in the laboratory of Guy's Hospital, and continued in the University of London where he gained his B.Sc. degree with second-class honours in chemistry. For three years he served as Research Assistant to Dr. J. Wade in the chemical laboratory at Guy's Hospital, where he laid the foundation of his extensive acquaintance with organic chemistry. In 1903 he entered the Research

Department of the Royal Arsenal at Woolwich, where he spent nine years in the Metallurgical Department. Here, he became thoroughly conversant with the analysis of metals, especially steel. He gave special attention to the physical methods used in testing the strength, hardness and other qualities of metals. Alloys were a great attraction to him. He discovered and patented a light alloy of high, tensile strength, and became an expert microscopical photographer. His attention was not, however, confined solely to metallurgical work. He devoted some of his energies to the study of explosives, and contributed several papers giving the results of his research thereon. In 1911 he came to this State to take charge of the testing department at the Lithgow Steel Works. He subsequently inaugurated the laboratory of the testing branch of the Department of Public Works in Sydney. His exceptional skill in devising suitable methods contributed greatly to the success of this laboratory, of which he remained in charge up to the time of his death.

The Reverend WILLIAM WALTER WATTS, F.L.S., who was elected a member of this Society in 1915, was born on the 5th October, 1856, near Ivybridge, Devonshire, England. He was a student at New College, London, for six years for the Congregational Ministry, but his health failing he came to Australia in 1887. He had a charge at Milton, Queensland, and in 1893 went to New Zealand. Later he had a charge at Orange, New South Wales. Subsequently, he joined the Presbyterian Church, and was Minister at Ballina, Richmond River, Young, and Gladesville near Sydney. In 1916 he was transferred to Wycheproof in Victoria. He wrote chiefly on ferns and mosses, and his papers are mainly to be found in the Proceedings of the Linnean and Royal Societies of New South Wales. He was coadjutor with Mr. Thomas Whitelegge in a Catalogue of

New South Wales Mosses. He made collecting trips to North Queensland and Lord Howe Island, and these localities, together with those already enumerated as his pastoral charges, give the key to his collecting grounds. From 1909 to 1916 he was Honorary Custodian of Ferns and Mosses in the National Herbarium of New South Wales, and did excellent work there, and added considerably to the national collection of these plants. He was a quiet, unobtrusive worker, and his loss is much felt.

Reverend WILLIAM MOORE WHITE, A.M., LL.D., Dublin, who was elected a life member of this Society in 1877, was born at Carrickfergus, Ireland, in 1843. He was educated at Trinity College, Dublin, and graduated A.M. and LL.D. Shortly after leaving the University he came to Sydney. He was minister of St. Andrew's Presbyterian Church, which used to stand behind St, Andrew's Cathedral, Sydney, for many years. His return to England in 1890 was much regretted by the adherents of his own church and a wide circle of friends. After his return to England, he took orders in the Anglican Church, and was vicar of St. James', Bournemouth, with St. Andrew's, Boscombe, for about ten years. Later he retired to Cheltenham, where he resided up to the time of his death.

During the year, His Majesty conferred the honour of Knighthood on Professor David. It is rarely that any man so completely reaches the hearts of all in the community as Sir Edgeworth David has done. His labour in the cause of science has been so great and so conspicuously successful that he occupies a very high place in the ranks of the scientists of this time. His unselfish devotion to the service of the country in its hour of need, at a time of life when he may well have given place to younger men, has won the admiration of all. Brilliant as a scientist and a good citizen, he also possesses such an endearing personality that it is no wonder the action of His Majesty was hailed with delight and satisfaction, not only by the members of this Society, but by everyone in the Commonwealth.

Mr. G. F. Earp, another member of the Society, was honoured by His Majesty the King. Always an active worker in all public movements, he entered with great zeal into the many activities connected with war work. Amongst the many things to which he gave his attention and assistance was that of the training of the returned soldiers, especially at Newcastle. The members of the Society and the public generally were very glad to hear that Mr. Earp had been made a Commander of the Order of the British Empire.

The Australasian Association for the Advancement of Science at its last meeting decided to award the Mueller Medal to Mr. R. T. Baker. News of this decision was very welcome to the members of this Society. Mr. Baker has been untiring in his labours in the cause of science, and has contributed very largely to a knowledge of the economic value of the natural resources of Australia. As a departmental colleague of Mr. Baker, it is a matter of particular pleasure to me to be able to call attention to the distinction which has been conferred upon him.

Events arising out of the great war altered the aspect of many things, but perhaps most of all that of science organisation. In fact it had become apparent as the war went on that the very existence of nationhood depended upon the efficiency with which scientific research was fostered and cared for. On the other hand, it soon became quite clear that the allied powers would have to withdraw from existing conventions relating to international scientific associations, and establish new international science relationship within the control of the allied nations. With a view to arriving at a knowledge of what should be done, two Conventions were held, one at London in October, 1918, and another a month later at Paris. At these Conferences many resolutions of a very important nature were passed. One of the resolutions was to the effect that it was desirable that the nations at war with the central powers should withdraw from existing conventions relating to international scientific associations, and that new associations deemed to be useful to the progress of science and its applications, should be established without delay by the nations at war with the central powers, with the eventual co-operation of neutral nations. A list was prepared of the countries which would be eligible to send representatives to an International Research Council. It was suggested that in each of these countries a National Research Council should be established, and that representatives from these Councils should comprise the International Research Council. Early in February, 1919, a letter was received by this Society from the Secretary of the Executive Committee of the International Research Council, which apparently had been established on the lines suggested. The letter was addressed to this Society as the senior scientific society of the Commonwealth, with a request that steps should be taken to establish some organisation in Australia which would act as a National Research Council. Action was immediately taken by this Society, with the result that a conference was held at Sydney on the 21st August, 1919, for the purpose of forming an Australian National Research Council. At this Conference, a provisional council was appointed to hold office until a Council would be appointed at the next meeting of the Australasian Association for the Advancement of Science in January, 1921. At the meeting of the Australasian Association for the Advancement of Science, held in Melbourne in January, 1921, the following resolutions were passed:—

1. The Resolutions of the Conference held in Sydney on 21st August, 1919, shall cease to be operative from this day, 15th January, 1921.

2. The National Research Council shall consist of not more than 100 members and shall contain two or more representatives of each of the following branches of Science and of such others as may be determined from time to time by the General Council of the Australasian Association for the Advancement of Science :—Agriculture, Anthropology, Astronomy. Botany, Chemistry, Engineering, Geography, Geology, Mathematics, Meteorology, Pathology, Physics, Physiology, Veterinary Science, Zoology, with the addition of Economics and Statistics, Mental Science and Education, and Mining and Metallurgy.

3. The members of the provisional Council are hereby elected members of the Research Council, together with Mr. G. H. Knibbs and Mr. G. Lightfoot, representing Economics and Statistics, Professor Laby, representing Physics, and Messrs. R. Sticht and G. C. Klug, representing Mining and Metallurgy.

4. The members as defined in clause 3, shall co-opt additional members within the numerical limit prescribed in rule 2, and shall select such additional members in consultation with the Presidents of the more important Scientific, Technical and learned Associations and Societies of the Commonwealth.

5. The Council may appoint as associate members scientific workers resident in Australia who are deemed likely to confer benefit by their researches.

6. The Council may appoint such standing committees and special committees as it deems requisite for national or international purposes.

7. The Council may appoint such office-bearers as it may determine, these shall hold office for a term of two years and be re-eligible.

8. A meeting of the members, as defined in clause 3, shall be held in Sydney not later than May, 1921, for the purpose indicated in rule 4, and a meeting of the whole Council so constituted shall meet as soon as possible thereafter for the purposes indicated in rules 5, 6, 7, and for the formulation of by-laws and any other necessary business.

9. Members unable to attend any such meeting may communicate their views beforehand in writing to the Honorary Secretary, and all such communications shall receive full consideration at the meeting.

10. Every member and associate member shall retain his membership for life unless it be terminated (1) by his resignation, (2) by his ceasing to reside in Australia, (3) by vote of at least two-thirds of the members.

11. The Council shall submit a full report of its work and proceedings to the Australasian Association for the Advancement of Science on the occasion of each meeting of the Association.

12. Until other arrangements are made for the financial support of the Council, each member thereof shall be liable to contribute the sum of £2. 2s. per annum, and each associate member £1. 1s. per annum.

13. That the Provisional Executive Committee be asked to continue to act *pro tem.* till the Council has appointed its office-bearers.

The Australian National Research Council, now in process of formation in accordance with these resolutions, will be a body thoroughly representative of Australian scientific opinion. In addition to being the Australian unit in the international organisation concerned with questions of international co-operation in scientific affairs, it is to be confidently hoped that the Council will have an important influence in encouraging scientific research in Australia.

I am making the major portion of my address a descriptive and critical review of the Vocational Training System for returned soldiers designed and carried out by the Commonwealth Repatriation Department. A description alone of the system would, no doubt, be found interesting. It is, however, so unconventional in many of its main features, and so much data have been secured relating to branches of education in which hitherto very little has been attempted, that a critical, as well as a descriptive treatment, ought to be given. A fact of considerable importance which also points to the value of a critical account is that those who were responsible for the design of the scheme realised from the very first that the training of the returned men would, because of its scope, novel character and the adequacy of the funds available for the purpose, be more than likely to result in experience of extreme value in industrial education. Its working was, therefore, carefully observed with this end in view, and though its objective, namely, the training successfully of the soldiers for civil life, was ever the first matter in mind, the secondary value of the experiment as a field of useful observation was never lost sight of. In deciding to attempt to discuss it in a critical way, I am therefore swayed by a hope that I may be able to point to some conclusions which may be valuable to those who have to assist in carrying on technical education in Australia. Necessarily, owing to the limits within which an address of this kind must be kept, the description and criticism has to be confined to the most important features only, and no attempt can be made to deal with the history of all the circumstances connected with the scheme.

The idea of providing training for the returned soldiers arose out of the desire of the people of Australia to ensure, as far as possible, that none of those who actually served their country should suffer through war injuries.

The earliest efforts at training the injured commenced as soon as wounded men began to return. These efforts were made by the different State branches of the War Council, with the assistance, mainly, of the technical schools carried on by the State Governments and by the various Councils. Very good work was done by the War Council in this way, and it would be impossible to over-estimate the value of the help given by the authorities controlling the technical schools in all the States.

On its establishment early in 1918, the Repatriation Department took over the responsibility of training the injured. At this time, a total of 527 men, who were then in training, were taken over from the War Council, and though necessarily the men were not disturbed in their training, the responsibility for them passed to the Repatriation Department.

That Department had many very big and difficult problems to face, but it recognised that not the least of these was the training of the injured with a view to their re-entry, if at all possible, into civil life. Two very important conferences of experts were immediately called to discuss the problem of training in all its aspects. One conference was attended by the heads of the various State Technical Education Departments and by others who were qualified to deal with the purely educational side of the training. The members of the other conference were mainly representatives from the various State Chambers of Manufacture and Trades and Labour Councils. This conference dealt mostly with questions affecting the proposed training scheme in its relationship with the industrial laws and conditions in the different States of the Commonwealth. Both conferences dealt most exhaustively with all the questions then thought likely to require attention, and very valuable recommendations as to how a training scheme should be planned and carried out were submitted for the consideration of the Repatriation Commission and the Minister in charge of the Department.

Regulations to govern the working of a system of training, framed mostly on the recommendations of the conferences, were soon after put into force. The necessary arrangements were made for the giving of the training mainly through an agreement with the Education Departments in all the States of the Commonwealth. The regulations allowed, as far as was possible, for meeting the requirements of the very complex system of industrial laws in force in the different States, and provided comprehensively and very generously that every soldier eligible should get a good training so as to enable him to become expert in the calling selected.

In the early days of the Repatriation Department, when the conferences referred to were held, and when regulations were framed, the idea of training was confined entirely to those who returned injured, and to those whose scholastic or apprenticeship training was interfered with through active service.

As to the total number likely to require training, only the merest guess could be made. The fury of the war was so appalling that it was expected that there would be a very large number of men returning too injured to be useful in any but the very lightest kinds of work. Events now show that the number, though large, is, fortunately, nothing nearly so great as it was feared it would be. Perhaps one of the most wonderful features of the post-war history has been the fortitude and stamina displayed by very many of the Australians, who, though much injured, have returned to their work and are carrying on without help from the country. Australia in this respect compares more than favourably with the Home and Continental countries, owing, no doubt to the superior powers of the physically much better nurtured Australian in withstanding the rigours and injuries of war. The ending of the war, however, made it possible to estimate the number of the injured likely to require and be approved for training. Analysis of the statistics of the injured and the enlistment papers disclosed the total number of eligibles under the scheme. This number, which was of a fairly accurate character, had then to be reduced to the number of those who, being eligible, would apply and be approved for training.

It soon became evident as the Department went on with its work of investigating the claims of applicants for training, that there was a large number of men returning who were not eligible for training, but whose claims appeared to merit consideration. These were the soldiers who had enlisted as youths or even as boys and who had embarked and served abroad, and who, by so doing, had interfered with their chances of getting a proper training in some calling. The number of those who enlisted whilst still under twenty years of age, and who embarked and served abroad on actual war service, was very large. Nevertheless, it was decided, and wisely so, to alter the regulations so as to render these men eligible. Thus, an additional class of returned soldier became entitled to training.

The addition of the "under 20 enlistment men" involved such a large increase in the scope of the training arrangements that a review of the position immediately became necessary. The experience gained even during the short period which had elapsed since the establishment of the Department and the commencement of the training, showed also that a reorganisation was advisable, apart altogether from the question of increasing its scope to provide for the additional class of eligibles.

Experience had also gone to show that an officer acquainted with the industries of the Commonwealth, and having experience in technical education, should be appointed to take control of the training, and be responsible to the Minister for its efficiency. A Director was accordingly appointed, who immediately proceeded to replan and reorganise the system of training. The reorganised scheme was approved of and was put into effect on the 10th April, 1919, and has been in operation since. It came not a moment too soon, because the men were then arriving in Australia at the rate of 30,000 per month, and large numbers weekly were making application for training. The remarks which follow throughout this address apply mainly to the reorganised scheme.

It must not be allowed to appear, however, that in deciding to devote this account to the scheme as reorganised, that what had been done previously by the Department is unworthy of any attention. As a matter of fact, the fundamentals of everything of any importance done since the earliest regulations of the Department were framed, were decided upon partly on the recommendations of the conferences already mentioned, and were largely influenced by the splendid imagination and administrative powers possessed by the small body of men who first had to do with the direction and control of the department. The re-planning of a system of training early in April, 1919, was merely the crystallising into practical working form of the valuable experience gained during the first years of the Department's operations. The commencement of the reorganised scheme of vocational training marked a stage of positive achievement in the shape of a workable system with a clearly recognisable objective, with its machinery for working out the problems to be faced apparently well planned out and with a clear understanding of the external forces likely to affect it. It is on this account that it offers the opportunity for study and criticism, and why attention is being paid in the course of this address to it especially, as a part of the work of the Repatriation Department.

In planning the reorganisation of the scheme, an accurate estimate of the total number of men to be trained had to be made, otherwise the very foundations of the scheme would be faulty. It has already been pointed out that the ending of the war made it possible to determine the number of injured, and that this number could, in the light of the data obtained by experience, be reduced to the number likely to apply for and go on successfully with training.

There was, however, very little upon which to base an accurate estimate of the likely number of applicants amongst those eligible in the "under 20 enlistment class." Some basis for an estimate was afforded by the ratio of those attending technical schools in peace time to the number of the population in cities, and through a knowledge of the character and outlook of the young Australian. This slender basis, together with an allowance for the heightening of the men's ambition due to travel, was, as a matter of fact, used, and results have shown that the judgment made was wonderfully near to the final total number applying for and successfully proceeding with training.

After much research amongst the records at the Base Record Office of the Defence Department, and the exercise of judgment in the light of the data available, it was decided that under the reorganised scheme—that is from the 1st April, 1919, onwards—a total of 15,110 would be put into and would succeed in training. This total was composed of 3,960 injured, and 11,150 of the "under 20 enlistment class." The figures given were arrived at after making allowance for the number of those who would be approved for training and would fail to begin, and the proportion who would withdraw shortly after having commenced. At the present time, very few men remain to be selected and put into training, so that the work of investigating claims and putting men into training has practically ended. It is, therefore, now possible to ascertain the value of the estimate made in April, 1919. Since that time 15,475 men have been put into training and have gone on successfully, so that the estimate has been justified.

Prior to the reorganising of the scheme in April, 1919, 5,269 men had been dealt with. This number, together with the number which have been put into training since, namely, 15,475, makes a grand total of 20,744 men already dealt with by the Repatriation Department since its establishment in 1918. It will be interesting to know that an additional 8,896 were approved, but either failed to begin or withdrew after having commenced training, thus making a complete total of 29,640 men approved for training. The withdrawals amount to 30 per cent., which compares more than favourably with the percentage of withdrawals of students who enter on evening courses of instruction in ordinary schools.

The next important step was to allot with the greatest care and judgment the estimated number, as from the 1st April, 1919, to the different callings in the various States of the Commonwealth. This was most necessary, because the question of successful absorption into civil employment after training had to be considered and allowed for, otherwise there would be the danger of having too many trained for a particular calling. Moreover, it was but fair and economically sound that each profession and trade should take its proper proportion of the men. This was done by first breaking up the total, namely 15,110, into seven parts, having the same proportion to each other as the proportionate total of embarkations from the various States. Thus each State was allotted a total for training in proportion to the number of men embarked from it for active service abroad. It was assumed as a consequence, that in each State a number equal to the number allotted to it would be approved for and would succeed with training. This method had to be adopted, because much time would have been lost in making the detailed investigation necessary to decide the matter for each State separately, and also in view of the fact that, even if the enlistment papers for each State were examined in detail, there would still remain some uncertainties as residents in some States journeyed in fairly large numbers to other States to enlist, for various reasons which need not be discussed here. Speed in making computations was imperative, since, as already mentioned, it was a matter of vital importance to get the reorganised system into working order as quickly as possible in view of the very large numbers of men then returning to Australia. The method has been justified fairly well by results.

The total number of men to be trained in each State, arrived at in the way indicated, was then subdivided into a number of parts, each part corresponding with the estimated absorptive capacity of one of a group of callings. In Table I, the first column gives the names of the different groups of callings. The columns 2 to 7, inclusive, contain the numbers of men allotted to each group and the totals for each State. The last column gives the total for each group for the Commonwealth, whilst at the foot thereof is a cross-total of State numbers and numbers in the groups. The totals for each group in each State were then subdivided into the numbers to be allotted to each of the callings, trades, or branches of the particular group. In this way practically every profession, trade and skilled calling in the different States of the Commonwealth had a number allotted to it as its share in the absorption of the total number to be trained.

Table I.—*Vocational Training.*

Calling.	N.S.W.	Vict	Qland.	S A.	W.A.	Tas	No. to be trained (from 1/4/19.
Professional	305	2[illegible]0	155	50	45	20	785
Engineering Trades	870	680	434	130	190	85	2,389
Building Trades ...	2,135	1,450	386	370	350	225	4,916
Manufacturing and General ...	1,130	810	461	490	350	80	3,321
State Departments	1,000	435	327	160	150	70	2,142
Applied Art	225	205	77	60	45	20	632
Commercial	300	260	250	35	55	25	925
	5,965	4,050	2,090	1,295	1,185	525	15,110

Note A.—The numbers as shown for the State Departments include the proportion allotted to each of the different groups of callings.

Note B.—The figures given above are exclusive of those who were trained to take up Pastoral and Agricultural pursuits. Men desiring to go on the land were given special courses of training by the Lands Departments of the various States.

The subdivision of State numbers into parts for the groups of callings, and the further subdivision of each group into callings within it, was an estimate based upon whatever statistics were available, and upon a general knowledge of the relative proportions of workers in the groups. Unfortunately no exact information was obtainable. The statistics available at the time made no distinction in any calling between the skilled and unskilled. For example, it did not appear possible to distinguish between mechanics and labourers in the total given in any statistics of the Engineering Group of trades. If it were possible to know exactly how many journeymen mechanics were employed in the engineering and other groups of callings, the matter of settling the proportion, not only for the groups but also for the different trades in each group, would have commenced from a sound basis. The only difficulties would then have been the making of the necessary adjustments for probable trade depression or prosperity in any group for a number of years ahead, and in making allowance for possible abnormal occurrences retarding or accelerating recruiting through ordinary channels such as apprenticeship and immigration.

The allotment of a definite number to be absorbed by practically every calling in all the States of the Commonwealth was a daring action, because unless it was found possible during the discussions which would take place when working out the scheme to agree to such allotment, unending trouble and confusion would ensue. In some instances, the allotments have been proved to be rather wide of the mark, especially in the more sparsely populated States. Fortunately, however, in the majority of cases, the allotments have been found satisfactory. In this connection it is worthy of note that the allotments have generally been accepted by the various Soldiers' Industrial Committees throughout the Commonwealth. The personnel, functions, and powers of these committees will be discussed at a later stage. It will be sufficient now to say that Soldiers' Industrial Committees represented employers and employees' organisations, and, consequently, were able to express opinions of the greatest value on any matter relating to absorptive capacities of the trades and callings which they represented.

Some attempt, even if only of the nature of a first approximation, had to be made to allot a number of men to each of the callings in each State, otherwise there would have been nothing to go upon in planning the arrangements for the training and for the absorption of the men into civil life after leaving the schools. Moreover, as already pointed out, it was of economic importance that each calling should receive into the ranks of its workers a just proportion of the men trained. It was consequently necessary at the very start of the working of the scheme to inform each branch of industry of the number for the absorption of which it was expected to prepare.

In most of the Australian States, but perhaps particularly in New South Wales, the question of the ratio of apprentices to journeymen in the various trades is one that has been the subject of discussion for many years. With a view to preventing the exploiting of boy labour and still providing for the proper supply of journeymen mechanics to meet the needs of the future, laws have been introduced limiting the number of apprentices generally in the proportion of one apprentice to each three journeymen employed by any employer. It is unnecessary to discuss the various bearings of the law. It will be sufficient to say that it is generally admitted to be arbitrary and unscientific in its incidence, and that there are many who contend that it has a seriously retarding effect on the proper recruiting of apprentices for many of the trades. Most employers and trades' unionists would welcome a more scientific method of apprenticeship allocation, a method that would properly provide, but not more than provide, for the number of apprentices being taken yearly that would meet the future needs of the various industries. Obviously it should be a method allowing for varying conditions of trade and industry, adaptable to special needs of industrial stimulation and not necessarily applicable in exactly the same way in every part of the State.

The method adopted in the allotment of the total number of men to be trained under the Repatriation Vocational Training Scheme over the callings, based, as it was, on a careful estimate of the absorptive capacities of the different trades for some years ahead, perhaps points the way to a better method of apprenticeship allocation. It does certainly appear that it ought to be a very much easier matter to determine exactly the number of boys leaving schools each year than it was to determine the number of returned men which would apply for, and accept training. It should also be an easier matter to allocate these boys in numbers to training, since statistics could be prepared showing the ratio of increase of workers over periods of, say, five years, and to make the necessary adjustments to estimates in view of trade depression or prosperity, since such could be done very deliberately in the light of data especially accumulated. In allotting numbers under the Vocational Training Scheme, a few days only were available for the work, and the statistics available were not exactly of the kind needed. Nevertheless, as has been indicated, a very fair measure of success was met with.

All but a very small percentage of the men applying for training were essentially of a good type. All had responded to the call of country, and, in this respect, had discharged one of the highest obligations. Travel abroad, even though within the limits of war service, had broadened their outlook. Many of them had distinguished themselves, and most returned with an increased desire to take a useful part in the civil life of the country if they could but be put in the way of so doing. On the other hand, the injured were more or less handicapped according to the nature of their wounds or sickness, and even the fit men were mentally in an abnormal state as a result of their appalling experience. Further than this, habits, tolerable enough in the rough conditions of war, but incompatible with the conditions of school and college life, were, by a section at any rate of the men, not easily broken. It was, therefore, necessary to deal with all of them thoughtfully and patiently so that they might be put successfully on the road, which, in their hearts, they wished to follow. Success depended more perhaps on the wisdom shown in selecting each for the most suitable calling than even on the actual training itself, though the way in which the latter was carried out was important enough to demand the greatest care. The selection of callings for the injured presented the most difficult part of the problem. With these men it was not so much the question of what they were naturally most fitted for mentally and aptly, but of what, in view of their disabilities, they could work at. Fortunately, from the first it was a principle in selecting that, even with these men, taste and aptitude were not overlooked, and unless medical opinion was against it, the men were encouraged to try and qualify, in spite of the handicap of physical disability, for a calling which they were naturally fitted by aptitude and mental capacity to follow. The wisdom of this course has been justified by results. The number of injured men who have failed to make the necessary progress in some kind of calling, and by so doing keep on the road to final arrival into useful civil life, is surprisingly small. In the early days of repatriation, it was expected that it would be necessary to establish permanent national workshops in each State for the permanent employment of the injured who failed to reach a standard of admission as ordinary workers under the usual conditions of civil employment. So few are the men listed as residuals of the existing scheme of training, that establishments of this kind now appear to be quite unnecessary. At the most, all that will be necessary will be the establishment of a school in each State providing a few courses of training lasting over a fair number of years, and leading to the men taught therein qualifying to carry on special small home industries.

Under the conditions of control, first by the War Council, and later by the Repatriation Department, the selection of suitable callings for injured men was carried out by Vocational Training Committees. These Committees were comprised of medical men, representatives of the Chambers of Manufacture and Trades and Labour Councils, and experts in education. Each applicant for training was brought before either a full committee, or a sub-committee thereof, and had his case fully investigated. As the number of applications increased very largely after the ending of the war, and especially so after the introduction of the regulation making the "under 20 enlistment class" eligible for training, the work became quite beyond the powers of voluntary committees. At any rate, this was so in the States with the larger populations. The Director of Vocational Training had over two year's experience as chairman of one of these sub-committees in one of the States, and had assisted in the selection of callings for many hundreds of injured returned men. The experience thus gained in connection with the special problem of selecting callings for the returned men, together with an experience of over 25 years in technical education and with the callings and industries of the country, enabled him, when re-organising the scheme, to systematise the arrangements for carrying out quickly the work of selecting callings for the large number of applicants which had to be dealt with daily. The system of selecting the men for callings involved the appointment of a special Selection Officer for each State. This officer had to be a man with a wide knowledge of the industries of his State, he had to understand the general conditions of work in the many callings carried on in these industries, and it was necessary that he should understand the industrial laws. Fortunately in making the appointments it was possible to obtain the services of men who had the kind of knowledge described. It was also possible, in each case, to appoint a man who had been a member of a Vocational Training Committee. Thus, in each case, was brought into use an experience of great value. For the use of and with the concurrence of these officers, directions were drawn up setting forth the main lines on which judgment should be based when selecting.

The Selection Officers were asked to consider applicants for trade training as divisible into the following classes:—

Class I. Those suitable for professional callings.
,, A. Those suitable for highly skilled trades.
,, B. Those suitable for medium skilled trades.
,, C. Those suitable for little skilled trades.
,, D. Those specially suitable for commercial work.
,, E. Those specially suitable for some branch of Applied Art.

A catalogue in which all the trades and callings were grouped was prepared for the use of Selection Officers. To assist these officers in discovering to which class an applicant belonged the following directions were also prepared.

Directions to Selection Officers.

All applicants must be interviewed and sufficient time allowed for their examination to enable everything to be discovered about standards of education, experience and inclination.

Class I. Professional Class.

Generally, these will be cases of students whose studies were interfered with by enlisting.

Applicants—

(*a*) Must have matriculated prior to enlistment or obtained equivalent qualification for entrance to a University Course; or

(*b*) Must be able to prove that they were about to obtain the qualification for entrance to a University course; or

(*c*) Must have entered into a pupilage for a professional career or be able to prove that they were about to do so, and

(*d*) Must be able, having satisfied any of the above conditions, to show that they have maintained the standard of qualifications.

Trades and Callings Other than Professional.

Class A. *Highly Skilled Trades.*

In these trades, knowledge as well as skill is requisite, hence applicants must give positive promise of being able to learn, and that they will be able to acquire the necessary skill.

(1) General personal smartness.

(2) Preparatory education should have reached at least a fair knowledge of arithmetic, including decimals, and the ability to write a simple sentence correctly and legibly. Ability to make a scale drawing useful, but not essential.

(3) Positive evidence of mechanical aptitude, and an inclination for one of the callings in this group. The best evidence of mechanical aptitude will be the production by the applicant of a piece of work involving some mechanical skill, such, for example, as a model of some machine or part thereof, or something such as a boat or house. Boys gifted with mechanical aptitude very often produce this kind of work either in the Manual Training Classes of the Junior Technical School or at home. In the absence of any evidence of this kind, questions should be asked with a view to discovering whether the applicant has observed with success any of the various machines, such as locomotives and electric motors, which are to be seen almost everywhere. If a youth has taste and aptitude for mechanical work he will at least be able to give an intelligent description of such things.

Class B. *Medium Skilled Trades.*

Applicants who possess qualifications better than those needed for callings grouped in "C" Class and less than those required for Class "A" should be placed in this class. It may be noted that weakness in preparatory education is of less consequence than absence of aptitude and inclination, since the want of preparatory knowledge can be remedied, whereas aptitude and taste is rarely gained, however good the training may be.

Class C. *Little Skilled Trades.*

Workers in these trades are what can be best described as operatives rather than mechanics.

Standards.

(1) Want of alertness.

(2) Preparatory education poor. Unable to work in decimals or to write a simple sentence correctly.

(3) Entire absence of any mechanical aptitude or constructive capacity. Selection officers are cautioned about the necessity for making the fullest investigation before coming to the conclusion that an applicant has no aptitude for any of the trades in Class B. It sometimes happens that the environment of home, and even of school life, are against a child, with the result that he is listless and discouraged. The consequence may be the prevention of the development of all his natural qualities, which too often are only discovered when it is too late to make the best use of them.

Class D. *Commercial.*

Standards.

(1) General personal smartness.

(2) Fair knowledge of arithmetic and ability to write a sentence correctly and legibly.

(3) Either an entire absence of mechanical aptitude or a lack of interest in anything pertaining to the mechanical and construction trades. Some evidence of constructive capacity should, however, be exhibited by applicant. Aptitude for commercial pursuits involves the spirit of enterprise and shrewdness. These qualities are not easy to discover during a short interview. Selection Officers may, however, find something to base an opinion upon by questioning the applicant as to interest in sport, which, if nothing else, requires enterprise on the part of those who play successfully. Shrewdness as a characteristic may be apparent as the result of some experience

described by the applicant. For example, an applicant may be able to say that he was fond of making deals with his fellow scholars whilst at school. Some of the best business men whilst still at school, showed strong characteristics in this direction by the success with which they were able to effect exchanges, and sell the trifling articles which children value.

Class E. *Trades or callings requiring a keen perspective of form and colour.*

(1) Preparatory education should, of course, be fair, but it is not essential that it should be so, since any shortcoming can be rectified during training.

(2) Absence of mechanical aptitude.

(3) Positive evidence of power to perceive colour and form. Tests should be made of the power of the applicant to perceive, even if only in an elementary way, the difference between good and bad effects of colour, harmony and contrast. Appreciation of form by the applicant will be easily apparent by his capacity to delineate by freehand drawing simple objects. Applicants suitable for the callings under this heading will be found to have already done some drawing. Efforts of this kind can be produced for the inspection of the Selection Officers. Sometimes, however, circumstances may have been such as to allow this capacity to have remained dormant. If the Selection Officer suspects the applicant of possessing the qualities required for this class, he should ask him to make a sketch during the interview. If there is any natural ability it will be disclosed, even though the drawings be those of an untrained hand, and consequently very crude in execution.

It was realised when issuing these instructions that, in the majority of cases, only the most meagre grounds upon which to base a decision would be found, especially amongst applicants in the 'under 20 enlistment class.' Only very little experience had been gained by the men in this class between leaving school and enlistment, and usually that experience was entirely in unskilled work. As a matter of fact, experience by the Selection Officers went to show that it was generally necessary, in settling the question of the best training for the men in the 'under 20 enlistment class,' to take into consideration the characteristics developed by them during their school life. Of course there was a number of cases in which the military experience was of special character, and afforded valuable information for the use of the Selection Officers. The selection of trades for the injured men, whilst carried out generally in accordance with the directions set out above, differed materially from what was necessary for the men in the 'under 20 enlistment class.' There were, of course, injured men who had enlisted under 20, but the majority had had more or less experience in some calling between the time of leaving school and enlistment. Indeed, many of the injured men had followed skilled callings prior to going on active service. In such cases, Selection Officers were instructed to make the best possible use of pre-war experience as a basis for re-training. These instructions were carried out, with the result that a complete change of occupation was only resorted to when no other course was possible. For example, an injured man, who, before enlisting, had been a journeyman carpenter, which required that he should be able to climb about a building in course of erection, but whose injuries made this no longer possible, was trained to be a cabinetmaker, provided that he could work indoors at a bench, or to be a foreman carpenter, or where education and aptitude were especially good, to be an architectural draftsman. Another example of the principle followed would be that of a man being trained as a meat inspector, who, by reason of his war injury, was unable to follow his pre-war occupation as a butcher.

The Selection Officers were directed to try and discover, on the lines suggested, just what would be the best calling to put each applicant into, and having made their decision, to try and convince the man that the calling chosen would be the best for him. Selection Officers were, however, cautioned against forcing any man into training for a trade or calling against his will. In actual practice, however, it was very seldom that, having proceeded on the lines as suggested, the Selection Officer was unable to convince a man that the trade suggested would be the best. On reviewing the result of the work of the Selection Officers, it certainly does seem that they did their work well. Of course, they made many mistakes. It was inevitable that they should do so, but, on the whole, they managed to get the men very well suited. Many visitors, capable of judging and offering useful criticism, after looking at the men at work in the various workshops and classrooms, expressed the opinion that the outstanding feature of the whole training scheme was the apparent suitability of the men for the trades for which they were being trained. The greatest proof, however, of the wisdom shown in selecting the men for training, appears from the fact that already 8,735 men have passed through training, and are earning a standard rate of wage as journeymen in the callings for which they were trained.

One feature worthy of notice is that medical opinion and advice were available when selections were being decided upon. Such assistance was, of course, indispensable when deciding upon a calling for an injured man, but help of this kind was by no means without value in settling the cases of many who would be classed under the regulations of the Department as uninjured. Medical officers showed a keen interest in the work of the Selection Officers, and took great pains to familiarise themselves with the physical requirements of the different callings, so that the recommendations to applicants to follow particular callings were the consensus of opinion arising from medical, psychological and technical points of view.

There is an old adage full of wisdom and recognised as a basic principle in business that "it is easy to sell well if one has bought well." This principle applies particularly in the matter of selection of a calling or trade. If a career has been well chosen, its working out will be a pleasure to the end of life. If, on the other hand, a mistake has been made, work becomes a misery instead of a pleasure. There are few things so much to be deplored as a misfit in a calling, and, recognising this, most educational systems now contain provision to enable children to keep clear of this kind of tragedy. In this country, the syllabus of the primary schools includes subjects which tend to develop an elementary interest by the children in nature and in human activities. There are also pre-vocational schools following the primary schools, in which the tastes and interests started in the primary schools are further developed in the hope that the children will be able to form opinions sufficiently clear and strong to enable them to help themselves very materially in the matter of deciding what careers will be the best for them. Beyond what help the teachers can give in the way of direct advice and what the parents can do, no more assistance is available. Yet more is unquestionably needed. Added to what is now being done in the schools should be some systematic method of studying the suitability of the children for the different kinds of professional, business and trade callings, and, moreover, machinery should be established for directing them by advice and with facility into the callings selected. The schools reach the limit of their powers in what is now being done. To secure further direction, help must be obtained from the industrial side. That is to say, in deciding the important question of what a child should select as a career, the industrial world must join with the educational, and, between the two, provide children with the help and direction needed. Or, putting the matter more plainly, a child when about to choose a career, should have, not only the help of his teacher who will advise him in the light of his attainments, tastes and aptitude discovered during his school life, but also the help and advice of those who know the callings and exactly what is required to carry on successfully.

It ought to be easier for a man in the early portion of adult life to decide what calling he could successfully follow than if he were still a child, because he has reached an age of greater discernment, and has had some experience of the world, but it is quite safe to say that, if the returned soldiers had been left to enter into training without expert advice, there would have been an enormous number of misfits and failures. The system of investigation adopted, simple as it was, resulted in the men being directed into careers in which, in view of their natural qualifications, they were best fitted to succeed. With children, the need is surely greater, and possibly the example set in dealing with the returned soldiers, and the results from the experiment, may be useful in establishing some system to help them. It appears to be likely that the Board of Trade in this State will establish some machinery to work in conjunction with the Education Department in directing the boys and girls who leave school each year into suitable occupations. It is to be hoped for the sake of the workers in the industries in the future, and in the interest of the prosperity of the country, that the Board of Trade will be able to do something in this direction.

Mention has already been made of the Soldiers' Industrial Committees. It is now proposed to describe the important part taken by these committees in the work of the vocational training of returned soldiers. At the very inception of the Repatriation Department it was recognised that any attempt to train returned men must have the approval and assistance of all who were working at or directing the callings for which the men were to be trained. Moreover, it was realised that the necessary help would only be forthcoming provided that there was a definite relationship established between the work of the department and the various associations and societies representing the employers and employees in the different callings. The recognition of the necessity for this co-operation and the decision to establish a relationship between the industrial work of the country and the training operations of the department was one of the finest things among the many to the credit of those who set the work of the department into going order. Without this kind of help it would have been impossible to solve the many problems arising out of a proposal so novel in character and bristling with so many industrial difficulties. It was with the object in view of learning what was the general nature of the relationship which should be set up, and of getting advice as to the best way of preparing to meet the outstanding difficulties due to industrial customs and laws, that one of the two conferences already referred to was called. Amongst many recommendations of a fundamental nature, as regards the training, was one for the establishment of Committees of Advice to be called Soldiers' Industrial Committees, formed of representatives of employers and employees' organisations. Generally, the functions and powers of these committees were to advise as to the employment of the men trained, and to assess their progress as the training proceeded. Later on, under the re-organised scheme, these committees were given increased functions. The constitution of them as bodies of a representative character was made a matter of more definiteness, and their number was much increased. As a matter of fact, provision was made for the establishment of a committee for each calling or group of callings in each State as the need should arise. Each committee was comprised of an equal number of representatives of employers and employees, officially nominated by their respective trade organisations. The functions of a Soldiers' Industrial Committee consist of:—

(*a*) The giving of advice as to the number which should be trained for the particular trade or calling. This function actually consists of reviewing the numbers of the allotments made by the Director of Vocational Training when planning the re-organisation referred to earlier.

(*b*) The giving of expert advice as to the accommodation and equipment needed for workshops and class-rooms in the different schools to be fitted up for training purposes.

(*c*) The giving of expert advice as to the qualifications of applicants for positions as teachers under the scheme.

(*d*) The giving of advice from the point of view of workers and employers in a calling as to the general features of the training required for that calling. Committees were not asked as to the details of the training. This was left to the educational experts who controlled the schools. The members of the committees were, however, always given to understand that an expression of opinion even on matters of detail would be of value, and would always be welcomed.

(*e*) The preparation of periodical reports on the progress of the men in training as from the point of view of the worker and employer.

(*f*) The giving of advice and assistance in getting students from the school employed as trainees.

Each committee has the exercise of power inasmuch as it is responsible for the assessment of the value of the trainees' progress in efficiency. This assessment is a very important matter, since upon it is based the relative proportions of the wages, paid in accord with the Industrial Court Awards, which shall be borne by the employer and by the Department. The committees in the discharge of the duties allotted to them were brought very closely into touch with the smallest details of the training operations. The work of the Department was thus not only greatly helped, but thoroughly understood by all who were members of the committees. As a result, the great body of workers in the different callings and the employers were kept in touch with what was being done, so that knowledge brought sympathy and help instead of the inevitable restlessness and opposition which would have arisen as a result of ignorance. The committees, though of an honorary character, had an official standing in the department, so that influence was real and could not be disregarded. The result was that they had a very good effect in keeping all the ramifications of the training operations up to a good standard of effective working. Whilst always ready to allow for the difficulties which the staff of the Department and those controlling the schools met with on every hand in carrying on the training, the members were frankly critical at all times, and really severe when avoidable mistakes were made. Altogether, 144 of these committees were established in various parts of the Commonwealth, and have continued to work unceasingly in the discharge of the functions and powers given to them. This has meant that the members have sacrificed much time and given freely of their abilities in a most praiseworthy manner. It would have been quite impossible to have done without such help. It is therefore not without reason that the officers of the Repatriation Department have the greatest admiration for the unselfish devotion to a noble cause displayed by the members of the many Soldiers' Industrial Committees.

One result of the work of these committees, apart altogether from the vocational training, is that those who have been, or still are, members of these committees, have been brought very closely into touch with technical education. The benefit arising out of this consists not only in what the members have learned for themselves, but as representatives of their different associations or unions they have had to report to their constituents about what was being done. In this way, through them, thousands of people have had vividly brought before them the facts in regard to this very interesting experiment in an important branch of education. Thus public attention has been focussed on technical education in a way that it never would have been had there been no Vocational Training Scheme nor any Soldiers' Industrial Committees.

Experience of the working of the Soldiers' Industrial Committees in relationship with the Vocational Training Scheme goes to show that advisory committees of this kind would be of the greatest value in connection with any system of education. At any rate, with those systems which aim at meeting the need of any special branch of human activity in civil life. It is admitted that the aim of education may be said to be the improvement of the standard in thought and action of all these activities, but it has also to minister to them, and it cannot either minister to or improve them without understanding them. An understanding, especially in the technical professions and callings, may not be reached if approached entirely from the academic point of view. It does seem, therefore, that those who control technical schools and all who have the direction of those sections of universities which are devoted to higher technical education, should be very closely in touch with the needs of the callings for which the students in them are being trained. Advisory Committees consisting of representatives of those who are carrying on callings can bring just the kind of advice needed to enable professors and teachers to shape the courses and train a type of man possessing not only a practical and common-sense power to work usefully, but to re-organise and effect improvements. Severe criticism is often levelled at what is described as the impracticability of the courses of training of technical schools, and even of some universities. Such criticism would not be made, at any rate it would have small effect, if the work of these institutions was better understood by the community at large. On the other hand, the influence of such committees would ensure that the courses were such as would meet the requirements of the callings, and this being the case, the ground for such criticism would be removed.

The courses of training were divided into two classes, namely, (1) University, higher technical or professional pupilage; and (2) Trade.

All who had either commenced or had intended taking a university or higher technical course, or entering as pupils with professional practitioners, were granted facilities to carry out their intentions, provided that, if injured or sick, they were able to stand the stress involved. Various Australian universities and technical colleges acted very generously to the Department of Repatriation by considerably reducing fees. In cases where no university or technical college course was available, or where custom required articled pupilage, arrangements were made with qualified practitioners to take trainees. It was consequently only in very rare cases that the Department found it necessary to provide for the establishment of classes for professional training. All the returned men approved for professional training had their fees paid and were granted sustenance at the rate of £2 2s. per week for single men. Those who had married received an extra allowance. The first year's fees and sustenance were a gift, but anything paid out by the Department beyond this was granted as a loan to be re-paid by the trainee within a reasonable period after qualifying for his profession. As already stated, the men within this class were required to have satisfied entrance qualifications if desiring to proceed to a university or technical college, or if to articled pupilage, to possess the necessary preparatory education. No attempt was made to shorten the period of undergraduateship required by the universities and higher technical colleges, nor would it have been wise to have attempted to do so. These courses of training were well established and available, and it was merely a matter of taking care that the men sent to them were sufficiently well prepared, and to secure that they attended properly to the courses for which they were approved.

The question of carrying out successfully training for the different trades presented unique difficulties. The men to be trained were nearly all adults. The industrial laws of the States required that all adult workers at trades should be paid the minimum wage required by the awards. Since it was fully recognised that the men could not be trained up to the standard of fully competent tradesmen in the technical schools, some way of meeting the wage conditions had to be discovered. The method of overcoming the difficulty was devised during the deliberations of the first Industrial Conference called by the Repatriation Department. This conference has already been referred to as one of the two called at the inception of the work of the Department. After discussing the matter from every point of view, it was finally decided to recommend that the Department should divide the trade training in two stages. The first stage called the "student period" should be taken by the men in technical or trades schools. During this period, they should be given intense courses of training mainly with the object of rapidly assisting them to a useful degree of skill in practical work. During the period of studentship in technical or trades schools, the single men were to be paid sustenance at the rate of £2 2s. per week. Extra allowance was to be given, if married, in proportion to responsibilities. On reaching a standard of skill equal to an earning capacity of 40 per cent. of the minimum wage payable in the callings for which they were to be trained, they were to be placed out with employers as industrial trainees, so that they might continue their training under actual trade working conditions. Immediately on being placed with employers, they would be paid as adult workers, the Department refunding to the employers the difference between the assessed efficiency of the men and the minimum wage rate. It was expected that the efficiency of the men would rapidly increase, so that as time went on, the amount to be refunded by the Department would be continually decreasing until a time would be reached when the trainees would be capable of earning the minimum wage, and thus be able to fend for themselves as fully competent journeymen. It was suggested that, during the period of industrial training with employers, the men should be assessed by the Soldiers' Industrial Committees at intervals of three months, so that the Department would be in a satisfactory position with the employers as to the amount of refund as efficiency increased.

A very important recommendation on the question of proportion of trainees to tradesmen in the callings was also made by this conference. The recommendation was to the effect that one industrial trainee could be taken for every six or part of six journeymen employed by any employer in any of the trade callings. This recommendation was of the nature of an agreement with the Department on this question, because the conference was an official gathering of representatives of the Chambers of Manufacture and the Trades and Labour Councils of the State of the Commonwealth, capable of speaking on behalf of the bodies which they represented.

The recommendations were accepted by the Department of Repatriation and made the subject-matter of regulations. These regulations have practically remained unaltered up to the present. The only change of any importance has been one made at the request of an official gathering of trades' representatives held during August in 1919. The alteration was one making the part of six not less than three in the proportion of trainees to journeymen, so that an employer could not take a trainee unless he had at least three journeymen employed. A provision was, however, made in the altered regulation allowing the reduction of the minimum to one in any case where trade conditions rendered a lower minimum necessary, and provided that the Soldiers' Industrial Committee consented. The sustenance paid during the student period and the refund to employers made on behalf of the trainees, have been, from the beginning, made a gift to the men who have been trained for trade callings.

By the terms of an agreement with each of the State Educational Departments, space and equipment in the technical colleges and trades schools not required for ordinary technical education was made available to the Repatriation Department without charge for the training of the soldiers. This agreement also provided that additional accommodation, equipment and teaching staff would be made available wherever necessary, provided that the Department of Repatriation supplied the necessary funds to meet the expense involved. The agreement also provided that any additional buildings would be taken over by the State Education Department, and, further, that if the latter desired, equipment especially provided for the soldiers' training could also be taken over. Under this agreement, the Department of Repatriation has had the use of much accommodation and equipment, and the services of expert advisers and teachers, especially in the States with large populations. In the less populated States, there was, as a matter of fact, very little in the way of existing technical schools, but little as there was, it was most readily made available. It was, nevertheless, necessary, even in the more densely populated States, to add considerable accommodation and equipment, and to appoint a large additional staff of teachers. In some cases, it became necessary to second the efforts of the State Educational Departments by the establishment of special schools more directly under the control of the Repatriation Department than were those established by the Educational Departments. The building of the additional class-rooms and workshops and the acquisition of necessary additional equipment during a time of great scarcity of materials of every kind were matters surrounded with many difficulties, and especially so because speed in getting training facilities into operation was of the greatest moment. In fact, the difficulty of obtaining equipment became so acute that it was necessary, in some cases, to invoke the aid of the Business Committee of the Defence Department, with a view to commandeering whatever was available in the Commonwealth. Competent tradesmen to act as teachers were also very difficult to find, because so many of the best men were away on active service. However, as the result of unflagging effort, there soon came a time when, in every State, there were in full operation classes of instruction in almost every calling carried on in the Commonwealth. It was realised, even in the earliest stages of the work of the Department, that the courses of training ordinarily given in technical schools would fail to meet the special requirements of the returned soldiers.

Usually, the courses of instruction in the technical schools in this country are given in the evenings, and, at the most, require only a few hours of attendance weekly; consequently they spread over lengthy periods of time. It is true that in some instances day courses of trade training are available, but they are rare, and even then they are confined to a few of the trades. The evening courses again are designed, and properly so, to be supplementary to what is learnt by the students at their work as apprentices or journeymen during the day-time, or they fall rather short of what will be valuable to those who intend the knowledge to be useful in a calling. The returned soldiers had to be rapidly trained to a stage of being useful to some degree in the employment into which they would enter as industrial trainees, with a view to completing their training. This meant that they would have to have training, which, though of a preliminary nature, should be rather on the practical side, and, further, that the conditions of training should approximate to actual working conditions. As a matter of fact, it would differ only from the usual workshop conditions in that it would be under the direction of practical teachers, whose sole business would be the careful instruction of the men under their charge. One consequence of the establishment of training conditions of this kind was that full-sized articles would result, and that arrangements would have to be made to dispose of them by sale. It was found that no difficulty whatever was met with in selling the articles manufactured in the classes. Both employers and employees' representatives on the Soldiers' Industrial Committees helped in securing markets for the product.

Generally the articles were sold to the trade. The principle of manufacturing full-sized articles of a saleable character worked out so well that it was eventually extended to house building by the trainees in the building trades. In most of the States there are to be seen very well constructed houses built entirely by the students under the Vocational Training Scheme. The houses were built either for the War Service Commissioner or for the State Housing Boards.

The authorities controlling the Technical Schools keenly appreciated the necessity of carrying on the training on the lines as just described, and very soon had classes in operation to meet the needs of the Returned Soldiers. It was impossible in all cases, to establish special soldiers' classes, so that some students under the Vocational Training Scheme had to be taken in the ordinary classes, but generally speaking all classes in Technical Schools, and certainly all in the special schools established by the Repatriation Department, were designed and operated practically as school workshops, wherein were given courses of intensive training in practical work on full-sized articles of a saleable kind. The preliminary training periods lasted generally three months for little skilled callings, six months for medium skilled, and twelve months for the more highly skilled trades. Generally the industrial training period which followed the preliminary training, lasted for about twelve months for the highly skilled trades, with proportionate reductions in time for the medium and little skilled occupations.

Those of the men put into training, who were really desirous of learning, and most of them were so, and who were well suited by inclination and aptitude for the training being given, made progress at a rate which can best be described as amazing. The Australian can always be credited with remarkable powers of adaptability to circumstances and with resourcefulness, and it is to these characteristics that probably much of his success in training can be ascribed. The fact that a careful process of selection was carried out, with a view to each man being put into the training for which he was best suited, no doubt had its influence as a factor in his rapid progress. Probably, however, what had a very great deal to do with his success, was the fact that he had reached an age sufficient to allow of some power of analysis and judgment being used by himself in an attempt at understanding what he was set to do. On the other hand, he was not old enough to have lost the plasticity of his mind, or the power of acquiring manual skill. At any rate, whatever may be the cause, the results go to show, that Australians whose ages range from eighteen to twenty-five years, are not too old to learn quickly, and to acquire skill, provided only that they be put to learn a trade or calling which suits them. There are shown in this hall some examples of what can be achieved by men after remarkably short periods of instruction, who had no skill whatever, and very little preparatory education, prior to entering into training. Each specimen is labelled with information as to the time spent in training prior to completing the piece of work, and with a certificate as to the work being none but that of the student whose name is given. The specimens are types of what has been done in the classes. Necessarily only one specimen from each of a few classes can be conveniently shown here, but those who view the specimens can be assured that they are reasonably representative of what has been done by students being trained in practically all of the callings carried on in all parts of the Commonwealth. One remarkable feature about all the men put into training, was the scantiness of general education up to the time of applying. It was extremely difficult to find men even up to the simple standards of preparatory education set out in the instructions to the Selection Officers. Thinking people often deplore the fact that the incidence of the Industrial Laws is such as to require a boy who wishes to become an apprentice to a trade, to leave school not later than when sixteen years of age, thus ending his period of general education much too soon. The results obtained from the training of the returned soldiers, go to show that no harm whatever would be done through entering on apprenticeship at a later age than what is now the custom. As a matter of fact, the evidence is all in favour of entering on actual trade instruction at an older age, and that probably the three years spent in learning a trade, from the age of eighteen to twenty-one, would give better results than are now obtained in the five years, from sixteen to twenty-one years of age. If this be so, it would leave two years more for the general education necessary to an appreciation of the humanities, and consequently to good citizenship.

It was very interesting and instructive to observe the attitude adopted towards the vocational training of the returned soldiers by the employers and employees in the various callings affected. It is not too much to say that all helped in every way, and that it was only by the generous assistance so freely given, that it was possible to proceed with the undertaking. The help was, however, generally given solely in a spirit of patriotism and with a desire to help the men who had sacrificed so much by their war service. The social and economic value of the scheme, as an attempt to add 20,000 men to the skilled workers of the community was not generally recognised. Certainly its value as an educational experiment on quite unique lines was not realised either by employers or employees. On the other hand, many of the employees' organisations, whilst loyally and generously giving the help needed, were filled with mistrust of the scheme, arising from a fear that it might lead, through swamping the market for skilled labour, to the breaking down of some of the industrial laws and customs which had been established as the result of years of hard fighting. Events have shown that these fears were groundless. The scheme involved the training of an estimated number of men for each calling. The estimates have been exceeded in only a few cases, and in those with the consent of the Soldiers' Industrial Committees concerned. The undertaking has, however, demonstrated that it is possible to estimate the number who can be put into a trade without endangering employment. It has further shown that our laws permit of a very much more systematic method of directing suitable recruits to the callings than what is now in operation. Further than this, the working out of the system has demonstrated the advantage of both employers and employees' organisations having a voice in the training of those who are to be the workers of the future in the callings carried on in the country. Some feared that it might even tend to destroy the system of apprenticeship. So far from having that effect, it has demonstrated the opposite, inasmuch as it proved the value of disciplinary courses of training specifically designed for such callings and comprised of both trades school instruction and actual workshop training. As a matter of fact, it was in its very essence an apprenticeship training, since the later trainee stage was served to an employer under the same conditions as those of the old established apprenticeship custom. The assessment of the value of the services of the trainees was, moreover, on a more equitable basis than is the case with ordinary apprenticeships, since the employer paid according to periodical assessment made by expert tribunals, and consequently got what he paid for in the way of services.

The economic value of the scheme is not difficult to estimate. At a very moderate valuation, each of the men trained will be able to earn at least £2 per week more than if he were left as he was when he returned from the war, either too injured to follow his former kind of occupation, or unskilled because he enlisted at a very early age. If the estimate of increased earning power is correct, 20,000 men together would be able to earn at least an additional two million pounds per annum, or, at any rate, their increased power to produce wealth would be worth that amount per year to the Commonwealth. Capitalised at 5 per cent., this income represents a capital sum of forty millions. The scheme was estimated to cost not more than three million pounds, so that it is evident, in view of the figures, that it was indeed a very good undertaking from a business point of view. The economic results arising out of the training of these men, however great, is as nothing when compared with the social aspect. A Minister of the Crown in one of the more largely populated States of the Commonwealth mentioned the other day that an investigation of the records of prisoners in the gaols of that State had disclosed the fact that only 10 per cent. of the prisoners belonged to professional or trade callings. All the rest were unskilled. A little reflection about this interesting statement will show that, after all, it is not a matter to cause much surprise. The worker in a profession or trade has positive advantages over the ignorant and unskilled, in that he has been educated and trained to work for some definite objective in life, so that the future always has possibilities for him. Moreover, competence to take an active part in some constructive work, either in production or manufacture, or in some branch of the many phases of business life, increases his self respect, with the result that his code of ethics is the better. A man without a profession or trade or some definite calling has none of these things to help him, and indeed needs to be strongly inclined to a good moral standard to help him through his aimless and unseeing life. There is, of course, a percentage of people in every community whose mental capacity is of a standard which permits them to go through life in comparative happiness though quite ignorant and unskilled. These are best left to be "hewers of wood and drawers of water," and as such they will fill a useful place in the community and live a life of good citizenship. The danger, however, lies in leaving in the ranks of the unskilled those whose natural gifts fit them for more important work. At uninteresting work these people necessarily become discontented and unhappy, and, in their hearts, wage war with the social system which denies them the right of congenial employment. Undirected and undisciplined, their very ability may become dangerous and lead them into criminal channels. The Vocational Training Scheme of the returned soldiers not only aimed at putting 20,000 men into the way of skilfully assisting in the development of the resources of the country, but also in its working, provided that all who were put into training were not merely of the class of "hewers of wood and drawers of water," but were fitted to follow some kind of trade or business calling which required mental capacity or manual skill. It thus had a social side of immense importance. It had a value of this kind directly, inasmuch as it dealt with a definite number of men who were trained to be of use in the skilled work of the country. It also had an indirect value, since it indicated what could be done on a very much larger scale in the deliberate direction of boys and girls from school into occupations for which they are naturally suited.

The Scheme of Vocational Training has not yet worked itself out. Indeed, some considerable time must yet elapse before every man put into training shall have reached an efficiency enabling him to earn the usual income in the calling for which he has been trained; but a very large number have already proved able to do so, and are managing for themselves. Moreover, most of those still in training give every promise of also being able to do so. A very seriously abnormal trade depression, which would render it difficult for the trainees to complete their training with employers, would retard the completion of the scheme, and indeed might permanently impair it, but apart from this danger, there is no reason to doubt the final and complete success of the scheme.

Such is a brief account of what has been done by the Commonwealth Repatriation Department in training and retraining those men of the Australian Imperial Forces who returned without a calling to go to, through having enlisted when very young, or who, through having been injured, were unable to return to their pre-war occupations. In describing what has been done in designing and carrying out a system of training to meet the special needs of these classes of returned men, no opportunity has been lost of noting observations and mentioning conclusions made during the working out of this remarkable effort in education. This has been done, as already mentioned, with a view to assisting in the solution of the problem of properly providing always for the necessary proportion of competent workers for each of the callings carried on in the country. As the observations and conclusions arrived at have been referred to in a discoursive way, it may perhaps be advisable to summarise them as follows:—

(1) The experience gained in working out the scheme went to show that it is necessary to have advice and assistance from experienced practitioners or workers in a calling when designing and carrying out training for that calling.

(2) That it is possible, provided suitable statistics and expert professional or trade advice are available, to make allotments of trainees for any calling so as to provide with reasonable certainty that the needs of that calling will be met, even at a time sufficiently ahead to allow of the necessary training being given.

(3) That it is possible to systematically direct boys and girls from the schools into occupations for which they will be suitable by temperament and aptitude.

(4) That those of early adult age gain knowledge and skill very quickly, thus making it appear likely that, if entered upon at a later age than at present, the period of apprenticeship may be reduced. The point of this is that boys might be able to remain at school with a view to arriving at a higher standard of general education without in any way lessening their chance of arriving at a proper standard of competence at 21 years of age, by making the appenticeship time from the beginning of 18 years until the completion of 21 years of age.

(5) That an apprenticeship system is still the best provided that proper allotment of numbers to any one calling could be made, that systematic investigation as to suitability for training all those allotted be carried out, and that increases of wages on actual efficiency and progress be made on periodical assessments rather than on fixed increments as at present.

(6) That preliminary training in a trades school, designed more on the lines of a school workshop, should be part of a trade apprenticeship training, and should precede the part spent with an employer.

ON THE OCCURRENCE OF A NEW PHENOL IN THE ESSENTIAL OILS OF THE "LEPTOSPERMUM."

By A. R. PENFOLD, F.C.S.

[*Read before the Royal Society of N. S. Wales, June 1, 1921.*]

IN the course of an investigation on the esssential oil obtained from the leaves and terminal branchlets of *Leptospermum flavescens* it was found to contain a phenolic body which varied in amount according to the different localities from which the material was collected. In the oil obtained from material growing in the Lane Cove district it was found that when separated in the usual manner using an iron coil in the condenser it was so dark in colour that it was impossible to determine its optical characters. On using a coil of pure tin, however, the crude oil was of a brownish yellow colour. On clearing up the oil by means of a 3% aqueous solution sodium hydroxide no less than 8% by weight of the phenol was obtained. The amount thus present in the oil of this species varied according to the district from which the material was collected, viz:—

District.	Date.	Phenol in Crude Oil.
Longueville (Lane Cove)	18/11/20	8%
Ditto ditto	27/1/21	8%
Hill Top, N.S.W.	26/2/21	0·75%
Kuring-gai	21/3/21	2·7%
Blackheath, N.S.W.	15/4/21	1%

Unfortunately, the locality yielding the phenol in highest amount was rather sparse as regards quantity of material on account of the rapidity with which it is being cut out due to the spread of population. Altogether, however, about 60 grams of the phenol was obtained by treating the crude oils with 3% aqueous solution sodium hydroxide, removing the non-phenolic bodies by repeatedly washing it with ether, acidifying with dilute sulphuric acid, extracting the liberated phenol with ether, and washing the ethereal solution with sodium bicarbonate solution to remove small amounts of acids. The ether, was removed by distillation, and the phenol purified by repeated distillation under 10 mm. pressure.

Properties of the Phenol.

Thus obtained it is a somewhat viscous liquid, almost colourless, though sometimes possessing a faint lemon tint, with a pleasant and characteristic odour, and giving with ferric chloride in alcoholic solution a brilliant distinctive orange-red colouration. It also reacts with solutions of copper salts giving an intense blue colouration resembling cupric ammonium sulphate solution.

It possesses the following characters, viz :—

Boiling point 145 – 146° C. at 10 mm.
or 275 – 278° C. at 770 mm. (uncorr.)
optically inactive
Refractive index at 20° C. 1·5000
Specific gravity at 20° C. 1·073

The formula appears to be $C_{14}H_{20}O_4$ as indicated by the following combustion and molecular weight results, viz:

(1) 0·1240 gm. gave 0·3011 gm. CO_2 and 0·0896 gm. H_2O
C = 66·23%, H = 8·03%

(2) 0·1496 gm. gave 0·3652 gm. CO_2 and 0·11 gm. H_2O
C = 66·58%, H = 8·17%

(3) 0·1494 gm. gave 0·3636 gm. CO_2 and 0·1072 gm. H_2O
C = 66·37%, H = 7·97%

$C_{14}H_{20}O_4$ requires C = 66·67%, H = 7·94%

Molecular Weight Determinations.

(*a*) A molecular weight determination by the Landsberger boiling point method using acetone as solvent gave the following result:—

1·1192 gram. in 26 c.cs. acetone elevated the boiling point 0·35° C. M.Wt. = 248.

(*b*) A determination by the cryoscopic method using benzene, resulted as follows:—

0·4652 gram. in 10 grams. benzene lowered the freezing point of the solvent 0·95° C. M.Wt.=246

$C_{14}H_{20}O_4$ requires 252.

Under ordinary conditions the author has so far been unable to prepare any derivatives of this interesting body, neither a phenylurethane, benzoyl, or acetyl compound resulting. No evidence was obtained of the presence of methoxy or ethoxy groups. This phenol bears a very strong resemblance to "Tasmanol," a similar phenolic body found in some Eucalyptus Oils, and first described by Messrs. R. Robinson, D.Sc., and H. G. Smith, F.C.S., in this Journal, Vol. XLVIII, page 518. The writer has had practical experience of this substance having separated it from the oil of *Eucalyptus Risdoni*, and has also been unsuccessful in obtaining solid derivatives, its behaviour being similar to the phenol just described.[1]

The chief differences between the two phenols lie in the refractive index, which in the case of Tasmanol is 1·524 to 1·528 at 20° C., and the boiling point under reduced pressure, which for the same body is 164 – 165° C. at 12 mm. Tasmanol also contains fewer carbon atoms in the molecule, whilst the different red colourations produced with ferric chloride in alcoholic solution are quite distinct. I think, therefore, on the evidence adduced that whilst the phenolic body herein described is closely related to Tasmanol, it possesses distinctive characters of its own, and the name "Leptospermol" is proposed for it.

I have once again to express my indebtedness to Mr. F. Morrison, Assistant Chemist, for able assistance in the work.

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[1] See Baker and Smith's "Research on the Eucalypts," 2nd Edition, page 396.

NOTE ON THE RELATION OF STREAMS TO GEOLOGICAL STRUCTURE, WITH SPECIAL REFERENCE TO BOATHOOK BENDS.

By W. R. BROWNE, B.Sc.

[*Read before the Royal Society of N. S. Wales, July 6, 1921.*]

IN his interesting reports on the physiography of the Federal Capital Territory and of Eastern Australia,[1] Mr. (now Professor) Griffith Taylor has done a signal service to physiographic science in Australia by drawing attention to many facts and problems in connection with the river drainage of the country. Some of Dr. Taylor's conclusions are based on actual personal observations in the areas concerned, but, as he himself points out, it is impossible for anyone to have a personal knowledge of the whole region dealt with, and so suggestions have been made as to the explanation and significance of certain physiographic peculiarities which are made evident by a study of topographical maps.

In both reports Dr. Taylor draws attention to the remarkable and abnormal courses of certain of the tributaries of the Upper Murrumbidgee and of some of the other rivers in New South Wales and Queensland. These tributaries, instead of meeting their trunk streams at angles which are obtuse on the down-stream side, do just the reverse; in other words, they run "up stream." To this type of junction Dr. Taylor has applied the name "boathook bend," and he considers that these boathook bends indicate river capture, the tributaries formerly belonging to a system

[1] Bulls. 6 (1910) and 8 (1911), Commonwealth Bureau of Meteorology, Melbourne.

draining in a different direction from that in which their trunk stream is now flowing.

While by no means denying the probability that Dr. Taylor's theory correctly accounts for the phenomena in certain cases, the author, from observations made in various parts of New South Wales, has been led to believe that these boathook bends may at times originate otherwise than by river capture, and may in fact represent features of the normal development of a river system undisturbed by accident of any kind.

Given a homogeneous land surface with a seaward tilt, the river systems will develop normally, the tributaries of each stream having a symmetrical disposition towards it, and joining it at angles which are obtuse down stream. In such circumstances the presence of boathook bends would almost certainly be conclusive evidence of river capture and a breached divide. But where, as is very often the case, the land surface is non-uniform in structure and in the nature of its component geological units it is inevitable that in the mature stages of the river's history there should be considerable adjustment of streams to geological structures, and this will particularly affect the tributaries which come into existence after the steep gradients of the original consequent stream have been worn down. There will be a seeking out of softer strata, and an avoidance of the more resistant geological units as far as possible. In other words, the law of physiographic symmetry enunciated by Taylor will not necessarily hold. This is well exemplified in many of our New South Wales river systems, as has been pointed out by Mr. E. C. Andrews and others. In particular the more or less meridional courses of the streams heading in the Monaro region are surely related to the geological structure of the country, and to the disposition of hard and soft geological units. A glance at the geological map of the State reveals the existence of large elongated masses of acid igneous rocks in among the sedimentary formations, which themselves have been folded along sub-meridional axes. The author has observed this sort of thing in the neighbourhood of Cooma, where the Silurian and Ordivician sediments, chiefly shales and slates, limestones and phyllites, upturned, steeply dipping and often much cleaved, have been invaded by long sill-like masses of gneissic granite and quartz-porphyry. The courses of the streams, the Murrumbidgee and the smaller rivers, are markedly influenced by the existence of these hard bars, which have themselves not improbably been brought into being as a result of the folding movements which affected the sedimentary strata. It seems to the author that this fact of lithological character and disposition of the geological units has not been given sufficient weight by those who have studied the physiography of this region, and it does not seem impossible that part, at least, of the valley of the Upper Murrumbidgee, which has been explained by Sussmilch and Taylor as due to sub-meridional trough-faulting, may really be the result of the erosion of a terrane composed of units of widely varying hardness.

Among the most important factors which may modify a river's history are to be placed rock-cleavage and jointing, and the influence of these is clearly to be seen in some parts of the area already referred to. The country is in part composed of schists and micaceous gneiss with conspicuous jointing almost at right angles to the nearly vertical schistosity, and the courses of many of the tributaries of the Murrumbidgee, and to a less degree, that of the main stream itself, are determined by these two structural features, being very tortuous and formed of a succession of right-angled bends, the factors determining the channels being now the schistosity, now the jointing.

The main stream itself, north of Cooma, flows for the most part in a direction slightly oblique to the direction of the strike of the country, and there are indications that some incipient tributaries are being determined predominantly by the schistosity. This has suggested a means by which boathook bends may be brought about in the case of the tributaries of a main river which is flowing obliquely across the grain of the rocks. The course of the tributaries, being governed largely by the cleavage of the rocks, will on one side of the river be normal, and on the other side abnormal. A similar condition of affairs will obtain if the main stream flows obliquely across joint systems, or across fault planes or crush zones, and is a natural consequence of the river system, during its normal development, seeking the lines of least resistance and readiest erosion.

Professor Taylor's conception of the significance of boathook bends was first enunciated in connection with the physiography of the Federal Territory, where some striking examples of the phenomena occur, a number of the tributaries of the Murrumbidgee showing abnormality of direction. For example, the Gudgenby River is a normally-directed tributary of the Murrumbidgee, but Guise's Creek and Sawyer's Creek, two other tributaries, make boathook bends with the trunk stream, and the Orroral, Nursery and Rendezvous Creeks, tributaries of the Gudgenby, meet it in similar fashion. It is considered that the abnormally-directed tributaries originally belonged to a south-flowing river, the ancestor of the Snowy River, and that a north-flowing Murrumbidgee (the divide being in the Federal Territory) through headward erosion by itself and its tributaries such as the Gudgenby, breached the divide and captured the Snowy tributaries.

The author has never personally investigated this particular part of the State, but an examination of Professor

Taylor's map (Fig. 6 in Bulletin No. 6, referred to above) reveals a very suspicious parallelism in the courses of many of the tributary streams, such as commonly and almost inevitably results from the presence of directive structures, as for example, schistosity or gneissic foliation, or more probably in this case, shear zones, fault planes or joint systems.

It can be seen that this same principle applies also, where beds of varying degrees of hardness have been folded or tilted. If, for example, a stream flows obliquely across an anticline, some of the component beds of which are softer than others, the tributaries which develop as subsequent streams will, as erosion proceeds, tend to carve out valleys along the junction of the hard and soft beds, and it is evident that the direction of these tributaries will be normal on one side of the main stream and abnormal on the other (Fig. 1). Pursuing the investigation a bit farther,

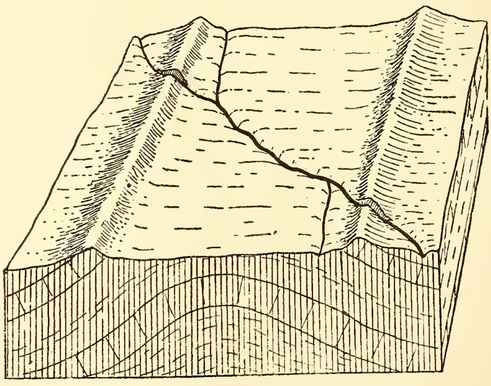

Fig. 1.

one can see that if the anticline in question has a pitch, the tributaries flowing along its flanks may diverge, giving all the features of a breached divide. (Fig. 2).

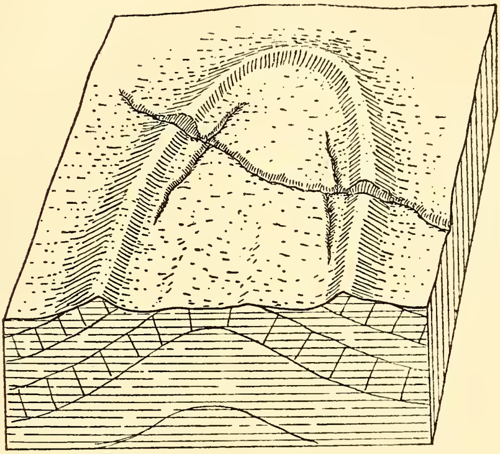

Fig. 2.

The same principle holds good if a consequent stream, working backwards, finds a barrier of resistant rock across its path. Instead of heading back through the barrier, it begins to throw out feelers, as it were, along the margin. This is well illustrated, as Andrews has pointed out,[1] by the Clarence River in New South Wales, where the courses of the north and south arms have been determined by an elongated mass of resistant New England granite running almost parallel to the coast and not quite at right angles to the course of the river. The result has been the production of a boathook bend where the south arm joins the main stream, while the junction of the north arm is a normal one.

Yet one more suggestion of a reason for the existence of boathook bends may be advanced, which is possibly applicable to some of the rivers of New South Wales. It may be that a stream is flowing towards the sea, when slow coastal uplift takes place, with a tilt inland. If the river has

[1] New South Wales Handbook, B.A.A.S., 1914 p. 512.

sufficient erosive energy it may succeed in keeping its course against the uplift, in other words it may become an antecedent stream. Now in the new cycle of erosion initiated by the uplift a certain amount of drainage will take place in an inland direction, and under these circumstances we might expect to find a main river flowing seawards against the rising ground, while those of its tributaries developed as a consequence of the uplift are flowing inland and forming boathook bends (Fig. 3, *a* and *b*).

A similar ultimate result might be brought about if the uplift was uniform, and raised a terrane consisting of level-bedded soft sediments overlying harder strata with a gentle inland dip. Immediately subsequent to the uplift the consequent tributaries would probably be normal in character, but eventually, when the softer strata were removed by denudation and the harder, underlying dipping strata formed the land surface, there would naturally result inland-flowing tributaries.

An interesting physiographical problem is presented by the relation of the Shoalhaven River to its tributary, the Kangaroo. The tributary meets the main stream between the right-angled bend at Tallong and the sea, and it makes a pronounced boathook junction. Taylor again sees in this fact evidence for a former western course for the Shoalhaven, but an examination of Harper's beautiful stereogram of the South Coast District shows that the gradual slope upwards in the land surface from the Sydney depression comes to an end about Robertson, from which point the tilt of the land surface (virtually the dip of the Hawkesbury Sandstone) which has been to the north and west, now changes to a slight but noticeable tilt to the south and west. It is through this country that the lower Shoalhaven flows, and it is here that the Kangaroo takes its rise—and, quite appropriately, a few leaps.

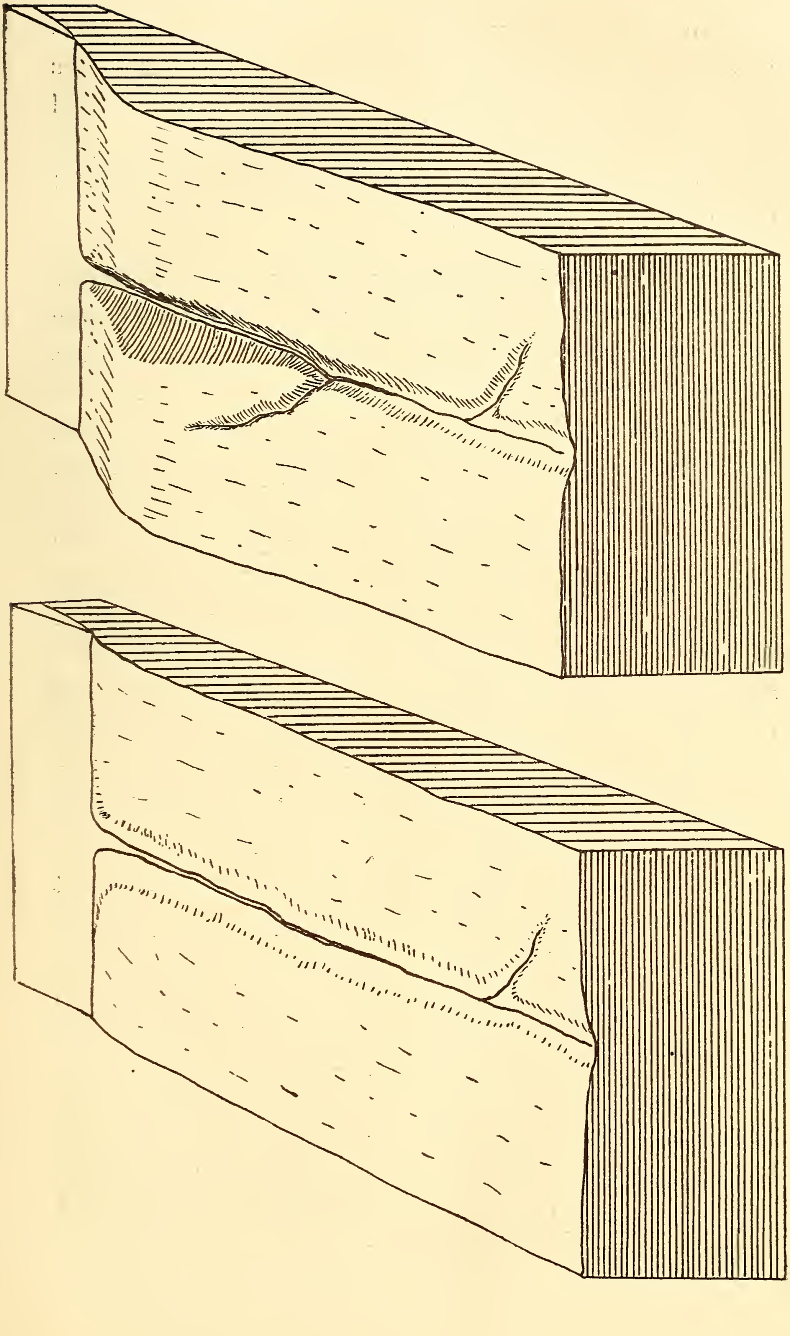

Fig. 3.

If we accept Andrews' theory that the Shoalhaven as it now exists antedates the Kosciusko uplift and kept its seaward course against the slow uprising of the coastal area, then it seems highly probable that the Kangaroo was brought into being subsequent to, and as a consequence of that uplift.

It seems not unlikely that investigation of the Hunter River and its tributaries would afford illustration of some of the principles enunciated above. Taylor maintains that this river, by reason of the softness of the Permo-Carboniferous sediments through which much of its course lies, has been enabled since Tertiary times to cut through the former divide and capture the head waters of some of the westerly-flowing streams. The theory is based, largely at all events, on the fact that a number of the tributaries of the Hunter form boathook bends with the main stream, and a breached divide is believed to exist near Pokolbin, the Wollombi Brook, Fal Brook, Upper Hunter and other tributaries entering the Hunter "up stream." Apart from the enormous amount of erosion with which this theory would credit the Hunter as compared with other east-flowing streams of similar age, there are a number of considerations which may well give us pause before we accept unreservedly the theory that a breached divide is indicated by the peculiar arrangement of the tributaries. If we neglect for the moment the "up stream" direction of certain of the tributaries, the Hunter system is essentially symmetrical, tributaries being developed on both sides, and the main stream (that is the Lower Hunter plus the Goulburn) having a remarkably straight course. If it can be proved that the boathook bends are due to an adjustment of the streams to structures, then the evidence for the breached divide breaks down.

Now not merely the soft Permo-Carboniferous, but the Carboniferous strata, of very varying degrees of hardness, play important parts in the structural geology, especially of the more easterly part of the Hunter Basin. In one part of the area the dominating geological structure is the great Lochinvar anticline, with a general south-south-west pitch. This structure is composed of hard Carboniferous rocks overlain by the generally softer strata of the Permo-Carboniferous. The Carboniferous contains such weak strata as the varve rocks on a number of different horizons, and the generally hard lava flows, tuffs and fluvio-glacial conglomerates. The Permo-Carboniferous strata are dominantly softer rocks, with occasional harder horizons such as the Ravensfield Sandstone.

Again, elsewhere, especially on the northern bank of the Lower Hunter, the strata are mainly Carboniferous, containing both hard and soft members, the strike showing in some cases a suggestive correspondence with the courses of tributaries.

It must be borne in mind, further, that both Carboniferous and Permo-Carboniferous strata have suffered considerable faulting, which has in all cases produced lines of weakness, and has sometimes brought soft Permo-Carboniferous strata into contact with hard Carboniferous rocks.

It is hardly to be expected that all these factors have been without considerable influence on the development of the river and its tributaries, especially as the whole basin is in a state of mature erosion. Indeed Andrews seems to believe that the straight course of the Goulburn-Lower Hunter river, as well as the low altitude of the divide at Cassilis are both due to a fault which lowered the height of the divide as compared with the New England and Central Tablelands, and formed a line of easy erosion for the stream that subsequently came into existence. The author has personally observed instances where the course of the Lower Hunter is determined by fault planes bringing Permo-Carboniferous sediments and Carboniferous lavas into juxtaposition, and where the stream winds in conformity with the hard lower or kernel strata of the Lochinvar anticline; and one tributary valley at least, strongly suggests, on stratigraphical grounds, a formation by trough-faulting.

Where such actual dependence of stream course on geological structure can be demonstrated, and where the possibilities for further such dependence exist, it seems that careful examination of all the apparent anomalies of behaviour of the Hunter tributaries should be made before the hypothesis of river capture and breached divide, with all that it implies, is finally accepted.

THE DECOMPOSITION OF DIMETHYL OXALATE BY ACETIC ACID.

By E. E. TURNER, B.A., D.Sc., A.I.C., and F. H. H. WILSON.

[*Read before the Royal Society of N. S. Wales, July 6, 1921.*]

THE difficulty attending the preparation of pure methyl acetate suggested the desirability of investigating the action of acetic acid under various conditions upon dimethyl oxalate, since the latter may be obtained in a state of purity starting from commercial methyl alcohol, even when this product contains ethyl alcohol, whilst methyl acetate cannot be prepared without a preliminary purification of the alcohol through dimethyl oxalate.

It was thought probable that slightly diluted acetic acid would react with dimethyl oxalate to give a sufficiently large yield of methyl acetate to render the method useful in the laboratory as a means of obtaining small quantities of methyl acetate such as are frequently required for physico-chemical work. In practice, the method is even better than was anticipated; with sixty-five to seventy-five per cent. acetic acid, dimethyl oxalate is very completely converted into methyl acetate.

The results of a few initial experiments are given below:

Percentage concentration of acetic acid.	Molecular proportions of water.	Percentage yield of methyl acetate.
100	0	0
95	1	6
80	4	40
77	5	70
70	7	83
65	9	76
58	12	64

Method: One molecular proportion of dimethyl oxalate heated under reflux with five molecular proportions of glacial acetic acid and the appropriate quantity of water for three hours; the products fractionated twice, and the methyl acetate formed analysed by the usual methods. (It contained not more than eight per cent. of water and less than 0·25 per cent. of acetic acid).

The above figures show that both glacial acetic acid and dilute acetic acid give less methyl acetate than acid of a moderate dilution.

Having established the fact that, with a large excess of acetic acid, dimethyl oxalate may be converted into methyl acetate, it was important to find to what extent a reduction of the excess could be carried. An experiment using one molecular proportion of dimethyl oxalate with two molecular proportions of acetic acid and two molecular proportions of water showed that an excess can be dispensed with entirely, since on this occasion over eighty per cent. of the desired conversion was effected.

It is thus evident that the investigation requires extending in order to determine, among other obvious factors:

(1) The optimum concentration of acetic acid for the conversion.

(2) The correlation between this concentration and the existence of definite hydrates of acetic acid.

(3) The extent to which the method is capable of extension for the preparation of methyl esters generally.

At this stage, it is sufficient to point out that pure acetic acid is practically undissociated, and dilute acetic acid dissociated to a measurable degree, and that a definite hydrate, $C_2H_4O_2, H_2O$ is known and corresponds to the 77 per cent. acid giving the best yield of ester. It should further be pointed out that the formation of methyl acetate does not depend on its withdrawal from the system in which it is produced, but is the result of the equilibrium expressed by the equation:

$$MeO_2C.CO_2Me + 2\ Me.CO_2H,\ aq. = HO_2C.CO_2H,\ aq. + 2\ Me.CO_2Me.$$

It is therefore hoped that subsequent experiments may throw some light on the mechanism of ester formation generally.

NOTES ON CASSITERITE CRYSTALS FROM THE NEW ENGLAND DISTRICT, NEW SOUTH WALES, AND STANTHORPE, QUEENSLAND.

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(Communicated by Assistant-Professor L. A. COTTON, M.A., D.Sc.)
With Plate I and 12 Figures.

[*Read before the Royal Society of N. S. Wales, July 6, 1921.*]

CASSITERITE.

The cassiterite crystals dealt with in this paper were obtained from various New England areas in New South Wales, and in one instance from Stanthorpe, Queensland. The majority of the crystals described were chosen from a hand specimen of felspathic vein material, very rich in cassiterite, from the Stannum district. For this unique specimen I am indebted to Assistant-Professor L. A. Cotton, who kindly placed it at my disposal. The investigation of these tinstone crystals constitutes the first part of the present paper. This is followed by notes on some well-formed crystals, exhibiting unusual features, from Pheasant Creek, Stanthorpe, and Mandoie Station in the Ashford district—these I owe to the kindness of Dr. Anderson, Director of the Australian Museum, in placing them at my disposal. Considerable work has already been done on the crystallography of cassiterite from the New England district,[1] but owing to the wealth of material at hand and

[1] Dr. C. Anderson: Rec. Aust. Museum, Vol. VI, Pt. 5, 1907, pp. 404–407; Vol. XIII, No. 1, 1920, pp. 22–25.

the economic importance of tinstone it seemed advisable that it should receive further investigation.

The specimen of felspathic vein material referred to above, was obtained from the Bark Hut Lode about one and a half miles from Stannum (Vide Plate I). It is rich in tin, which occurs as minute cassiterite crystals, especially abundant in numerous small vughs present, where the crystals line the walls of the cavities. Quartz is also present in well formed prisms contrasting with the decomposed felspars which form the bulk of the specimen.

The cassiterite crystals vary in appearance; the majority show highly polished smooth surfaces, while a few have lustreless faces and less smooth surfaces. A special feature of the crystals is their minute size—no intertwinned group observed exceeding 1·5 mm. in any direction, in fact the greater number of groups did not measure 1 mm. in their greatest dimension.

A number of crystals were carefully loosened from the rock and washed in alcohol, in readiness for examination. Over fifty crystals were selected, mounted, and observed; the majority proved quite valueless for goniometric work, but twelve crystals, in good state of preservation, were finally chosen as being sufficiently well developed to warrant measuring. In colour the crystals were mostly bluish-black, and generally have a marked lustre, but occasionally the reddish tinge of the so-called "ruby tin" could be observed.

With a single exception all the crystals are twinned, the twinning occurring on *e* (101), according to the usual law. Doublets are common, but triplets and fourlings are also frequent. Owing to the mode of attachment, rarely more than half a twin group is developed, thus accounting, probably, for the absence of crystals composed of more than four individuals.

The various members of all the twin groups observed tend, as far as may be judged from their development as twins, to assume the form shown in the single crystal (figs. 1, 2). Thus there is but one crystal type present, of which the single crystal is typical.

This type crystal is the only untwinned one observed; it is very small, measuring approximately ·75 × ·75 × ·6 mm. in the direction of the *a*, *b* and *c* axes respectively. It has a stout prismatic habit, and is terminated by a large basal pinacoid. All the prisms present with the exception of the *a* face, are strongly striated, the striations, running parallel to the *c* axis, being due to oscillatory combination between the various forms present, the first order prism *m* (110) being the predominating form. The *a* face is a well-marked smooth form giving excellent reflections. The prisms present are *a* (100), *m* (110), *B* (570), *r* (230), *h* (120) and (540)—the last mentioned one being listed by Borgström as a doubtful form. The *h* face is a remarkably narrow and frequently occurring form. Owing to the position and similarity in size of the two prominent prisms *a* (100) and *m* (110), the crystal assumes a roughly octagonal shape as seen in the orthographic drawing (fig. 1). This is still more emphasized by the presence of the large *c* face regularly bounded by the *s* and *e* faces. Other forms represented are the primary pyramid *s* (111), a prominent face with a bright smooth surface and yielding good reflections; the second order pyramid *e* (101), also a smooth face giving good reflections and rectangular in shape; *z* (231) a remarkably small form giving only faint signals, and *c* (001) the basal pinacoid, a large pitted and lustreless face, yielding very distorted reflections.

The main features of this crystal—striated strongly developed prism zone; smooth *a* face, giving excellent reflections (which are of great assistance in mounting the crystal); very narrow *h* face; large *m* face; prominent basal pinacoid with rough surface and giving poor reflections; and small *z* (231):—are also the chief features which characterize all the twinned crystals observed from this locality. Owing to twinning, however, the complete development of individual crystals has often been checked. Extra faces which occur on some twins, and which are absent from the type crystal are the prisms *k* (340) and *A* (780), sometimes replacing and sometimes occurring with *r* (230), *B* (570) and (540); and the pyramid *t* (133), a small face giving indefinite signals. (For frequency of occurrence of faces, see table of distribution of forms).

The common form of doublet developed is that shown in figs. 3 and 3a. Both segments are about the same size and equally developed. The twin plane is distinct, but rëentrant angles are not very marked. In other similar doublets the *t* (133) and *c* (001) faces are absent, and so the rëentrant angles are still less marked. A noteworthy feature is that certain *z* (231) faces of the normal crystal, instead of remaining small in size, often become elongated and narrow, running parallel to the twin plane. Occasionally only one individual of the twin is well developed (fig. 4), then the junction line between the two crystals follows an irregular course between the basal pinacoid of one crystal and the *a* face of the other segment. Thus the more developed crystal appears to arch over the other segment.

Sometimes, again, one or two small individuals are seen in twin position projecting from the end of a stoutly prismatic crystal, (fig. 5). The *s* (111), *z* (231) and *e* (101) faces are well developed on the large normal crystal and the twin segments projecting from these are clearly seen. In fig. 5 the third individual is extremely small and twinned on *e* ($\bar{1}$01), while the second larger segment is twinned on *e* (101) of the normal prismatic crystal.

Twin groups composed of three individuals are, relatively speaking, larger, the figured group measuring about 1·5 mm. in its greatest dimension (fig. 6). In contrast to the crystals described so far, the larger individual [which supports the two smaller portions twinned to it on the opposite faces of *e* (101)] is doubly terminated, large dull *c* faces being present. The composite crystal is inclined to be tabular on the plane containing the twin axes, so that the two opposite faces of *a* (100) are the largest planes developed. One of these, shown in front in the figure, is smooth and bright, giving a good signal, although it is a composite face formed by coplanar portions of the three twinned segments. The *a* face at the back of the drawing is rough and irregular and evidently the crystals were attached to the matrix by it. Another feature shown in the figure is the oscillation between *a*, *e* and *s*: this is unusual.[1]

Figure 7 represents a clinogram of a fourling. It is not unlike the triplet described above; the point of attachment to the matrix is again the $\bar{a}$ face. A third twin segment has been added to the normal large crystal thus eliminating one of the *c* faces.

Elements.—Twelve crystals were measured on the two-circle goniometer, five of these gave excellent signals, and the angles obtained from them were utilized to determine the axial ratio. The data and results appear in the following table.

Forms	ϕ	ρ	Limits. ϕ	Limits. ρ	No. of Observations.	c
e	0° 01½′	33° 53′	0°00′ – 0°04′	33°49 – 33°55′	11	·67155
s	45° 00′	43° 33′	44°56′ – 45°04′	43°31 – 43°36′	14	·67217

[1] Cf. Crystals described by Dr. Anderson, supposed to come from Tingha: Rec. Aust. Mus , Vol. XIII, No. 1, 1920, p. 23.

Weighting these results according to the number of observations made, the value of c is 0·67189 as compared with Becke's ratio 0·67232.

Combinations.—The following table shows the distribution of the forms in the twelve crystals examined. Where triplets and fourlings occur the table shows the aggregate number of forms developed on the segments twinned to the normal crystal. The table also gives the total number of faces present on each crystal. Crystal IX with 73 faces is the fourling shown in fig. 7. Crystal IV is the untwinned type crystal. It will be noticed that the most common forms are a (100), h (120), m (110), and z (231).

Forms and Angles.—The forms present, together with their measured angles and those calculated from the axial ratio are tabulated below, and the degree of error also shown. The average quality symbol of the signals observed is given in the second column. It will be seen that no results are given for c (001) due to the indefinite signals obtained. α signifies an excellent, and ϵ a very faint signal. Faces of the forms e (101) and s (111) will be seen to have two quality symbols, a good and a poor one. Both forms tend to be well developed and give bright signals, (when the readings obtained were used to determine the crystal elements), but where the twinning interferes with the development of these faces they are small and give poor reflections—hence the two quality symbols.

	NORMAL CRYSTAL.													TWIN CRYSTAL.												
Crystal.	*c* 001	*a* 100	*h* 120	*r* 230	*B* 570	*k* 340	– 540	*A* 780	*m* 110	*e* 101	*s* 111	*t* 133	*z* 231	*c* 001	*a* 100	*h* 120	*r* 230	*k* 340	– 540	*A* 780	*m* 110	*e* 101	*s* 111	*t* 133	*z* 231	No. of Faces on Crystal
I.	×	×	×	–	×	×	–	–	×	×	×	×	×	×	×	×	–	×	–	–	×	×	×	×	×	35
II.	–	×	×	–	–	×	–	–	×	–	×	–	×	×	×	×	–	×	–	–	×	×	×	–	×	27
III.	–	×	×	–	–	×	–	×	×	×	×	–	×	×	×	×	×	–	–	×	×	×	×	–	×	58
IV.	×	×	×	×	×	–	×	–	×	×	×	–	×	–	–	–	–	–	–	–	–	–	–	–	–	37
V.	×	×	×	–	–	×	–	–	×	×	×	–	×	×	×	×	×	×	–	–	×	×	×	–	×	56
VI.	–	×	×	×	–	×	–	–	×	×	–	–	×	–	×	×	×	–	–	–	×	–	–	–	–	26
VII.	×	×	×	–	–	×	–	–	×	×	×	×	×	–	×	×	×	×	–	–	×	–	–	–	×	31
VIII	–	×	×	–	–	×	–	×	×	×	×	–	×	–	×	×	–	×	–	–	×	–	–	–	–	18
IX.	×	×	×	–	×	×	×	–	×	×	×	–	×	×	×	×	×	×	×	–	×	×	×	–	×	73
X.	×	×	×	–	×	×	–	×	×	×	×	–	×	×	×	×	–	×	–	×	×	×	×	–	×	47
XI.	×	×	×	×	–	×	–	×	×	×	×	–	×	×	×	×	–	×	–	×	×	×	×	–	×	51
XII.	×	×	×	×	×	×	–	×	×	×	×	×	×	×	×	×	×	×	–	×	×	×	×	–	×	48

ANGLES.

Form.		Average Quality Symbol.	Measured. ϕ		Measured. ρ		Calculated. ϕ		Calculated. ρ		Error. ϕ	Error. ρ
			°	′	°	′	″	′	°	′	′	′
c	001	indefinite	–		–		–		–		–	–
a	100	α	0	02	90	00	0	00	90	00	2	0
h	120	δ	26	35	,,		26	34	,,		1	0
r	230	δ	33	45	,,		33	41	,,		4	0
B	570	γ	35	37	,,		35	32	,,		5	0
k	340	$\gamma-\delta$	36	49	,,		36	52	,,		3	0
–	540	γ	38	31	,,		38	32	,,		1	0
A	780	$\gamma-\delta$	41	13	,,		41	11	,,		2	0
m	110	$\beta-\alpha$	44	59	,,		45	00	,,		1	0
e	101	$^{1)}\beta\ ^{2},\epsilon$	0	04	33	52	0	00	33	54	4	2
s	111	$^{1)}\beta\ ^{2)}\delta$	45	00	43	32	45	00	43	33	0	1
t	133	δ	18	40	35	07	18	26	35	19	14	12
z	231	ϵ	33	39	67	31	33	41	67	35	2	4
$\underline{c}$	001	indefinite	–		–		–		67	48	–	–
$\underline{a}$	100	α	0	06	22	08	0	00	22	12	6	4
$\underline{h}$	120	$\delta-\epsilon$	10	41	65	33	10	41	65	32	0	1
			37	09	34	10	37	05	34	06	4	4
$\underline{r}$	230	$\gamma-\delta$	14	19	59	12	14	08	59	06	11	6
			29	38	39	27	29	32	39	36	6	9
$\underline{k}$	340	$\gamma-\delta$	15	56	56	26	15	48	56	15	8	11
			26	37	42	13	26	44	42	12	7	1
–	540	δ	16	37	54	39	16	48	54	46	11	7
$\underline{A}$	780	δ	23	19	45	37	23	30	45	32	11	5
$\underline{m}$	110	$\alpha-\beta$	20	38	49	12	20	41	49	06	3	6
$\underline{e}$	101	$^{1)}\beta\ ^{2)}\epsilon$	0	02	33	51	0	00	33	54	2	3
			0	01	78	20	0	00	78	18	1	2
			35	51	71	48	35	45	71	40	6	8
$\underline{s}$	111	$\beta-\gamma$	45	06	43	32	45	00	43	33	6	1
			29	43	79	49	29	40	79	48	3	1
$\underline{t}$	133	ϵ	10	37	78	44	10	48	78	30	11	14
$\underline{z}$	231	ϵ	6	56	31	25	7	00	31	06	4	19
			11	30	51	48	11	41	51	46	11	2
			38	26	55	19	38	32	55	23	6	4
			35	18	70	24	35	25	70	42	7	18

PHEASANT CREEK, (Fig. 8).

A doublet from this locality was examined and has proved of unusual interest.

Only about half the crystal is developed; it measures 3 × 2 mm., and is black in color with reddish patches. The faces are smooth and very bright giving excellent reflections, and striations are entirely absent.

The prism zone in both individuals is well developed; the forms represented are the commonly occurring *a* (100), *h* (120), *r* (230), and *m* (110). The pyramids *s* (111) and *z* (231) are present, and also the very uncommon forms

ANGLES.

Forms.		Measured. ϕ		Measured. ρ		Calculated. ϕ		Calculated. ρ	
		°	′	°	′	°	′	°	′
a	100	0	03	90	00	0	00	90	00
h	120	26	28	,,		26	34	,,	
r	230	33	36	,,		33	41	,,	
m	110	45	08	,,		45	00	,,	
S	111	45	08	43	34	45	00	43	33
Z	231	33	46	67	36	33	41	67	35
N	241	26	43	71	12	26	34	71	36
M	8.15.4	28	15	70	50	28	04	70	40
R	13.17.6	37	20	67	42	37	24	67	22
$\underline{a}$	100	0	14	22	15	0	00	22	12
$\underline{h}$	120	37	04	34	17	37	05	34	06
$\underline{r}$	230	29	51	39	36	29	32	39	36
$\underline{m}$	110	20	42	49	11	20	41	49	06
$\underline{z}$	231	6	47	30	50	7	00	31	06
$\underline{z}$	231	38	25	55	11	38	32	55	23
$\underline{s}$	111	45	19	43	46	45	00	43	33
$\underline{s}$	111	29	49	79	54	29	40	79	48
$\underline{N}$	241	2	40	25	21	2	42	25	11
$\underline{N}$	241	35	19	47	01	35	17	47	17

N (241), *M* (8.15.4.), and *R* (13.17.6). The form *N* occurs several times on both portions of the twin, a small irregularly shaped face, while *M* and *R* occur only on the larger segment. *R* is a long narrow face, *M* is relatively large, almost replacing *N*, which is correspondingly small where these occur together. *N*, *M* and *R* are extremely unusual forms, and have been described by Borgström in cassiterite crystals from Pitkäranta.[1] The forms observed are listed in the table above showing their measured and calculated ϕ and ρ.

STANTHORPE, QUEENSLAND, (Figs. 9, 10.)

This crystal is by far the largest examined, measuring $1{\cdot}2 \times 1$ cm. in the direction of the *c* and *a* axes respectively. It is doubly terminated, the primary pyramids *s* (111) being very prominent, and the *e* (101) faces almost entirely absent. Two parallel *a* faces (100) ($\bar{1}00$) are very large, thus giving the crystal a tabular habit; the faces of the prism zone are relatively small and striated. The crystal is dark, with distinct lustre, but it is not in a good state of preservation, and it is feared that some small faces along the edges have been lost. The reflections, generally, were satisfactory, and the readings reliable; a table of angles is omitted as it is not considered necessary. The large crystal supports at one end a very small crystal in twin position, and a distinct feature is the oscillation which has occurred during development from one segment to the other, as seen on the prism zone. This zone in the large crystal is cut by the prism zone of the small twin (fig. 9); and it is noteworthy that the *a* face is present on the lower portion of the prism zone and absent from the upper. Moreover this also applies to the twin which is divided by the upper portion of the prism zone of the first crystal.

[1] Zeitschrift für Krystallographie, Band 40, 1905, pp. 1 – 12.

The forms present are *s* (111), *e* (101), *z* (231), and the prisms *a* (100), *m* (110), *B* (570), *r* (230), *h* (120) and (130). This last mentioned form is referred to by Hintze[1] and is very unusual. Readings obtained for ϕ (130) were 18° 21′ and 18° 27′, as compared with the calculated ϕ angle 18°26.′

MANDOIE STATION, ASHFORD DISTRICT.

(Figs. 11, 12.)

The crystal illustrated is one of two fine specimens from this district kindly placed at my disposal by Dr. Anderson. The crystals are similar; the larger measures 8 mm. in diameter, and the smaller (the one described here) is about half this dimension.

This crystal supports at one end a very small segment in twin position according to the usual law, but this is so small as to admit of an almost complete development of the larger crystal. The faces of the larger crystal are smooth and well developed, giving excellent reflections, and measured and calculated angles are in close agreement; those of the smaller segment, however, give distorted reflections and unreliable readings, hence the dotted lines.

The crystal is doubly terminated; the pyramids *s* (111), *z* (231), and *e* (101) are prominent, and the prism zone is reduced to a few small faces *a* (100), *r* (230), *h* (120) and *m* (110), and at times these too are absent. Thus the crystal has a strikingly bipyramidal habit. A curious feature is the fact that the two *z* (231) faces near the broken portion of the crystal, marked z'' and z''' respectively, have replaced each other, thus giving that part of the crystal an unusual aspect. A table of angles has not been appended for this crystal, as it was thought unnecessary.

Summary.—All the crystals taken from the hand specimen of felspathic vein material, were remarkably small, and

[1] Hintze: Handbuch der Mineralogie, Vol. I, 1902, p. 1679

only the minority were of value for goniometric work. The crystals observed all belong to one type, as exhibited by the only single crystal found. Doublets are common, but triplets and fourlings also occur. The crystals are singly terminated, except in the more complex groups, which are doubly terminated and where the point of attachment to the rock matrix is the *a* face. A stout prismatic habit prevails, and the prisms, with the exception of *a* (100), are strongly striated; the basal pinacoid is usually present as a pitted face giving indefinite signals, and *z* (231) occurs as very small faces. The forms developed are *a* (100), *c* (001), *h* (120), *r* (230), *B* (570), *k* (340), *A* (780), *m* (110), *e* (101), *s* (111), *t* (133), *z* (231) and (540); the last mentioned face is not listed in Goldschmidt's "Winkeltabellen." The most commonly occurring forms are *a* (100), *h* (120), *m* (110) and *z* (231).

The doublet examined from Pheasant Creek has the following forms developed: *a* (100), *h* (120), *r* (230), *m* (110), *s* (111), *z* (231), *N* (241), *M* (8.15.4) and *R* (13.17.6). *N*, *M*, and *R* are rare forms occurring also on crystals from Pitkäranta.

The crystal from Stanthorpe is large and doubly terminated, the primary pyramids being very prominent; in habit it is tabular. During development, oscillation has occurred between this crystal and the small twin it supports at one end.

The doublet described from Mandoie Station consists of a large crystal of bipyramidal habit and a small segment in twin position. The prism zone is reduced to a few small faces *a* (100), *r* (230), *m* (110) and *h* (120), and the pyramids *s*, *e* and *z* are prominent.

In conclusion I wish to express my indebtednes to Professor Sir Edgeworth David for the encouragement given and the interest he has always taken in this investigation. To Assistant-Professor L. A. Cotton my best thanks are due, for his kindness in placing the material at my disposal,

and for valuable advice on various points. In particular, I wish to record my indebtedness to Dr. C. Anderson, Director of the Australian Museum, for his constant generous help and advice, and his kindness in placing some excellent crystals at my disposal.

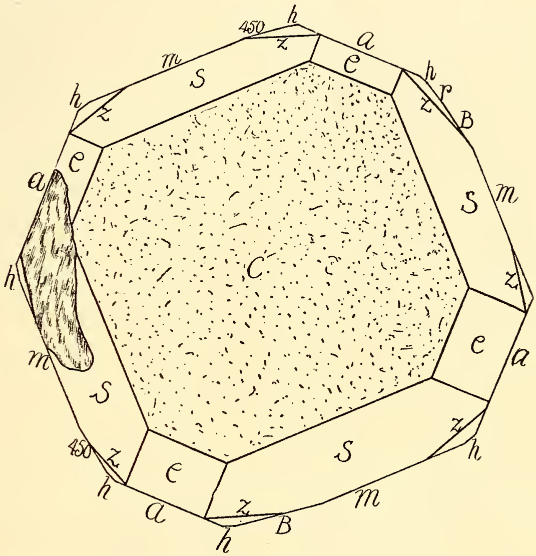

Fig. 1.

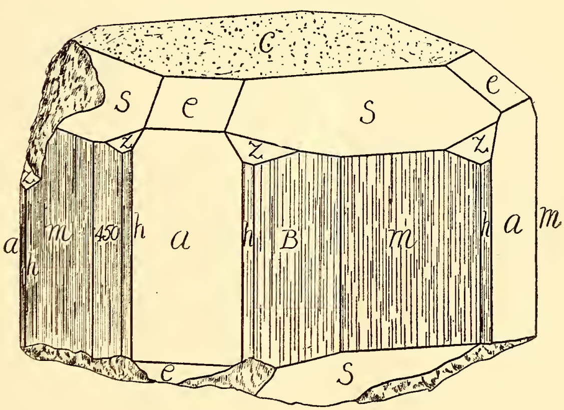

Fig. 2.

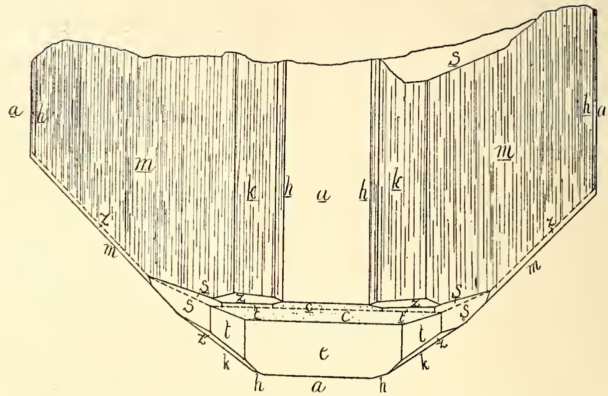

Fig. 3.

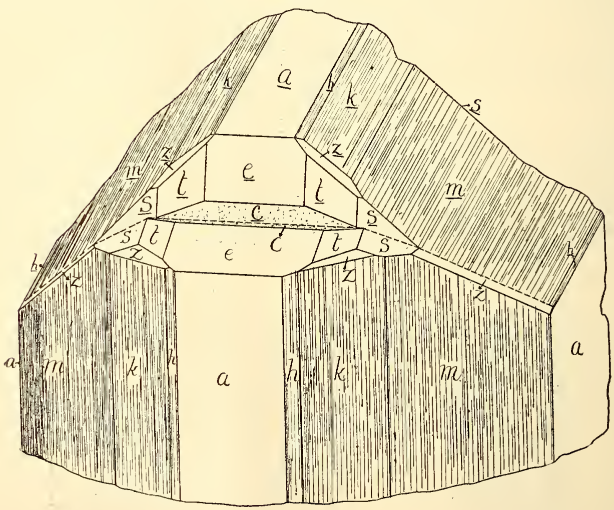

Fig. 3A.

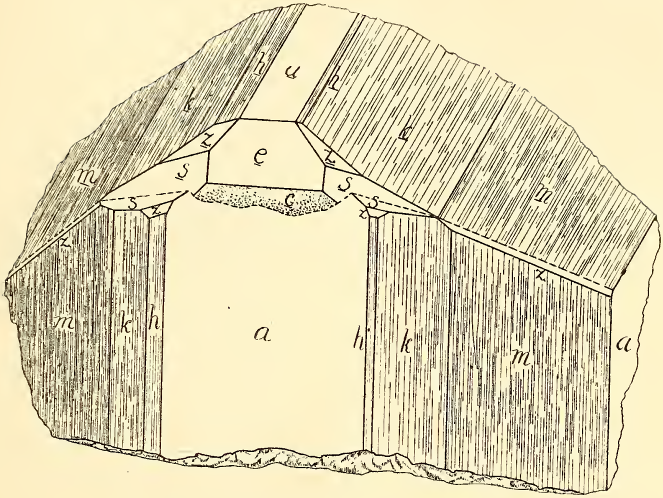
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Fig. 4.

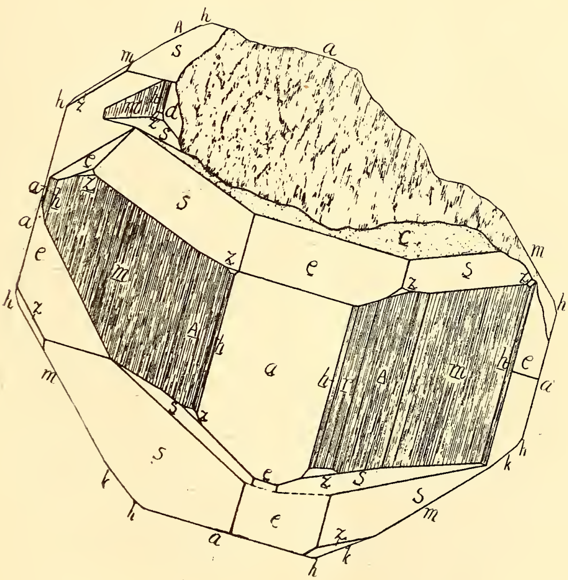
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Fig. 5.

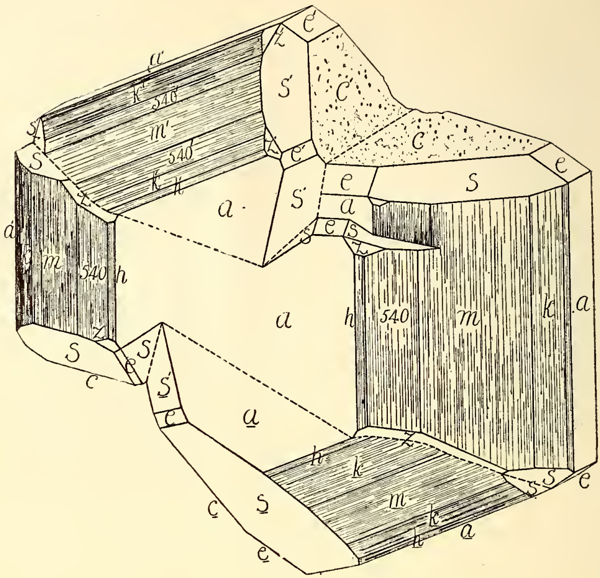

Fig. 6.

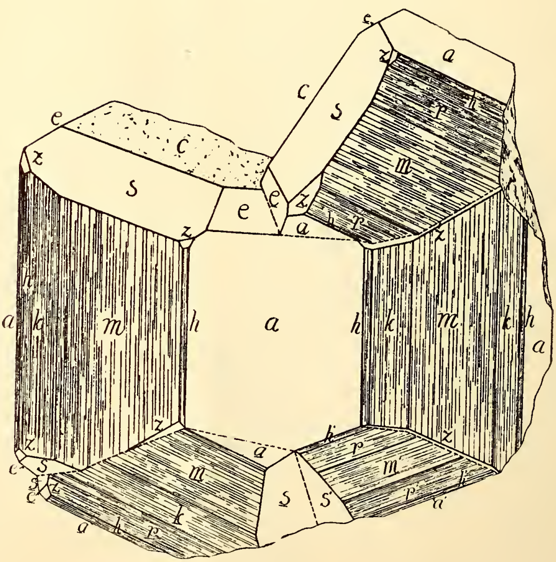

Fig. 7.

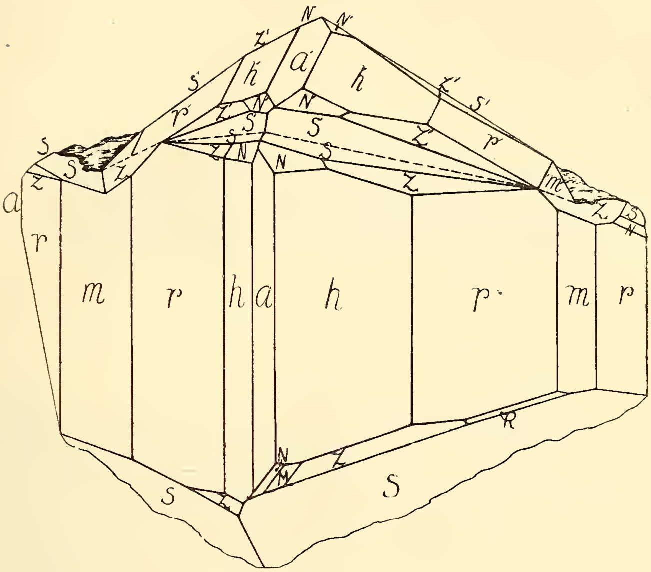

Fig. 8.

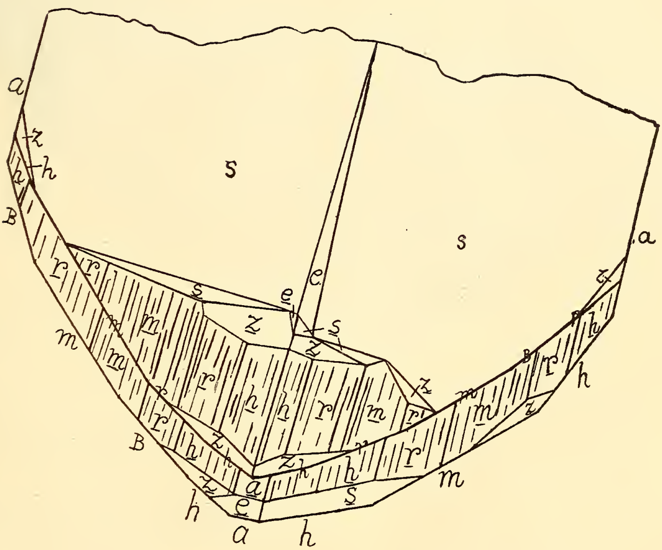

Fig. 9.

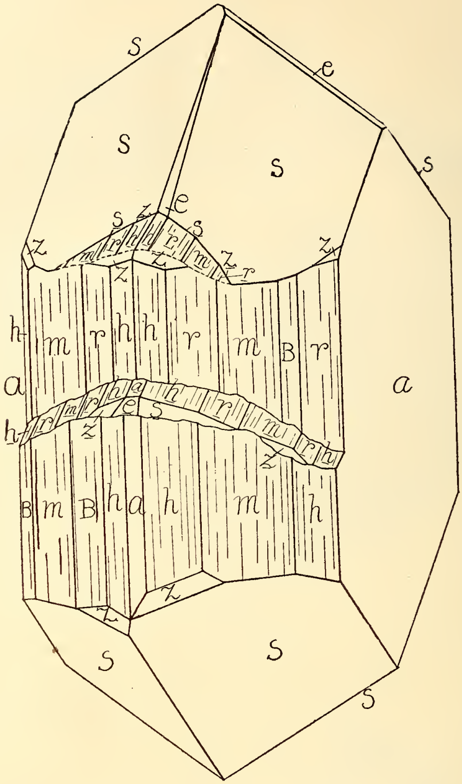

Fig. 10.

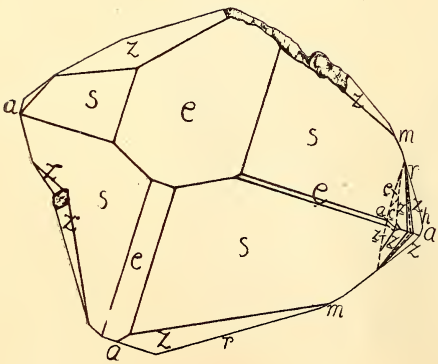

Fig. 11.

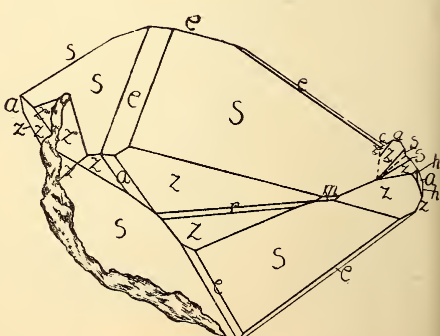

Fig. 12.

Felspathic vein material from Bark Hut lode.

THE KURRAJONG EARTHQUAKE OF AUGUST 15TH, 1919.

By Assistant-Professor LEO A. COTTON, M.A., D.Sc.

[*Read before the Royal Society of N. S. Wales, July 6, 1921.*]

THE earthquake described in this paper occurred on Friday 15th August, 1919 at 8·23 p.m. Sydney standard time. The shock was distinctly felt throughout the city and suburbs, though not noticed by all persons. It was not felt in this area by people who were moving about at the time.

Earthquakes are relatively rare in the Sydney district, and no systematic study of their occurrence has yet been attempted. The first Seismological Committee of the Australasian Association for the Advancement of Science tabulated the earthquakes of Australasia for the period 1880 to 1891, but this good work has not been kept up to date.(5)

In the interval mentioned four earthquakes were noticed which affected the Sydney district. Two of these appear to have originated in the Southern District, the particulars indicating seismic foci near Yass in one case and near Lake George in the other.

A summary of the chief features of these is given as follows:—

Yass Earthquake.

Date.	Intensity at Yass.	Intensity at Sydney
30th November 1886.	VII.	IV.

Lake George Earthquake.

Date.	Intensity at L. George.	Intensity at Sydney.
6th July, 1888.	III. to IV.	III.

In addition to these there are two other shocks which affected the Sydney district, and these appear to have been felt more severely at Mulgoa and Double Bay respectively. The particulars are as follows:—

Mulgoa Earthquake.

Date.	Intensity at Mulgoa.
26th March, 1886.	III.

Double Bay Earthquake.

Date.	Intensity at Double Bay.
4th June, 1890.	IV to V.

Unfortunately no records appear to have been kept prior to 1880 nor since 1891.

The only account of an earthquake in the Sydney district prior to 1880 with which the writer is acquainted is that kindly supplied to him by Professor Wood. This account appeared in Historical Records of New South Wales, and because of its relation to the recent Kurrajong earthquake described in this paper is quoted in full as follows:—

"From 'Historical Records of New South Wales,' page 315, Vol. IV.—Hunter and King, 1800, 1801, 1802.

Parramatta, 25th August, 1801.

Sir—About 11 o'clock at night on 12th February, 1801, I was awoke by an earthquake, which gave repeated shocks for about three minutes, though in other places not far from me it was said not to last above a few seconds. At Sydney I believe it was but little felt, but at the Hawkesbury it was felt as severe as with me. It came from the east and proceeded to the west—that is, it began at the eastern end of the house and went off at the western. It first began like thunder at a distance, and shortly after the floor began to move under me with such violence as I think would have thrown me down had I been standing up or walking. Fortunately no further damage was done than a few brick houses a little shattered, where it was felt with less violence than with me. Had the like happened in England the consequence must have been fatal, for the buildings would have been very much shattered and many thrown down. At this time the weather was hot and close, and the clouds very large. Thunder and lightening is very common, but of late we have not had any. I lament that I was asleep, as at first when it waked me I was like as if I was stupified.

Yours etc., George Caley."

From this letter it appears that the shock was greater in the Hawkesbury district than at Sydney, so that quite probably the earthquake originated along the Kurrajong Fault.

Doubtless other earthquakes have from time to time been felt at Sydney, and it is desirable that accounts of these should be collected and recorded; but this work is beyond the scope of the present paper.

The first reports of the recent Kurrajong earthquake which came to hand were naturally from the metropolitan area. From the newspaper accounts it appeared that the shock was felt more strongly along the coastal area than in the city and western suburbs. This suggested that the earthquake was of submarine origin.

The author has recently been working on the problem of earthquake frequency and tidal stresses in the lithosphere. It was natural that he should have made an application of his results to this earthquake. It was found that the tidal stresses were such as to tend to cause rupture on a nearly meridional fault dipping at about 64° to the west. The only considerable fault known in the Sydney district which has a westerly dip is that described by Professor David as the Kurrajong fault. It therefore seemed important to obtain information from this locality. On the second day after the earthquake the writer therefore visited the Kurrajong and made personal inquiries from a number of residents. He found that the shock was much more severe here than in the city or suburbs. A careful search also enabled him to find a good exposure of the fault plane and to record the dip which is an angle of 59° in a direction W. 14° S.

Hence it appeared probable that the Kurrajong fault may have been the origin of the shock and that the movement was precipitated by tidal forces.

In order to ascertain as accurately as possible the area of greatest disturbance it was desirable to collect sufficient information to enable the isoseismals to be drawn. The following circular was therefore sent to the headmasters of schools within an area, which, judging by the newspaper accounts, seemed sufficient for the purpose:—

"Geology Department, Sydney University,
18/8/19.

The Headmaster. Public School ————

Dear Sir,—You have no doubt heard of the earthquake which was felt in the Sydney district on Friday night last. The shock occurred at 8·21 p.m. and appears to have been felt over a considerable area. In view of the rarity of such shocks in the past it is very important to obtain full and accurate data of this earthquake. One looks naturally to a teacher as the most capable investigator in such matters because of his educational training The school, too, is an ideal centre of investigation as it reaches practically every family and home in the district. Will you be kind enough to assist in this question and so make a contribution to the Advancement of Science?

It is important to collect as far as possible answers to the following questions:—

1. Was the earthquake generally felt by everyone in the district?
2. Was it felt by people moving about out of doors?
3. Was it felt only by people at rest indoors?
4. Was it possible to estimate the direction in which the shaking took place?
5. Was the earthquake accompanied by any sound?
6. Was the sound heard before or after the shock was felt?

7. Was there any disturbance of movable objects, such as, doors, windows, cracking of ceilings?

8. Was there any disturbance of furniture, beds, tables, etc.?

9. Was there any movement of suspended objects such as chandeliers?

10. Was there any stoppage of clocks by the shock?

11. Was there any overthrow of movable objects such as a fall of plaster, ringing of church bells?

12. Was there any fall of chimneys or cracking of walls of buildings?

Might I suggest that the questions listed above be dictated to the school children who might take them home and ask their parents to furnish the answers. Any other particulars bearing on the earthquake but not covered by the questions would be welcomed.

It is also desirable to find out whether any earthquake shock has previously been felt in your district and to obtain as accurately as possible the time of day and date of its occurrence.

As it is quite possible that further shocks might be felt I should be grateful if you would be willing to co-operate in further investigations by instituting inquiries immediately following any such occurrence."

The press also kindly published the above circular and many replies were received from this source. The Meteorological Bureau also very generously instituted special enquiries and placed much useful information at the writer's disposal. Altogether more than one hundred replies were received. In a number of cases a single reply represented many—even some hundreds of enquiries.

In order to eliminate as far as possible any unconscious personal bias, the letters received were each summarised in a card index, one card being used for each letter. The cards were then examined without reference to the geographical position of the informant, and estimates of the intensity on the Rossi-Forel scale were noted on each card. A map was then prepared showing the distribution of the recorded intensities. This map was prepared so that it showed no place names, but only the distribution of seismic intensities. From this map the isoseismals were drawn. (Fig. 1.)

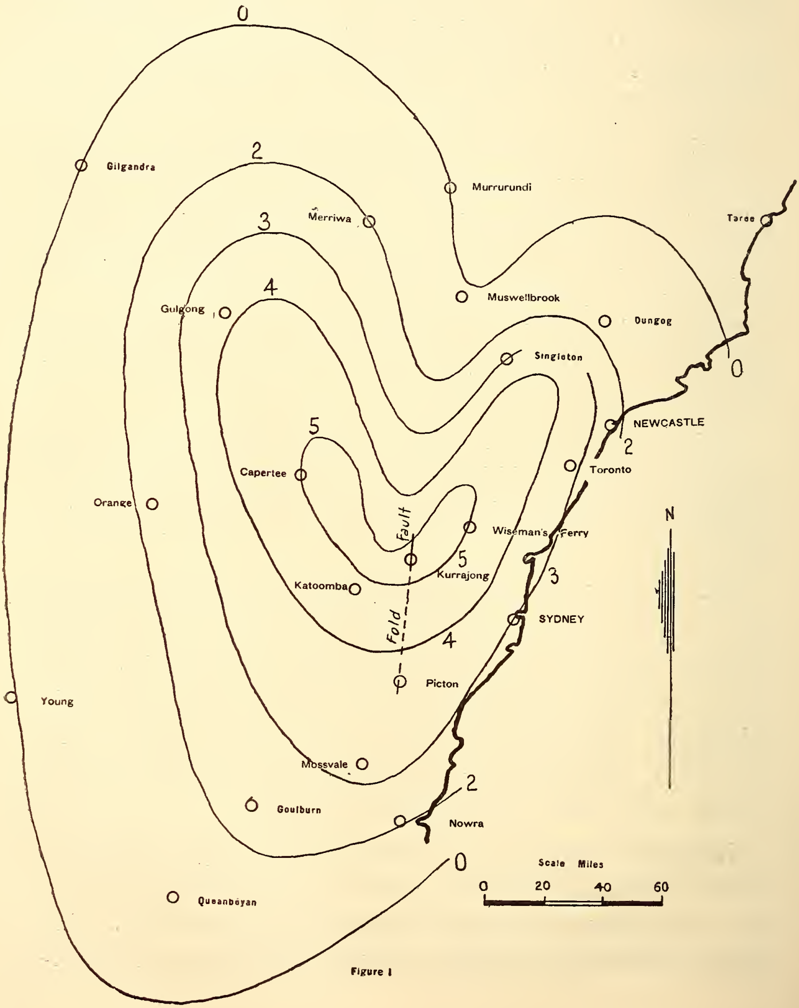

Figure I

The isoseismals show that this earthquake has some special features which render it of great importance, and it is therefore desirable to publish a number of the letters received describing the phenomena within the region where the shock was felt. The more important of these are given as follows:—

Report of L. S. Vincent Welsh of Abermain.

"Without the least warning a distinct pulsating rumble with vibration of the floor commenced. (The house is large, is built of wood, and supported upon brick pillars.) The pulsations gave one the impression that some great force of wind was swaying the house. My sense of direction suggested to me that the pulsations were coming from the south, as that is where they seemed to originate.

The floor appeared to give violent bumps as though some one were jumping hard upon it (possibly the joists lifted from the brick piers) The windows and doors rattled violently. I called out to my housekeeper to ask her what she was jumping about for in her room. She came to her door in a seriously alarmed state and said that she was at a loss to account for the noise. The house stands upon a gravel soil overlying thick beds of sandstone and lower down conglomerate overlying the lower seam of Abermain No. 1 Coal Mine.

The strata are dipping in a south-easterly direction. I remarked at the time that the disturbance was due either to an earth tremor or else to a huge fall in the mine. I was greatly interested to read next day an account of this earth tremor. Curiously enough the only other people about this township who heard the quake live almost in a a line with me in a southerly direction. The owner of the house is head clerk at the Abermain mine and his first impression was that a big subsidence had taken place in the mine, as the workings extend under our house."

Report of Meteorological Bureau, Bathurst.

"Although the shock was not very severe it was felt by persons moving about the streets. Persons at rest indoors felt the shock quite distinctly."

Report of George Tyndsley of Beecroft.

"The shock was plainly felt between Cheltenham and Beecroft. Crockery rattled, and a boy of 9 or 10 who was alone in the house ran out and took refuge with a neighbour."

Meteorological Report, Berry.

"The earthquake was felt only on the higher portion of the town; the shock concentrated itself in about a quarter of a mile on the hill of this township. One house right on the top of the town reports that a table moved at least three inches."

Report of O. Brown of Bilpin.

"The earthquake seems to have been felt locally to a more considerable extent than in any other district judging by the press reports on the occurrence. A lady resident experienced a distinct lurch forward against a table at which she was standing, whilst her young son was almost thrown from his bed experiencing quite a shock. A slight earthquake shock was felt at Mount Irvine about ten years ago at midnight."

Report from Mrs. Chapman of Blackheath.

Mrs. Chapman was expecting her husband home by the train due at Blackheath at 8·23 p.m. She heard a rumbling which she thought was the train approaching from the south and noted a silver mug move slightly on the polished surface of the sideboard. The train, as it happened, was late, and could not have caused the noise or the vibration.

Meteorological Report, Brooklyn.

"The motion felt as though the house were shivering. I was seated in a heavy armchair and felt the chair being agitated but heard no sound. The tremor took place shortly after 8 p.m. One member of my family was at work in the machine shop (mechanical) and all the tools and windows, as well as the building were agitated. We are located right on the main Divide."

Report of H. W. Smith of Cassilis.

"The shock must have been slight in this locality as it was felt by comparatively few persons and no damage occurred."

Meteorological Report, Cooerwull.

"People walking about in the house noticed it. The kitchen stove was shifted slightly and the crockery on the table rattled. The electric light suspended from the ceiling swung to and fro."

Report of A. E. Drew, Gulgong.

"In some instances crockery was shaken off the dressers or mantle pieces, and there are some who being in bed say that their beds were momentarily shaken. A wall was cracked in the centre of the town and some tanks rumbled."

Report of F. Cotton of Hornsby.

"I was sitting in a room when I felt a sudden decided shake. The windows were shaken as they sometimes are by a passing train—but there was no train—and the ceiling which is cracked seemed to be suddenly cracking all over. The earthquake was accompanied by a rumbling sound—as of a very heavy dray rumbling over a bridge."

Report of Edith F. Suttor of Katella.

"On the night in question we were playing cards when our attention was suddenly attracted by a noise as if a huge bird was flying round and round the chandelier and we all looked up to see what caused it, and were waiting to hear it again when we felt our chairs rock. I was sitting on a large Chesterfield facing the doors which open on to the verandah (front)—our house faces due east—and the sofa distinctly rocked from east to west. I cannot say whether the chandelier moved as I was most concerned about some china ornaments on the mantle piece which we could hear rocking."

Report of Mrs. E. Freeman of Katoomba.

"On the night of the tremor I was standing at a table thinking about retiring, when suddenly the place shook as if after a blast had exploded. It was very pronounced."

L. A. Cotton from enquiries at Kurrajong.

" The shock was most pronounced in this locality.

A lady who was at the time at the washup basin felt the table (which is a very heavy one) give a sudden jolt upwards, and looked under the table to ascertain the cause.

Another observer states that the whole house shook violently as if shaken by a heavy explosion. The movement seemed to be upward from beneath the house.

In many houses the furniture moved and alarmed the inmates."

Report of T. T. Goff of Mangrove Creek.

" My own experience was whilst sitting reading in School Residence. I was sitting with legs of chair tilted backwards when the shock reached the residence. I heard as though the bump of (say an elephant) against the N.W. corner of room, and the windows rattled loudly—wall and roof creaked and I thought I noticed the swaying movement. I felt it sufficiently to lose balance on chair and immediately got up and went round the house to see what had bumped it."

Report of A. A. Roberts of Macdonald Upper.

"Several persons moving about out of doors felt the shock. Some who had been asleep were awakened by it. Movement of beds was felt by persons lying in them. Soot fell from chimneys and "candle bark" was observed by one person to fall from gum trees."

Report of F. A. Heffernan of Mount Wilson.

"In most of the homes there was a decided movement, windows rattled, crockery moved, in one house the clock stopped, and the occupants of chairs were almost thrown into each others' arms. In another house the inmates became so alarmed they left the sitting room and went outside, they thought that the safest plan, the chandelier shook so much, and they swayed in their chairs they knew something very unusual was happening."

Meteorological Report, Newcastle.

"There was a very slight earthquake shock felt at Newcastle on August 15th at 8·15 p.m. The tremor was so very slight at Newcastle that it was only felt by a few people at rest indoors. At Raymond Terrace, a small country town sixteen miles north of Newcastle, it was felt more severely. It is reported to have disturbed the furniture, shaken walls and windows, etc."

Report of L. Macrae of Newnes.

"Felt by all. Beds and tables noted to move. Electric chandeliers moved."

Report of J. B. Murphy of Pitt Town.

"On night of shock I was sitting on edge of rocking chair leaning forward with elbows on my knees. A sudden thud as of a heavy body falling or the sound of a dynamite explosion underground followed by rather violent oscillation lasting about two seconds. My chair rocked perceptibly, helped no doubt by my forward position. I was facing S.S.W. and the impression conveyed to my mind was that the motion was from S.W. My daughter was practising music in room (S.W. corner of house) and rushed out alarmed at the concussion and jangle of the piano. She says that the door, slightly ajar opened about six inches, and that the ceiling cracked. The window shook violently as from someone shaking it from outside."

Report of F. W. Parker of Richmond.

"I was sitting reading facing W. with arms resting on a table in a cottage at the College, which is of weatherboard. Suddenly the table began to rock in a direction roughly N.N.E.—S.S.W. Could not tell from which direction shock travelled. Looked at watch, 8·20. Knew it was an earthquake as have had experience in California. The table rocked quite hard for quite half a minute. Windows rattled with considerable noise and quick movements, suggesting that they were across line of movement. Went out on verandah where some loose sheets of iron rattled hard."

Reports from Sydney District.

Report of A. Whitehead of Brighton-le-Sands.

"I may state that I was at home when all of a sudden I heard a peculiar noise like a heavy woof, and looking up the china in dresser rattled, and in the breakfastroom, which is lined with match lining, I distinctly saw the wall move. The boards moved in their groves and tongues which appeared to be wonderful. They moved twice. On looking at the clock it was just 23 past 8. I wish to state that I am a carpenter and joiner by trade, and my cottage I built myself, and it is well braced."

Report of Master Jack Sharpe of Burwood.

When I was lying in bed awake on Friday night suddenly the whole room shook and the door started to slam quickly to, but when it got about three-quarters of the way it started to go slowly, it just touched the catch but did not latch. My bed kept on shaking and the bedstead hit a picture at the top of the bed, and made it rattle. It made me hold my breath, and when the bed stopped shaking I hopped out of bed and crept down stairs and told my sisters about it. They said they heard a noise and thought it was somebody knocking hard at the back door, or a door slamming, but never heard it again so thought it was nothing and took me back to bed again."

Report of J. Reynolds of Croydon.

"About 8·20 p.m. when seated round the fire, the room being perfectly still, we were startled by a distinct trembling of the house. Our attention was particularly drawn to the door of the room facing east which shook rapidly five or six times. It was closed at the time. A sideboard on the same side as the door as well as the articles on it also trembled. Another member of the family drew attention to the shaking of the gas jet suspended from the ceiling. I remarked at the time that it was evidently an earth tremor and I eagerly scanned the paper the following morning to see if it had been recorded."

Report of E. Tulloch of Double Bay.

"On the night of the tremor I was reading and heard a rumbling noise as if a heavily laden vehicle was passing. The furniture was shaken and the crockery rattled. The chair on which I was sitting moved gently. (Time about 8·15 p.m.) I became alarmed and went outside to where my husband was smoking. He had not felt or heard any noise."

Report of Captain T. H. Brownlow of Double Bay.

"I was at my private residence at lower Ocean Street, Double Bay situated close to the harbour front and very few feet above sea level. The night was very still and I was reading with one arm resting on the dining room table, facing eastward when suddenly and without warning I felt a sudden jolt forward, as if the table and the chair upon which I was seated had been resting upon a round object and had slipped off. There was no report or noise other than that caused by the movement of the chair or table.

Naturally I was on the alert, and listened or waited for the next diversion, but nothing else occurred. The time by watch showed 8·25 p.m."

Report of Fred. T. Berman of Five Dock.

"Of a senior class of 56 pupils (the only class I thought it advisable to collect evidence from) only four noticed it. One boy stated that the glass doors at his home shook. Another boy who was playing ludo with his father and mother stated that one of the ludo buttons moved and the table shook, making all look under the table to see if another brother, who had left the room had crept under the table to play a joke. At the same time a pet parrot in a cage hanging from the ceiling "squeaked" from no apparent cause.

At my home in William Street, Chatswood, of three windows (set in one frame) in a wall running N.W. and S.E. *one only*, the most northern, shook, probably for 45 seconds. The shaking mystified my wife and myself so much that I went to inspect the windows thinking some one was outside, shaking at it. My wife averred that the floor vibrated, but I did not notice it. It was not until I returned from my inspection outside that it dawned upon me that an earthquake was probably the cause."

Report of J. Drabble of Homebush.

"The first thing to attract my attention was a sudden explosive sound, dull and deep, like that of a tremendous blasting charge fired a long way off. It was immediately followed by the intense vibration of the whole cottage. The vibration reached its maximum a few seconds after the explosion, and then gradually subsided, the whole thing lasting about half a minute. I was a good deal puzzled, and went outside to listen, but everything was then apparently tranquil."

Report of Annie Courtenay of Mosman.

"My son, age 13, and I were seated quietly in the study, he reading and I writing, when we both heard a noise resembling a thud accompanied by a vibration of crockery in a cupboard in the room. The table at which I was seated I could feel vibrate. We also heard a noise overhead as of a heavy body rolling over the ceiling or roof, such a noise as an oppossum might make. I really do not think that the latter noise had anything to do with the earthquake as it occurred a couple of seconds later; I simply state what happened. I instinctively glanced at the pictures on the wall when I felt the vibration, so I can positively assert that so far as I could see nothing had moved."

Report of J. N. Forrest of North Sydney.

"I was seated by the fireside reading to my wife when a peculiar rumbling sound passed through the house, then the dining room door and one window only started rattling for some seconds, say equal to one and a half minutes, the door first ceased, then immediately after the window stopped, it kept on with a tapping noise for about twenty seconds. From the position I was in I could not say if any other part of the house was affected. I looked through the window when the tremor was on, but except for a certain darkness there was nothing unusual about the night."

Report of Marion Lockyer of Point Piper.

"I was sitting in my room writing a letter to my brother in Melbourne when the table I was writing on shook as if some immense thing hit the front of the house. One of the little girls was sleeping in a room at the back of mine and she wakened up calling out 'Some one is shaking my bed.' Then one of the maids came up from the kitchen and said, 'Oh! Miss Lockyer there was such a funny noise downstairs,' so I told her I thought it must be a slight shock of earthquake."

Report of H. Stanbury of San Souci.

"On the evening of the 15th August my daughter, grandson and myself were quietly sitting in our dining-room when suddenly we heard a loud rumbling sound coming from the east end of the room (which is a large one). The walls swayed, the couch on which I was seated vibrated, and my head felt quite dizzy. The armchair in which my daughter was sitting swayed and moved, and she noticed that the glass chandelier moved and the flame swayed. The direction appeared to be directly east to west down the room. Quantities of dust and bits of rubbish were scattered about the rooms from the vibration. Our house is rather distant from other houses, and is on rather low ground. We have only heard of two others who noticed the disturbance."

Report of M. Petrick of Waterloo.

"I was sitting in my diningroom looking in the fire when I felt my chair rock violently; the electric light and cord attached swayed to and fro for some considerable time. There was a sound as of a heavy body falling or jumping. The noise seemed to be on the roof. The sound was so plain that I went outside to see if any person had jumped from Wentworth Hall (which is next door) on to the roof of my house. I knew before I went outside that it was an earthquake, and only went as a matter of precaution. The shock was so severe that my two dogs (one was asleep on the hearthrug before the fire, and the pug snoring on his cushion on a chair) woke up as with a fright. The one on the rug sat up and seemed very frightened, stared round and growled for quite a long time. The pug barked and would not be pacified until I went to bed at 11 p.m. A glass ornament in an electroplated stand was broken off sharp by the shock. It stood on the table."

Report H. T. J. Dawson of Taralga.

Sound of window rattling, wood ceilings cracking. In a two-story shop a man heard rattle of crockery upstairs and ran up thinking that some intruder was there. In my own place one of the children put up a window and said, "That's funny! I heard thunder and there are no clouds."

Report of W. W. Filmer of Toronto.

"Extract from my note book made about fifteen minutes after the shock. "Time 8·27 p.m. Sounds like three large explosions. Second explosion about half a second after the first, and third about one-fifth second after second. Then a rumbling sound which as it got louder appeared to be due to something having struck a number of telegraph lines. This sound continued for about ten seconds. Then a sound on the roof like that which would be made by a huge soft rubber ball bouncing from one end of the roof to the other end, from the N.W. end to the S.E. end (the roof is 40 feet long), the roof is of iron, and the sound lasted probably a little more than one second. During the time of the roof sounds the bed vibrated up and down (I was in bed at the time). This alarmed my wife. I mentioned this to show how conspicuous the vibrations were. My son who was also in bed noted the bed vibrations in his room. Total time of shock about twelve seconds. Sound appeared to come from the air; this was probably due to the roof vibrations. Immediately after the shock I ran to my laboratory to see if a delicate pendulum one metre long was vibrating. It was perfectly still. The vibrations appeared to come from the N.W. or a little to the W. of that point."

Report of H. Schomberg of Greta.

"We first felt the shock about 8·25 p.m. It was heralded by a sort of explosion similar to what one would hear during blasting operations. Then the windows in the room began to rattle violently (there are three in the room), and the table at which I was sitting seemed to move; and then we distinctly heard the tinware in the kitchen rattling."

Report of Miss J. Gentle of Webb's Creek.

"Shock was generally felt by everyone in the district. One man relates that he was talking to another in the street when he felt the shock, which seemed to make his knees bend a little. Shock was felt more by people in bed than otherwise. Beds shook and seemed to move towards the W. with a short quick movement. Shaking seemed to come from E. to N.E. direction with a short quick movement. One man recounts having heard a sound like distant thunder immediately before shock was felt. Doors standing ajar were caused to swing while windows shook and rattled. Beds and tables were moved as by a sudden bump."

Report of D. H. Gilfillan of Wentworth Falls.

"I have heard of one person walking indoors who felt it. The shock seemed to me to be from S. to N. I was in bed on a stretcher on my verandah at the time. It appeared to me as if the foliage of some large gum trees surrounding the house rustled for some seconds after, not as if blown by the wind, but in a manner more continuous than gusty. Comparing notes with a friend living at Double Bay who also happened to be in bed on a verandah at the time, I should say the shock would be considerably more severe here. We are about twenty miles in a straight line from Kurrajong Heights."

Report of J. F. Olde of Wiseman's Ferry.

"Tremor felt by persons standing out of doors. Shock felt by persons moving about indoors, even by persons dancing. No permanent disturbance, rattling of windows, shaking of chimneys, one instance part of chimney fell. Beds violently shaken also tables and chairs, articles on sideboard moved about. Crockery on kitchen dresser shaken off in two instances. Also articles on shelves shaken down."

The reports quoted above, together with many others, were found quite sufficient to establish the isoseismals. These are represented in Fig. 1, and are numbered to correspond to the intensities of the Rossi-Forel scale. The

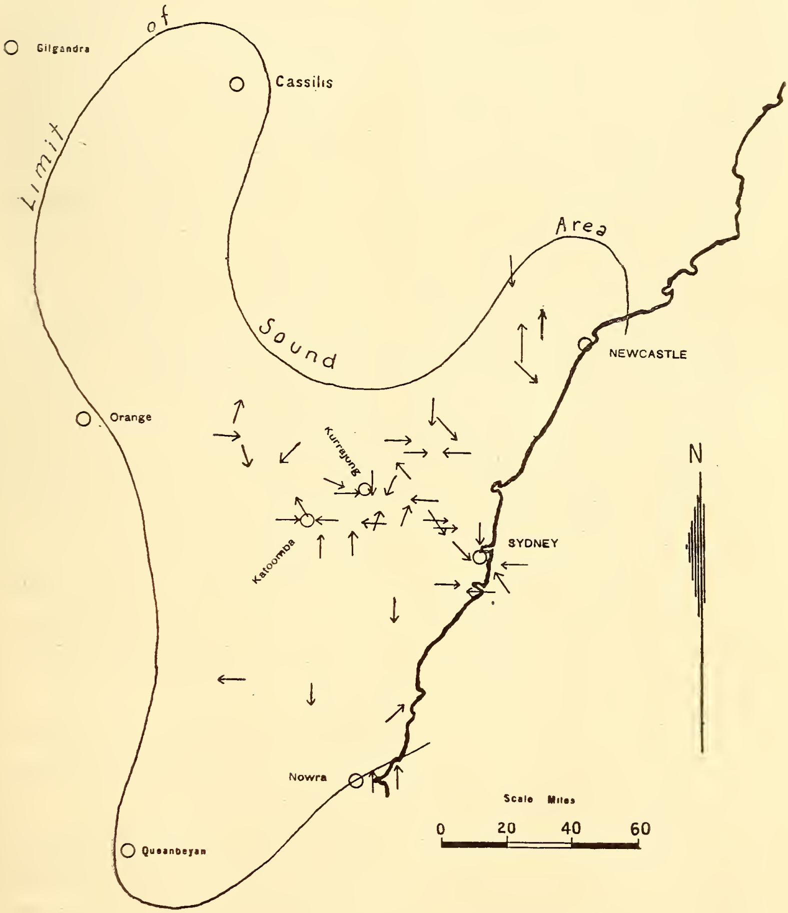

Figure 2

innermost curve, therefore, represents the area of greatest disturbance. An inspection of the isoseismals reveals a systematic L shaped distribution of the curves, the significance of which is discussed below.

As many of the reports furnished estimates of the direction of vibration, and as in most cases a sound was recorded it was thought advisable to summarise this information graphically in the form of a map. In Fig. 2 the boundary of the sound area is represented. This conforms well with the isoseismal curves and exhibits the same L shaped form.

The directions of vibration are represented in direction by straight lines, and in sense by the arrow head. The points of the arrows are placed at the centres where the observations were recorded. It will be seen from this map that though the evidence is somewhat conflicting, yet on the whole the directions of vibration correspond to the distribution of the isoseismals. In view, however, of Branner's investigations[1] it is doubtful if the observed directions of vibration have any real significance.

Instrumental Evidence.

There are two seismograph stations within the area of sensible shock. The first is that of the Riverview Observatory, and the second at the Sydney Observatory.

The Rev. Father Pigot, S.J., has kindly allowed the writer to examine the Riverview record, and Professor Cooke has extended the same courtesy for the record of the State Observatory at Sydney.

The Riverview record was made by a Wiechert instrument, while that of the Sydney observatory was made on a Milne installation—photographically recorded.

The total duration of the first and second preliminary tremors could be accurately determined from the Riverview record, and amounted to 6·7 seconds. The record of the Sydney Observatory was of course, much more unsuitable for measurement. It was studied by a low power microscope fitted with a micrometer eyepiece. The mean of a number of observations gave a value of 7·1 seconds for the total duration of the first and second preliminary tremors. The variations in measurement, however, indicate that this value may be in error by plus or minus one second. The time estimated would have little value by itself, but is useful as agreeing with the value obtained at Riverview.

These values, when used in conjunction with Omori's curves(4) for near earthquakes give the distances of the earthquake centre as 57·5 and 59 miles from the Riverview and Sydney Observatories respectively. Unfortunately the initial impulses were not sufficiently well marked to enable the direction to be ascertained.

Geological Considerations.

The Kurrajong fault is about 37 miles distant from the Riverview Observatory. If the shock originated on the Kurrajong Fault at a depth of fifteen miles, the actual distance of the centre of the disturbance would be fifty-two miles from the Riverview Observatory and fifty-five miles from the Sydney Observatory. Hence the instrumental records confirm the distribution of the isoseismal curves of the eastern limb which indicate the Kurrajong fault as a seismic focus. The form of the isoseismals however, shows that the seismic focus is not a simple one. The obvious interpretation of the isoseismals is that the earthquake was due to block faulting, in which one corner of a crustal block was simultaneously displaced along two intersecting fault planes.

Although the eastern limb of the isoseismals can be definitely correlated with a known feature—the Kurrajong fault,(2) no such correlation can be made for the western limb of the L-shaped curves. The area over which the latter extends is however practically unknown from the geological point of view, and for the most part is a very rugged and sparsely inhabited region. Professor David has pointed out to me that the direction of this western limb of the isoseismals corresponds to that of a very important fault system in the Maitland area, and that it is moreover nearly coincident in both direction and actual position with the trough of the Permo-Carboniferous and Triassic geosyncline, which is the major structural feature of the area affected by the earthquake shock.[3]

As far as the writer knows this is the first earthquake which has been interpreted in this way. The principles involved are simple and of general application, and on physiographic and theoretical grounds such a type of faulting may be of relatively common occurrence. It is hoped that the emphasis placed on the geological aspect may lead to a more detailed and careful study of the distribution of isoseismals in the case of other earthquakes.

Acknowledgements.

The writer's warmest thanks are offered to the many correspondents who very kindly, often at great personal inconvenience, collected and forwarded information with regard to the Sydney earthquake. Without such cordial co-operation the work could not have been undertaken.

Best thanks are also due to the Rev. Father Pigot, S.J., and to Professor Cooke for kind permission to examine the seismograms of the earthquake recorded at Riverview and the Sydney Observatory respectively.

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ACACIA SEEDLINGS, PART VII.

By R. H. CAMBAGE, F.L.S.

[With Plates II - V.]

[*Read before the Royal Society of N.S. Wales, August 3, 1921.*]

SYNOPSIS:

Vitality of Seeds in Sea-Water.
Rapid Germination.
Sequence in the Development of Leaves.
Number of Pinnæ on One Leaf.
Closing Up of Phyllodes at Night.
Flowering Seedlings.
Description of Seedlings.

Vitality of Seeds in Sea-Water.

A seed of *Acacia melanoxylon* from Jenolan Caves germinated when planted after having been immersed in sea-water 4 years and 1 month. This constitutes a record for this experiment so far as I am aware.

Rapid Germination.

During these experiments it has been noted that seeds of *Acacia pendula* and *A. Oswaldi* germinate very rapidly after being placed in hot water and planted, and that both species produce fleshy cotyledons. They, especially the latter, will grow in hot districts with a low rainfall, and in many instances may germinate as the result of a thunder-storm. It would seem, therefore, that this character of speedy germination may have developed to allow the young plants to become established quickly after a rain storm and before the ground again becomes dried up as often happens in the far interior.

Sequence in the Development of Leaves.

In Part VI, (p. 147), it was mentioned that 95 species had been found to commence with one simply pinnate leaf, while 12 had an opposite pair. The following four may be added to the former list, which brings the total to 99:—*A. Catechu* Willd., (Hawaii, E. C. Andrews, cultivated), *A. Havilandi* Maiden, *A. Jonesii* F.v.M. and Maiden, *A. Westoni* Maiden.

To the twelve species commonly having an opposite pair of simply pinnate leaves the following two may be added:—*A. arabica* Willd., (Hawaii, E. C. Andrews, cultivated), *A. Koa* A. Gray, (seeds from Hawaii, E. C. Andrews).

Although *A. Westoni* usually has only one simply pinnate leaf it occasionally has an opposite pair.

A. linifolia may have an opposite pair (J. J. Fletcher).

Number of Pinnæ on One Leaf.

In addition to those phyllodineous Acacias already recorded as having more than one pair of pinnæ on one leaf (Part VI, p. 147), the following may be added:—*A. difformis*, *A. longifolia* and *A. Westoni* may have two, and *A. melanoxylon* nine pairs.

Closing Up of Phyllodes at Night.

The closing up at night of leaflets on plants of the Family Leguminosæ, including the genus Acacia, is well known. Recently, however, it was noticed that the phyllodes of *A. complanata* respond to changes from light to darkness. On a small plant, with the stem bent almost into a horizontal position, the lower margins of two almost opposite phyllodes were 7 cm. apart during sunlight, while at night they closed up to within 3 cm. of each other, the movement of each amounting to 2 cm., or just over $\frac{3}{4}$ of an inch.

Flowering Seedlings.

Several examples have been quoted of Acacia seedlings having flowered in 4, 5 or 6-inch pots, (Part VI, p. 151), and the following are now added:—*A. accola*, *A. complanata*, *A. decora*, *A. flexifolia*, *A. hakeoides*, *A. penninervis*, *A. podalyriæfolia*, *A. rubida*, *A. subulata*, *A. trinervata*, and *A. vomeriformis*.

Description of Seedlings.

Pungentes—(Uninerves).

Acacia asparagoides A. Cunn. Seeds from Medlow and Mount Victoria. (Plate II, Numbers 1 to 3).

Seeds dull black, often mottled, oval to oblong-oval, 3 to 3·5 mm. long, 2 mm. broad, 1·5 mm. thick.

Hypocotyl terete, brownish-green to pale pink above soil, thickening into flange at root, 9 mm. to 1·5 cm. long, ·8 to 1 mm. thick at base, about ·5 mm. at apex, glabrous.

Cotyledons sessile, auricled, oblong-oval, 4 mm. long, 2 to 2·5 mm. broad, upperside green, underside pale green to pinkish, with one or two raised lines.

Stem terete, brownish-grey, slightly tomentose. First internode ·5 mm.; second 1 mm.; third 1 to 3 mm.; fourth 1 to 5 mm.; fifth and sixth 2 to 6 mm.

Leaves—No. 1. Abruptly pinnate, petiole 3 to 5 mm., channelled above, green, glabrous; leaflets two pairs, oblong-acuminate to obovate, about 4 mm. long, 1 to 2 mm. broad, upperside green, underside paler; rachis 2 mm., glabrous, with terminal seta; stipules reduced to scales.

No. 2. Abruptly bipinnate, petiole 5 mm. to 1 cm., channelled above, glabrous, with terminal seta; leaflets one to two pairs, the basal pair oblong-acuminate, the apical pair obovate, mucronate, 1 to 5 mm. long, ·5 to 2 mm. broad, upperside green, underside paler; rachis 4 to 5 mm., with terminal seta.

Nos. 3 and 4. Abruptly bipinnate, petiole 7 mm. to 1·1 cm., channelled above, glabrous; leaflets two pairs, similar to those of No. 2; rachis 4 to 7 mm.; stipules tapering to linear, 1 mm. long.

Nos. 5 and 6. These may be linear phyllodes or they may be abruptly bipinnate similar to No. 4.

Nos. 7 to 12. Linear, tapering, rigid, pungent-pointed phyllodes, 7 to 8 mm. long, about 1 mm. broad, with a prominent vein on each side and usually with a very slight angle near the base on the upper margin which is channelled below the angle in the early phyllodes.

Many seeds of this species produce twin plants which in most cases soon become separated.

UNINERVES—(Racemosæ).

ACACIA BANCROFTI Maiden.[1] Seeds from Eidsvold, Queensland (Dr. T. L. Bancroft, per J. H. Maiden). Plate II, Numbers 4 to 6.

Seeds black, oblong, 9 mm. to 1 cm. long, 4 mm. broad, 2 mm. thick. The water in which the seeds with funicles were immersed turned pale brown.

Hypocotyl terete, red, 1·3 to 3·5 cm. long, about 2 mm. thick at base, 1 mm. at apex.

Cotyledons sessile, auricled, oblong, 1·3 to 1·4 cm. long, 4·2 to 5 mm. broad, upperside green, underside reddish-brown to red.

Stem terete, reddish-brown, becoming brownish-green, glabrous. First internode ·5 to 1 mm.; second 1 to 3 mm.; third 2 to 3 mm.; fourth 3 to 6 mm.; fifth 3 to 8 mm.; sixth 3 mm. to 2·7 cm.

Leaves—No. 1. Abruptly pinnate, petiole 6 mm, to 1·2 cm., with gland near basal pair of leaflets, brownish-green, glabrous; leaflets four to five pairs, oblong-acuminate, the apical pair slightly obovate, mucronate, 5 mm. to 1·2 cm.

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[1] Proc. Roy. Soc., Queensland, Vol. xxx, 26, (1918).

long, 1·5 to 5 mm. broad, midrib distinct on underside, upperside green with splashes of reddish-brown, underside reddish-brown; rachis 1·5 to 2·2 cm., with terminal seta; stipules reduced to scales.

No. 2. Abruptly bipinnate, petiole 1·7 to 2 cm. vertically flattened to from 2 to 3 mm. broad, the midrib sometimes distinct, at others absent or coinciding with the lower margin, the upper and lower margins nerve-like, gland near base, terminal seta present; leaflets two to four pairs, often unequally pinnate, oblong-acuminate to obovate, 2 to 6 mm. long, 1 to 3 mm. broad; rachis up to 7 mm.; stipules reduced to scales.

Nos. 3 to 6. Phyllodes from 3 to 8 cm. long, 8 mm. to 2·7 cm. broad, falcate, with distinct midrib, prominently penninerved, the upper margin sinuous with from one to three lobes terminating in a gland.

This is the fifth seedling described in this series where the No. 3 leaf may be reduced to a phyllode, the previous cases being *A. excelsa*, *A. alata*, *A. aspera*, and *A. flexifolia*. (See *A. Oswaldi*, *infra*.)

UNINERVES—(Racemosæ).

ACACIA DIFFORMIS R. T. Baker.[1] Seeds from Wyalong, New South Wales. (Plate II, Numbers 7 to 9.)

Seeds brownish or rusty-black, oblong-oval, 7 to 8 mm. long, 3·5 to 4 mm. broad, 2 mm. thick.

Hypocotyl terete, very pale green, to pale pink or red, 1·3 to 4·5 cm. long, 2 to 2·5 mm. thick at base, ·8 to 1·2 mm. at apex, swelling into flange at root, constricted immediately above the soil, glabrous.

Cotyledons usually two, in one case three, sessile, auricled, oblong, apex rounded, 9 mm. to 1 cm. long, 3·5 to

[1] Proc. Linn. Soc. N.S. Wales, XXII, 154, (1897).

4 mm. broad, upperside often at first yellowish-green, becoming green, underside brownish-yellow to purple and reddish-brown, with one or two raised lines along central portion, and sometimes several glands or warty protuberances, soon becoming revolute and cylindrical.

Stem terete, reddish-green to brownish-red, glabrous, first internode ·5 mm.; second 1 mm.; third 1 to 6 mm.; fourth 1 to 7 mm.; fifth 2 mm. to 1·1 cm.; sixth 6 mm. to 1·6 cm.; seventh 6 mm. to 1·8 cm.

Leaves—No. 1. Abruptly pinnate, petiole 2 to 7 mm., glabrous; leaflets four to six pairs, oblong-acuminate, 5 to 9 mm. long, 1·5 to 4 mm. broad, upperside green, underside paler, margins sometimes red; rachis 1 to 2 cm., with terminal seta; stipules reduced to scales.

No. 2. Usually abruptly bipinnate, petiole 6 mm. to 2 cm., glabrous, with terminal seta; leaflets three to five pairs, oblong-acuminate, the apical pair often obovate, 2 to 5 mm. long, 1 to 2 mm. broad; rachis 7 mm. to 1·4 cm.; stipules reduced to scales.

In one case No. 2 was simply pinnate with one pair of leaflets; in another case it was abnormally bipinnate, with one leaflet about the middle while towards the apex there was one pinna with three pairs of small leaflets, and opposite to this was a single leaflet.

No. 3. Usually abruptly bipinnate, petiole 8 mm. to 2·1 cm.; leaflets three to five pairs; rachis 6 mm. to 1 cm.

In one case No. 3 was simply pinnate with two pairs of leaflets; in another case the leaf had a terminal pair of pinnæ and about the middle of the common petiole there was one large leaflet intact on one side of the midrib while the other side was divided into four small leaflets.

Leaf No. 3 may be twice pinnate.

No. 4. Abruptly bipinnate, petiole 1·2 to 3·4 cm. long, up to 3 mm. broad, with the midrib practically along the lower margin, the upper margin nerve-like, often with a gland towards the base; leaflets four to six pairs.

Nos. 5 to 9. Rarely No. 5 may be bipinnate, but usually Nos. 5 to 9 are falcate, linear phyllodes, with the midrib usually just below the centre of the lamina, and a finer vein above, starting from the base but not reaching the apex. No. 5 varies from 2 to 7 cm. long, 3 to 7 mm. broad; No. 6, 3 to 11 cm. long, 3 to 7 mm. broad; Nos. 7 to 9, 3 to 17 cm. long, 3 mm. to 1 cm. broad.

UNINERVES—(Racemosæ).

ACACIA CULTRIFORMIS A. Cunn. Seeds from Wyalong. (Plate III, Numbers 1 to 3.)

Seeds dull black, oblong to oblong-oval, about 5 mm. long, 2·5 to 3 mm. broad, 1 to 1·5 mm. thick.

Hypocotyl terete, reddish, up to 1·8 cm. long, about 2 mm. thick at base, ·7 to 1 mm. at apex.

Cotyledons sessile, slightly auricled, oblong, apex rounded 5 to 6 mm. long, 3 to 4 mm. broad, upperside at first brownish-yellow to brownish-red, becoming dark green, underside reddish to brownish-red, with one to three longitudinal nerves, soon becoming revolute and cylindrical.

Stem terete, reddish-green to green, glabrous. First internode ·5 mm.; second 1 mm.; third 2 – 3 mm.; fourth 3 – 4 mm.; fifth 1 to 4 mm.; sixth and seventh 1 to 5 mm.

Leaves—No. 1. Abruptly pinnate, petiole 3 to 5 mm., glabrous; leaflets three to four pairs, oblong-acuminate, the apical pair often obovate, 4 to 6 mm. long, 1 to 3 mm. broad, upperside green, underside paler, rachis 3 to 6 mm., with terminal seta; stipules reduced to scales.

No. 2. Abruptly bipinnate, petiole 4 mm. to 1 cm., glabrous, with terminal seta; leaflets two to four pairs, oblong-acuminate to obovate, 2 to 5 mm. long, 1 to 2·5 mm. broad, upperside green, underside paler; rachis 3 to 8 mm.; stipules flat acuminate scales. No. 2 may have two pairs of pinnæ. In one case No. 2 was simply pinnate.

Nos. 3 to 5. In one case No. 3 was simply pinnate, but they are usually abruptly bipinnate, petiole 6 mm. to 1·5 cm. often with a gland on the upper margin; leaflets two to six pairs; rachis 4 mm. to 1·4 cm.

Nos. 6 and 7. These may be phyllodes, or abruptly bipinnate, petiole 1 to 1·2 cm. long, dilated up to 4 mm. broad, with the main nerve along the lower margin, a gland on the upper margin; leaflets seven pairs; rachis about 1 cm.

Nos. 8 to 12. Falcate to almost triangular phyllodes, 6 mm. to 1·5 cm. long, 4 to 8 mm. broad, greyish-green on both sides, the midrib below the centre of the lamina, which contains numerous lateral parallel veins, mucronate, the upper margin nerve-like, having an angle terminating in a gland, glabrous or slightly glaucous.

PLURINERVES—(Oligoneuræ).

ACACIA TRINEURA F.v.M. Seeds from Wyalong. (Plate III, Numbers 4 and 5.

Seeds black, oblong, about 3·5 to 4 mm. long, 2 mm. broad, 1 mm. thick.

Hypocotyl terete, red to pink, up to 1·7 cm. long, about 1 mm. thick at base, about ·5 mm. at apex.

Cotyledons sessile, auricled, oblong, 5 mm. long, 2 mm. broad, upperside green, underside brownish-red.

Stem terete, brownish-grey. First internode ·5 mm.; second to fourth about 1 mm.; fifth 3 to 4 mm.; sixth and seventh 5 mm. to 1·2 cm.

Leaves—No. 1. Abruptly pinnate, petiole about 3 mm., glabrous; leaflets one to two pairs, the basal pair oblong-acuminate, the apical pair often obovate, 3 to 4·5 mm. long, 1 to 2·5 mm, broad, upperside green, underside reddish-brown, midrib distinct on underside; rachis about 2 mm., with terminal seta.

No. 2. Abruptly bipinnate, petiole 4 to 9 mm., glabrous, with terminal seta; leaflets two to three pairs, oblong-acuminate to obovate, 2 to 5 mm. long, 1 to 2 mm. broad, mucronate; rachis 4 to 7 mm., with terminal seta; stipules flat acuminate scales.

Nos. 3 and 4. Abruptly bipinnate, petiole 6 mm. to 1·4 cm., glabrous; leaflets three to five pairs; rachis 6 mm. to 1 cm.

Nos. 5 to 7. Abruptly bipinnate petiole 1·1 to 2·9 cm., vertically dilated to 1 mm. in No. 5, and to 6 mm. in No. 7.

In the case of No. 6 the midrib is below the centre of the lamina, with a finer parallel vein above. In No. 7 the midrib is below the centre of the lamina, with a finer parallel vein above and below, and above each of these there is an even finer vein. Leaflets five to seven pairs.

No. 8. This may be a phyllode or abruptly bipinnate, petiole up to 2·5 cm. long, 5 mm. broad.

Nos. 9 to 12. Cuneate-oblong, glabrous phyllodes, sometimes slightly viscid, with venation similar to the dilated petiole of No. 7, except that the three principal veins in the phyllodes are of about equal prominence, the middle one runs along the centre of the lamina, and sometimes a fourth very fine vein may be seen near the lower margin, making seven in all.

PLURINERVES—(Microneuræ).

ACACIA PENDULA A. Cunn. Seeds from Boggabri (Mrs. F. C. S. Holt). Plate IV, Numbers 1 to 3.

Seeds brown, obovate to almost orbicular, 4·5 to 6 mm. long, 3·5 to 5·5 mm. broad, about 1 mm. thick. The seeds germinate quickly.

Hypocotyl terete, green to light brown, up to 3 cm. long, 1 to 2 mm. thick at base, ·5 to 1·5 mm. at apex.

Cotyledons sessile, auricled, obovate to almost orbicular, up to 8 mm. long, 5 to 7 mm. broad, thick or slightly fleshy, upperside green, underside pale green.

Stem terete, greenish-brown to grey, glabrous, or with a slight glaucescence. First internode ·5 mm.; second ·5 to 3 mm.; third 1 to 5 mm.; fourth to eighth 2 mm. to 1 cm.

Leaves—No. 1. Simply pinnate, (in one case there was an opposite pair), petiole 3 to 6 mm., glabrous; leaflets three to five pairs, oblong-acuminate, 4 to 8 mm. long, 1·5 to 2·5 mm. broad, upperside green, underside paler; rachis 6 mm. to 1 cm., with terminal seta; stipules small.

No. 2. Abruptly bipinnate, petiole 7 mm. to 1 cm., green, glabrous, with terminal seta; leaflets three to four pairs, oblong-acuminate, the apical pair obovate, 3 to 5 mm. long, 1 to 2·5 mm. broad, mucronate; rachis about 7 to 8 mm.; stipules small. No. 2 may have two pairs of pinnæ.

Nos. 3 to 5. Abruptly bipinnate, petiole 5 mm. to 2·8 cm., green, glabrous, leaflets three to six pairs; rachis 7 mm. to 1·5 cm.

Nos. 6 to 12. Abruptly bipinnate, petiole 2·2 to 6·5 cm., dilated from about ·5 to 1·5 mm. broad; leaflets five to seven pairs; rachis 1 to 2·5 cm.; stipules about 1·5 mm.

Nos. 13 to 20. Abruptly bipinnate, petiole 2·3 to 9·3 cm., dilated up to 2 mm. broad, midrib distinct, leaflets six to seven pairs; rachis 8 mm. to 2·3 cm.

Nos. 21 to 30. Some of these may be linear phyllodes, or abruptly bipinnate, petiole up to 12 cm. long, up to 5 mm. broad, midrib distinct, lamina finely striate with parallel nerves on each side of midrib.

Nos. 31 to 40. Usually linear phyllodes, similar to the dilated petiole of Nos. 21 to 30.

PLURINERVES—(Microneuræ).

ACACIA OSWALDI F.v.M. Seeds from Boggabri (Mrs. F. C. S. Holt), Cobar (Archdeacon F. E. Haviland), Broken Hill (E. C. Andrews), and Tottenham, New South Wales. (Plate III, Numbers 6 to 8).

Seeds very dark brown to black, oblong-oval to almost orbicular, up to 8 mm. long, up to 6 mm. broad, 3 mm. thick, areola 4 to 5 mm. long. The seeds germinate very quickly, and in hot weather the seedling may appear in six days after the seed has been planted.

Hypocotyl terete, pale green to reddish-brown, 1·5 to 3·4 cm. long, 2 to 3 mm. thick at base, up to 2 mm. at apex, expanding into flange at base.

Cotyledons sessile, sagittate, obovate, 8 mm. to 1 cm. long, 5 to 8 mm. broad, thick or somewhat fleshy, upper-side at first pale green, becoming dark green, underside at first yellowish-green, becoming pale green, sometimes remaining until the phyllodes appear. One plant had three cotyledons, one of normal size and two smaller.

Stem terete, brownish-green to grey, glabrous. First internode ·5 to 1 mm.; second and third 2 to 4 mm.; fourth to sixth 2 to 5 mm.

Leaves—Nos. 1 and 2. Simply pinnate, forming an opposite pair, petiole 7 mm. to 1·2 cm., often slightly dilated, glabrous; leaflets one to four pairs, 7 mm. to 1·4 cm. long, 3 to 5 mm. broad, oblong-acuminate, the apical pair sometimes obovate, venation distinct, green on both sides; rachis 1 to 2 cm., with terminal seta.

No. 3. This may be a phyllode or simply pinnate, petiole 5 mm. to 1·3 cm., sometimes slightly dilated, glabrous; leaflets one to four pairs, often unequally pinnate; rachis 4 to 7 mm., sometimes vertically flattened, with terminal seta.

No. 4. This may be a phyllode or simply pinnate, petiole up to 2 cm., vertically flattened to 3 mm. broad; leaflets from one leaflet up to three pairs.

No. 5. Usually a phyllode, but may be simply pinnate with one pair of leaflets, or abruptly bipinnate with one or two pairs of leaflets, petiole up to 6 mm. broad.

Nos. 6 to 10. Phyllodes linear-lanceolate to cuneate, sometimes falcate, narrowed at the base, with a strong central nerve and two others less conspicuous not always confluent at the apex and some finer veins parallel or anastomosing, terminating in a somewhat pungent spine about 2 mm. long.

This is the sixth seedling described in this series where the No. 3 leaf may be reduced to a phyllode. (See *Acacia Bancrofti*, *supra.*)

This species, the seedling of which was described by Lubbock[1] from two plants, seldom produces bipinnate leaves, and may develop phyllodes when only an inch above the soil.

JULIFLORÆ—(Tetrameræ).

ACACIA LONGIFOLIA Willd. Seeds from Dundas, Woodford, Hill Top (E. Cheel), Termeil, New South Wales. (Plate V, Numbers 1 to 3.)

Seeds black, those from Dundas shiny black, oblong, 3 to 4 mm. long, 1·5 to 2·5 mm. broad, 1·5 to 2 mm. thick. The largest seeds were those from Termeil, and the shortest from Woodford.

[1] "A Contribution to our Knowledge of Seedlings," by Sir John Lubbock, I, 473, (1892).

Hypocotyl terete, at first pale, becoming brownish-green, 6 mm. to 1·8 cm. long, the largest being from Hill Top, 1·5 to 1·7 mm. thick at base, ·6 to 1 mm. at apex.

Cotyledons sessile, auricled, oblong to oblong-oval, 4 to 6 mm. long, about 2·5 mm. broad, upperside green, underside reddish to reddish-brown or brownish-green, becoming revolute and cylindrical.

Stem at first angular, becoming terete, sometimes at first reddish, later green to greyish-green, glabrous to slightly pilose. First internode ·5 mm.; second 1 to 2 mm.; third and fourth usually 1 to 4 mm. but 2 cm. in one Lane Cove plant (collected by Mr. J. J. Fletcher); fifth usually 3 mm. to 1 cm. but 5·6 cm. in one Lane Cove plant (J. J. Fletcher); sixth 6 mm. to 2·8 cm.; seventh 8 mm. to 5·3 cm., the longest and some of the moderately short being from Woodford.

Leaves—No. 1. Abruptly pinnate, petiole 5 to 6 mm., in Hill Top specimens up to 1 cm., glabrous; leaflets two to four pairs, oblong-acuminate, 4 to 7 mm long, 2 to 3 mm. broad, upperside green, underside reddish to pale green; rachis 5 to 8 mm., up to 1·1 cm. in Hill Top specimens, with terminal seta.

No. 2. Abruptly bipinnate, petiole 6 mm. to 2 cm. in Hill Top specimen, sometimes with small gland, with terminal seta; leaflets two to four pairs, oblong-acuminate, the apical pair often obovate, 2 to 5 mm. long, 1 to 2 mm. broad; rachis 6 mm. to 1 cm., stipules small. In one case this leaf was simply pinnate with one pair of leaflets.

Nos. 3 and 4. Abruptly bipinnate, petiole 1·4 to 2·7 cm. in No. 3, 2·5 to 5·2 cm. in No. 4, the latter sometimes vertically flattened to 7 mm. broad, with a strong nerve along or close to the lower margin and a finer one above, not always confluent at the apex, a gland sometimes on upper margin; leaflets four to six pairs in No. 3, and five to eight in No. 4; rachis 1·1 cm. to 2·5 cm. in Hill Top plants of No. 4; stipules up to 2 mm. long. No. 4 may have two pairs of pinnæ.

No. 5. Sometimes a phyllode but often abruptly bipinnate, petiole 4·4 to 8·8 cm. long, 1 to 9 mm. broad, with a strong nerve below the centre of the lamina and a slightly less prominent vein above the centre, besides smaller veins; leaflets usually six to seven pairs, but up to nine in Hill Top plants, up to 1·2 cm. long, 4 mm. broad in Woodford and Lane Cove specimens; sometimes twice pinnate.

Nos. 6 to 8. Usually phyllodes, but sometimes abruptly bipinnate, the latter state being only found on Nos. 7 and 8 in one Hill Top specimen, 3·7 to 7·5 cm. long, 3 to 7 mm. broad; leaflets up to ten pairs on No. 6 in one Hill Top specimen; rachis up to 4 cm. No. 7 may have two pairs of pinnæ.

Nos. 9 to 12. Oblong-lanceolate to linear phyllodes, from about 6 to 8 cm. long and under 1 cm. broad, up to 23 cm. long and perhaps 1·5 cm. broad, with two conspicuous veins the lower one the more prominent, the rest of the lamina faintly reticulate.

The Hill Top specimens belong to the form named *A. intertexta* Sieb.

JULIFLORÆ—(Tetrameræ).

ACACIA FLORIBUNDA Willd. Seeds from Dundas near Sydney. (Plate V, Numbers 4 to 6.)

Seeds black, oblong, 3 to 3·5 mm. long, 1·5 to 2 mm. broad, 1 to 1·5 mm. thick.

Hypocotyl terete, pale green to reddish-brown, 1 to 4 cm. long, 1·5 mm. thick at base, about ·7 mm. at apex.

Cotyledons sessile, sagittate, oblong, apex rounded, 4·5 to 5 mm. long, 2 to 2·5 mm. broad, upperside green, underside brown, with a few lines along centre.

Stem terete, tomentose, greenish-brown to grey. First internode ·5 mm.; second ·5 to 5 mm.; third ·5 to 6 mm.; fourth and fifth 1 mm. to 1·3 cm.; sixth 1 mm. to 1 cm.; seventh and eighth 1 to 8 mm.

Leaves—No. 1. Simply pinnate, petiole 2 mm. to 1 cm., glabrous; leaflets two to three pairs, oblong-acuminate to obovate, 4 to 8 mm. long, 2 to 3 mm. broad, often mucronate, upperside green, underside paler; rachis 2 to 4 mm., with terminal seta.

In one case the first leaf had two pairs of leaflets except that one of the basal leaflets was transformed into a pinna with two pairs of small leaflets.

No. 2. Abruptly bipinnate, petiole 4 mm. to 1·2 cm., green, glabrous, with terminal seta; leaflets two to three pairs, oblong-acuminate, 2 to 5 mm. long, 1 to 2 mm. broad; rachis 5 to 6 mm.; stipules minute.

Nos. 3 to 5. Abruptly bipinnate, petiole 7 mm. to 2·8 cm.; leaflets three to six pairs, up to 7 mm. long, 3 mm. broad; rachis 8 mm. to 2 cm.; stipules about 1 mm. long.

Nos. 6 to 8. Abruptly bipinnate, petiole 1·1 to 4·2 cm. long, often dilated to about 1 to 1·5 mm. broad, with a strong nerve along or near the lower margin; leaflets five to nine pairs; rachis 1·2 to 3 cm.

Nos. 9 and 10. These may be linear phyllodes, or abruptly bipinnate, petiole 1 to 5·4 cm., dilated to about 1·5 mm.; leaflets five to ten pairs; rachis 7 mm. to 3·5 cm.

Nos. 11 to 20. Linear phyllodes, about 3 to 7 cm. long, 1 to 3 mm. broad, with distinct midrib, and finer parallel vein above not confluent at the apex, and where the lamina is broad enough an even finer nerve may be seen with pocket lens below, the phyllode terminating in a short mucrone, straight, or curving slightly outwards. In later phyllodes there may be at least three veins on each side of the central nerve.

BIPINNATÆ—(Botryocephalæ).

ACACIA POLYBOTRYA Benth. Seeds from Mudgee (J. H. Maiden). (Plate IV, Numbers 4 to 6.)

Seeds glossy-black, oblong, 6 to 8 mm. long, 3 to 3·5 mm. broad, 2 mm. thick.

Hypocotyl terete, brownish-red, 1 to 2·5 cm. long, up to 3 mm. thick at base, 1 mm. at apex.

Cotyledons sessile, auricled, oblong, apex rounded, up to 9 mm. long, 4 mm. broad, upperside green, underside reddish, soon becoming revolute.

Stem brown to green, or bluish-green on exposed side, glabrous to pilose. First internode ·5 to 1 mm.; second 1 to 3 mm.; third and fourth 6 mm. to 1·5 cm.; fifth to seventh 1 to 2·8 cm.

Leaves—No. 1. Abruptly pinnate, petiole 4 to 7 mm., usually with gland, glabrous; leaflets four to five pairs, the basal leaflets sometimes alternate, oblong, rather obtuse, the apical pair usually obovate, 3 to 7 mm. long, up to 4 mm. broad, midrib distinct, upperside green, underside paler; rachis 9 mm. to 1·3 cm., glabrous, with terminal seta.

No. 2. Abruptly bipinnate, petiole 8 mm. to 1·8 cm., brownish-green, with gland and terminal seta; leaflets four to five pairs, the basal leaflets sometimes alternate, oblong to obovate, 2 to 6 mm. long, 1 to 3 mm. broad; rachis 1 to 1·5 cm., with terminal seta; stipules reduced to scales.

Nos. 3 and 4. Abruptly bipinnate with one to three pairs of pinnæ, from 1 cm. in the single petiole to 3·7 cm. in the common petiole, with gland, pilose; leaflets five to nine pairs; rachis 1·1 to 2·8 cm.

Nos. 5 to 9. Abruptly bipinnate with three to eight pairs of pinnæ, common petiole 2·6 to 6·5 cm., with gland near base, and sometimes also at base of apical pair of pinnæ, pilose; leaflets eight to ten pairs; rachis up to 3 cm., pilose.

BIPINNATÆ—(Botryocephalæ).

ACACIA DISCOLOR Willd. Seeds from Woodburn near Milton, Medlow and Mosman, New South Wales. (Plate V, Numbers 7 to 9.

Seeds black, oval to oblong-oval, 4 to 5·5 mm. long, 2·5 to 3·5 mm. broad, about 1·5 mm. thick.

Hypocotyl terete, reddish to red, 1·2 to 4 cm. long, up to 2·5 mm. thick at base, 1 mm. at apex, glabrous except sometimes with a few roots.

Cotyledons sessile, sagittate, obovate-oval, up to 6 mm. long, 4 mm. broad, upper and underside red, the latter with a raised line along centre, becoming revolute in a few days.

Stem at first angular, becoming terete, brownish-red to brownish-green, glabrous in the Milton specimens, with a slight tomentum in the Medlow plants. First internode ·5 mm.; second 3 mm. to 2·7 cm.; third 3 to 6 mm.; fourth to seventh 4 mm. to 1·7 cm.

Leaves—No. 1. Abruptly pinnate, petiole 2 to 6 mm., glabrous; leaflets four to six pairs, oblong-acuminate, often mucronate, 4 to 8 mm. long, up to 2 mm. broad, upperside reddish-green, underside red; rachis 5 mm. to 2·1 cm., reddish, with terminal seta.

No. 2. Abruptly bipinnate, petiole 5 to 9 mm., pilose to hirsute, a gland on upper margin, terminal seta present; leaflets four to nine pairs, oblong-acuminate, the apical pair often obovate, 3 to 5 mm. long, 1 to 3 mm. broad, mucronate, upperside reddish-green, underside red; rachis 8 mm. to 1·8 cm.

Nos. 3 and 4. Abruptly bipinnate, petiole 7 mm. to 1 cm., with a gland, hirsute; leaflets four to eight pairs on No. 3, eight to twelve pairs on No. 4; rachis 1·1 to 2·5 cm. No. 4 may have two pairs of pinnæ.

Nos. 5 to 10. Abruptly bipinnate, Nos. 7 to 10 having from three to five pairs of pinnæ, common petiole from 8 mm. in No. 5 to 5·4 cm. in No. 10, pilose to hirsute, gland on petiole and sometimes at base of apical pair of pinnæ; leaflets eleven to seventeen pairs; rachis up to 4 cm.

A well grown seedling of a few feet may often have ten and eleven pairs of pinnæ and rarely up to thirteen pairs.

EXPLANATION OF PLATES.

Plate II.

Acacia asparagoides A. Cunn.

1. Cotyledons and pinnate leaf. Medlow.
2. Pinnate leaf, bipinnate leaves and pungent pointed phyllodes.
3. Pod and seeds.

Acacia Bancrofti Maiden.

4. Cotyledons with portion of pinnate leaf showing. Eidsvold, Queensland, (Dr. T. L. Bancroft).
5. Seeds.
6. Pinnate leaf, bipinnate leaf and phyllodes.

Acacia difformis R. T. Baker.

7. Cotyledons. Wyalong.
8. Pinnate leaf, bipinnate leaves, phyllodes, and root nodules.
9. Pod and seeds.

Plate III.

Acacia cultriformis A. Cunn.

1. Cotyledons with tip of pinnate leaf showing. Wyalong.
2. Pinnate leaf, bipinnate leaves and phyllodes.
3. Pod and seeds.

Acacia trineura F.v.M.

4. Pinnate leaf, bipinnate leaves and phyllodes. Wyalong.
5. Pod and seeds.

Acacia Oswaldi F.v.M.

6. Cotyledons and tips of opposite pair of pinnate leaves. Tottenham.

Acacia asparagoides (1 – 3); *A Bancrofti* (4 – 6); *A. difformis* (7 – 9).
Three-fourths Natural Size.

Acacia cultriformis (1 – 3); *A. trineura* (4 and 5); *A. Oswaldi* (6 – 8).
Three-fourths Natural Size.

Acacia pendula (1 – 3); *A. polybotrya* (4 – 6).
One-third Natural Size.

Acacia longifolia (1 – 3); *A. floribunda* (4 – 6); *A. discolor* (7 – 9).
Two-thirds Natural Size.

7. Opposite pair of pinnate leaves, abnormal bipinnate leaf and phyllodes. Boggabri.
8. Pod and seeds. Boggabri. (Mrs. F. C. S. Holt).

Plate IV.

Acacia pendula A. Cunn.

1. Cotyledons. Boggabri. (Mrs. F. C. S. Holt).
2. Pinnate leaf, bipinnate leaves and phyllodes.
3. Pod and seeds.

Acacia polybotrya Benth.

4. Cotyledons. Mudgee. (J. H. Maiden).
5. Pinnate and bipinnate leaves.
6. Pod and seeds.

Plate V.

Acacia longifolia Willd.

1. Cotyledons, pinnate leaf and tip of bipinnate leaf. Dundas.
2. Pinnate leaf, bipinnate leaves and phyllodes.
3. Pod and seeds.

Acacia floribunda Willd.

4. Cotyledons and pinnate leaf. Dundas.
5. Pinnate leaf, bipinnate leaves and phyllodes.
6. Pod and seeds.

Acacia discolor Willd.

7. Cotyledons. Medlow.
8. Pinnate and bipinnate leaves.
9. Pod and seeds.

A PRELIMINARY EXAMINATION OF THE LATE PALÆOZOIC FOLDING IN THE HUNTER RIVER DISTRICT, NEW SOUTH WALES.

By G. D. OSBORNE, B.Sc.

With Plate VI.

[*Read before the Royal Society of N. S. Wales, August 3, 1921.*]

CONTENTS.

I. Introductory.

During the Palæozoic era various areas now constituting parts of New South Wales were subjected to a number of diastrophic cycles. Mountain building forces had their day and ceased to be, time and again. The state of our knowledge regarding the actual details of these somewhat rhythmic earth movements, however, is incomplete, but from the pioneering geological work already done it is sufficiently clear that many areas were involved in periods of crustal compression, which were relatively rapid and intense, separated by long periods of peneplanation and sedimentation in geosynclines and epeiric seas.

R. T. Chamberlin[(1)] has remarked on the possible periodicity of these movements and their relation to deformative processes in other parts of the world. The close of the Devonian in N.S.W. was marked by a period of pronounced diastrophism,[(2)] and during the epoch following on to the beginning of the Mesozoic important orogenic movements were going on in the North-eastern part of the State. Benson[(3)] has shown that in late Carboniferous times a strong crustal activity affected New England. The Lower Hunter area does not seem to have participated in this movement, unless the Hunterian disturbance [(4, p. 282)] can be correlated with it. The work of Andrews[(5)] in the New England area emphasises the importance and magnitude of the crustal upheavals in Permo-Carboniferous times, and it is possible that there was more than one period of activity. Much of the elucidation of this problem depends on the age of the Drake slates, the palæontological evidence seeming to indicate a facies transitional between Kuttung and Lower Marine or between Burindi and Lower Marine,[1] although Walkom[(6)] has suggested the possibility of continuous sedimentation from Lower to Upper Marine time. It is definite that the diastrophism which affected the New England area decreased in intensity southwards, and as Sussmilch[(7)] has pointed out, the only expression of corresponding movement in the Hunter River strata is the existence of overlap of some beds on others. During the latter part of the Permo-Carboniferous period the mountain building forces had a greater effect on the Hunter district, producing a series of anticlines and synclines accompanied by normal faulting. Of this folding the initial portion occurred in pre-Newcastle time, when the Lochinvar anti-

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[1] Verbal communication from Professor David.

cline was already beginning to rise, but the final phase of it took place subsequent to the long period of crustal stability which obtained during the development of the Upper Coal Measures.

It is with this last orogenic folding of New South Wales that the present paper is concerned. The writer has been able at intervals to examine many sections which display this folding, and a perusal of the papers by Van Hise[8] and R. T. Chamberlin,[9, 10] especially those of the latter on the diastrophism of the Appalachians and the Colorado Rockies, prompted him to apply to the Hunter district, the methods so clearly discussed by Chamberlin.

II. General.

(i) *Principles involved.*

Students of diastrophism agree that, in general, the determination can be made of the nature of an earth block subjected to compressional forces, provided certain elemental features of the resultant folding are known. Assuming that there is no volume change consequent upon the impression of the diastrophic forces, then the depth of the folded earth segment can be computed in the following manner:

If A = The present length of the section in question,
B = The original length of the section, so that $(B-A)$ = the crustal shortening,
C = The elevation produced by the lateral stress, and
D = The depth of the folded block,

Then $$D = \frac{A \times C}{B - A}$$

It will be readily seen that the first pre-requisite to form a basis for any investigation of this sort is a detailed geological section across the folded region, in a general direction perpendicular to the strike of the folds. From this it is necessary to restore the folded structure to what it was at the completion of the folding, before erosion had been able to make any impression on the newly risen area. From such a restored section the crustal shortening can be determined by choosing some suitable competent horizon, which has behaved uniformly throughout the folding, and tracing along it through all the corrugations, thus obtaining its original length which is now squeezed into a smaller horizontal extent.

The elevation of the region due to folding is determined after the selection of a datum plane, above which to measure the average vertical height of the folds, this datum plane being the present day expression of the plane from which the folds rose.

Any regional epeirogenic uplift, rise of sea-level, etc., must be taken into account in choosing this datum line, and it is often found that a study of the physiography of the district enables one to unravel the effects of post-folding processes. It is clear that the more remote, geologically, the diastrophism has been, the more difficult will be the endeavour to arrive at the position of such a datum plane.

The above considerations are admittedly theoretical, and numerous small modifications come into the practical investigation. For a clear exposition of the factors which enter into the work and tend to affect the quantitative determinations, the reader is referred to the papers by Van Hise and Chamberlin, (see Bibliography).

In all work of this sort the investigator has to use his discretion and be guided by features peculiar to the area under his consideration.

(ii) *Outline of the Work.*

The section chosen for the present study is that across the Hunter district from Port Stephens to Rix's Creek, near Singleton, a section in a general east and west direction, traversing the folds more or less normal to their strike.

It is, with a slight modification, Section No. III, given by Professor Sir Edgeworth David in the portfolio accompanying that monumental work, "The Geology of the Hunter River Coal Measures."(11) This section forms the basis of the work, and the writer is fortunate in having such a section already prepared on which to make this study.

The section starts in the neighbourhood of Morna Point and is drawn crossing successively the Kuttung series and no less than seven coal basins of the Permo-Carboniferous system. The modification made in the present paper concerns the portion near the western end, viz., from E to A on Professor David's section.

As an alternative the section is stopped near the Hunter River at the fault, which, throwing S 18° W, displaces the Greta coal about 500 feet, and is then shifted to the east side of the Cranky Corner Basin, described by Walkom.(12) This procedure is thought to be permissible, and cannot involve much error or affect the general conclusions.

This modified section was used in order to eliminate the possibility of error involved in reconstructing the folds across the tract D to C on Professor David's section which includes the disturbed and fractured zone near the Hunter River where a possible displacement of 5000 feet is indicated.

A section was drawn linking up the maps of Prof. David and Dr. Walkom, thus obtaining some idea of the relation of the coal measures of Cranky Corner Basin to those of the Branxton Basin. It is very evident from the work of Walkom in the Glendon Brook district that the Lower Marine series thinned out quickly to the north, their thickness at Cranky Corner being only 900 feet. An advantage of the slightly altered section is that it includes the Cranky Corner Basin, which was formed as a result of local cross-warping, it being undoubted that the Permo-Carboniferous strata north of the Hunter, in this particular district, were continuous with those south of the Hunter.

In the reconstruction of the folds careful attention has been paid to the varying degrees of development at different localities, exhibited by the various strata, as, for example, the Dempsey beds, which apparently are a localised series. The text of Professor David's memoir has been of constant help in supplying many of the details which were needed in working out the reconstruction. Concurrent with the appreciation of the variable development of some of the strata has been the recognition of the tectonic history of the lower Hunter area during Permo-Carboniferous time. The overlaps referred to above have been carefully considered, and the fact that the Lochinvar dome had already begun to rise before the Upper Coal Measure swamps had reached a big development has been borne in mind. On account of this pre-Newcastle bulging it seems fairly certain that the Newcastle Coal Measures only flanked these initial folds.

In the estimation of the crustal shortening the base of the Bolwarra conglomerate was chosen for measurement. This horizon was followed throughout all the folds with a rota-meter, its original length before compression thus being obtained. This conglomerate, the lowest division of the Muree beds, constitutes an admirable horizon for the purpose in question for the following reasons:—it shows uniform development over the whole of the area, giving good outcrops in the field. In addition, it has probably behaved the most uniformly of any of the strata throughout the folding, being essentially a competent horizon. Furthermore, from the stratigraphical details exhibited in the field and recorded on the section, it is seen that the vertical interval separating the base of the Muree beds from the upper surface of the Greta coal measures is fairly constant, showing that the accumulation of the Bolwarra conglomerate occurred at a general uniform level. These considerations permit of the above choice being made with confidence.

To arrive at the present position of a datum plane, which corresponds to the surface from which the strata rose, the physiographic history of Eastern New South Wales in Post-Permo-Carboniferous time has been considered. The surface which became wrinkled in post-Newcastle time stood, (with the exception of the initial bulging referred to before), essentially at sea-level. There have been no folding movements impressed on the Hunter area since the close of the Palæozoic era, so that the only movements we have to consider are of an epeirogenic nature. Although the contrasted low relief of the Lower Hunter valley, compared with the bordering higher land, is due in a measure to differential erosion on a grand scale, still it seems that the Lower Hunter segment sagged behind in at least the last upward movement which affected the Eastern portion of New South Wales. This last statement is made mainly on information kindly supplied by Mr. Sussmilch concerning the tectonics of the southern margin of the Barrington Tableland. On both stratigraphic and physiographic evidence he has noted the very probable existence of heavy step-faults flanking that tableland on the southern side, (see [13]).

Taking these facts into consideration and allowing for the effect of comparatively recent movements along the coast the writer has arrived at the figure of 1100 feet for the post-folding uplift in the Hunter area.

The section which is seventy-one miles in length was divided up into seven portions, six of which being ten miles long, and the seventh, which is the westernmost, being ten and a half miles in length. The depth of the folded block was worked out separately for each of the seven sectors according to the method detailed above. Particulars of all the results are given below. The actual section which was used in the investigation was drawn to a scale twelve times that of Plate VI.

III. Details of the Results.

(i) *The Shortening of the Crust.*

Beginning at the eastern end of the section, and numbering the section portions I to VII, the following measurements were obtained.

	Miles.
Section No. I.	
Distance traced on the base of the Bolwarra Congte. ...	10·6
Present horizontal length...	10·0
Crustal shortening... ...	·6
Section No. II.	
Distance traced on the base of the Bolwarra Congte. ...	10·41
Present horizontal length...	10·00
Crustal shortening... ...	·41
Section No. III.	
Distance traced on the base of the Bolwarra Congte. ...	11·3
Present horizontal length...	10·0
Crustal shortening... ...	1·3
Section No. IV.	
Distance traced on the base of the Bolwarra Congte. ...	11·8
Present horizontal length...	10·0
Crustal shortening... ...	1·8
Section No. V.	
Distance traced on the base of the Bolwarra Congte. ...	11·8
Present horizontal length...	10·0
Crustal shortening... ...	1·8
Section No. VI.	
Distance traced on the base of the Bolwarra Congte. ...	11·3
Present horizontal length...	10·0
Crustal shortening... ...	1·3

	Miles.
Section No. VII.	
Distance traced on the base of the Bolwarra Congte. ...	10·75
Present horizontal length...	10·50
Crustal shortening... ...	0·25
Total length of the Bolwarra Conglomerate	77·96
Total present horizontal extent	70·50
Total Crustal shortening... ...	7·46

(ii) *The Height of the Folded Area.*

The amount of the vertical bulging was measured for each division of the section and the values when reduced to average vertical heights for the respective divisions, resulted as follows:

	Average Height in Miles.		Average Height in Miles.
No. I Section	... 2·505	No. V Section	... 1·914
,, II ,,	... ·440	,, VI ,,	... ·825
,, III ,,	... 1·611	,, VII ,,	... ·532
,, IV ,,	... 1·157		

From these figures it would appear that the general average elevation of the folded tract over the whole section was originally of the order of 1·3 miles or 6800 feet.

(iii) *Depth of the Deformed Earth Block.*

From the results of (i) and (ii), with the employment of the formula given in Part I, the depth, for each ten-mile strip of the earth zone which was involved in the diastrophism has been calculated. The values are given here:

	Depth in Miles.		Depth in Miles.
No. I Section ...	... 41	No. V Section	... 10
,, II ,, ...	... 11	,, VI ,,	... 6·5
,, III ,, ...	.. 12	,, VII ,,	... 21
,, IV ,, ...	... 6		

IV. Preliminary Discussion of the Results.

From the results obtained above it is seen that the diastrophism which affected the lower Hunter area in late Permo-Carboniferous time was of an intermediate intensity, producing a crustal compression whereby 70·56 miles of the earth were shortened by 7·46 miles.

The shell involved in the folding appears to have been a fairly thin one, and, at first sight of a peculiar shape. The margins of the tract in question are underlain by the deepest zones, and the central portion is the surface of a comparatively thin block.

Turning to the values for the depths of the earth blocks for the individual section portions one is struck by the low values obtained for sections No. IV and No. VI. The numerical value of the thickness of the folded block is obtained from a fraction whose value is dependent on the measure of the crustal shortening and the average vertical bulging per mile. In the case of Section No. VI the amount of the height of the folded structure above the datum plane is very small, since the Upper Coal Measures, (the topmost strata of the section under consideration), are in places below the line of the datum plane.

This is undoubtedly due to the fact that after the folding, or, at any rate, towards the close of the folding, heavy faulting occurred letting some of the strata down to the extent of 5000 feet. Thus to arrive at the depth of the zone under the portion No. VI one must consider the restored section in its pre-faulting position. A similar procedure should be adopted for the whole section in order to gain a truer conception of the nature of the deformed zone.

The original procedure of reconstructing the whole section without allowing for faulting was quite justifiable for the following reason. There was no conclusive evidence to show that the heavy faulting, which characterises the section, occurred wholly within the period of folding or not. It was quite reasonable to assume the faulting began long before the completion of the thrusting, and that a general accommodation between the deformation and the faulting movements took place.

In view of the above considerations the whole section was re-drawn to represent, with as much accuracy as possible, the state of affairs before faulting.

V. Results Obtained from the Amended Section.

From the alternative reconstruction of the section a new set of values for the vertical uplift due to folding and for the depths of the deformed zones for each section-portion was obtained. These values are as follows:

(i) *The Height of the Folds.*

	Average Height in Miles.		Average Height in Miles.
No. I Section	... 2·505	No. V Section	... 1·914
,, II ,,	... ·663	,, VI ,,	... 2·103
,, III ,,	... 1·773	,, VII ,,	... ·532
,, IV ,,	... 1·395		

These figures indicate an average vertical elevation over the whole area of about 8000 feet.

(ii) *Depth of the Folded Shell.*

	Depth in Miles.		Depth in Miles.
No. I Section	... 41	No. V Section	... 10
,, II ,,	... 16·5	,, VI ,,	... 14
,, III ,,	... 13·5	,, VII ,,	... 21
,, IV ,,	... 8		

VI. General Discussion and Conclusion.

We are now able to view the results as being more or less of a final nature, so far, at any rate, as this preliminary report goes. It is seen that the folding under examination has been produced by the active deformation of an earth shell varying in thickness from 8 miles to 41 miles. This deformation produced a crustal shortening of 7·46 miles in a section 70·5 miles long.

A comparison with the American areas is fitting here. The comparison can be made along two lines chiefly, viz., concerning the crustal shortening and the nature of the folded shell.

In the Appalachians the folding effected a shortening in the earth's crust of 15 miles in 66 miles. The Rocky Mountain folding in Colorado was such that, after thrusting, the section which was originally 140·69 miles in length became 132 miles long. The Hunter area, therefore, displays diastrophism of intensity intermediate between these two American areas, in that a strip 77·96 miles long was reduced by 7·46 miles. Also in this connection it is to be noticed that the folding in the Lower Hunter district is of a fairly open type, there being no examples of true overfolding.

Regarding the comparison of the folded shells it is interesting to notice certain general conclusions drawn by Chamberlin concerning the relation between the intensity of the folding and the nature of the disturbed zone.

He found that mountain ranges, where the folding has been intense and the crustal compression consequently of a high magnitude, have been produced by the crumpling of a relatively thin shell, and are characterised by the absence of any great vulcanism which is resultant upon the diastrophism. Mountain tracts, on the other hand, which display open folding, the absence of thrust faulting, and the presence of strong resultant vulcanism represent the product of the deformation of a very thick zone. With regard to these generalisations it can be said of the Hunter folding that a comparatively thin shell was involved, and associated with this shallow zone is the evidence of fairly strong crustal compression and the absence of thrust faulting and resultant vulcanism.

Therefore it may be stated, that although not exhibiting the advanced stages of crumpling, the Lower Hunter diastrophism is essentially of the thin-shell type.

In the drawing in Plate VI an attempt has been made to link up the adjacent earth blocks so as to obtain some idea of the possible disposition of the shear plane, which may be looked upon as separating the zone which participated in the crumpling from the lower undisturbed portion. Taking into consideration the fact that the section under investigation is an incomplete one, and that the folded structure is probably continued for some distance to the west of Rix's Creek, and also probably extended to the east of the present coastline, it is possible that the deeper earth blocks which underlie the borders of the present section are portions of huge wedge-shaped segments of the earth's crust with whose margins alone we are dealing.

In concluding this tentative discussion of the whole work the chief feature which is the outcome of the investigation may be stressed. This is that in the analysis of folding in a region where heavy strike-faulting has occurred, the age of which in relation to folding is uncertain, the examination is best made first upon the reconstruction of the folds in the faulted positions, and then upon the restored section with the strata in their pre-faulting disposition. The two sets of results may then be compared and used to arrive at the conception of the set of conditions obtaining during the whole of the diastrophism and its resultant phases.

The writer wishes to acknowledge his indebtedness to Professor David, Professor Cotton, and Dr. A. B. Walkom for advice in connection with this work.

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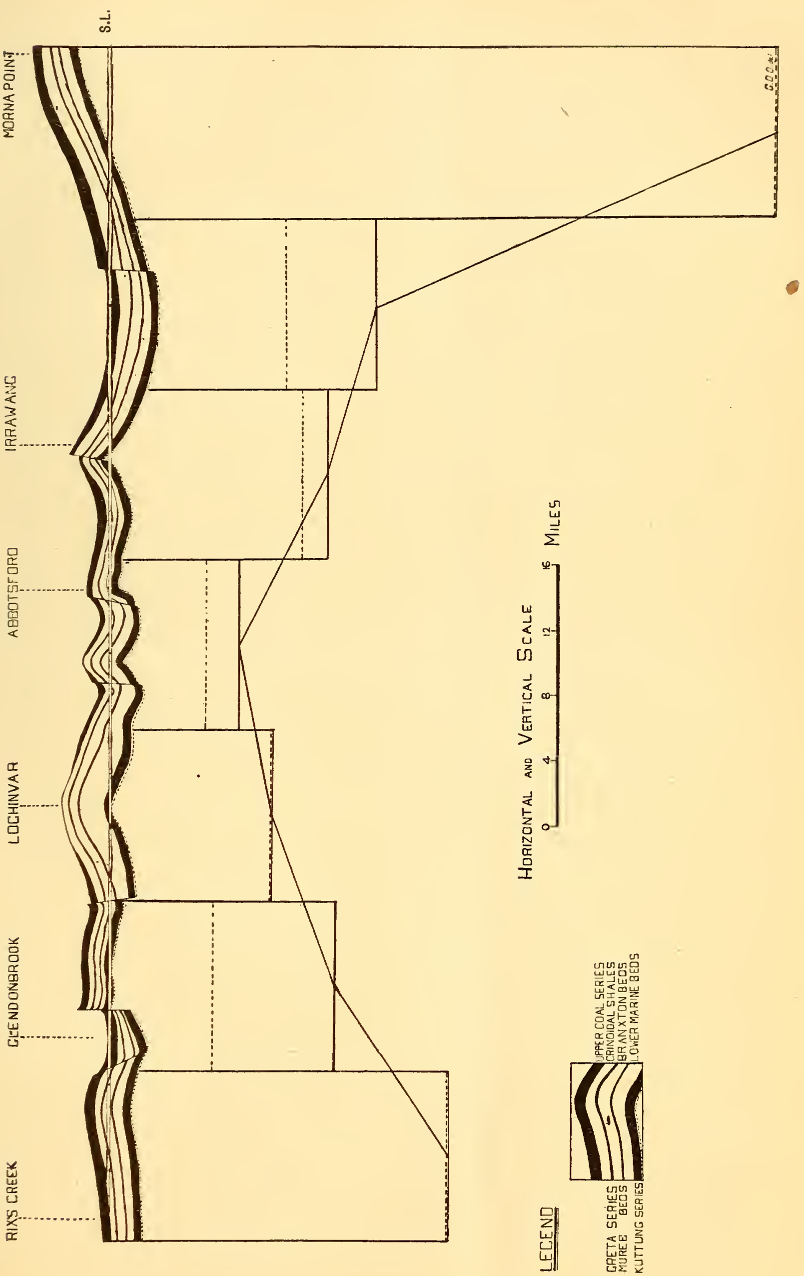
EXPLANATION OF PLATE.

In Plate VI is given a drawing showing the reconstructed section and the depths of the deformed zone based on dimensions obtained from the two sections (see text). In order to make the horizons of the Greta Coal Measures and the Muree beds clearly seen on the small scale, in which the section is necessarily drawn, these two series have been exaggerated at the expense of the Branxton Beds and the Crinoidal Shales respectively. A uniform thickness of Kuttung rocks is shown beneath the Permo-Carboniferous series, but no particular horizon in the former series is intended to be represented. The whole of the Upper Coal Measures, that is all strata above the Upper Marines, have been considered collectively, and thus are coalesced in the section. In the drawing of the earth blocks under each section portion, dotted lines have been used to represent those blocks whose dimensions were obtained from the original section, and full lines for the blocks whose dimensions resulted from a consideration of the amended section.


S.L.
MORNA POINT
IRRAWANG
ABBOTSFORD
LOCHINVAR
GLENDONBROOK
RIX'S CREEK
HORIZONTAL AND VERTICAL SCALE
0
4
8
12
16
MILES
LEGEND
GRETA SERIES
MUREE BEDS
KUTTUNG SERIES
UPPER COAL SERIES
CRINOIDAL SHALES
BRANXTON BEDS
LOWER MARINE BEDS

NOTE ON THE POSITION OF THE DOUBLE LINKAGE IN PIPERITONE, PART I.

By A. R. PENFOLD, F.C.S.

With Plate VII.

[*Read before the Royal Society of N. S. Wales, August 3, 1921.*]

Mr. H. G. Smith, F.C.S. and the present author in a paper entitled "On the manufacture of Thymol, Menthone, and Menthol from Eucalyptus Oils," read before this Society in June 1920,[1] pointed out that piperitone—the ketone found occurring in certain Eucalyptus oils—on account of the formation of the aforementioned bodies was a menthenone, with the carbonyl group at position 3. These authors were unable at that time to bring forward evidence that would establish the position of the double bond, but contented themselves with the statement that it was either in the fourth or first positions, leaving the decision until such time as the evidence in favour of either one or the other was forthcoming, particularly as they were dealing with only those bodies which threw light on the carbonyl grouping. At the time of reading of this paper, they considered there was a little evidence in favour of the fourth position, although the chemical and physical constants of the ketone agreed very closely with those given by Schimmel & Co. for $\triangle^1$-Menthenone-3.[2]

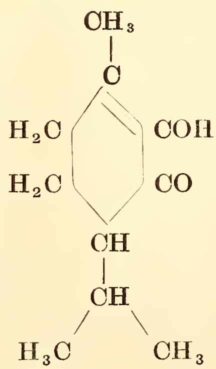
During the past year the writer has carried out a series of experiments on the decomposition of piperitone by means of both alkaline and neutral potassium permanganate solutions with a view to deciding the constitution of this

[1] This Journal, Vol. LIV, 40, (1920).

[2] Semi-annual Report, October, 1910, p. 97.

interesting ketone. Although the work is not yet completed, in view of the great interest evinced in this body since the publication of the paper (*l.c.*), more particularly in the technical press, the writer felt justified in making available, as soon as possible, any conclusive evidence determining the position of the double linkage. A further reason for this decision, was that whilst preparing this note, the "Perfumery and Essential Oil Record" of March 1921, page 80, came under notice, wherein appears an article on the constitution of piperitone by Messrs. L. Givaudan & Co., Vernier, Geneva, Switzerland. This firm make certain deductions based on theoretical considerations and upon a comparison of the chemical and physical constants given by Messrs. Wallach, Schimmel & Co., and Roberts, for various preparations of $\triangle'$-Menthenone-3, and mention that very likely piperitone is identical therewith.

From the oxidation products of piperitone the author isolated diosphenol, a ketophenol, whose structure is well known. It was synthesised by Messrs. Semmler and McKenzie in 1906, and by Cusmano in 1913, so that the position of the double bond in this body has been established beyond doubt. It is as follows, viz.:—



As the double bond in this ketophenol is in the first position, it naturally follows that it is conclusive evidence of the linkage being in a similar position in the molecule of piperitone, as if it were at 4, it could not yield diosphenol on oxidation. This decisive evidence is thus recorded in this note merely as a preliminary, thereby leaving the account of the other interesting acid products of oxidation for a Part II communication.

Experimental.

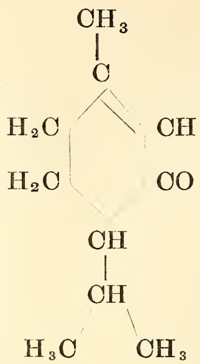
104 ccs. of piperitone possessing the following characters:

Boiling point at 760 mm. ...	235° C. (corrected)
Specific gravity at 15° C. ...	0·9383
Optical rotation	−0·4°
Refractive Index at 20° C. ...	1·4837

were oxidised at 18° C. with 2% aqueous solution potassium permanganate. On completion of the reaction and separation of the solution from the manganese sludge, steam was blown through it, when 7 grams of a white crystalline body were obtained. This material was purified by sublimation, when it was obtained in monoclinic needles possessing a mixed odour of mint and menthol. (See Plate VII.)

The crystals melted at 82° C., and were insoluble in water but soluble in a cold 5% aqueous solution sodium hydroxide. From the latter they were liberated again on addition of dilute acid. They gave a green colouration with ferric chloride in alcoholic solution, restored the colour to Schiffs' solution, reduced both ammoniacal silver nitrate and Fehling's solutions, behaviour characteristic of diosphenol. It was confirmed by the preparation of the oxime, m. pt. 125° C., and phenylurethane, m. pt. 41° C.

On combustion it gave results in accord with the formula $C_{10}H_{16}O_2$. The crystals having been proved to be diosphenol, piperitone must necessarily possess the following structure:—



It is therefore, identical with the following:—

(1) △′-Menthenone-3 prepared synthetically by Wallach.[1]

(2) The ketone found occurring in Japanese Peppermint Oil,[2] identical with (1).

(3) The ketone found in Camphor Oil, identical with (1).[3]

(4) △′-Menthenone-3 found in the oil of *Cymbopogon sennaarensis.*[4]

The name piperitone takes priority for this ketone, △′-Menthenone-3, as it was first discovered by H. G. Smith, F.C.S., in Eucalyptus oils in the year 1900.[5]

I have to express my thanks to Mr. T. C. Roughley, Economic Zoologist, for the photograph of the crystals of diosphenol, and to Mr. F. Morrison, Assistant Chemist, for his help in this work.

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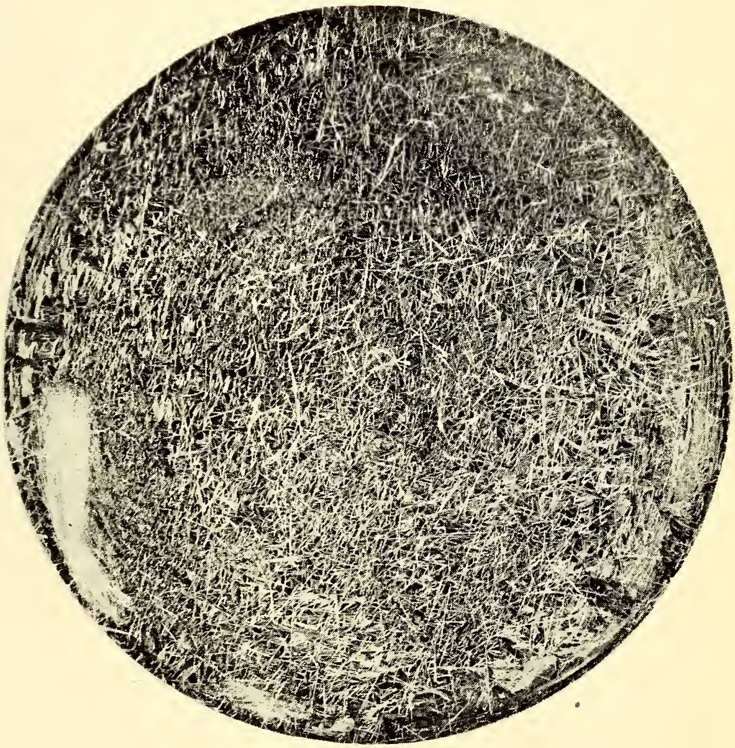
[1] Ann. 362 (1908), p. 271.

[2] Schimmel & Co., Semi-annual Report, Oct. 1910, p. 97.

[3] Gildemeister & Hoffmann, 2nd German edition, p. 482.

[4] Roberts, J. C. S., 107 (1915), 1465.

[5] This Journal, Vol. xxxiv, (1900), p. 136.



Sublimate of Crystals of Diosphenol from Piperitone. (Nat. size.)

Photo. by T. C. Roughley.

EARTH MOVEMENTS AT BURRINJUCK AS RECORDED BY HORIZONTAL PENDULUM OBSERVATIONS.

By Assistant-Professor LEO A. COTTON, M.A., D.Sc.

[Read before the Royal Society of N. S. Wales, August 3, 1921.]

THE investigations into the strength of the earth's crust which are being carried out at Burrinjuck were undertaken at the suggestion of Dr. W. G. Woolnough who was then Assistant-Professor of Geology at the University of Sydney. He pointed out that the construction of the Burrinjuck Dam would offer a unique opportunity for testing the behaviour of the earth's crust under a fluctuating load of considerable magnitude. This project was supported by the Australasian Association for the Advancement of Science which voted a preliminary grant to start the investigation. Professor Woolnough was shortly afterwards appointed to the Chair of Geology at Perth and this rendered it impossible for him to proceed with the investigation.

Some time later the Rev. Father Pigot S.J., who had recently returned from Europe suggested to Professor David that certain horizontal pendulums which he had seen during his visit abroad would be eminently suitable for the Burrinjuck research if they could be procured. Professor David therefore approached Geheimrat Helmert with a request for the loan of these instruments. The request met with a very generous response, and Helmert, with the co-operation of Hecker and Wolf, forwarded three very valuable instruments for the purpose. These were loaned to the Australasian Association for the Advancement of Science, and were shipped free of charge.

One of the three pendulums is that which was employed by Hecker at Potsdam in his classical investigation on earth tides, and another was used by Schweydar at Heidelberg for the same purpose. These are both of the Rebeur-Ehlert type. The third instrument is of the Zöllner suspension type and was specially constructed to Hecker's design. The installation and maintenance of the pendulums at Burrinjuck have been provided for under the joint auspices of the State Irrigation Commission and the Australasian Association for the Advancement of Science.

The pendulums are housed in tunnels the sites of which were jointly chosen by Professor David, Father Pigot, Mr. D. F. Campbell, and the author. These tunnels are placed from 20 to 40 feet above the highest water level, and are from 60 to 80 feet in length.

The design of the installation was prepared by Father Pigot, who also set up the first of the pendulums in May 1914. The instruments were finally adjusted by the writer and all three were in working order in October of the same year. Their care has since been in his charge.

A preliminary account of the deflections of the earth's crust during the first year of the records has been already published[1] and it is only necessary to review briefly this work. It was pointed out in this preliminary account that four types of earth movements have been recognised. These are as follows:—

(1) Earth tides. (3) Fault movements.
(2) Earthquakes. (4) Slow deflections of the vertical.

These movements are briefly discussed in the paper above mentioned. This communication is only concerned with the movements of the fourth type. The study of these indicates that many of them occur synchronously with

[1] Leo A. Cotton, "Some Geo-physical Observations at Burrinjuck." This Journal, XLIX, 1915, pp. 448—462.

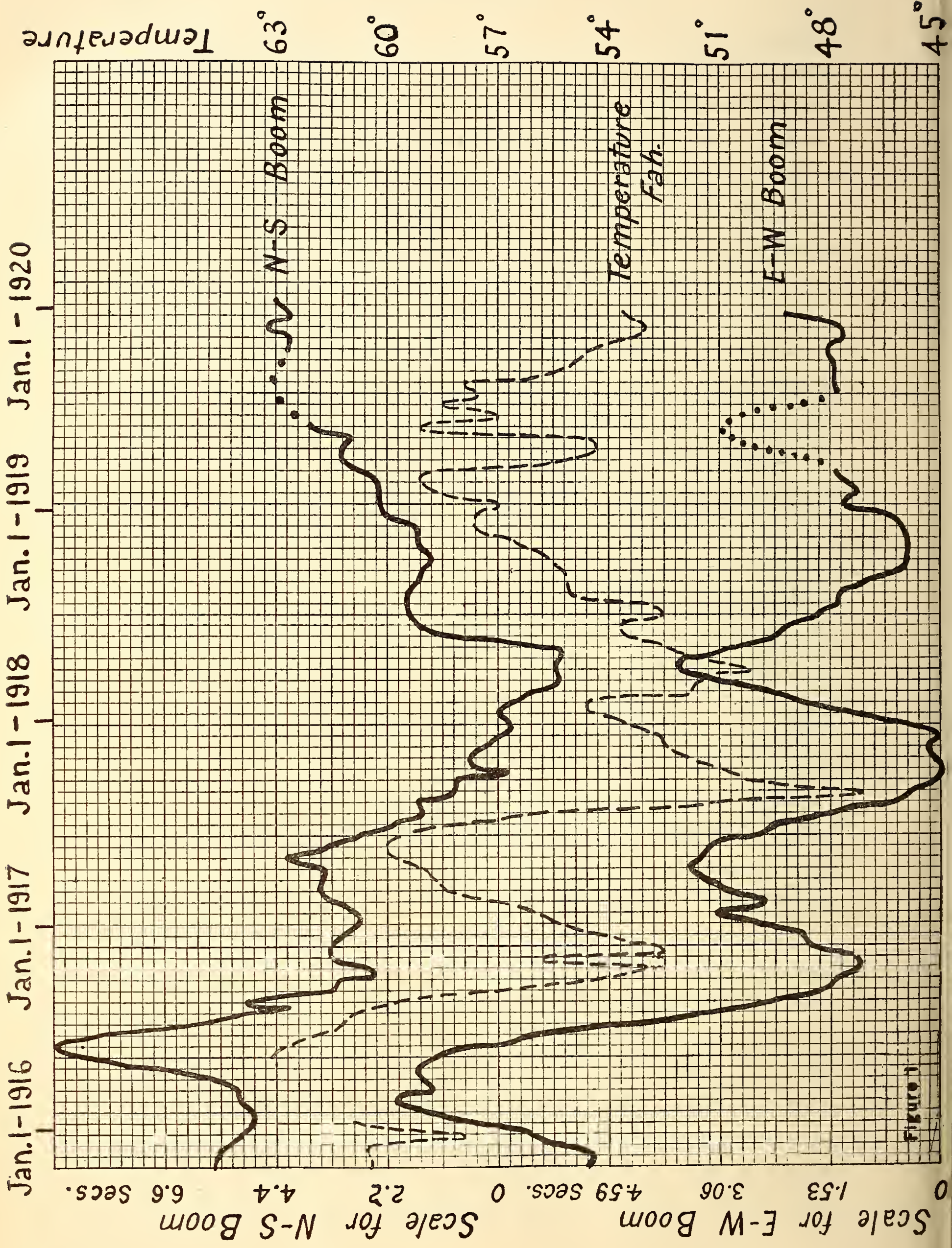
changes in the water level and are no doubt connected with such changes. The movements of larger amplitude, however seem to have another origin.

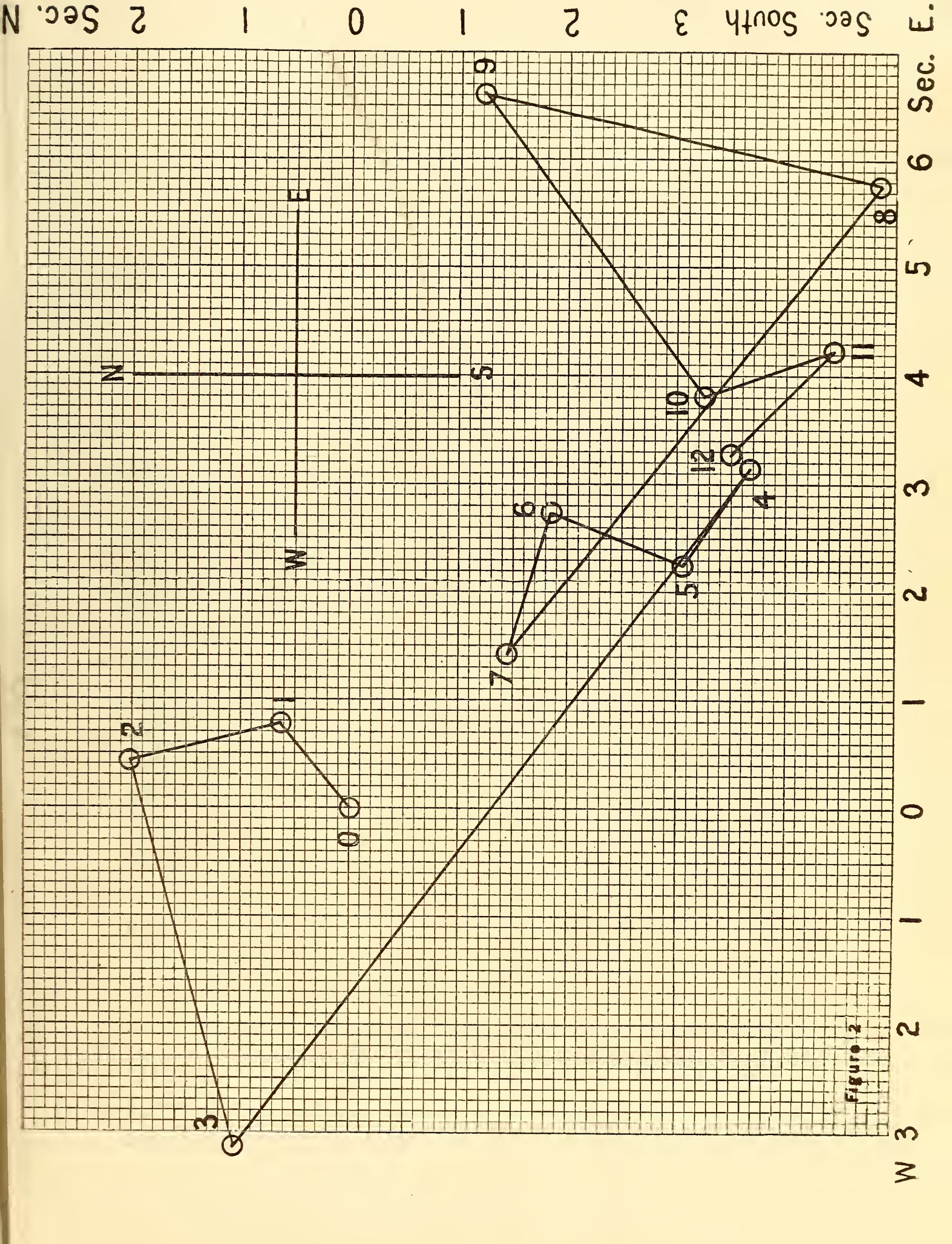
Mr. D. F. Campbell the resident engineer at Burrinjuck, who has generously devoted much of his leisure to the care and maintenance of these instruments, has recently called my attention to the fact that these major changes are more or less seasonal in character and that they follow the same kind of variation as the temperature changes registered by a thermometer which had been placed in the concrete dam at a distance of 80 feet from the surface. Acting on this suggestion I have worked out in detail the changes recorded by the pendulum installed at Dale's tunnel, for the period of four years from 1916 to 1919 inclusive. The results are represented graphically in figure 1, in which the movement of each boom is plotted and compared with the temperature curve for the corresponding period. As the temperatures are those recorded by a thermometer placed 80 feet within the wall of the dam, the temperature variations therefore lag some months behind the air temperatures at the surface. This is, of course, due to the low heat conductivity of the rocks.

The degree of correspondence between the movements of the pendulums and the temperature variations is very remarkable, and casts a new light on the movements of the outer earth's crust.

The scale of the deflections given in figure 1 is different for each pendulum boom as will be seen by reference to the scale of seconds placed at the left hand side of the diagram.

The actual amounts of movement measured in seconds of arc may be readily obtained from figure 2, in which the separate components of the two booms have been compounded into a single resultant movement. In this diagram the stations marked 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, correspond to the following dates:—


Temperature
63°
60°
57°
54°
51°
48°
45°
N-S Boom
Temperature
Fah.
E-W Boom
Jan.1-1916
Jan.1-1917
Jan.1-1918
Jan.1-1919
Jan.1-1920
6.6 Secs.
4.4
2.2
0
Scale for N-S Boom
4.59 Secs.
3.06
1.53
0
Scale for E-W Boom
Figure 1


Sec. N
Sec. South
Sec. E.
W 3
N
S
E
W
0
1
2
3
4
5
6
7
8
9
10
11
12
Figure 2

0	corresponds to	20th October, 1915
1	,,	18th January, 1916
2	,,	17th February, ,,
3	,,	27th May, ,,
4	,,	4th October, ,,
5	,,	23rd November, ,,
6	,,	22nd January, 1917
7	,,	2nd May ,,
8	,,	9th October, ,,
9	,,	8th April, 1918
10	,,	17th July, ,,
11	,,	25th October, ,,
12	,,	2nd February, 1919

The deflections are all referred to station 0 of the 20th of October, 1915, as the standard of reference. The east and west deflections are measured horizontally, and the north and south deflections vertically as shown by the cardinal points on the diagram. The deflections are measured in seconds of arc. In order to obtain the direction and amount of the tilt corresponding to any of the points marked 1, 2, etc., the following procedure is adopted: Take for example the deflection for the 8th of April, 1918, as recorded at station 9. Join 9 to 0. The length of the joining line is 6·74 divisions and therefore represents a deflection of 6·74 seconds of arc. The angle made by the line joining 0 and 9 with the horizontal or east direction can be measured with a protractor (or calculated from the tangent relation) and is thus seen to be 10½ degrees. The tilt is therefore 6·74 seconds in a direction east 10½ degrees south. Similarly for station 2 the tilt can be shown to be 2·07 seconds in a direction north 12½ degrees east; and so on.

The amount of tilting is very surprising and suggests that the rocks are undergoing great strain as the result of temperature changes. Hence it is possible that the effect of temperature changes, which is so well recognised as a process of weathering, extends far deeper into the earth's crust than has previously been recognised.

This discovery of the relation between the movements of the pendulums and the temperature variations is a most important one in connection with the primary investigation of the deflections due to the water load; for the movements due to the temperature changes are large and must be sorted out in order to evaluate correctly the other movements.

These relations between the temperature changes and the movement of the outer shell of the earth's crust are very interesting in themselves, and the author proposes to investigate them further by comparing the underground rock temperatures with the insolation at the surface for different months of the year. This will, of course, involve a detailed study of the topography in the immediate neighbourhood of the pendulum station. This study is now being carried out in connection with the geological survey of the area.

The results so far obtained are very encouraging and the research promises to provide the most interesting and important information with regard to some of the geophysical problems of the earth's outer crust.

RECORDS OF AUSTRALIAN BOTANISTS.

By J. H. Maiden, I.S.O., F.R.S., F.L.S.

SECOND SUPPLEMENT,

(For First Supplement see Report Aust. Assoc. Adv. of Science XIII, p. 224, 1911.)

[With Plates VIII, IX.]

[Read before the Royal Society of N.S. Wales, September 7, 1921.]

Prefatory Note.—The list of worthies already recorded by me can readily be ascertained by consulting the last reference. I use the same numbering (heavier type) in the quotation of previous papers, as in the First Supplement.

Anderson William (–1778). See (**4**), p. 11.

He was surgeon of Cook's Third Voyage, which lasted from 1776 to 1779, and made a number of botanical enquiries, relatively unimportant if compared with those of the First Voyage (Banks and Solander). The expedition did not call at the Australian mainland, but at Tasmania. He died after "lingering under a consumption for more than twelve months." A very full account of what is known of him is given by Mr. James Britten in Journ. Bot. LIV, 345, and LV, 54.

Armit, William Edington de Margrat (1848 – 1901). See (**6**), p. 374.

He was born at Liège, Belgium. Additional particulars of this botanical collector will be found in the Annual Report on British New Guinea from 1st July 1900 to 30th June 1901, and at pages xli and xlii will be found additional notes. He was Resident Magistrate, Northern Division, when he died on 3rd January, 1901. On 20th November, 1895 he became Sub-collector of Customs, etc., at Samarai.

He retired towards the end of 1897, but was re-appointed to the public service in charge of the Northern Division during 1899. He communicated a good deal of useful information concerning New Guinea to Australian newspapers, particularly the Melbourne *Argus* and *Age*.

BAUER, FERDINAND (1760 – 1826).

In my "Sir Joseph Banks" (1909), I have given all the details I could get together of the life and work of this eminent botanical artist. [See also particulars in the same work of his distinguished brother, Francis (1758 – 1840)]. He was in the employment of Sir Joseph Banks, and was the coadjutor of Robert Brown in Australia, 1800-5. Valuable supplementary information to that given above, will be found in "Ferdinand Bauer's drawings of Australian plants," by James Britten, in Journ. Bot., April 1909, p. 140.

LEWIN, J. W. (? 1770 – 1819) See (1), p. 110.

I have a list of such of Lewin's drawings referred to, formerly the property of the late Hon. P. G. King, M.L.C. They are also valuable because of their association with Allan Cunningham. There are some details concerning him in William Dixson's "Notes on Australian Artists," Journ. Roy. Aust. Hist. Soc., V, 236, 1919). See also various volumes Hist. Rec. N.S.W. and Hist. Rec. Austral.

AUSTIN, ROBERT.

Mr. James Drummond reported on the collections of plants made by Assistant Surveyor Robert Austin, dated at "Hawthornden Farm (W.A.), April 16th 1855," pp. 272-3, Vol. 26 for the year 1856 (Journ. Roy. Geog. Soc.) I am indebted to Mr. Thomas Gill, C.M.G., for this reference. The plants were 54 in number, not in a good state of preservation. The letter is, however, in general terms, only two or three botanical names being given. The plants seem to have been obtained from north of Perth, towards the Murchison.

Mr. H. S. King, the Surveyor General of Western Australia, has been kind enough to favour me with a list of the districts in which he worked, compiled from various plans and field books. In addition, he conducted an important exploring expedition, leaving Perth in June 1854, when he explored the country between Toodyay and the Upper Murchison.

BAILEY, FREDERICK MANSON (1827 – 1915).

The eminence of this doyen of Australian botanists, from Mueller's to his own death, makes an extended notice at this place unnecessary, since his life and work are well known. He was born in Hackney, London, on 8th March, 1827, and died in Brisbane, 25th June, 1915. He was the son of John Bailey, one of the earliest of South Australian horticulturists, who arrived in that Province in 1839. The subject of this notice left South Australia after a few years, went to Victoria mining, and afterwards to New Zealand. He came to Queensland in 1861, then recently separated from New South Wales, but it was not until 1875 that he had a chance of utilizing his botanical knowledge, when, the Queensland Government having appointed a Board to enquire into the causes affecting live stock and plants, he received his first botanical appointment. His early work dealt with grasses and ferns. Subsequently he was placed in charge of the botanical section of the Queensland Museum, and in 1881 he was appointed Colonial Botanist of Queensland, a post he held till his death. His work was chiefly on Queensland plants, and the results of many of his separate papers will be found in his "Queensland Flora," a work which incorporates Bentham's "Flora Australiensis" so far as plants from that State are concerned. A full account of his career, and a bibliography of his works, will be found in Proc. Roy. Soc. Q., XXVIII, 1916. He leaves the reputation of an entirely efficient public servant, and of a most lovable man.

BETCHE, ERNST, (1851 - 1913).

Born 31st December, 1851, at Potsdam near Berlin, died 28th June, 1913 at Sydney. Collector, Botanic Gardens, Sydney, 26th September 1881, and nominated by me Botanical Assistant, 3rd March 1897, a post he held until his death. He suffered from ill-health all his life, and so personally was not known to very many, but he was a sound botanist and left a permanent mark on the flora of New South Wales. I published an account of his career at p. 14 of my 1913 Report of the Botanic Gardens, Sydney, to which my readers are referred. After his death there was published the "Census of New South Wales Plants," (in 1916) a work on which he and I had been engaged for many years.

BRADLEY, HENRY HOUGHTON (1845 – 1918).

He was born in Surry Hills, Sydney, 4th November 1845, and died at "Grantham," North Sydney (the former home of Admiral P. P. King, R.N.) on 23rd November 1918. He distinguished himself in various walks of life. He was a leading solicitor, succeeding his father, not only as head of the long-established firm in Margaret Street, Sydney, but also in his love for horticulture, and capacity for improving bulbous plants. His horticultural eminence, for he was the most distinguished Australian horticulturist of his time, overshadowed his botanical side, for he was well versed in the literature and practice of hybridisation and genetics. One of his few papers is entitled "Hybridising at the Antipodes," Report of the 3rd Int. Conf. 1906 on Genetics, published in the Journ. Royal Hort. Soc., pp. 388 – 400. Mr. Bradley's paper deals with *Narcissus*, *Hippeastrum*, *Gloriosa*, *Lilium*, Sporting, Graft-hybridisation and Bigeners. He was awarded at the Paris meeting (4th Int. Conf. on Genetics, 1911) the Mendel medal struck in connection with that conference.

In his younger days he was an authority on the subject of spiders and their architecture, and was an original member of the Entomological Society of N. S. Wales, contributing to its Proceedings and to the first volume of those of the Linnean Society of N. S. Wales. He was an Elective Trustee of the Australian Museum from 7th November, 1878, and succeeded Dr. J. C. Cox as Crown Trustee, an office he held until his death.

He was Honorary Secretary of the Horticultural Society of New South Wales from 1893 to the last year of his life, when he was President. His garden at "Grantham" was a marvellous gardeners' garden, and earnest students of horticulture were always welcome. His unique collection of *Crinums* and *Hippeastrums* which embodied much of his work of later years, was presented by Mrs. Bradley to the Botanic Gardens, Sydney. He sternly forbade publication of any notices in which his name appeared, under pain of exclusion from his wonderful garden. A sympathetic notice by Henry Selkirk (one of his co-workers) will be found in the *Sydney Mail* for 5th February, 1919. See also a note in my Report of the Botanic Gardens, Sydney, for the year 1918.

CALEY, GEORGE (177- -1829). See (1), p. 94, (4), p. 13, also my "Sir Joseph Banks," p. 127.

He was a most eminent botanical observer, though the identity of many of his plants has been lost through the incorporation of them in the collections made by and under the auspices of Robert Brown, his superior officer, during the first four years (1800-4) of their combined stay in Australia, Caley remaining on till 1810. We know Caley's small handwriting on his very small labels (paper was very scarce then), and it is very desirable we should trace his collecting localities.

I am indebted to Mr. Henry Selkirk for a Surveyor's record of Caley's land at Parramatta, which was his principal headquarters when in the Colony.

For notes on Caley's journeys in the present Camden and Oaks districts, see R. H. Cambage in Proc. Linn. Soc. N.S.W., XXXVI, 545, (1911), and my "Sir Joseph Banks," p. 132.

An article, "George Caley, an early botanist" by Captain J. H. Watson, will be found in the "Sydney Morning Herald" of 18th July, 1914.

A name association with Caley is Pendle Hill, viâ Wentworthville near Parramatta, where there is a Post Office. Pendle Hill and Pendleton are near Manchester, England. Another association is with the Middleton (Lancashire) Botanical Society, one of the celebrated scientific societies of working men for which the north of England is famous. The Society is still doing excellent work. Caley lived at Middleton when a boy and rejoined the Society on his return from New South Wales ("Sir Joseph Banks," pp. 127, 139).

As regards the monument of stones on the Blue Mountains known in the early days as "Caley's Repulse," see my "Sir Joseph Banks," p. 133. In the "N.S.W. Calendar" for 1833, in the Itinerary of Roads at p. 109 we have "49 m. (from Sydney). A pile of stones called Caley's Repulse, well known in the history of this (Blue Mountains) road." It received this name from Macquarie, and the name has erroneously adhered to it to this day. The heap of stones or a cairn is in the vicinity of Linden, and was probably erected by Bass or Hacking, but they left no record of having done so.

CRAWFORD, ALEXANDER ROBERT (1840 – 1912).

Born in Dublin, Ireland, 21st February, 1840, died at Moona Plains, Walcha, N.S.W., 27th March 1912, and buried at Walcha. Both his parents came from the north of Ireland, and he managed Cunderang Station for his uncle, Mr. Richard Hill, for many years before he took up collecting for the late Baron von Mueller. Mueller was so pleased with his work that he asked him to go to Western Australia to collect, but this was declined. I am indebted to his brother, Mr. Guy H. Crawford, for these details. Mueller valued his work highly, and quoted him in his "Select Extra-tropical Plants." After Mueller's death in 1896, I got into touch with him through Mr. J. F. Campbell, L.S., and my relations with him were very pleasant and continued till the close of his life. I found him a critical observer, and he made many critical observations, particularly on grasses and Eucalypts. He discovered *E. globulus* in New England, and a specimen of his notes will be found in my "Critical Revision" of the genus, Part II, p. 66, under *E. obliqua*, but he did not publish, so far as I am aware. Any specimens he sent to me are in the National Herbarium, Sydney.

FISHER, WILLIAM ROGERS (1846 – 1910).

This is one of the few instances in which an Australian has gone to Britain and has very highly distinguished himself in botanical and cognate matters. Mr. Fisher was born in 1846 in Sydney, where his father, F. Fisher, was Crown Solicitor in 1835 and 1836, but afterwards became the first Attorney General of New Zealand in 1841, but he held the post for only three months. The son was educated at Cambridge, and afterwards entered the Indian Forest Service, becoming subsequently Professor of Forestry in the Royal Indian Engineering College at Cooper's Hill, England. He co-operated with Dr. Schlich in bringing out

Vols. IV and V of the latter's Manual of Forestry, and it is perhaps in connection with this work that he is best known to Australians. He died on 13th November 1910, and there are lengthy notices of him in "Nature" for 24th November and the "Gardeners' Chronicle" for 26th November, the latter containing a portrait. He was a most distinguished man, but was very little known in his native country, partly because it does not appear that he returned to Australia after his departure for England in his youth.

FITZALAN, EUGENE F. A. (1830 – 1911).

He was botanical collector in Lieut. J. W. Smith's Expedition to the Estuary of the Burdekin River, Q., in the year 1860. An account of the plants is contained in the following:—

1. "Essay on the plants collected by Mr. Eugene Fitzalan during Lt. Smith's Expedition to . . . the Burdekin," Melbourne, 1860, fcp. This report is referred to in the Gardeners' Chronicle, 29th September, 1861, p. 868.

2. "Report of the Proceedings of the Queensland Government Schooner 'Spitfire' in search of the mouth of the River Burdekin on the north-eastern coast of Australia; and of the Exploration of a portion of that coast extending from Gloucester Island to Halifax Bay." Published by authority, Pugh's Printing Office, Brisbane, 1860.

Mr. J. W. Smith, R.N., Commanding the Expedition, Mr. Fitzallan (so spelt) "Botanical Collector." Places mentioned, M. Island, Cumberland Group, Port Molle. The publication contains a list of specimens (130) collected by Mr. Fitzalan, roughly classified by Mr. Walter Hill, Botanic Gardens, Brisbane. The object of the Expedition was the desire of the new Government (Queensland had just been separated from New South Wales) to find a port suitable for the trade of the Kennedy district, and Port Denison (Bowen) was fixed upon.

Mueller described a number of Fitzalan's plants, and he is commemorated by the following interesting species:—*Gardenia Fitzalani* F.v.M. = *Randia Fitzalani* F.v.M.; *Psychotria Fitzalani* Benth.; *Eulophia Fitzalani* F.v.M.; *Ficus Fitzalani* Miq. = ?; *Eria Fitzalani*, *Dendrobium Fitzalani.* Mr. Fitzalan told me that he collected for Mueller until the completion of Bentham's "Flora Australiensis."

Lieut. Smith was a marine surveyor borrowed by the Queensland Government from one of H.M's. surveying ships then in Sydney Harbour. Mr. Fitzalan's account of the expedition appeared in the "Brisbane Courier" of 1st September 1861, and in the Sydney papers a little later.

The latter was born 12th July, 1830, at Londonderry, Ireland, son of an architect who died young, and was trained in the gardens of the Earl of Enniskillen, and at Veitch's of London. He came out to Victoria in 1849 and had commissions to bring out certain plants. He first came to Geelong, where the merchants of that town were then beginning to form homes, and he laid out places, also in Melbourne. He went to Queensland on 6th December, 1859, establishing a seed and plant shop in Edward Street, Brisbane. (It is worthy of mention that F. M. Bailey went into the same class of business in the same street, two years later). Port Denison (Bowen) then (1862) became his headquarters, of which he was one of the pioneers. He principally collected here, and formed a large nursery garden and made excursions to the unknown bush at intervals. It was his local reputation which caused him to be selected as Collector to Lieut. Smith's Expedition. He knew Morrill or Murrells (recovered from the natives, see (6), p. 383), and composed some lines on his adventures, particulars of which he received from Morrill himself. He told me that at one time he often broke into verse. He walked up the coast from Bowen and stated that he "knew every nook and corner to Cape York." In 1887 he moved to Cairns and exported large numbers of orchids, palms, palm-seeds, ferns and other plants during the ten years he lived there. He retired to Loch Street, South Brisbane, where he lived with his daughter (Mrs. R. R. Robinson) until his death on 22nd June, 1911. The photograph which is reproduced was taken in 1909. He was one of those botanical pioneers to whom Australian, and particularly Queensland botany owes much. Many of the personal notes above I obtained from Mr. Fitzalan himself, and from his daughter.

FOELSCHE, PAUL HEINRICH MATTHIAS (1831 – 1914).

He was born at Moorburg, near Hamburg, Germany, 30th March 1831, and died at Darwin, Northern Territory, 31st January, 1914. He became a naturalised British subject on 9th December, 1869, having previously resided in South Australia for fifteen years, joining the police in 1853 or 1854. He was made a Companion of the Imperial Service Order in 1904. He joined the police force of the Northern Territory in 1870, and spent the rest of his life there, holding the office of Inspector of Police for very many years. He thus possessed unique opportunities for acquiring a knowledge of the aborigines, and being an excellent photographer, he acquired a remarkable collection of negatives of them. He wrote some papers in regard to them, chiefly in the journals of geographical societies. For some photographs of the Northern Territory aborigines he received a "magnificent gold hunting watch and signed enlarged photograph of the Kaiser." He became a useful botanical collector and correspondent for Mueller, who (amongst other species) named *Eucalyptus Foelscheana*, a well known Northern Territory tree, after him. The photograph was taken early in 1884.

GUILFOYLE, WILLIAM ROBERT (1840 – 1912).

He was the doyen of Australian landscape gardeners, and I enjoyed his warm friendship for many years. Once, when in a reminiscent mood, he wrote down for me an account of the principal events in his life.

He was born on the 8th December, 1840 at Chelsea, London, three doors from the house where his mother and grandmother were both born. His father was Mr. Michael Guilfoyle, for many years one of our best nurserymen and landscape gardeners, who arrived in Sydney in 1851 or 1852 and at once established a nursery at Redfern. The spot is now occupied as a Sports Ground and faces the big sand-hill, which is surmounted by the Roman Catholic Church of Mount Carmel. Mr. Guilfoyle told me there were only a few huts on that hill when his father lived on the flat. When the gold discoveries took place Mr. Michaël Guilfoyle's men deserted him, and he had to abandon the nursery. He then laid out Greenoaks for Mr. T. S. Mort, and when that work was finished he established a nursery at Double Bay, Sydney, which made his name famous. He brought together a wonderful collection of plants from all parts of the world. He also did good work in making Australian and Pacific Island plants better known in many parts of the world. At the same time that he owned the Double Bay nursery, he laid out scores of other gardens around Sydney and in the country. He obtained his training in England under Joseph Knight of the Royal Exotic Nursery, King's Road, Chelsea, which was subsequently Veitch's establishment. Mr. Knight had such a belief in Mr. Michael Guilfoyle's abilities that he sent him to many parts of the Kingdom to lay out or remodel parks and gardens frequently without even inspecting his work. Two of his sons followed in their father's footsteps, William, the subject of this notice, and John, who was in charge of the parks and gardens controlled by the Metropolitan Parks Board of Melbourne, but he was an exceedingly strict man, treating his sons with Spartan severity, and both of them informed me that he never gave his sons a single lesson in landscape work.

William was privately educated by his uncle, Mr. Louis Delafosse, and also at Lyndhurst College, Glebe, while he was much indebted in his studies to William Sharpe Macleay and John McGillivray, both of Sydney. Glad to leave his father's nursery at Double Bay, he in 1868 accepted the invitation of Commodore Rowley Lambert to accompany him in H.M.S. "Challenger" to the South Sea Islands. A dozen Wardian cases were supplied by Mr. Charles Moore, then Director of the Sydney Botanic Gardens, and they were filled by Mr. W. R. Guilfoyle with most valuable plants. On that cruise Mr. Guilfoyle discovered plants which were eagerly sought after as acquisitions to horticulture. On his return, Mr. Moore selected six of the Wardian cases for the Sydney Botanic Gardens, and handed over the other six to Mr. Michael Guilfoyle as an act of grace. He published some articles "A botanical tour amongst South Sea Islands" in the "Sydney Mail" in 1868.

In the following year, 1869, Mr. W. R. Guilfoyle settled on the Tweed River on some large blocks of sugar land that his father had purchased. He remained on the Tweed for four years. In 1878 he received the offer of the Directorship of the Melbourne Botanic Gardens, and entered on his duties on the 21st July of that year. His valuable work in the remodelling of the Melbourne Botanic Gardens is known to everybody, and is his monument.

In 1896 he made an extensive tour of Europe and some records of what he saw will be found in a series of twenty-four articles from 1897 onwards, which appeared in the "Bankers' Magazine of Australasia."

Although not an actual native of Sydney, his boyhood's days were spent there, and he lived in Sydney and New South Wales until he attained the age of 33 years. From time to time he paid visits to Sydney, and while entirely loyal to the city which gave him the chance to carry out his life work, he never faltered in his affection for the older city, and used to break into poetry as he spoke of "the dear old Sydney Garden." He was a strong personality, and the vehemence of his affection to his friends can readily be traced to some of his Celtic forbears.

See also "Men of the time in Australia (Victorian Series), 2nd Edition, 1882. He is commemorated by the genus *Guilfoylea* (Mueller), *Melodinus Guilfoylei* F.v.M., *Epipogon Guilfoylei* F.v.M. = *E. nutans* Lindl., *Eucalyptus Guilfoylei* Maiden. See also in the "Victorian Naturalist," "A new Victorian Clematis," (xv, 97); "An unrecorded species of *Bursaria*," (xvii, 42).

Helms, Richard (1842 – 1914).

There is such an admirable necrology of this well known naturalist in the Presidential Address of Mr. Charles Hedley, (this Journal, xlix, 11, 1915), that I will content myself with reproducing a brief note I received from his daughter a few days after his death. He was an excellent botanical collector, his best work being done in connection with the Elder Exploring Expedition, and his photograph reproduced, was taken at that time.

"He was born at Altona, Germany, on December 12th, 1842, and came out to Victoria in 1858-9. After two or three years he went to New Zealand (Dunedin), after a few years there returning again to Victoria. About 1869 he returned again to New Zealand and settled in Greymouth, where he married in 1878. In 1887 he came to Sydney and made trips to Mount Kosciusko for the Australian Museum. He was Naturalist to the Elder Exploring

Expedition of 1891. In 1895 he again visited Greymouth for a short time. In the same year he went to West Australia on the staff of the Department of Agriculture, where he remained until 1900. Then he came back to Sydney where he has since lived continuously except for a six weeks' visit to New Guinea and Solomon Islands, from which he returned ill and died a week later on July 17th, 1914."

JOHNSTON, ROBERT MACKENZIE (1845 – 1918).

Born at Connage, Invernesshire, Scotland; died at Hobart, March 1918. He was Registrar General and Government Statistician of Tasmania for many years, and one of her best known scientific men. In 1893 he published a "Reference list of various books and memoirs on scientific and social and on economic subjects, written and published since the year 1873." It contains 102 items. His most important work is a large quarto entitled "Systematic account of the geology of Tasmania." In Natural History subjects he wrote on geology and palæontology, fishes, molluscs and plants. There is an obituary notice, and list of papers contributed to that Society, in "Papers and Proc. Roy. Soc. Tas." for 1918, p. 136, which has 103 items. He died in March 1918.

LAUTERER, DR. JOSEPH (1848—1911).

He was born on 18th November, 1848 at Freiburg in Baden, Germany, and died at South Brisbane, 29th July, 1911. He served as a surgeon in the Franco-Prussian War. He published "Excursions Flora von Freiburg und seine Umgebung," pp. 224 with 24 text figures, Freiburg, 1874. He arrived in Australia in March 1885, and after residing on the Blue Mountains, N.S.W., he left for Queensland in the following November, and remained there till his death. He interested himself in the vegetation of the neighbourhood of Brisbane, and also made some chemical investigations into plant products, *e.g.*, the gums and resins, and also into Macrozamia poisoning. His papers were published as a supplement to F. M. Bailey's Botany Bulletins, and also in Journ. Roy. Soc. Q., of which he had been President. He was an excellent linguist and student of languages, and a public spirited man. He left no children, but his adopted son, Mr. William Lauterer Taylor, served in the A.I.F. and was badly gassed in Belgium.

MORRISON, ALEXANDER (1849 – 1913).

He was born at Wester Dalmeny, near Edinburgh, on 15th March 1849, died at Cheltenham, near Melbourne, 7th December 1913, and was interred in the Kew Cemetery. There is a biographical notice in "Journ. Nat. Hist. and Sci. Soc. of W.A." Vol. v, p. 108. Ill health dogged him nearly the whole of his life. He graduated in medicine at Edinburgh. He was in medical practice in Victoria (chiefly in East Melbourne) for a number of years. In the early nineties he again travelled for the benefit of his health, and went to the New Hebrides (he dwelt, amongst other places, at Havannah Harbour and Efate), and sent plants to Mueller. Thence he went to Western Australia, and did admirable work in his capacity (almost honorary) of Government Botanist. He did not write much, but always effectively, and most of his botanical papers are in the journal which contained his obituary notice, and also in the "Year-book of Western Australia. He was a contributor to the "Victorian Naturalist, and two of his papers are "New Victorian Micro-fungi" (x, 90, 119), and "Some plants found growing at mouth of River Yarra and at Werribee" (xv, 87). He was a charming man, full of information, and anxious to impart it, and Australian science has to deplore that the state of his health did not permit him to publish more.

NELSON, DAVID (– 1789). See (4), p. 23.

Botanical collector and coadjutor of William Anderson in Cook's Third Voyage. He collected in Tasmania. His non-Australian plants were much more important. See supplementary information concerning him by Mr. James Britten, "Journal of Botany, LIV, p. 351.

PHILLIPS, WILLIAM (1803 – 1871).

Born in Norwich, England, April 1803, died at Regent Street, Sydney, June 1871. Arrived in Sydney 1842; devoted himself to the study of botany. Became in 1844 an intimate friend of Dr. Leichhardt, whose "Journal of Expedition to Port Essington" he prepared for the press, and Leichhardt endeavoured to persuade him to accompany him on his last journey. Being an excellent artist, he executed the botanical drawings which were used by Mr. Charles Moore to illustrate the lectures on botany delivered by him at the Sydney Botanic Gardens in the fifties. His skill as an artist and earnestness as a student of botany may be seen in his annotated copy of Brown's "Flora Novæ Hollandiæ," in the Library of the Botanic Gardens (presented by Mr. Yarrington). Mr. Phillips made extensive collections of plants in the neighbourhood of Sydney and on the Blue Mountains, which he sent to various museums and botanists in Europe. He was an excellent classical scholar and schoolmaster. Mr. Phillips was a close friend of Major R. Lynd, with whom he shared Leichhardt's friendship. For most of the above particulars I am indebted to my friend, the Rev. W. H. H. Yarrington, M.A., Mr. Phillips' nephew. Professor W. H. Harvey named a sea-weed, *Hypocalymna Phillipsii* in his honour.

READER, F. M. (? 1850 – 1911).

He was born in Berlin about 1850, and was an industrious and accurate botanist who chiefly worked on the elucidation of the flora of Victoria. He died in March, 1911.

So far as I know, he published only in the "Victorian Naturalist," (Melbourne). See "The phanerogamous plants of Studley Park, Kew, near Melbourne," Vol. I, 172; II, 24, 36. His "Contributions to the Flora of Victoria" will be found from No. 1 in Vol. XI, p. 146, to No. 17, Vol. XXIII, p. 89. His later years were spent at Dimboola, Victoria.

SMITH, CHARLOTTE, Mrs. (Fl. 1839, but she must have worked until at least 1855—when Harvey was in Tasmania).

Britten and Boulger in "Some little known British Botanists" in Journ. Bot. L, 195, have a note which throws light on the references "Smith, Charlotte," and "Smith McDonald" in (4), p. 27. They appear to be the same. There is another Mrs. Smith quoted by me, but she was née Mary Ballantyne.

SOLANDER, DANIEL (1733 – 1782). See my "Sir Joseph Banks" p. 73 and (1), p. 81.

An account of the Banks and Solander New Zealand plants will be found in the Preface to Hooker's "Handbook of the New Zealand Flora," p. 9.

"An interesting incident connected with this establishment (Bergielund Botanic Garden, Sweden) was the gift in 1808 of £250 by Sir Joseph Banks, Bt., F.R.S., the income to increase the professional stipend, but with the proviso that the annual return should be enjoyed during life by Fru A. M. Idman, a relative (married sister) of Daniel Solander, Banks' fellow-traveller and afterwards his librarian. The lady died in the same year, 1808, so the increment came at once to augment Swartz' modest salary." (" Kew Bulletin, No. 4, 1915, p. 182).

There are two monuments to Solander, one in England and the other in New South Wales. As regards the former, the Linnean Society of London has a photograph of a memorial erected in 1914 by the Royal Academy of Sciences Stockholm, in the Swedish Cemetery at Woking (Brookwood), consisting of a headstone of Swedish granite, inscribed "Kungliga Vetenskapsakademien reste varden 1914. Daniel Solander 1733 – 1782." An account of this monument will be found in "Nature," 4th March, 1915, p. 13. There is a striking portrait of Solander by John Zoffany in the possession of the Society, and a copy of an engraving of the same in the possession of the Linnean Society of New South Wales.

The New South Wales monument erected at Kurnell, Botany Bay, also consists of an obelisk, and bears the following inscriptions:—On the front side: "This Monument was erected to the memory of the Swedish Scientist Daniel Carl Solander, who landed with Captain Cook and Joseph Banks at Botany Bay on the 29th of April, 1770." On the reverse side, looking towards the water, is written: "Erected by his countrymen in Australia, August 1914."

SONDER, O. W. (?1812 – 1881).

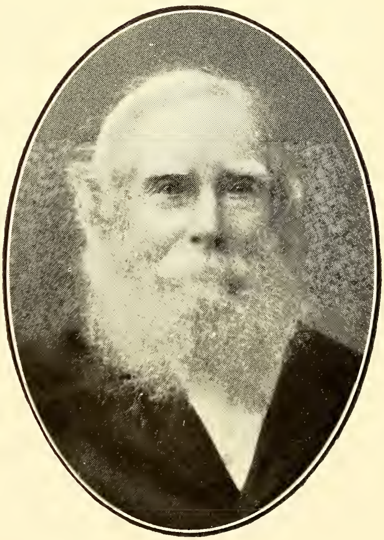
He died at Hamburg, Germany, 21st November, 1881, having been, for over 30 years, a leading pharmacist of that city. His name will ever be associated with the botany of Australia and South Africa. In 1844 he described, for Lehmann's "Plantæ Preissianæ" (Western Australian plants), the important families of Epacrideæ and Stylideæ, and also the Algæ. Algæ had a special attraction for him and he co-operated with W. H. Harvey in regard to such plants from both Australia and South Africa. In the latter's "Phycologia Australica" we have figured *Erythroclonium Sonderi* Harv., *Caulerpa Sonderi* F.v.M., and *Cystophora Sonderi* J. Ag. In 1871 he contributed a paper "Die Algen des tropischen Australiens" (Abh. Ges. Hamb., v, Hamburg, 4to.). His botanical activities were by no means confined to those already indicated, and no doubt an adequate necrology of him was published. He co-operated with Harvey in the latter's "Flora Capensis." He is commemorated by the following Australian plants :—*Aster Sonderi* F.v.M. = *Olearia grandiflora* Hook.; *Calocephalus Sonderi* F.v.M.; *Helichrysum Sonderi* F.v.M. = *Ixiolæna tomentosa* Sond. and Muell.; *Coleostylis Sonderi* F.v.M. = *Levenhookia Sonderi* F.v.M.; *Styphelia Sonderi* F.v.M. = *Astroloma conostephioides* F.v.M.; *Xerotes Sonderi* F.v.M.

VERREAUX, JULES P.

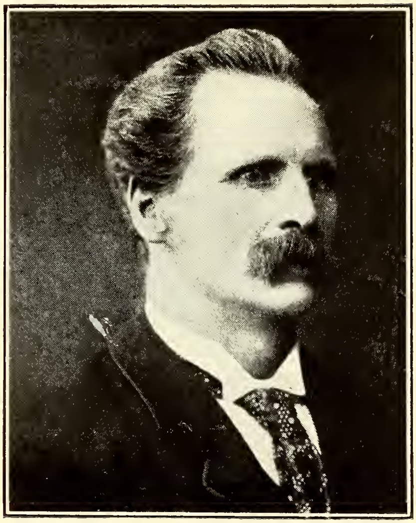
The following note usefully supplements those given in (7), p. 153. It is taken from "Southey on Colonial Wools," London, 1851, foot note to p. 119, and I am indebted to Mr. Thomas Gill, C.M.G., of Adelaide, for it :—

"Besides the names of botanists already mentioned, it may be proper to add that M. Jules Verreaux, a Frenchman, who has for the last five years been travelling in Australia and Van Diemen's Land, has just returned to Paris with a collection of more than 115,000 specimens of natural history, among which are many species hitherto unknown. This gentleman was sent out upon this special mission by the Directors of the Museum of Natural History in Paris, and his valuable collection is now deposited in their establishment. The readers will have been prepared to admit that the scope for researches of this kind in Australia is almost unbounded; and although in Van Diemen's Land, Labillardière, Brown and Cunningham preceded the new commissioner, sent out by a learned corporation in France, and there laboured with great assiduity, even after the results of their studies were made known, it was on all hands acknowledged that ample room was still left for future gleanings. It is, however, most fervently to be hoped that M. Jules Verreaux will have extended his researches to other subjects besides those connected with Natural History, as his illustrious companion, M. Alcide D'Orbigny, did when he was sent out on a similar mission by the same parties to Peru."

P. H. M. Foelsche.
(1884.)



Eugene F. A. Fitzalan.
(1909.)



Richard Helms.
(1894.)

E. Betche.
(1905).

WALTER, T. R. C.

The initials of this gentleman are given as above in (5), p. 26, but they are R. T. R. G. according to a note in the "Western Mail" of 28th August 1919, where it is stated that in January 1842, Mr. Walter published the usual official note giving intention of his leaving Western Australia at the first opportunity. What his subsequent movements were, I know not.

WATLING, THOMAS. See (1), p. 128.

He was the author of "Letters from an Exile at Botany Bay to his aunt in Dumfries; giving a particular account of the settlement of New South Wales, with the Manners and Customs of the Inhabitants." (12mo., pp. iv, 128. Penrith, printed by Ann Bell, 1794).

The writer, who styles himself "Principal Limner in New South Wales," was extremely anxious to deserve better of his country, and proposed, with due deference under the patronage of an Impartial Public, the execution of a Picturesque Description of that Colony in a highly finished set of drawings, done faithfully upon the spots, in mezzo, aquatinta, or water colours. ("History of N.S.W. from the Records," by G. B. Barton, Vol. I, 585, 1889).

There are some additional details concerning Watling in William Dixson's "Notes on Australian Artists," (Journ. Roy. Aust. Hist. Soc., v, 227, 1919).

WATTS, WILLIAM WALTER (1856 – 1920).

An account of his life and work will be found in the Presidential Address of Mr. James Nangle (this Journal, Vol. LIV, 3 1921). A portrait of him will be found in "The Presbyterian " for October, 1920.

THE ESSENTIAL OIL OF *LEPTOSPERMUM FLAVESCENS* (SMITH).

By A. R. PENFOLD, F.C.S.

[*Read before the Royal Society of N. S. Wales, October 5, 1921.*]

THE essential oils described in this paper are those obtained by distilling the leaves and terminal branchlets of the tea tree described by Smith in Transactions of the Linnean Society, Vol. 111, (1797), page 262. It is a tall, graceful shrub, varying from about four to twelve feet in height, found growing extensively in the coastal and mountain districts within about 100 miles of Sydney. It is one of the commonest of our tea trees, and it is somewhat surprising that its essential oil has not previously been investigated. At various periods of the year, and from shrubs growing in different localities, a pleasant faint lemon-like odour is detected upon crushing the leaves. This is shown in this paper to be due to small amounts of the aldehyde, citral, varying from 0·25% to 0·75%. Leaves and terminal branchlets were obtained from a number of distinct localities, such as Longueville (Lane Cove River, Sydney), Kuring-gai on the Northern Line, 25 miles from Sydney, Hill Top, southern district, N.S.W., 80 miles, and Blackheath on the Blue Mountains, 75 miles from Sydney.

The Essential Oil.

The oils obtained from the different consignments of leaves of this species were of a deep yellow to greenish-brown colour, somewhat viscous and possessing a pleasant distinctive odour of terpene bodies, modified by small amounts of alcoholic constituents and citral.

Altogether 1,210 lbs. of leaves and terminal branchlets, cut as for commercial distillation, were distilled, and gave an average percentage yield of 0·8%, varying from 0·6% to 1·1%, according to time of year.

The principal constituents of the oil so far determined are:—

(1) The dextro-rotatory bicyclic sesquiterpene alcohol eudesmol, both solid and so-called liquid forms.

(2 and 3) A mixture of dextro-rotatory sesquiterpenes, the one occurring in greatest quantity being considered identical with eudesmene and the other aromadendrene.

(4) β Pinene.

(5) α Pinene.

(6) A liquid phenol, $C_{14}H_{20}O_4$, giving an orange-red colouration with ferric chloride in alcoholic solution.

(7) Citral.

(8) Small amounts, not exceeding about 5%, of unidentified alcoholic bodies.

Although the oil has never been distilled for commercial purposes, the writer considers it possesses certain economic possibilities, particularly in view of the large percentage of sesquiterpenes present in those samples where the solid eudesmol is practically absent. In its crude state it is of value for soap perfumery, and it could likewise be used as a substitute for cedarwood and similar oils. The sesquiterpenes themselves possess a fine cedarwood like odour, and the author feels confident that, in the near future, these bodies will find suitable commercial application, if obtainable in sufficient quantity. As the investigation of the oils of the Leptospermum proceeds evidence is not wanting that these interesting constituents abound therein.

Very good agreement is shown in the results obtained in the examination of the various oils separated from the leaves collected in different districts. It will be observed that no solid eudesmol was detected in the oils obtained from material collected in the Lane Cove and Kuring-gai districts of Sydney; the sesquiterpene alcohol being a liquid, which it was impossible to isolate in a state of purity owing to the large amount of sesquiterpenes present. The fact that the principal sesquiterpene appears to be eudesmene justifies the author, especially in view of a similar experience with oils from other species of Leptospermum, and an analogy in the Eucalyptus oils, in considering it to be either the so-called liquid form of eudesmol, or a very closely related alcohol.

It was surmised that probably altitude or soil conditions, apart from that of season, had a bearing upon the production of solid eudesmol in the plant, especially as Lane Cove and Kuring-gai are but 200 feet and 700 feet respectively above sea-level, whilst Hill Top is 2,030 feet. In order to decide the question, a locality was selected on the Blue Mountains, about an equal distance from Sydney as Hill Top and of high altitude. A collection of material was, therefore, made from Blackheath, which is 3,495 feet above sea-level, and seventy-five miles from Sydney, with the result, as shown later, of the presence of considerable solid eudesmol.

Some workers, however, might possibly be inclined to consider the shrubs growing at Hill Top and Blackheath as a variety of the species growing close to Sydney. As botanists are unable to detect any morphological differences the writer thinks that the evidence put forward justifies his opinion that the variations in the chemical composition of the different oils is due merely to changes produced by environment.

It has been observed that at times the shrubs of the species exhibit a difference in colour of the upper branches, some becoming of a distinct red colour, whilst others remain a characteristic green. This observation was brought under the writer's notice by Mr. E. Cheel of the National Herbarium, Sydney, so that when material was being collected at Hill Top, N.S.W. in February 1921, the leaves of the plants with the different coloured upper branches were kept apart and distilled separately.

It was thought that possibly two varieties of this species existed on this account, but the results of the examination of the oils, as shown in Table I, marked with an asterisk, do not show quite sufficient differences to warrant their being considered varieties, just at present. The variations in percentage yield of oil, etc., are what would be expected from single shrubs.

Experimental:—The 1,210 ℔s. weight of leaves and terminal branchlets were collected at different periods from various localities, and on distillation yielded crude oils, which on examination, gave the physical and chemical characteristics, as shewn in the following table:—

Table I.

Date.	Weight of Leaves.	Percentage yield of Oil.	Specific Gravity at 15° C.	Optical Rotation.	Refractive Index 20° C.	Ester No. Hot $1\frac{1}{2}$ hours.	Ester No. Hot $1\frac{1}{2}$ hrs. after acetylation.	Solubility of Oil in 80% alcohol.	District from which material was obtained.	Remarks.
	lbs.	%		°						
9/11/1920	66	0·71	0·9409	+27·21	1·4987	7·43	118·86	1 in 0·7 vls	Hill Top †	sent by E. Cheel
19/11/1920	118	0·66	0·9093	+14·5	1·4920	4·78	60·61	insol. in 10	Longueville Lane Cove	young material (phenol removed)
,,	104	0·59	0·9206	+14·1	1·4948	7·61	67·08	do	ditto	old material in full flower
27/1/1921	103	0·57	0·9231	+14·32	1·4937	21·00	62·82	do	ditto	
26/2/1921	$232\frac{1}{2}$	0·72	0·9296	+30·2	1·4947	8·75	109·00	1 in 0·9 vls	Hill Top* †	red upper branches
,,	182	0·58	0·9232	+26·12	1·4925	6·54	99·00	1 in 1·1 vls	ditto * †	green upper branches
5/4/1921	211	1·06	0·9035	+5·8	1·4881	13·46	77·12	insol. in 10	Kuring-gai	
19/4/1921	194	1·1	0·9198	+25·15	1·4925	10·60	111·85	1 in 0·8 vls	Blackheath†	

* See remarks on page 173. † Solid or crystalline eudesmol present in quantity.

The crude oils after removal of phenol, gave the following results on distillation, 100 ccs. of each taken :—

Table II.

Sample.	Percentage by volume.	Specific gravity at 15° C.	Optical Rotation. Degrees.	Refractive Index, 20° C.
Hill Top, 9/11/20.				
42 – 50° C. at 10 mm.	6	0·8615	+36·95	1·4676
50 – 60 „	9	0·8666	+34·81	1·4685
60 – 120 „	3	0·9012	+16·10	1·4826
120 – 135 „	32	0·9469	+20·65	1·5045
135 – 154 „	5			
154 – 156 „	40	0·9728	+29·20	1·5110
Lane Cove, 19/11/20 (young)				
163 – 190° C. at 756 mm.	17	0·8655	+15·20	1·4751
190 – 200 „	12	0·8735	+11·72	1·4787
200 – 243 „	9	0·8921	+6·40	1·4859
243 – 268 „	45	0·9349	+6·81	1·5026
268 – 276 „	15	0·9420	too dark	1·5064
Lane Cove, 19/11/20 (old)				
163 – 190° C. at 756 mm.	29	0·8650	+13·40	1·4744
190 – 210 „	8	0·8792	+8·83	1·4794
210 – 243 „	9	0·8905	+5·25	1·4845
243 – 267 „	43	0·9308	+6·00	1·5023
267 – 272 „	9	0·9416	+10·20	1·5060
Hill Top, 26/2/21 (red and green)				
40 – 60° C. at 10 mm.	21	0·8627	+33·50	1·4689
60 – 120 „	10	0·8766	+21·60	1·4765
120 – 142 „	34	0·9429	+24·11	1·5039
142 – 156 „	24	0·9671	+32·22	1·5072
Residue				
Kuring-gai 5/4/21				
50 – 60° C. at 10 mm.	28	0·8634	+4·45	1·4735
60 – 120 „	24	0·8885	+3·55	1·4822
123 – 141 „	41	0·9258	+7·55	1·4999
Blackheath, 19/4/21				
40 – 60° C. at 10 mm.	32	0·8581	+24·81	1·4732
60 – 120 „	17	0·8944	+16·52	1·4838
120 – 140 „	18	0·9468	+26·00	1·5027
140 – 150 „	18	0·9705	+32·20	1·5072
Residue				

Determination of Terpenes.—The fractions boiling at 60 – 90° C. at 10 mm. from the various samples of oils were re-distilled at 760 mm. and found to consist almost entirely of α and β pinene, the latter preponderating, viz.:—

α Pinene.

Sample.	Boiling Point. °C.	Specific gravity at 15° C.	Optical rotation, Degrees.	Refractive index, 20° C.
Hill Top, 9/11/20 ...	156 – 158	0·8613	+ 35·20	1·4665
Kuring-gai, 5/4/21 ...	158 – 160	0·8648	+ 6·11	1·4725

The last named gave an excellent yield of nitrosochloride, which on careful purification, melted and decomposed at 109° C. The former behaved similarly when mixed with an equal volume of lævo-rotatory pinene from oil of *Eucalyptus phlebophylla*, $[\alpha]_D$ 20° C. – 50·18°, both of which failed to do so singly.

β Pinene.

Sample.	Boiling Point. °C.	Specific gravity at 15° C.	Optical rotation, Degrees.	Refractive index, 20°C.
Longueville, 19/11/20	160 – 163	0·8600	+ 16·55	1·4713
ditto	163 – 166	0·8645	+ 15·25	1·4732
ditto	166 – 169	0·8630	+ 13·51	1·4752
Kuring-gai, 5/4/21 ...	162 – 166	0·8658	+ 3·00	1·4755

All these fractions on oxidation with alkaline potassium permanganate solution by the method described in "Parry's Essential Oils," second volume, page 37,[1] yielded crystals of sodium nopinate, which on decomposition with dilute sulphuric acid gave crystals of the free acid. On recrystallisation from benzene they were obtained in needle crystals melting at 127° C. The terpenes are, therefore, α and β pinene.

Alcoholic bodies (unidentified).—In the repeated re-distillation of the portion of the oils boiling at 90 – 123° C. at 10 mm., the following fractions were obtained:—

[1] See author's paper on the "Essential oils of *Leptospermum flavescens* var *grandiflorum* and *L. odoratum*, this Journal, LIV, (1920), p. 203, 204.

Boiling Point	Percentage.	Specific gravity at 15° C.	Optical rotation, degrees.	Refractive index at 20° C.
99 – 105° C. at 10 mm.	3	0·9174	+ 3·00	1·4810
105 – 118 ,,	5	0·9172	+ 0·61	1·4888

Although they appeared to be mixtures containing terpineol and geraniol in quantity, the presence of these alcohols could not be confirmed. No combination with phthalic anhydride or phenylisocyanate nor hydration with 5% solution sulphuric acid could be effected after repeated trials.

Determination of the Sesquiterpenes.—These were worked up from the various fractions of boiling point 123 – 140° C. at 10 mm. They were allowed to stand over metallic sodium for a week, and then repeatedly fractioned over the same metal at 10 mm. In this way, two distinct fractions were separated, consisting of pale yellow tinted mobile oils of pleasant odour, somewhat resembling cedar wood. The one of higher boiling point constituted the main bulk, the lower boiling one existing in but small amount in most of the samples.

Oil.	Boiling Point ° C. at 10 mm.	Specific gravity at 15° C.	Optical rotation, Degrees.	Refractive index, 20° C.
Hill Top, 9/11/20 ...	129 – 132	0·9275	+ 17·52	1·5049
Lane Cove, 19/11/20...	129 – 132	0·9253	+ 4·82	1·5046
Hill Top, 26/2/21 ...	129 – 132	0·9273	+ 22·52	1·5046
Kuring-gai, 5/4/21 ...	123 – 126	0·9116	inactive	1·4966
ditto ...	129 – 132	0·9171	+ 13·75	1·5040

(Equal volumes of the respective sesquiterpenes were separated from the last named sample).

Much smaller fractions boiling at 123 – 126° C. at 10 mm. were obtained from the other lots of oils, but seeing the larger amount prepared from the Kuring-gai sample in a fair condition of purity, there is but little doubt that aromadendrene is a definite constituent of the oil of this species.

The physical constants of the principal fraction boiling at 129 – 132° C. point to the presence of eudesmene in quantity, although the refractive index is on the low side. None of the well known derivatives of sesquiterpenes could be prepared, but the samples gave the beautiful colour reactions described for eudesmene and allied sesquiterpenes (See paper by the author, this Journal, LIV, (1920), p. 205, 206), viz:—

(*a*) Bromine vapour allowed to fall upon the surface of an acetic acid solution gave a violet crimson colouration changing to indigo blue.

(*b*) A few drops of sulphuric acid added to a solution in acetic anhydride gave a bright green colouration changing to deep blue on standing.

Although the refractive index is lower than usually found for eudesmene, 1·5074 to 1·5078, as it is a very difficult matter to prepare these bodies in a state of absolute purity, the writer prefers to consider this constituent as eudesmene contaminated with small amounts of unknown impurities.

Determination of the Sesquiterpene Alcohol.—The fractions of the oils from Hill Top and Blackheath material boiling at about 140 – 156° C. at 10 mm. (See Table II) which solidified on keeping, were spread out on porous plates for absorption of adhering sesquiterpene to take place. After about ten days, the hard cakes were dissolved in alcohol, filtered, and recrystallised by addition of water. This was repeated until crystals were obtained of fixed melting point after drying upon porous plates. They formed an exceedingly light and bulky white mass of well developed acicular crystals possessing a silky lustre, quite characteristic of eudesmol. The crystals melted at 81° C. (Hill Top specimens) and 79 – 80° C. (Blackheath sample), and boiled at

156° C. at 10 mm. The three samples from different distillations, after melting on the water bath, gave the following specific rotations in chloroform solution, viz:—

Hill Top, 9/11/20, M.pt 81°C., 1·3775 grams in 10 ccs. chloroform at 20° C. $[\alpha]_D$ 20° C. +38·87°

Ditto, 26/2/21, M.pt 81° C., 1·6480 grams in 10 ccs. chloroform at 20° C. $[\alpha]_D$ 20° C. +33·67°

Blackheath, 19/4/21, M.pt 79 – 80° C., 1·6054 grams in 10 ccs. chloroform at 20° C. $[\alpha]_D$ 20° C. +38·32°

It is, therefore, identical with the bicyclic sesquiterpene alcohol, eudesmol, a widely occurring constituent of the oils of the Myrtaceæ. The high saponification number of the acetylated oils is due to this alcohol.

Determination of the Phenol.—The isolation and determination of this constituent, apparently new to science, was described in a separate communication to the Society on the 1st June, 1921, see pp. 49 – 51.

Determination of Citral.—This aldehyde was separated by agitation of the crude oil with a 35% solution of crystallised sodium sulphite. The aqueous layer, after repeated washing with ether, was treated with caustic soda solution, and the liberated aldehyde separated. It varied in amount from 0·25% to 0·75%. It possessed the usual well known characteristic lemon odour and appearance of citral, and was quite inactive when examined in the polarimeter. It had:—Specific gravity, 15° C. 0·8972

Refractive index, 20° C. 1·4884

β napthocinchonic acid, m.pt 199 – 200° C.

Summary.—The oil of *Leptospermum flavescens* (Smith) consists essentially of the following bodies, viz:—Dextrorotatory eudesmol, eudesmene, aromadendrene, α and β pinene, leptospermol (phenol), together with small amounts of citral and unidentified alcoholic bodies.

I have to specially thank Mr. F. Morrison, Assistant Chemist, for the usual able and kindly assistance rendered by him in the above detailed investigation, and to Mr. C. F. Laseron, Museum Collector, for the collection of most of the material. My thanks are also due to Mr. E. Cheel of the National Herbarium, Sydney, for his kindness in forwarding the first collection of authentic material from his property at Hill Top, 9/11/20.

PRELIMINARY NOTE ON THE OCCURRENCE OF PORPHYRITIC INTRUSIONS AT YASS, N.S.W.

By C. W. Mann.

With Plate X, and Text Figure.

[*Read before the Royal Society of N. S. Wales, October 5, 1921.*]

OUTLINE.

i. Introduction.

ii. Stratigraphy and General Geology.

iii. The Porphyries—Evidences of Intrusion.

iv. Bibliography.

Introduction.

This paper has been written on the evidence collected during excursions to Yass and a subsequent residence of three and a half years in the Yass District, and has been made necessary owing to the fact that, with limited evidence to hand, some geological workers have suggested a volcanic origin for the porphyries. The need for a fuller and more complete account is felt, and the paper is offered as a preliminary to a more extensive work on the same area. In connection with the investigation I am indebted to Professor L. A. Cotton of Sydney University, who has assisted me on every possible occasion by his advice and kindly criticisms.

General Geology.

From Jerrawa in a westerly direction, a section which has been described by Shearsby, cuts through the following structures:—

Beds.	Thickness.
1. Jerrawa Beds	?
2. Bango Porphyry	1200 feet.
3. Bango Beds	800 ,,
4. Douro Porphyry	1500 ,,
5. Yass Beds	1200 ,,
6. Laidlaw Porphyry	650 ,,
7. Hume Beds	2000 ,,
8. Bowning Porphyritic Series ...	?

The Sediments.

The Jerrawa Beds consist of shale and limestone and contain many characteristic Silurian Corals.

The Bango Beds, Yass Beds and Hume Beds contain limestone, shale and sandstone. These are all rich in fossils. The close resemblances of these three series suggest a common origin and also that they were laid down during uniform conditions. The only reason for giving characteristic names is that of convenience in working on the beds; they were possibly laid down during the same great phase of sedimentation. The beds dip at from 10° to 15° in a direction W. 10° S.

Fossils are very abundant in each bed; the Hume Beds at Hatton's Corner and Derrengellen Creek being extremely interesting to the palæontologist. The most abundant are corals:—

Favosites sp.
Cyathophyllum sp.
Heliophyllum Yassense

Heliolites sp.
Syringopora and the characteristic Silurian Coral
Tryplasma liliiformis
Trilobites and Brachiopods are fairly numerous.

The Igneous Rocks.

This paper is concerned mainly with the Bango, Douro and Laidlaw porphyries. These alternate with the sediments and were formerly thought, probably on account of their conformity with the bedding planes of the sediments, to be flows with associated tuffs (refer to map in Plate X). The evidence to hand would suggest that these are intrusions. The rocks of the intrusions are typical quartz porpyries, large phenocrysts of quartz being embedded in a crystalline mass. The rock in places is coarse, approaching a granitoid texture, and is columnar in a few occurrences. It is rich in ferromagnesian minerals and in all places is holocrystalline, many crystals being well developed.

The Douro porphyry is best examined in the cliffs in the Yass River a few chains above the Yass Bridge. The occurrence here is columnar, large columns measuring several feet along the column face.

The approach to the cliffs from the town is over the porphyry which is much weathered, the decomposition of the felspar being very advanced. The porphyry here is rich in biotite. On the Laidlaw Trig. Station is a good occurrence of Laidlaw porphyry. The porphyry here forms a hill some 150 feet high at the top of which the porphyry outcrops in large columns.

Evidences of Intrusion.

In order to establish the intrusive nature of the porphyries, it is necessary to examine the contact on the top surface of the intrusions. Thus the work detailed in this paper, is almost entirely confined to the western edge of the Douro and Laidlaw porphyries, the dip of the junction and the shale being to the west.

A few chains west of the junction of the Yass Beds and the Douro porphyry is a margin of contact breccia (Plate X). This contains quartz and felspar, which has included large fragments of shale in its intrusion towards the surface. As the molten magma was injected between the bedding plane of the Hume-Yass Beds, it tore from the upper contact surface portions of the sediments, and these undigested fragments became enclosed in the magma, forming a breccia. The actual thickness of the breccia is about 15 feet and the breccia strikes parallel to the Yass-Douro junction.

A similar occurrence of breccia to the west of the Laidlaw-Hume junction forms an important physiographic form on the way from Yass to Hatton's Corner. Here a ridge of resistant material on the crest of a steep slope marks the position of the breccia. The breccia on the Laidlaw-Hume junction is about 20 feet in thickness and strikes parallel to the upper junction.

Associated with each of these breccia are thin sills of fine grained porphyries, a felsitic phase of the main mass. These occur to the west of the large masses, and are thus on the upper contact surface.

The felsite is a fine grained rock with well marked joint planes, splitting in large hexagonal and rectangular prisms. The hexagonal prisms would certainly suggest an igneous origin for the felsite. The outcrop in the Booroo Ponds Creek, a few chains from its junction with the Yass River, is very compact and contains phenocrysts of quartz. It conforms with the bedding plane of the overlying shales and has included in its intrusion fragments of the basal beds of the Hume phase of sedimentation, many fragments being fossiliferous.

Overlying this felsite at Hatton's Corner, is a band of eight feet of metamorphosed rock, mainly indurated shales and sandstones. This is capped with a thin sill of felsite about six feet or seven feet in thickness, from which at least two apophyses inject the overlying shales. These latter are also considerably indurated. The actual junction between the sill and the main mass of porphyry is not apparent, there being a considerable amount of alluvium covering the outcrop.

Not far from this occurrence and in the Marchmont Paddocks on the way to Hatton's Corner, is an important intrusion in which the magma has caught up large fragments of fossiliferous limestone, some specimens measuring up to 5 cm. in diameter. The felspar is considerably decomposed and large grains of quartz are still abundant. The magma which included the limestone has a strong resemblance to the decomposed fragments of the main mass and is probably a direct apophysis from the main mass of the Laidlaw porphyry. Associated with these direct effects from the intrusion is an extensive formation of silicified limestone and a large intrusion of quartz rock.

At Derrengullen Creek, some five miles from the above mentioned occurrence, is a thin sill of quartz porphyry some six feet in thickness interbedded with the shales. This occurs above the upper surface of the Laidlaw porphyry. (These features are shown in the section, fig. II.)

The features on the western edge of the Douro porphyry are similar to those recounted above. (See Plate X.) Sills of felsite are present and associated with them is a considerable amount of contact breccia. Silicified limestone and quartz rock are also present.

At the southern end of the Laidlaw intrusion and in the Golf Links Paddock, the mass peters out in a tongue-shaped plan (See Plate X). Here is a large formation of quartzite,

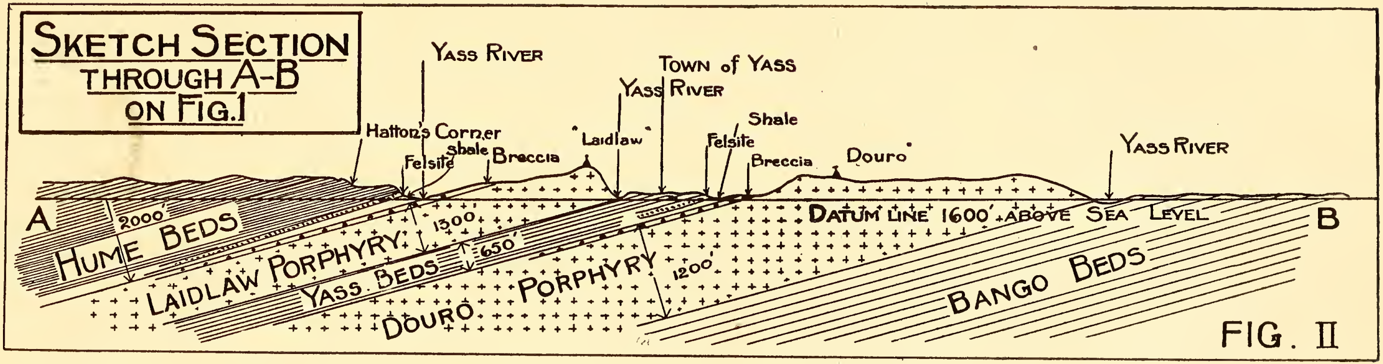

SKETCH SECTION
THROUGH A-B
ON FIG. I
YASS RIVER
TOWN of YASS
YASS RIVER
Shale
Hatton's Corner
Laidlaw
Felsite
shale
Breccia
Felsite
Breccia
Douro
YASS RIVER
A
2000'
HUME BEDS
1300'
LAIDLAW PORPHYRY
650'
YASS BEDS
DOURO PORPHYRY
1200'
DATUM LINE 1600' ABOVE SEA LEVEL
BANGO BEDS
B

FIG. II

formed as the result of contact metamorphism. Heated waters were injected into the sandstone of the Yass-Hume series at this point, resulting in the silicification of the sandstone into a quartzite. The rock is very compact and exceedingly hard. It is brownish-pink in colour and has many annelid burrows. The quartzite dips to the west and grades into a sandstone along the line of strike.

In addition to the above evidences there is the subordinate, but confirmatory evidence of faults. Numerous small faults occur in the Yass-Hume Beds. At Dutton Street (O'Conneltown) is a small trough fault, the fault plane of which strikes in a direction W. 18° S. The throw of the fault, about 3 feet and the heave 1 foot 6 inches. The faulted portion measures 30 feet (faults marked in Plate X).

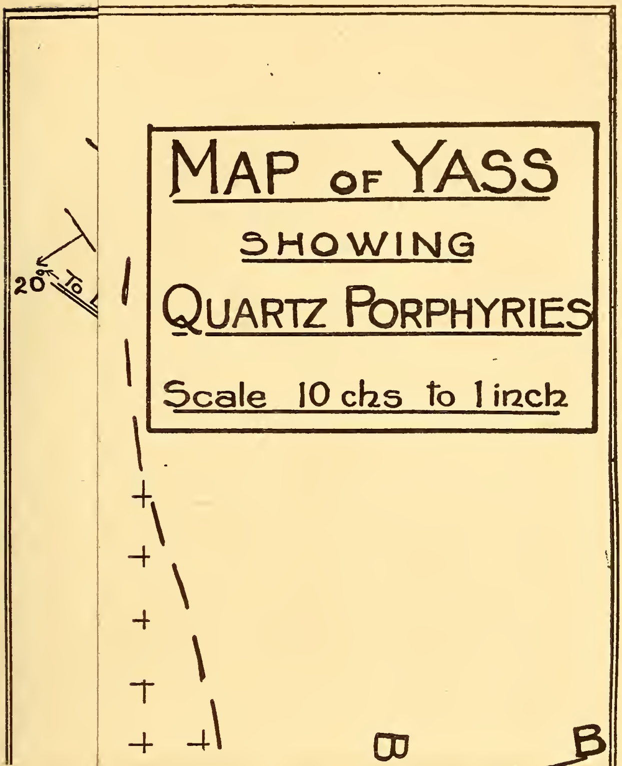
The Yass Beds in the bank of the Yass River, near the train bridge, and opposite the Yass District School are faulted in at least two places. The faults occur in the sandstone-shale beds.

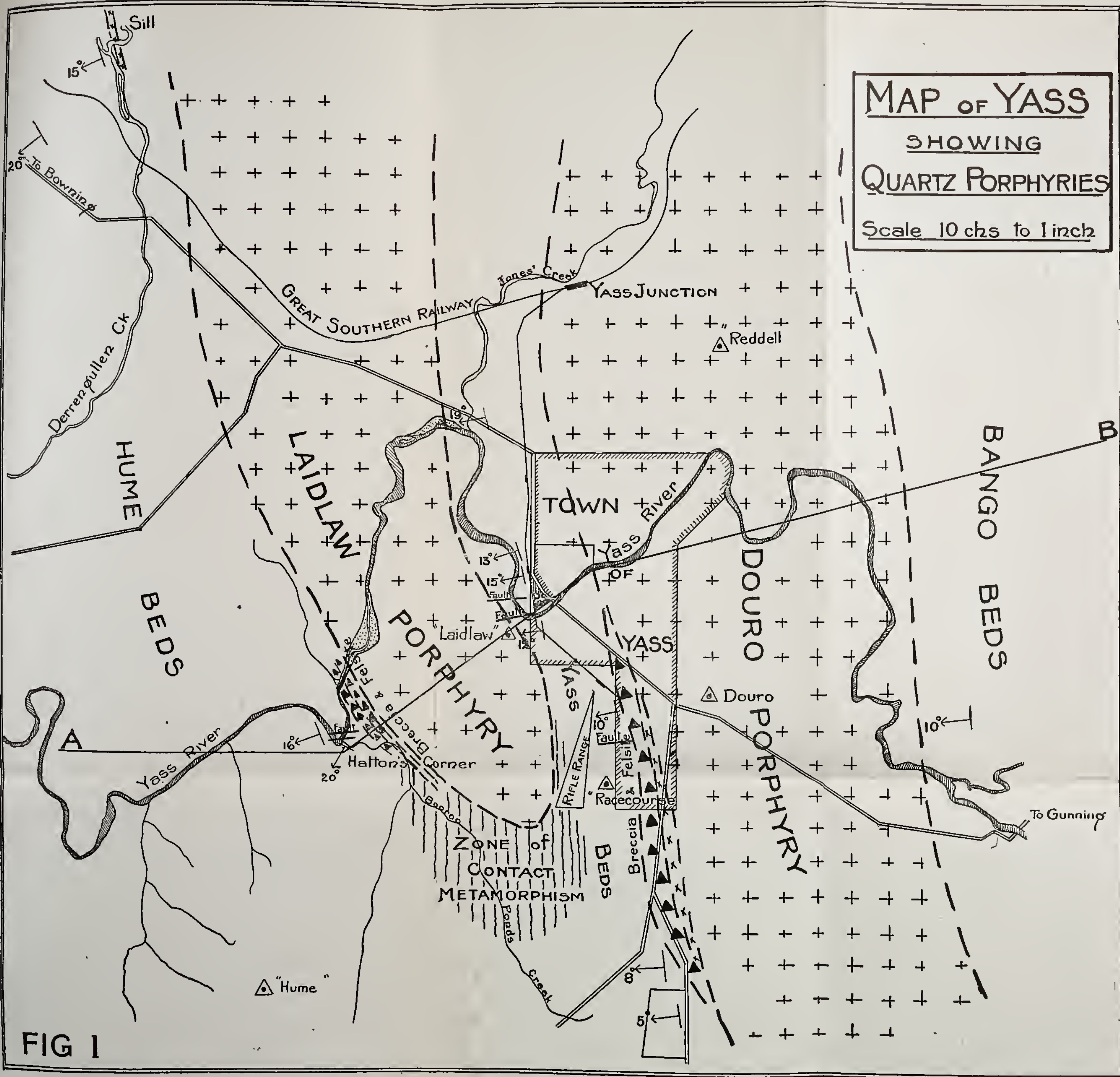
The collated evidence would indicate that the Yass porphyries are certainly intrusive. The dip of the junction as far as can be ascertained, from a number of observations conforms with the bedding plane of the accompanying sediments. Hence the occurrences are sills. In support of the intrusive nature of the porphyry is the holocrystalline texture of the rock. The high degree of crystallinity would point to the period of slow cooling and hence a subsurface position. This would not be possible if the porphyritic masses were lava flows contemporaneous with the sedimentation. Instead of a slaggy upper surface, the contact with sediments has produced a brecciated material.

Age of the Intrusions.

The fossils found in the sediments point undoubtedly to a Silurian age. The presence of the characteristic Silurian

Plate X.


MAP OF YASS
SHOWING
QUARTZ PORPHYRIES
Scale 10 chs to 1 inch
20°
B
B


MAP OF YASS
SHOWING
QUARTZ PORPHYRIES
Scale 10 chs to 1 inch
Sill
To Bowning
Derrengullen Ck
HUME
BEDS
LAIDLAW
PORPHYRY
GREAT SOUTHERN RAILWAY
Jones' Creek
YASS JUNCTION
Reddell
TOWN
OF
YASS
Yass River
DOURO
PORPHYRY
BANGO
BEDS
"Laidlaw"
Fault
Felsite
Breccia
Hatton's Corner
A
B
Douro
RIFLE RANGE
Racecourse
Felsite & Breccia
ZONE of CONTACT METAMORPHISM
YASS
BEDS
Booroo Ponds Creek
"Hume"
To Gunning
FIG 1

coral, *Tryplasma liliiformis*; the sponge, *Carpospongia*, and the Annelid, *Arenocolites* is evidence of the age.

That the sediments were marginal upon the Silurian sea is adduced by the presence of rain prints, ripplemarks and suncracks in the three sediments. These occur in the paddocks adjoining the School Grounds. Thus the marginal deposition of such a large thickness would point to an area of slow subsidence. Subsequent to the deposition and consolidation the quartz porphyry sills were intruded between the bedding planes probably not reaching the surface.

It is therefore necessary to assign a post-Silurian age to the intrusions. This conforms with the general characteristics of Silurian deposition in New South Wales. The Silurian Period in this country was one of quiet deposition, volcanic activity and lava flows being the exception rather than the rule. In the south, the Murrumbidgee Area received large intrusions and volcanic flows during the Devonian Period and this suggests that the intrusion of the Yass province occurred during Devonian times. Concurrent with the intrusion, the contact breccia, and brecciated limestones were formed, the sandstone silicified and the faults produced. Subsequent erosion has denuded the porphyries which still form the resistant residuals of the locality.

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THE OCEAN CURRENTS AROUND AUSTRALIA.

By G. H. HALLIGAN,

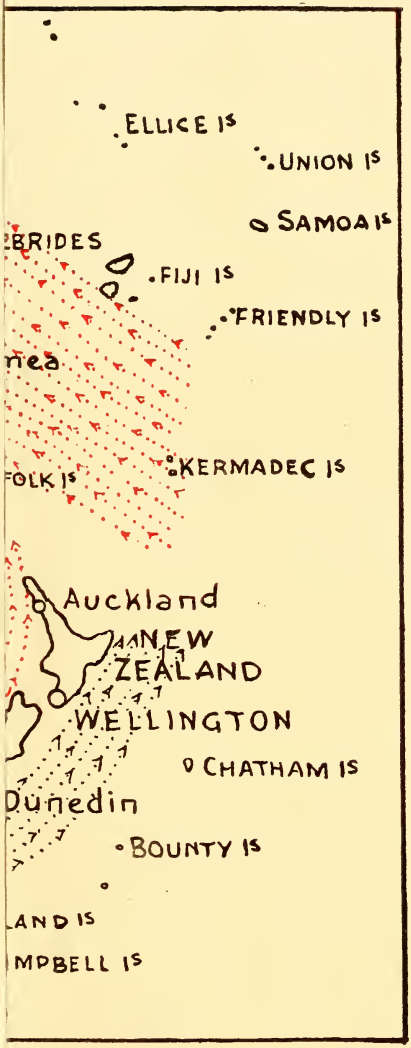
Late Supervising Engineer and Hydrographer, N.S.W. Government.

With Plate XI.

[*Read before the Royal Society of N.S. Wales, September 7, 1921.*]

PREVIOUS to the year 1770 when Cook explored and took possession of the east coast of Australia, practically nothing had been recorded of the currents around our coast, but since that time each of the following explorers has added to our knowledge:—Vancouver who entered and named King George's Sound in 1791, Flinders and Bass who extended the discoveries of Cook on the east coast in 1798, followed by Murray in 1802. During 1802-3 Capt. Matthew Flinders in H.M.S. "Investigator," explored the coast between Sydney and the Gulf of Carpentaria, and completed his remarkable voyage by sailing completely round Australia. About the same date the French explorers Baudin and Freycinet in the "Geographe" and "Naturaliste" examined the north-west and west coasts. The northern and north-western coasts were charted by Capt. King in 1820-4, followed by Captains Wickham and Stokes in 1837 to 1843, and Capt. Denham in 1858. Since 1872 the Admiralty has carried out detached surveys, mostly on the north and north-west coasts, but by far the larger portion of the shores of Australia are still very imperfectly examined and charted, both as regards the outline of the land, and the trend of the currents and tidal streams. Beside the names above mentioned a great number of isolated observations on the direction and velocity of some of the surface currents have been made by chance visitors or exploring expeditions at odd times, such as Capt. Sir James

Plate XI.


ELLICE Is
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WELLINGTON
CHATHAM Is
Dunedin
BOUNTY Is
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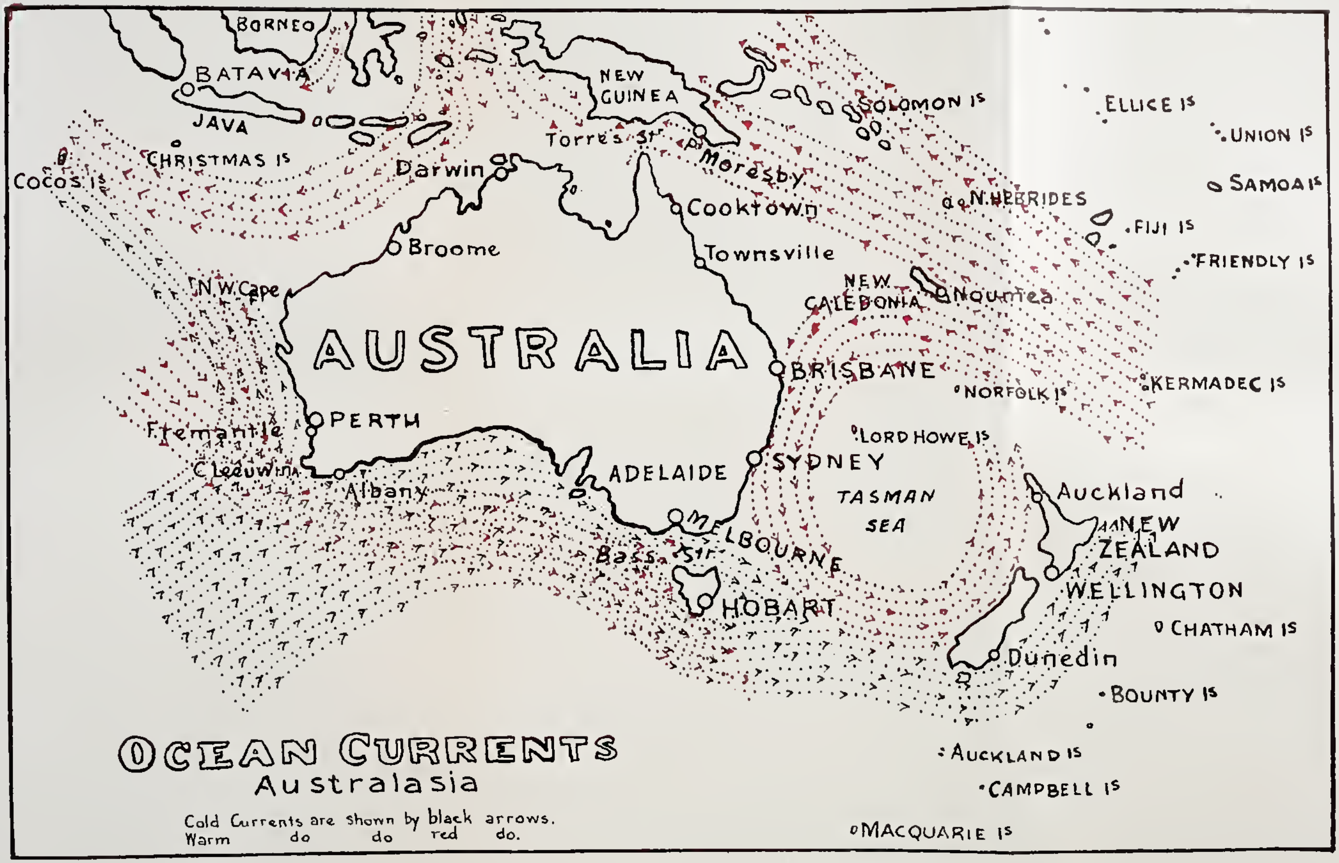
BORNEO
BATAVIA
JAVA
CHRISTMAS IS
COCOS IS
NEW GUINEA
Torres St
Moresby
Darwin
Cooktown
Townsville
Broome
SOLOMON IS
ELLICE IS
UNION IS
SAMOA IS
N. HEBRIDES
FIJI IS
FRIENDLY IS
NEW CALEDONIA
Noumea
N.W. Cape
AUSTRALIA
BRISBANE
NORFOLK IS
KERMADEC IS
PERTH
Fremantle
C. Leeuwin
Albany
ADELAIDE
LORD HOWE IS
SYDNEY
TASMAN SEA
Auckland
NEW ZEALAND
MELBOURNE
Bass St
HOBART
WELLINGTON
CHATHAM IS
Dunedin
BOUNTY IS
AUCKLAND IS
CAMPBELL IS
MACQUARIE IS
OCEAN CURRENTS
Australasia
Cold Currents are shown by black arrows.
Warm do do red do.

Ross in 1841, the French frigate "La Venus" in 1832, Capt. Wilkes in 1840, H.M.S. "Challenger" in 1874, the U.S.S. "Tuscarora" in 1874-6, and S.M.S. "Gazelle" in 1875.

It is necessary to remember that the observations were confined in most cases, to one season of the year, so that the results must be regarded as applying to that particular time and place only. It will thus be evident that from the paucity of the observations available, any conclusions arrived at concerning the ocean currents around Australia, must be regarded as more or less tentative.

The South Australian Current.—The whole of the southern shore of Australia, from Cape Leuwin to Tasmania, is swept by that largest and grandest of all streams, which is impelled on its majestic way by the anti-trades, or roaring forties, or the "brave west winds," so called by the illustrious Maury.

The unobstructed path of this wind, completely round the earth, between south latitudes 40° and 50° approximately, creates an easterly drift of the surface water known as the Southern Ocean Current. There is an indraft of water from the Antarctic Ocean, in a north-easterly direction, and so vast a quantity of cold water in the immediate vicinity of our southern shores has a very pronounced effect on the climate of a large portion of the continent.

There is also an indraft of warm water from the Indian Ocean which, having no outlet to the north, as in the case of the Atlantic and Pacific Oceans, must discharge the whole of its warm and comparatively light waters to the southward.

We are unfortunately destitute of information as to the width or depth or velocity or location of this discharge, but we know of a warm southerly and easterly surface drift from the vicinity of Cape Leuwin, at the south-west corner of Australia, and the "Challenger" observations show that a warm sub-surface current, about 400 miles wide, and about 250 fathoms deep, flows in an easterly direction off Cape Northumberland on the Victorian coast. At Cape Leuwin it is a surface current, but at Cape Northumberland it is about 150 fathoms below, and has cooled to the extent of about 16° Fah.

As the great Southern Ocean current of less temperature than 62° approaches the south-west coast of Australia it meets this warm southerly drift from the Indian Ocean, and its water being the heavier, it dips below the warmer stream, and flows as a sub-surface current until it meets the shore line. It bifurcates probably from 400 miles to 500 miles south-west of Cape Leuwin, one part flowing northwards along the western coast of West Australia, as far north as Sharks Bay, and the other flows easterly along the South Coast as far as Bass' Strait. The branch which flows northward dips under the warm southerly drift from the Indian Ocean before referred to, but upwells in the immediate vicinity of the shore line, forming a cold belt, which varies in width according to the strength and duration of the off shore winds.

There is not sufficient information available to enable us to say how far it extends as a sub-surface current to the west. The oceanic isotherm of 62° approaches the west coast approximately in an east and west direction, on about the latitude of Perth, until within from 50 to 200 miles from the shore line, according to the season, and then bends sharply to the south. Towards the end of June it is at its greatest distance (about 200 miles) south of Cape Leuwin, and it approaches to within a few miles of the shore line at the end of September. The waters adjacent to the shore between Eucla and North West Cape of West Australia, are reported to be about 5° colder than the water in the offing, and this is probably due to an upwelling of the water of the Southern Ocean current.[1]

[1] Report by J. J. East to the West Aust. Govt., August, 1912.

The southern branch continues as an easterly surface current across the Bight, with a rate varying from ·3 to ·4 knot as far as Spencer Gulf. The warm current from the Indian Ocean, which appears to be confined to the Bight, to that point, here dips below and becomes partly merged in the main stream until it strikes the Tasmanian Plateau. This obstruction, by deflecting the current to the south-east, causes a further mixing of the warm and cold waters, which accounts for the water in Bass' Strait being generally from 2° to 4° colder than the water off Cape Northumberland.

The Tasmanian plateau obstruction also causes a local retardation of the current velocity in Bass' Strait, to such an extent that the tidal currents become the more important, while both are, to a large extent, dominated by the wind.

The main body of the Southern Ocean current sweeps along the western side of the plateau, turning sharply and with increased velocity to the left, at the southern coast of Tasmania, and continues its majestic course north-easterly and easterly around the world.

Eastern Australian Current.—The Eastern Australian current, unlike that of the Southern Ocean, is a stream current, being a branch of the South Pacific Equatorial current, which after passing to the southward of the Fiji Islands and New Caledonia, is deflected towards the Australian coast. It first strikes the eastern Australian shore line near Great Sandy Island, where it is again deflected, this time to the southward, and flows, under the name of the Eastern Australian current close along the shores of southern Queensland and New South Wales as far as Jervis Bay. The coast line here bends slightly to the westward while the current continues its course southwards until it impinges upon the Southern Ocean current flowing eastwards, at about Latitude 43° South. It is here split into three portions, the first being bent round and flows eastward as a warm surface current; the second is also carried eastwards, and mixing with the colder stream, helps to account for the rise of temperature—from 41° Fah. to 50° Fah., according to season—which is observed between latitudes 50° and 60° south; the third is that part which, having become cooler and therefore heavier, sinks below the cold surface water, and taking a south-easterly course, flows as a comparatively warm under current, into the Antarctic Ocean.

This warm water, in conjunction with that of the Brazilian current in the South Atlantic, and the Aghulhas or Cape Current of the Indian Ocean may cause the undermining of the enormous ice-masses which form the "Ice barrier," detaching from them the numerous floating icebergs which strew the face of the Southern Ocean down to 50° and 40° South latitudes.

The melting of these ice masses produces a quantity of water, which, being fresher, is of less specific gravity than the salt water of the surrounding sea, and therefore floats upon it, but as the fresher water from the icebergs mixes with this salt water, the mixture being of lower temperature is rendered heavier and sinks, and hence the supply of cold water which, to a depth of several thousand fathoms, fills the basins of the Atlantic, Pacific, and Indian Oceans.[1]

The portion which is bent round and flows eastward continues its journey thus till it strikes the west coast of New Zealand, when it is again deflected to the northward along that coast as far north as Cape Maria Van Diemen, where it turns to the west and is lost in the waters of the Tasman Sea.

Between Great Sandy Cape and Jervis Bay, the Eastern Australian Current, for which the name Tasman Current is

[1] Thalassa by J. J. Wild, London, Marcus Ward & Co., 1877.

now proposed,[1] has a width of about 350 or 400 miles, at Latitude 34° South, and a depth of about 100 fathoms. Its velocity on the New South Wales coast is about $1\frac{1}{2}$ knots at the littoral and about 2 knots in the offing, at all times and seasons, and at all the salient points from Point Danger to Jervis Bay, its speed and direction have been measured or observed. On the littoral, the speed is, of course, diminished and the direction even reversed, on account of the current meeting headlands of varying form, but these return currents extend but a few miles, and are of local importance only.[2]

On the west coast of New Zealand the temperature of the stream is from 8° to 10° Fah. warmer than on the east coast, but the information available is not sufficient to enable us to state its dimensions.[3]

Between Jervis Bay and Bass Strait the direction and velocity of this current are variable, as it is very liable to interference by an extension northerly of that part of the Southern Ocean current flowing easterly through Bass' Strait. The area between the shore line and the western edge of the Tasman current, is alternately occupied by branches of the warm or the cold water, according as the wind blows from the south-west or from the south-east quadrant.

The western equatorial drift in the eastern South Pacific caused by the south-east Trades, will be found to extend to about latitude 20° or 22° South, and as before described,

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[1] The title Notonectian Current has been proposed for this stream by Mr. Charles Hedley, F.L.S., but the name does not appeal to the writer either as descriptive or distinctive. There are several southerly flowing currents in the ocean, so that the term Notonectian is not distinctive, and as this one has first a westerly course, then southerly, then easterly and finally northerly and north-westerly to its termination or extinction, it cannot be said to be descriptive.

[2] The Bar Harbours of New South Wales, by G. H. Halligan, Min. and Pro. Inst. C.E., Vols. 184-5.

[3] Rep. Aust. Assoc. Adv. Science, Christchurch, N.Z., 1891.

a portion of its waters is deflected towards the Australian coast at about New Caledonia. The remaining portion flows in a north-westerly direction towards Cape York and into the Arafura Sea.

Within the triangle formed by New Caledonia, Cape York and the Chesterfield Reefs, the currents are uncertain both as regards direction and velocity, being influenced largely by the prevailing winds, and, when close to the shore line, by the tidal currents which are very complicated, being partly produced by local conditions existing throughout the numerous islands.

Inside the Barrier Reefs the currents are mainly tidal, and the set is largely influenced by the wind, and by local land configuration.

Generally speaking the flood tide sets north, and the ebb tide south, but during the prevalence of the north-west winds, from December to March, these directions may be reversed.

Arafura Sea Currents.—In the Arafura Sea the current generally sets with the wind, its course, in the south-east monsoon season, from the beginning of April to the beginning of October, being to the westward. The velocity depends much upon the force of the wind, but seldom exceeds 1 to $1\frac{1}{2}$ knots. Along the northern side of Sirwatti Islands between Timor and the Tenimber group, the current sets to the eastward, or to windward, during the south-east monsoon season. During the north-west monsoon the currents generally set also to the eastward. Practically nothing has been done in investigating the currents of the Arafura Sea, or towards the solution of the many complicated problems appertaining to this area.

The North-west and West Coasts.—On the north-west and west coasts of Australia the current, though generally setting with the wind, is sometimes uncertain both in velocity and direction, being complicated with the strong tidal currents which prevail at those parts of the coast. The range of the tides between Van Diemen's Gulf, in Longitude 132° East, and Dampier Archipelago in Longitude 116° 30′ East is abnormally great, ranging from 19 feet to 38 feet at springs, the average of twenty-two stations being 26 feet. The greatest rise and fall on this coast is 38 feet at Hanover Bay, in Longitude 124° 45′ East, but at neaps, the range is reported to be only 2 feet at times.

Such large masses of water entering and leaving the gulfs and bays, necessarily cause serious indrafts and extensive outdrafts which being further complicated by great diurnal inequality, are a menace to safe navigation.

Owing to the predominance of offshore winds on the north-west and west coasts, the tendency is to keep the heated water away from the shore; the outward surface drift being replaced by a counter flow or upwelling of cold water from below. On this account the temperature, in the immediate vicinity of the shore, is made more bearable, while the increased warmth of the water in the offing, conduces to the growth of fish, and thus adds to the commercial prosperity of the country.

It will be noticed that the words 'probably' and 'about' are used in this paper more often than they should be in dealing with a subject of such vast importance to the community. They are rendered necessary on account of the very meagre information at our disposal, and in the author's opinion, this unfortunate and undesirable state of affairs should be remedied as soon as possible, quite apart from the commercial value of a complete knowledge of our ocean currents as affecting our fish supply and our climatic conditions upon which our farming industries so much depend.

TWO PINNATE LEAF BORONIAS AND THEIR ESSENTIAL OILS,

WITH DESCRIPTION OF A NEW SPECIES.

Botany by M. B. WELCH, B.Sc., A.I.C., *Economic Botanist;*
Chemistry by A. R. PENFOLD, F.C.S., *Economic Chemist,*
Technological Museum, Sydney.

[With Plates XII - XIV.]

[*Read before the Royal Society of N. S. Wales, November 2, 1921.*]

OVER twelve months ago the authors decided to undertake an investigation of the Boronias (N.O. Rutaceæ) and their essential oils, and this contribution is a result of the study of two pinnate leaf species. In the genus Boronia, series Pinnatæ, only three species are fully described for Eastern Australia by Bentham in the Flora Australiensis, namely, *B. microphylla* Sieber; *B. pinnata* Smith; both occurring in New South Wales, and also *B. pilosa* Labill., from the southern States. Four other Boronias of this series are limited to Western Australia. Under *B. pinnata* Bentham synonymises *B. floribunda* Sieber, but the latter species has since been raised by more recent writers to specific rank, chiefly on account of its large capitate stigma, and in the field these two species are readily distinguished. Under *B. pinnata* var. *Gunnii*, Bentham *l.c.* places *B. Gunnii* of Hooker in the Flora Tasmaniæ, a pinnate leaf Boronia from Tasmania, with more crowded leaflets, and less hairy staminal filaments than *B. pinnata*. Hooker (*l.c.*) also describes *B. citriodora* Gunn. MSs. a species found in alpine situations in Tasmania, but more dwarfed and with more coriaceous leaflets than *B. Gunnii*. *B. citriodora* possesses a distinct lemon scent, which is quite wanting in the other pinnate species from Eastern Australia. In his variety, *B. pinnata* var *Muelleri*, Bentham, *l.c.*, describes a specimen with distant leaflets and smaller flowers with less hairy filaments than the Port Jackson specimens, but no localities are given.

In the present investigation it was early observed that one of these pinnate leaf species differed from the other in its essential oil, as on crushing the leaves a pleasant and powerful characteristic ketonic odour was readily detected. Subsequent morphological examination, together with an investigation of the essential oil and field observation showed that it differed considerably from what is regarded as the type *B. pinnata*, Smith. On the evidence adduced the differences were thought to be of sufficient importance for it to be given specific rank, and it is, therefore, described herein as a new species. For purposes of comparison an incomplete investigation of the essential oil of *B. pinnata*, Sm., is detailed.

Mr. H. G. Smith, F.C.S., in a paper read before the Royal Society of Victoria, Vol. 32 (new series, part 1, 1919), page 14, entitled "On the essential oil of *Boronia pinnata* Smith, and the presence of Elemicin," gives the results of an examination of a sample of oil furnished by Mr. P. R. H. St. John, Melbourne, from material collected in the Longwarry district of Victoria in 1917. This material from Victoria, though morphologically close to the type *B. pinnata* described by Smith from the Port Jackson and Blue Mountains of N.S.W. in a volume of Tracts relating to Natural History in 1798, nevertheless yields an oil entirely different from those obtained from either of the two Boronias mentioned in this paper.

We defer further comment until we publish our second paper dealing with the pinnate leaf Boronias.

Boronia pinnata Smith, Tracts 290, t. 4.

Bentham in Flora Australiensis, Vol. 1, page 318, (excluding the reference to a sexually dimorphous form with a very short style bearing a thick globular stigma as large or larger than the ovary) (*B. floribunda*).

Anatomical characters of the leaf.

In transverse section, the leaf (Plate XIV, fig. 1) is found to be typically dorsiventral, and usually from 0·45 to 0·60 mm. in thickness. The palisade mesophyll is arranged in one or two layers, the larger portion of the leaf being taken up by the spongy tissue. The epidermal layers are fairly evenly developed, there being little difference in thickness or size of cells on either side, except that the lateral walls of the lower epidermis are slightly sinuate. The lateral walls in both cases have simple pits. In surface view the epidermal cells also show numerous small clear areas, apparently due to uneven thickening of the cuticle. Oil glands are not numerous in the leaves. They are directed towards either surface, and possess normally four thin cover cells representing the discharge mechanism. The glands are typically spherical in shape, and average about 0·10 mm. in diameter.

Essential Oil.

194 ℔s. weight of the branches of this plant in flower were collected at Middle Harbour, Sydney, on 28th August, 1920, and on distillation yielded but 20 grams of a mobile oil of pleasant terpenic odour. The percentage yield being, therefore, but 0·023%. A second lot of material in full bloom, 150 ℔s weight, was obtained from Mount Colah, Northern District, N.S.W., on 2nd September, 1921, and on distillation gave 68 grams of oil, equal to 0·1%.

The oil was quite mobile, almost colourless, with a most pronounced fluorescence, usually strongly indicative of the presence of the methyl ester of anthranilic acid. (The variation in the percentage yield of oil from the two collections is due partly to different methods of steam distillation, size of still, etc.)

The crude oils possessed the following characters, viz:—

	28/8/20	2/9/21
Specific gravity, 15° C.	0·8784	0·8917
Optical rotation	−4·7°	−15·25°
Refractive index 20° C.	1·4825	1·4762
Solubility in 80% alcohol (by weight)	insol. 10 vols.	soluble 1 vol.
Fluorescence	not detected	most pronounced

Sample 28/8/20, on distillation, gave about an 80% fraction boiling at 172 − 180° C., with the following characters, viz:—

Specific gravity, 20° C.	0·8510
Refractive index, 20° C.	1·4752
Optical rotation	− 12°

It did not yield a nitrosochloride or tetrabromide derivative when tested for by the usual methods applicable to limonene.

Sample 2/9/21, 40 ccs. crude oil, ester No. 5·38, were distilled at 10 mm.

It commenced to distil at 61° C., and gave the following fractions:—

Boiling Point,	Quantity.	Specific gravity at 19° C.	Optical Rotation, Degrees.	Refractive index, 20° C.
61 − 76° C. at 10 mm.	14 ccs.	0·8580	−21·4	1·4723
76 − 100 ditto	19 ,,	0·8889	−13·75	1·4759
100 − 116 ditto	4 ,,	0·9272	−11·95	1·4802

Neither a nitrosochloride or bromide could be prepared from any of the fractions. On oxidation with alkaline potassium permanganate solution a solid acid of melting point 100° C. was separated from a very sparingly soluble sodium salt, but sufficient was not available for further work. The terpenes gave a red colouration when a drop of sulphuric acid was added to their solution in acetic anhydride. The results, however, show that the principal constituent is a terpene or mixture of terpenes, and that the oil is quite distinct chemically from the other pinnate leaf species to be next described.

The high boiling fraction and residue when dissolved in acetic acid, and bromine vapour allowed to fall upon same, gave the well known purple colour reaction characteristic of sesquiterpenes. A very small amount of a paraffin-like body was also separated from the residue left in the still from the distillation, and on purification, as far as it was possible with the quantity, it melted at 64 – 65° C. Repeated attempts to confirm the fluorescence as being due to the methyl ester of anthranilic acid gave negative results. It is proposed to carry out later a special investigation to determine the nature of the fluorescence which is a characteristic of most of the essential oils of the Boronia.

BORONIA THUJONA sp. nov. (Penfold and Welch).

A tall glabrous shrub reaching a height in sheltered positions of 8 to 12 feet. Leaves opposite, pinnate; leaflets 9 to 15, rarely fewer, lanceolate to broad lanceolate, up to $1\frac{1}{4}''$ long, often with a double curve, margins serrulate, the serrations distant, marked by an oil gland, common petiole scarcely wider between the pairs of pinnæ, except towards the end of the leaf. Flowers in axillary or terminal cymes, usually in threes. Sepals small, at times somewhat acuminate, one to two lines long; petals up to six lines in length, and four lines broad, imbricate, not glabrous inside, and fringed with short hairs, usually acute or rounded, seldom mucronate; filaments flattened, with hairs along the margins of the entire length, alternately long and short, summit thickened, tuberculate; anthers all perfect, rarely apiculate; style comparatively long; stigma often slightly dilated, though not so pronounced as in *B. floribunda;* ovary glabrous.

Localities:—Narrabeen (A. R. Penfold); Middle Harbour, in creek beds and ravines; Bundanoon (C. F. Laseron); Wardell, N.S.W. (Bauerlen). This species will probably be found in most of the coastal gullies of New South Wales.

There is a specimen in the Technological Museum Herbarium collected by the late W. Bauerlen, at Wardell, New South Wales in September 1893. The specimen is in flower, and possesses the same leaf texture, though the leaves are somewhat narrower in the Narrabeen specimens. After all these years the strong characteristic smell can still be detected when the leaves are crushed.

This species differs from *B. pinnata* in its sciophilous characteristics, being found always in creek beds and in damp shady situations, where it reaches a height of twelve feet. It is altogether a much more willowy and graceful plant than the typical *B. pinnata*, found so commonly on our dry sandstone ridges. The leaves too are much darker green in colour, not glossy, paler on the under surface, and thinner in texture and are decidedly serrulate, a feature which is scarcely prominent in the thick rigid, coriaceous glossy leaves of *B. pinnata.* The scent from the leaves is distinctly noticeable, even if the plant is only brushed against when walking through the dense undergrowth in which this species is usually found. If the leaves are crushed the characteristic odour (closely resembling that of black currant) is very pronounced, whereas the typical *B. pinnata* has no very marked smell when the contents of the oil glands are freed. The leaves are also much thinner, averaging about 0·2 mm. in thickness, whereas in *B. pinnata* the leaves are coriaceous, and usually from 0·4 to 0·6 mm. in thickness. This is to be expected when the conditions under which the two species grow are taken into consideration.

It will be seen from the transverse section of the two species that the palisade layers in *B. pinnata* show much greater development, while the intercellular spaces in the spongy mesophyll are much smaller than in *B. thujona*. These characteristics are typical in the former species of a heliophilous plant, whereas in the latter species we have a distinctly sciophilous type. Warming (Plant Ecology) says that the stomata of sciophylls are found on either surface of the leaf, whereas in dorsiventral heliophylls the stomata are confined to the lower surface, or are more numerous there than on the upper face. In the case of *B. pinnata* and *B. thujona*, however, this generalisation is to some extent reversed, since stomata are very rarely found on the upper surface (Bundanoon), and were confined to the lower surface only, in material examined of *B. thujona* from Narrabeen. In *B. pinnata*, however, though somewhat smaller and fewer on the upper surface than on the lower, they are, nevertheless, quite numerous. *B. thujona* possesses also a lower epidermis with very sinuous lateral walls, a feature scarcely found in *B. pinnata*. In the case of *B. thujona*, the style is usually much longer and thinner than the stigma more dilated than in *B. pinnata*, with its short thick style. The flowers are larger in the former species than those of *B. pinnata*, and usually paler in colour.

Hooker mentions the fact that the leaves of *B. Gunnii* smell "powerfully of rue and tansy," but *B. thujona* is apparently a much more robust plant, attaining a height of 8—12 feet, whereas the Tasmanian plant grows to 2—4 feet in height. The stigma of *B. thujona* is also much less capitate than is figured by Hooker under his species in Flora Tasmaniæ, Vol. i, t. 10; in *B. thujona* also the leaves are as a rule decidedly serrulate, whilst no mention is made of this in Hooker's description of *B. Gunnii*, or are any serrations shewn in his figure. In *B. Gunnii* also the leaves are "more crowded, but the lowest pair always distant from the stem" than *B. pinnata* (Bentham, Fl. Aus., vol. 1), but in *B. thujona* the leaves are certainly not more crowded nor are the lowest pair always "distant" in comparison with *B. pinnata*, rather the reverse.

The young plants resemble *B. floribunda* in appearance, and in the size and colour of the flowers, and in the field would be much more readily taken for that species than for *B. pinnata*. *B. floribunda*, however, is readily distinguished by the large globular stigma and the absence of the strong smelling oil in the leaves and buds.

Anatomical Characters of the Leaf.

In transverse section the leaf is found to be particularly thin, (Plate XIV, fig. 3) averaging about 0·20 mm. in thickness. The palisade mesophyll is usually confined to one layer. Intercellular spaces are very prominent in the palisade tissue as seen in the left of figure (3), where the leaf is cut somewhat obliquely by an almost horizontal section so as to pass through both the palisade and spongy tissues. Intercellular spaces are also particularly noticeable in the transverse section. The lower epidermis has decidedly sinuate lateral walls, which are occasionally pitted. The cuticle in both cases is thin. The upper epidermis is composed of much larger cells, which are not sinuate, the lateral walls also possessing simple pits. Stomata are usually confined to the lower epidermis, and average about 300 per square millimetre, with an average size of 0·03 mm. by 0·025 mm. They are rarely found on the upper surface.

The oil glands are directed towards either side, and are usually from 0·1 – 0·15 mm. in diameter. The four epidermal cells forming the cover for the gland are much thinner than elsewhere, and are sunk slightly below the surface. This discharge mechanism which is similar to that found in *B. pinnata*, and corresponds with that observed by Haberlandt (Plant Physiology) in *Ruta* and *Pilocarpus*. The "cover" is about 0·05 mm. in diameter. Oil glands also occur in the petals and sepals (Plate XIV, fig. 4) and in the cortical tissues of the stems.

Essential Oil.

The characteristic and powerful ketonic odour which this plant gives when the leaves are bruised, readily distinguishes it from all other pinnate leaf species of Boronia so far investigated. The examination of the essential oil herein detailed, shows the principal constituent to be the ketone, thujone, $C_{10}H_{16}O$, both α and β forms, occurring to the extent of 80–90%. It is, therefore, one of the richest bearing thujone oils that have as yet been described. The oil is usually colourless, with slight fluorescence resembling that given by small amounts of the methyl ester of anthranilic acid, and possesses a delightful odour recalling that of "black currants." In fact, a perfect synthetic black currant essence can readily be compounded from it. On account of its characteristic habit of growing in sheltered gullies and ravines plentifully supplied with moisture, it is naturally somewhat limited in extent of quantity in any particular locality, although probably widely distributed throughout the State (N.S.W.) so far as known, and consequently, should a demand for its commercial utilisation arise, it will need to be cultivated.

Five collections of material, cut as for commercial purposes, were made in all from two different localities, a total of 176 ℔s. weight being distilled, and with average yield of 0·6%. Three collections were made from Narrabeen, near Sydney, whilst two were obtained from Bundanoon (Southern district), about 100 miles from Sydney. Both distillations of plants (total 128 ℔s.) collected at Bundanoon yielded oil equivalent to about 0·36%. It was later found, however, that this low result was due to a faulty method of distillation, an amount equal to 0·20% having been carried away through large excess of condensed water having been allowed to pass through the oil prior to separating same. The observation, unfortunately, was made too late to secure the oil.

On account of the comparatively small amount of oil available for investigation, specimens for Museum purposes having to be secured, it was only possible to determine accurately the principal constituent, especially as it occurs to the extent of about 90%. From the range of boiling points, physical characters, such as specific gravity and refractive index, and the increased saponification number after acetylation, it appears probable that a small amount of the corresponding alcohol thujol, is also present. A small amount of a paraffin-like body of melting point, 64 – 65° C. was found, whilst the small quantity of high boiling residue left after distillation gave the well known colourations for sesquiterpenes such as have been described for similar bodies from the Myrtaceæ. The presence of the methyl ester of anthranilic acid could not be confirmed.

A very remarkable feature of the oils examined will be observed from the table given under "Experimental" column for optical rotations. A collection of material made from plants growing in a gully at Narrabeen, yielded an oil of optical rotation – 20·2°, whilst a collection made a few days later in another gully, less than a mile away from the first and similarly situated, gave an oil of optical rotation + 13·91°. In view of the oil from Bundanoon material being also lævorotatory, it was deemed necessary to have confirmation of the dextro-rotation of the second Narrabeen sample. A further collection was, therefore, made about nine months later, and the dextro-rotation confirmed, the oil obtained giving a reading on the polarimeter of +13·65°.

As the samples of oil of dextro-rotation were rather small, the thujone was not isolated from them in a condition of purity, the oil from Bundanoon of lævorotation being used for that purpose. Specimens thus prepared through the bisulphite compound were found to be of specific rotation $[a]_D$ 20° C. – 72·3°. The literature records —10·23° for alpha thujone (lævorotatory), and +76·16° for beta thujone (dextro-rotatory). Alpha thujone of almost equivalent optical activity to that of beta thujone has thus been separated.

Experimental:—The 176 lbs. of plant material collected at Narrabeen near Sydney, and Bundanoon, Southern district, N.S.W., at different periods, yielded on distillation crude oils, which on examination gave the chemical and physical characters as shewn in the following table, viz:—

Date.	Locality.	Percentage Yield.	Specific Gravity 20° C.	Optical rotation, Degrees.	Refractive Index, 20° C.	Solubility in 70% Alcohol. Vols.	Ester Number before Acetylation	Ester Number after Acetylation
1/9/20	Narrabeen	0·52	0·9152	–20·20	1·4531	1 in 1·5		
6/9/20	Ditto	0·66	0·9144	+13·91	1·4543	ditto	17·8	43
27/9/20	Bundanoon (corr.)	0·55	0·9152	–45·60	1·4524	...	19·14	49·28
16/2/21	Ditto ditto	0·57	0·9121	– 56·54	1·4569	1 in 2	11·22	38·2
16/6/21	Narrabeen	0·57	0·9128	+13·65	1·4526	1 in 1·5		

On distillation the various samples of oils behaved as follows, viz:—

1/9/20, Narrabeen.—Commenced to distil at 194° C. at 760 mm. and gave between 90 – 95%, boiling at 195 – 200° C. This fraction had the following characters:—

Specific gravity at 19° C. ... ... 0·9145
Optical rotation ... ... –20·65°
Refractive index, 16° C. ... ... 1·4539

6/9/20, Narrabeen.—On distillation 85% distilled at 76 – 80° C. at 10 mm. This fraction had:—

Specific gravity at 20° C.	0·910
Optical rotation	+14·98°
Refractive index, 18° C.	1·4520

It readily gave the Schiff reaction, and yielded a semicarbazone, sparingly soluble in alcohol, of melting point 176 – 177° C.

The tribromide was also prepared which melted at 122 – 123° C. after recrystallisation from ethyl acetate.

27/9/20, Bundanoon.—40 ccs. were distilled at 767 mm., viz:—

First drops at 184° C.		Specific gravity 15° C.	Optical Rotation.	Refractive Index, 20° C.
184 – 191° C.	2 ccs.	...	– 43·20°	1·4571
191 – 199 ,,	18 ,,	0·9078	– 47·20	1·4555
199 – 210 ,,	13 ,,	0·9182	– 41·75	1·4545
210 – 218 ,,	4 ,,	0·9203	– 33·10	1·4598
Residue ,,	2 ,,			

The two main fractions were mixed and on redistillation the greater portion of it boiled at 75 – 77° C. at 10 mm., and had:—

Specific gravity at 15° C.	0·9128
Optical rotation	– 47·65°
Refractive index, 20° C.	1·4534

As the foregoing distillations showed the oil to consist mainly of thujone, the oil prepared from Bundanoon material 16/2/21, was used for the preparation of the ketone in a pure condition. 40 ccs. lots of the oil were, therefore, mixed with 150 ccs. 35% solution sodium bisulphite, 150 ccs. alcohol, and 24 ccs. water, and allowed to stand for several months until combination was complete. The bisulphite compound was then separated, washed with alcohol-ether, dried on a porous plate, and decomposed with caustic soda solution, when the liberated ketone was blown over in a current of steam. Two such preparations possessed the following characteristics:—

	No. 1		No. 2
Specific gravity 20° C.	0·9157	...	0·9158
Optical rotation	−65·3°	...	−66·22°
Refractive index, 23° C.	1·4493	16° C.	1·4520
Boiling point at 10 mm.	79 − 80° C.	...	79 − 80° C.
Tribromide, melting point	125 − 126 ,,	...	125 − 126 ,,
Semicarbazone, ,,	170 − 172 ,,	...	170 − 172 ,,
two forms	174 − 176 ,,	...	174 − 176 ,,

The dextro-rotatory oils not being used for preparation of the pure ketone, but being particularly rich in thujone, they were used directly for preparation of the derivatives, viz:—

Narrabeen sample, 16/6/21.

Tribromide recrystallised from ethyl acetate melting point 125 − 126° C.

Semicarbazone, soluble in alcohol, melting point 184 − 185°C.
Ditto, sparingly ditto 176 − 177°C.

It will be observed that the melting point of the tribromide is much higher than that usually recorded for this ketone, viz., 121 − 122° C. (Wallach).

We are greatly indebted to Mr. R. T. Baker, F.L.S., etc., for much assistance in this work, particularly in the botanical portion, and also for his excellent drawing of the floral parts. Our acknowledgements are also due to Mr. F. Morrison for assistance in the chemical part of the investigation, and to Mr. C. F. Laseron for superintending the collection of the botanical material.

Borǫnia thujona, sp. nov.

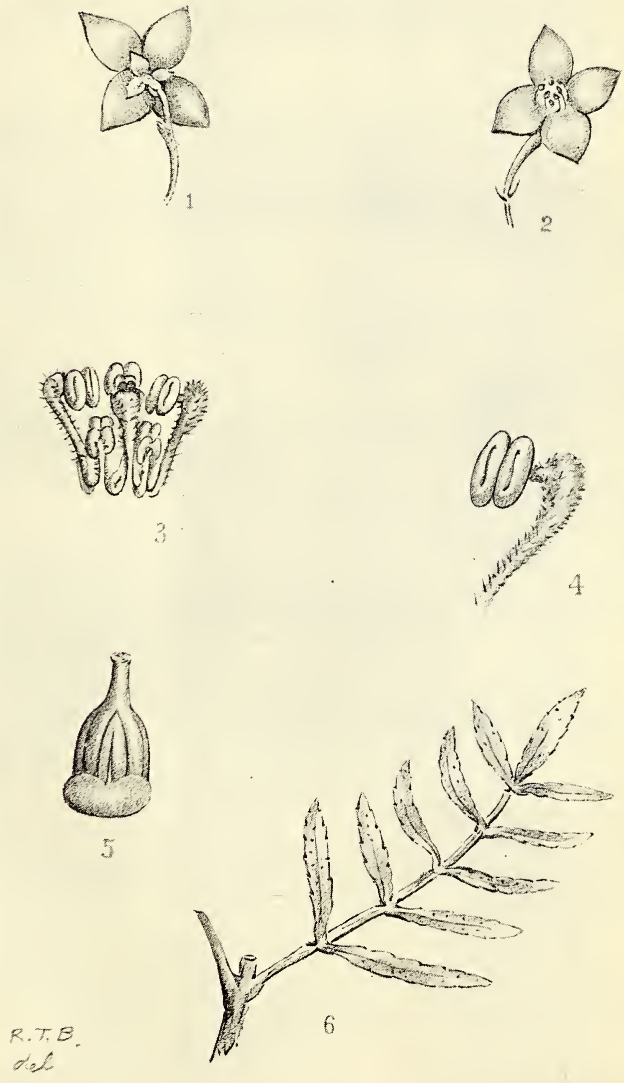
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Fig. 1.—Boronia pinnata, Sm.

Fig 2.—Boronia thujona sp. nov.

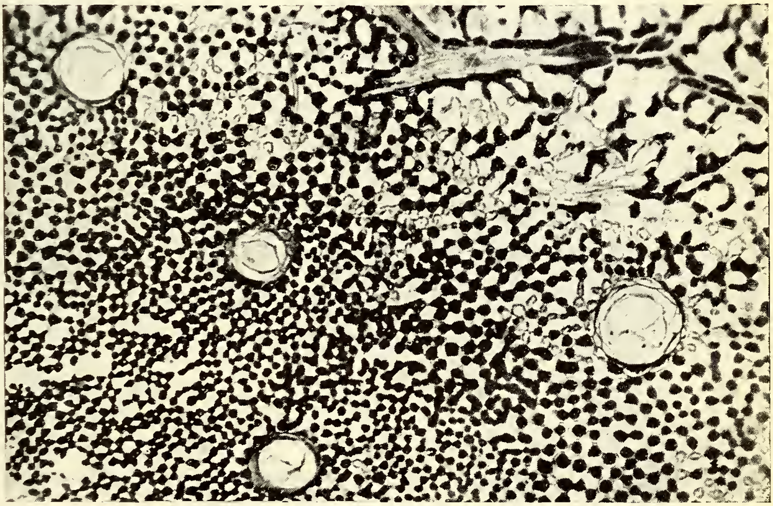

Fig. 3.—Boronia thujona.

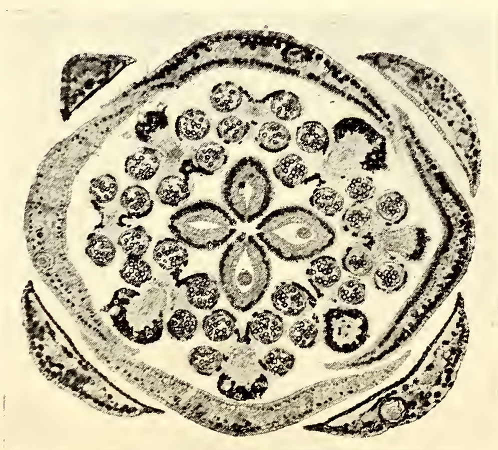

Fig. 4.—Boronia thujona.

EXPLANATION OF PLATES.

Plate XII.

Boronia thujona, sp. nov.

Plate XIII.

Figs. 1 and 2. Individual flowers.
,, 3. Stamens (enlarged).
,, 4. Individual stamen (enlarged).
,, 5. Ovary, style and stigma (enlarged).
,, 6. Leaf showing minute serrulations.

Plate XIV.

Fig. 1. Transverse section of the leaf of *Boronia pinnata*. Two oil glands in section are directed towards the upper surface, the one on the right with two cover cells sunk below the normal epidermis on either side. The epidermal layers are comparatively evenly developed, and stomata are found on either surface. The palisade tissues are distinctly seen towards the upper surface. × 27.

Fig. 2. The transverse section of the leaf of *Boronia thujona*, showing the thin texture with a very loose palisade and spongy mesophyll. Stomata are usually found on the lower surface only. The cells of the upper epidermis are much larger, and more heavily cutinised than those of the lower surface. A single oil gland is seen on the left. × 27.

Fig. 3. Horizontal section, slightly oblique, of the leaf of *Boronia thujona*. On the left the palisade mesophyll is cut transversely, gradually passing on the right into the spongy tissue, with increasingly large intercellular spaces. Four oil glands are shown in section. × 70.

Fig. 4. Transverse section of the flower bud of *Boronia thujona*. Peripherally are the four sepals in section, several possessing distinct oil glands. Within these are the four imbricate petals, those towards the top and left of the plate with a single oil gland The section passes through the eight perfect stamens and their connectives, though the filaments are alternatlely long and short. The pollen grains are distinctly seen. Within the anthers the upper portion of the ovary is shown in section with its four lobes, in two of which are the ovules. × 30.

THE OCCURRENCE OF RUTIN IN THE LEAVES OF THE BORONIA (N.O. RUTACEÆ).

By F. R. MORRISON,

Assistant Chemist, Technological Museum, Sydney.

(Communicated by A. R. PENFOLD, F.C.S.)

[*Read before the Royal Society of N. S. Wales, November 2, 1921.*]

WHILST investigations were being conducted at the Technological Museum, on the essential oils of the Boronias, it was observed that after steam distillation of the oil from the leaves, and on allowing the contents of the vessel to cool, small particles of a yellow substance had made their appearance on the leaves of certain species, and a yellow deposit had also separated from the water at the bottom of the still.

A preliminary examination showed this material to be possessed of dyeing properties, the colours produced on mordanted cloth being similar to those obtained with rutin or other glucosides of quercetin. The species from which the dye material was obtained for examination were *Boronia serrulata* (Smith, Trans. 292, t. 5, referred to in Bentham's Fl. Aust. Vol. 1, 323), the well known "Native Rose," and *B. thujona* (Penfold and Welch), a new species of pinnate leaf Boronia described in the present Proceedings of this Society, (Vol. LV, p. 200). In order to obtain a sufficient quantity of the substance for investigation, and at the same time to gain an idea of the quantity present in the leaves of the respective species, the leaves, after distillation of the oil were dried, stripped from the stalk, finely ground, and boiled with water; the hot liquid filtered through cloth, and the leaves again treated with boiling water, a further quantity of the dye material being thus extracted. On cooling, the material separated out from solution, and the dark coloured crude substance was filtered off, dried, and weighed.

The quantities of crude dye material thus obtained were as follows:—*B. serrulata.*—The yield calculated on the fresh material, stalks and leaves, as collected in the field was 1·6%. Calculated on the dry leaves alone (no stalks) was 6·6%. The actual quantity of colouring matter (Rutin) extracted with absolute alcohol (see under "experimental") was equal to 21·5% of the crude material.

B. thujona.—The yield calculated on the fresh material, stalks and leaves, as collected in the field was 0·7%. Calculated on the dry leaves alone (no stalks) it was 5%. The actual quantity of crude colouring material extracted with absolute alcohol was equal to 40%.

Experimental.

The preparation of the substance in a pure condition for analysis was carried out according to the method described by H. G. Smith (Trans. Chem. Society, 1898, 698):—The crude material was recrystallised from boiling water, dried, finely ground, and extracted with ether in a Soxhlet apparatus until all chlorophyll, etc., had been removed. The powder was then dried and boiled with absolute alcohol under a reflux condenser until the whole of the colouring matter had been extracted. On filtering the hot alcoholic solution, evaporating to a small bulk, and pouring into water, the substance separated out. It was purified by recrystallisation from dilute alcohol, and several times from boiling water. As thus obtained, the glucoside was of a pale yellow colour, with a slight greenish tinge, was very sparingly soluble in cold, more soluble in hot water. The addition of alkalies produced an orange coloured solution; ferric chloride added to an aqueous solution produced a dark green colouration, and with lead acetate a yellow colouration was obtained. The pure substance softened at 185° C., melting with decomposition at about 200° C. (Rutin behaves similarly).

On combustion, with material dried at 140° C. the following results were obtained:—

(1) 0·1194 gram gave 0·2328 gram CO_2, and 0·0560 gram H_2O. C 53·17, H 5·21, O 41·62.

(2) 0·2110 gram gave 0·4093 gram CO_2, and 0·0956 gram H_2O. C 52·90, H 5·03, O 42·07.

(3) 0·1254 gram gave 0·2420 gram CO_2, and 0·0578 gram H_2O. C 52·63, H 5·12, O 42·25.

(4) 0·1100 gram gave 0·2130 gram CO_2, and 0·0514 gram H_2O. C 52·81, H 5·19, O 42·00.

Calculating from these results, the formula appears to be $C_{27}H_{13}O_{16}$.

Rutin possesses the formula $C_{27}H_{13}O_{16}$, requiring C 53·12, H 4·92, O 41·96.

Products of hydrolysis.—To determine the products of hydrolysis a small quantity of the substance was added to a large volume of water, acidified with sulphuric acid and boiled for about three hours, until the volume of liquid was reduced to one-third of its original bulk. On cooling, pale yellow needles separated out, which were filtered off, washed with water and dried. The crystals thus obtained were soluble in alcohol, which solution gave with alkalies a yellow colouration; on addition of lead acetate a bright orange-red precipitate was produced, and with ferric chloride a dark green colour. The acetyl derivative was readily prepared, the almost colourless crystalline needles melting at 190 – 191° C. (The acetyl derivative of quercetin melts at 190° C.). The product thus obtained is apparently identical with quercetin.

Isolation of the sugars.—The filtrate from the quercetin was neutralised with barium hydroxide solution, the barium sulphate removed by filtration, and the neutralised solution evaporated to small bulk on the water bath. On standing white crystals separated out, which when examined with the microscope, appeared as tabular and prismatic plates. The osazone was prepared in the usual manner, when it was obtained in the form of golden-yellow crystals, which softened at 185° C. and melted with decomposition at 190° C.

To effect a separation in the event of more than one osazone being present, the method described by A. G. Perkin[1] was used, viz:—The osazone was dissolved in alcohol, the solution poured into about ten times its volume of ether, and then shaken repeatedly with water. On allowing the ether to evaporate slowly, a crop of crystals was obtained melting at 204 – 205° C. (the melting point of glucosazone), and by further careful fractional crystallisation another lot of crystals separated, which melted at 180 – 181° C. Rhamnose osazone melts at this temperature.

The two sugars resulting from the hydrolysis of this glucoside are, therefore, glucose and rhamnose, and since quercetin is shown to be the other product of hydrolysis, the yellow dye material is apparently identical with rutin. The physical and chemical characters, together with the results obtained upon combustion, furnish confirmatory evidence of its identity therewith.

It is worthy of note that the glucoside, rutin, was discovered by Weiss[2] in the leaves of *Ruta graveolens* Linn., which plant belongs to the same natural order as do the Boronias, viz:—Rutaceæ.

Since the completion of the above work the presence of a yellow dye material has been observed in the leaves of

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[1] Trans. Chemical Society (1910) part 2, 1776.

[2] Chem Zentr. 1842, 305.

Boronia pinnata Smith[1] and is apparently identical with that obtained from the leaves of the other two Boronias described above. There is every probability that rutin will be found to occur in other species of Boronia.

It may be as well to record the localities from which the material for this investigation was obtained, viz:—

B. serrulata—Narrabeen, near Sydney.

B. thujona—Narrabeen, north of Sydney, and Bundanoon 101 miles south of Sydney.

B. pinnata—Mount Colah, Northern district, N.S.W.

In conclusion I wish to express my thanks to the Curator of the Technological Museum, Sydney, for making available the facilities of the Institution. To Mr. A. R. Penfold, F.C.S., Economic Chemist, I am much indebted for kindly help and suggestions in the preparation of this paper, and to Mr. C. F. Laseron, Museum Collector, for assistance in collecting the leaves.

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[1] Tracts 290, t. 4.

NOTE ON THE OCCURRENCE IN NEW SOUTH WALES, AUSTRALIA, OF THE PERFECT STAGE OF A SCLEROTINIA CAUSING BROWN ROT OF FRUITS.

By T. H. HARRISON.

(Communicated by W. L. WATERHOUSE, B.Sc.)

With Plate XV.

[*Read before the Royal Society of N. S. Wales, November 2, 1921.*]

Introduction.

For the last century[4] the fungus *Sclerotinia* has engaged the attention of many of the ablest mycologists and plant pathologists. This Ascomycete, of which the *Monilia* stage causes the "Brown Rot" of fruits, is undoubtedly one of the worst enemies of horticulturists and pomologists throughout the world.

After Woronin's discovery in 1888[5] of the perfect stage of a *Sclerotinia* on Cowberry *(Vaccinium vitis-idœa)*, the occurrence of the apothecial stage of the Brown Rot fungus was predicted. But it was not until 1902 that the valued material was found by Norton in an orchard in Maryland, U.S.A.[3] This apothecium arose from a mummified peach. On numerous occasions since then, and especially in 1906 and 1910,[2] many apothecia, in all cases arising from mummified peaches and plums, have been found by various American workers.

On the Continent of Europe, Alderhold and Ruhland, in 1905, found apothecia arising from mummified apples and apricots,[1] but not until January 1920 was the perfect stage found in England. Wormald, in January 1919,[4] collected mummified plums which had been naturally infected the previous summer. After exposing the mummies to climatic conditions for twelve months, he succeeded in obtaining apothecia from them.

In Australia, the apothecial stage has not previously been reported.

Place of Occurrence.

Aided by a knowledge of the conditions under which apothecia were found in England and America, and acting upon the advice of Mr. W. L. Waterhouse, the writer commenced a search for apothecia at Pennant Hills, a fruit-growing district about twenty miles from Sydney. The site selected was an orchard situated at an elevation of 600 feet, having a north-westerly aspect and subject to frosts.

Weather Conditions.

In December of 1920, the coastal districts of New South Wales experienced one of the severest cyclonic disturbances on record. For over a week in early December (midsummer) torrents of rain fell, fourteen (14) inches being recorded. This weather was followed by a series of alternating fine and wet days, the old year closing and the new year opening with more drenching rain. At the time when these excessively humid conditions prevailed the crops of stone fruits were just reaching maturity.

The excessive rain caused the ripening apricots to crack thus preparing the way for the rapid work of the Brown Rot fungus. As a result in most orchards at Pennant Hills the apricot crop was completely destroyed. At the end of the summer, thousands of the mummified fruits remained on the trees. Slowly, under the action of climatic conditions, most of these fell to the ground where they lay undisturbed throughout several months. Although the vast majority had fallen by June, on many trees some still remain, being especially abundant on plum trees of Lutherborough and Burbank variety.

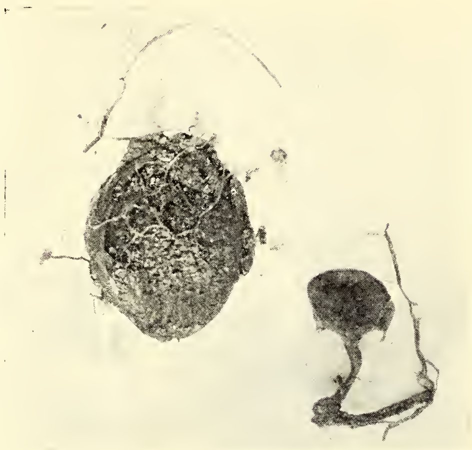

Fig. 1. × 1·12.

Left. Immature Apothecium projecting from Stroma which still enfolds the apricot kernel.

Right. Mature Apothecium showing Cup, Stipe and Stroma.

Fig. 2. Mature Apothecium. × 2·5.

Rule marked in Centimetres and Millimetres.

The ground on to which these mummies fell, had remained undisturbed since being roughly worked in the spring of 1920. Consequently, beneath the trees, were numerous pockets between large clods, in which mummies had accumulated.

Meteorological records show that in the winter of 1921 several frosts occurred. During the early part of September fine muggy weather prevailed, but on the 16th 165 points of rain fell. From the 17th – 21st inclusive, pleasant warm weather was experienced and the morning of the 22nd dawned fine and cool.

The Occurrence of the Apothecia.

On this occasion a search was made on the western side of a large apricot tree under which lay hundreds of mummies. The overlying débris of leaves and grass was cleared away from a pocket about eighteen inches from the tree trunk and about six inches wide and three inches deep. At the bottom of this pocket a fully mature apothecium was found. The small yellow-brown cup was projecting from a light covering of decaying leaves and finely powdered soil. Scraping this covering away, the stipe and parent stroma of the apothecium were revealed. The cup, 9 mm. in diameter, was connected to the black stroma by a stipe 8 mm. long, and of a diameter varying from 0·5 – 1 mm.

In a neighbouring pocket another apothecium was found. This one was, however, not fully mature. The small flattened yellow-brown cup, only 2 mm. in diameter was connected by a stipe 12 mm. long to a stroma which still enclosed the apricot seed. (Plate XV, fig. 1.)

In my opinion, the stroma in both cases was produced from a mummy formed in the previous summer (1920-21), for there had been no visible "brown rot" during the seasons 1918-19 and 1919-20.

Pathogenicity of the Organism.

The following steps were taken to prove that the apothecium discovered was really the Ascigerous stage of a Sclerotinia causing "brown rot" and not a harmless Peziza:—

1. Tissue plantings of the apothecium were made on Potato Dextrose Agar (200+15+20). A typical *Monilia* growth resulted which showed zonation and massive grey-brown tufts of conidia.

2. Ascospore dilutions and separations were made using the same medium. An abundant growth resulted from which pure cultures were obtained. Single spore isolations were made from these cultures.

3. A prick inoculation was carried out on loquat using conidia from the pure cultures obtained from the ascospores. In three days a chocolate coloured rot had extended over half of the loquat, and in a week the loquat was completely rotted. At the time of writing, twenty-two days after inoculation, the control loquat still shows no sign of rot but is slightly shrivelled.

4. Single conidia isolated from the infected loquat were sown on slopes of Potato Dextrose Agar (200+15+20) and the conidia from the resultant growth used to infect an apple of Smith's Pippin variety, On this apple a brown rot with numerous surface tufts of conidia was produced. The rot quickly involved the whole of the apple.

Intensive microscopical and cultural studies of this apothecium-producing strain of Sclerotinia are being conducted, the results of which will form the subject of a later paper. Already there are definite indications, however, that the organism producing the apothecium is *Sclerotinia fructigena*, and a distinct biologic form from both the European and American species.

Acknowledgements.

Grateful thanks are due and are willingly tendered to Mr. W. L. Waterhouse of the Faculty of Agriculture, University of Sydney, for the spontaneously kind way in which he guided the writer in the whole of the investigations.

The cultural work was carried out in the laboratories of the Faculty of Agriculture, University of Sydney.

Summary.

1. Although the Ascigerous stage of Sclerotinia is known in America and Europe, there is no previous record of its occurrence in Australia.

2. Two apothecia, arising from mummified apricots were found on September 22nd, 1921, near Sydney, New South Wales.

3. Inoculations of loquats with cultures from the apothecium caused typical brown rot lesions.

4. The organism is probably *Sclerotinia frutigena*. Further studies are in progress.

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THE CONDUCTION OF ELECTRICITY IN MOLYBDENITE.

By Associate-Professor O. U. VONWILLER, B.Sc.

[*Read before the Royal Society of N.S. Wales, December 7, 1921.*]

Summary.—When a current flows from copper to molybdenite to copper the main part of the resistance consists usually of the two contact resistances. The relation of these to the size and direction of the current is investigated. The resistivity of the material is found to be independent of the direction and magnitude of the current. Observations made with any but small currents are irregular on account of temperature changes produced by the passage of the current.

Readings at various temperatures ranging up to 200° C. show effects resembling those obtained at room temperature. The contact resistances decrease greatly on rise of temperature, but no constant relation holds between contact resistance and temperature. The resistance, apart from contact resistances, decreases with rise of temperature, but efforts to obtain a value for the temperature coefficient of resistivity or conductivity were not successful, probably because mechanical changes were caused by the heating.

For a circuit containing two copper-molybdenite junctions at temperatures differing by one degree the e.m.f. is found to be 560 micro-volts, the current flowing from copper to molybdenite at the hot junction.

In 1913 the writer read before this Society a paper on the rectifying property in silicon and selenium,[1] in which it was shown that in the former material the conductivity

[1] This Journal, Vol. XLVII, 129, (1913).

is constant, its value not being altered by changes in the magnitude and direction of the current unless changes of temperature are produced. It was also shown that the rectifying effect, the change in resistance on reversal of current flowing from metal to silicon to metal, is due altogether to the existence of contact resistances at the regions where the current enters and leaves the silicon, the magnitude of such a resistance depending on the area of the surface of contact, the pressure between the two materials and the direction of flow.

Experiments made since with other materials, including galena and copper pyrites, which possess the rectifying property, gave similar results, the actual resistance of the material being small and invariable if the temperature does not change, and the total resistance of preparations of these crystals being made up mainly of two contact resistances which vary with changes in magnitude and direction of current in the manner described in the case of silicon.

During the last few years several papers have been published having reference to the conduction of electricity in molybdenite, a substance preparations of which show the rectifying property. W. W. Coblenz[1] and others have described investigations on the change in resistance of this material on exposure to light, while A. T. Waterman[2] has noted several peculiar electrical properties of this substance. One of Waterman's conclusions is that "at ordinary room temperatures the resistance is a function of the applied potential difference and appears to approach the value of infinity as the potential approaches zero," and as these writers concern themselves simply with the over-all resistance, including the contact resistances, if such exist, it seemed worth while to ascertain whether with this material

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[1] Bureau of Standards, Bull. 16, (Science Papers No. 398) 1920, etc.

[2] Phil. Mag. Vol. xxxiii, 1917.

contact resistances are as important as with other materials possessing the rectifying property, and whether the actual conductivity of the substance does vary with the potential gradient.

Accordingly experiments with molybdenite were carried out on the lines employed with other materials, special attention being given to results obtained with very small currents. This material is of a nature which allows specimens suitable for these tests to be easily prepared. A thin strip of molybdenite was cut, the dimensions in most of the trials being within the following limits: length 2 to 4 cms., width 2 to 5 mms., thickness 0·3 to 1 mm.; contact was made at four regions along the strip, A, B, C and D, spaced at approximately equal intervals, by means of narrow strips of thin copper sheet bent over the molybdenite, as shown in figure 1, and clamped so as to touch it above and below.

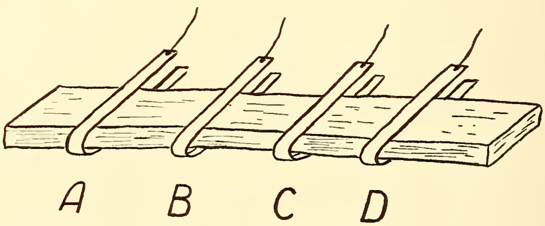


Fig. 1.

Copper wires soldered or otherwise connected with each copper strip served as means of conveying the current into and out of the molybdenite and allowed any two of the four points to be connected with a potentiometer so that the potential difference between them could be determined. The current entered and left by the end terminals A and D and was measured by determining the potential difference between the terminals of a coil of known resistance, usually 10 ohms, in series with the molybdenite.

The tests consisted in sending currents of various magnitudes through the preparation first in one direction and then in the other, and in measuring in each case the four potential differences A – B, B – C, C – D, and A – D, the ratio of the potential difference between any two of these points to that between the terminals of the known resistance giving a comparative value of the apparent resistance between the two points. As the contact resistances are at A and D, in the case of B – C this ratio should depend only on the dimensions of the molybdenite strip between these points and on the resistivity of the material; if the latter is constant the ratio is independent of the value of the current. In the case of the other pairs of contacts the ratio depends also on the value of the contact resistance at A or D or both.

In figure 2, curves are given for a specimen tested at 17° C.; the results shown there are typical. In these curves the abscissæ are proportional to currents, the values in

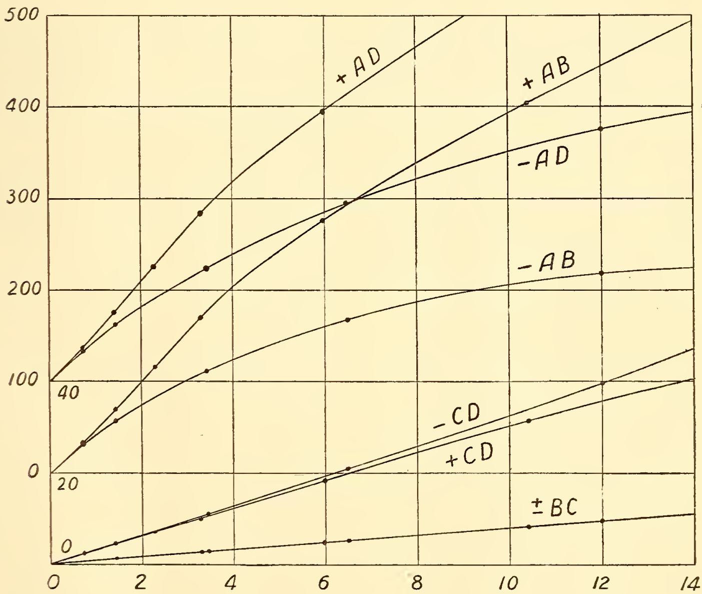


Fig. 2.

amperes being obtained by multiplying the numbers given by 0·000266. The ordinates are proportional to the differences of potential between the pairs of contacts, the + sign indicating that the current flows from A to D while the − sign indicates a flow in the opposite direction; thus the curve +C D gives the relation between the potential difference between C and D and the current when the direction of flow is from A to D. In the case of this specimen the drop of potential between A − B was much greater than those between B − C and C − D, and the scale of ordinates is five times as great for curves A D and A B as for C D and B C. The potential differences in volts are obtained by multiplying the numbers given by 0·00133. Three different zeros have been taken for the ordinates in order to prevent confusion.

Several points may be noted in connection with these curves:—

(1) The resistance of the whole, proportional to the ratio of ordinate to abscissa for the curve A D, is not constant, varying with the magnitude and direction of the current.

(2) At each of the end pairs of contacts A B and C D the potential difference for a given current is greater when the current enters than when it leaves. This was found to be the case with all specimens tested.

(3) For the higher values of current the curves +A D, −A D, +A B and −A B are convex upwards, showing resistance decreasing as current rises. Readings for currents considerably greater than those shown in figure 2 give a like effect for the curves +C D and −C D.

(4) For very low currents the curve +A B is concave upwards, there being a change of curvature later, that is the effective resistance between these points increases at first as the current rises from zero, decreasing later. Readings with larger currents show a like effect with −C D.

This effect was first observed with silicon *(loc. cit.)* and was found also with galena. The potential difference for the pair of contacts where the current enters the material increases at first at a greater rate proportionately than the current. In a case like that of figure 2 where the resistances for A B and C D differ greatly, we have a like effect for the curve +A D or −A D, the former in this case as the ordinates for A B are greater than those for C D, so that the over-all resistance has a maximum value not for zero current but for a small + current. Probably this effect exists in all cases in which rectification occurs, but frequently the currents and potential differences in this region of the curve are too small to allow satisfactory measurements to be made.

(5) The curve BC is a straight line, the same for currents in each direction; this is not shown well in fig. 2 on account of the scale selected, but readings taken with currents twenty-five times as large as the largest given there show no appreciable deviation from the linear relation between potential difference and current.

(6) The potential difference across B C is a very small fraction of the total potential difference A D although the four contacts are at roughly equal intervals, the distance between A and B being 13 mm., between B and C, 11 mm. and between C and D, 8 mm.

The curves show that the total resistance consists mainly of the contact resistances at A and D, a fact that is of course well known for most materials of this class because the resistance can be altered readily by changes in the pressure of the contacts; we see too from (5) that the actual conductivity of the material is constant for a wide range of current values. When large currents are used the curves AD, AB and CD become more nearly horizontal the apparent resistance continually decreasing, and the curve B C eventually shows a like effect, but there is no doubt that this is due to a rise in temperature caused not so much by the small C^2 R development of heat in the region B C as by heat conducted from the regions round A and D where on account of the big potential differences at the contacts there is a great development of heat on the passage of comparatively small currents. With large currents temperature differences in different parts can be detected by touching the specimen with the fingers. When large currents are flowing measurements are usually made with difficulty as conditions seldom remain steady for long; frequently permanent changes are produced in the contact resistances by the passage of large currents, changes like those produced by heating as described later.

These results, it is seen, have a bearing on Waterman's conclusion quoted above. Readings with very low currents show a large but finite resistance depending on the nature of the contacts and the maximum resistance occurs not for zero current but for a small current entering at the end where the contact resistance is greater. It is important to distinguish between the resistance measured between points such as A D and points such as B C as the former depends largely on the contact resistances, while the latter depends on the dimensions and on the resistivity of the material only.

In this specimen the resistance between B and C is about 4 ohms, while that between A and D, including the two contact resistances, for very small currents is about 237 ohms, the maximum value being 279 ohms for a positive current of about 0·000825 ampere. The thickness and width of this specimen were not recorded. Readings with various specimens give in many cases figures of the same order for B C but occasionally very high values are obtained, much higher than can he accounted for by differences in dimensions; in these cases it is frequently found that irregular changes occur, and it is thought that the high values are not due to actually higher values of resistivity but to discontinuities, sometimes temporary in nature, in the thin sheets or lamellæ of which the substance consists. The over all resistance A D may be increased to thousands or hundreds of thousands of ohms by alterations in the contact pressure and area.

In the paper quoted Waterman finds a relation between the resistance and temperature. In view of the above result it is likely that such a relation must refer mainly to contact resistances and does not give any information concerning changes in the resistivity of the material. Attempts were made therefore to investigate the behaviour of such preparations at various temperatures. Strips of molybdenite furnished as before with copper contacts were placed in an oven heated electrically, and the potential differences for several currents measured at a number of temperatures. Many specimens were tested over various temperature ranges, the highest temperature used being about 200° C. In all cases the results resembled those obtained at room temperatures. Always Ohm's law held for the central portion B C and the potential difference for an end pair of contacts was greater when the current entered at that end than when it left. The change of curvature noted above near the beginning of the +A B and −C D curves was observed in some cases and probably occurred in all.

In every trial the potential difference between each pair of contacts decreased with rise of temperature, but the relative decreases were not the same for all. In figure 3 are given curves for various temperatures for +A D and −A D and in figure 4 the corresponding curves for B C for the same strip from which the curves of figure 2 were obtained. The numbers placed near the lines give the mean temperature of the preparation during the observa-

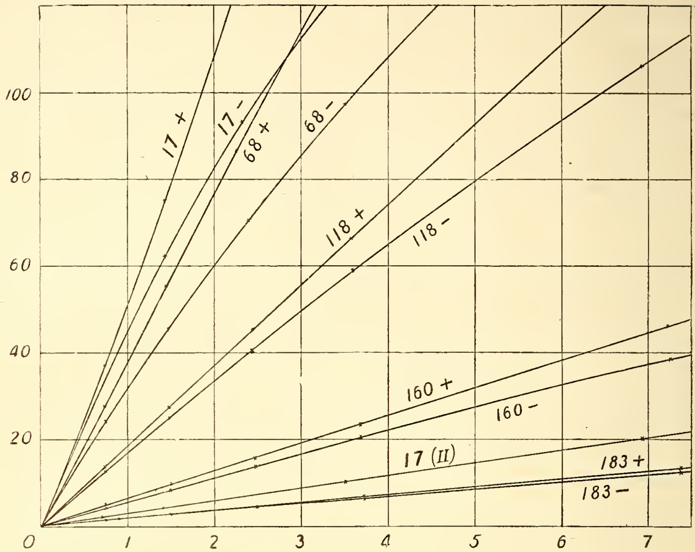

100
80
60
40
20
0
1
2
3
4
5
6
7
17 +
17 -
68 +
68 -
118 +
118 -
160 +
160 -
17 (II)
183 +
183 -

Fig. 3.

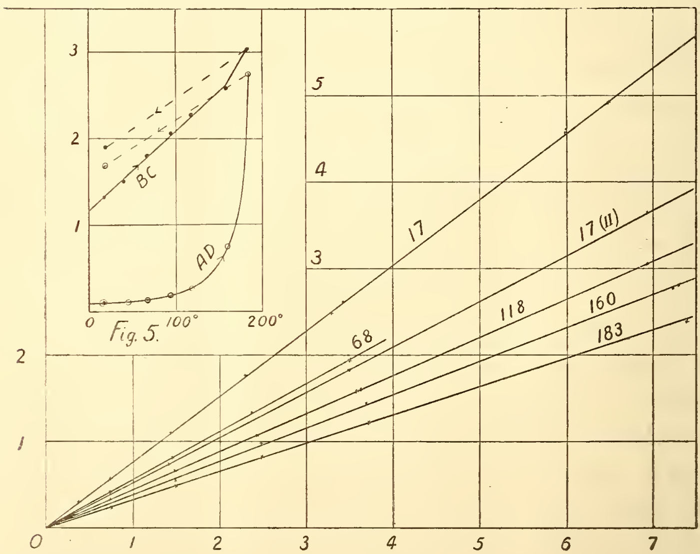

3
2
1
0
100°
200°
BC
AD
Fig. 5.
5
4
3
2
1
0
1
2
3
4
5
6
7
17
17 (II)
68
118
160
183

Fig. 4.

tions (it varied by 2 or 3 degrees for the three highest temperatures but by not more than a degree in the others), and the sign + indicates that the direction of current was from A to D while the sign − indicates a flow on the opposite direction. The numbers along the x and y axes must be multiplied by the same constants as in figure 2 to give amperes and volts respectively. In the case of figure 3 we see that the total resistance, proportional to the ratio of ordinate to abscissa, decreased to a very marked extent as the temperature rose, but on cooling back to 17° C. after the final heating to 183° C. the curve 17 (II) was obtained, showing a very slight recovery, the resistance being permanently reduced by the heating. It was found that, even if heated through but a few degrees, on cooling back to the original temperature the resistance was changed, usually being less than before the heating took place. As the total resistance is due mainly to contact resistances at A and D it is not surprising to find that large changes occur on heating, and also that the contacts are not restored to their original condition on re-cooling nor is it surprising that the effects of temperature changes are sometimes very different at the two junctions. The curves in figure 3 show only readings obtained with very small currents; at some temperatures readings were also taken for considerably larger currents and in these cases the full curve shows the same general effect as +A D or −A D in figure 2.

In figure 4 the curves for B C are all straight lines and a progressive decrease in resistance is seen as the temperature rises, the change being relatively much smaller than with the whole resistance A D. On cooling, a line 17 (II) is obtained, having a smaller slope than the original line 17 indicating a permanent change in conductivity as a result of the heating. This result is more unexpected than is the change in A D, but in practically every test made, even when the change of temperature is but 5 or 10 degrees, it was found on cooling that the resistance between B and C did not return to the original value. The results too, were very irregular, sometimes the resistance was lowered, at others raised as a result of heating and subsequent cooling. Even when the same specimen was repeatedly heated and cooled over the same range of temperature, with or without the passage of current at the higher temperature, it was found that sometimes for two or three trials the resistance would decrease after each cycle and after the next it would increase. In all cases, however, while the temperature was constant at any value the curve for B C was a straight line. In the hope of obtaining a value for the temperature coefficient trials were made with widely different conditions; sometimes very thick pieces of the material were used and at others very thin strips, less than 0·1 mm. thick; the contacts were altered in nature, consisting sometimes of clamped metal strips, at others of wires with rounded ends pressing against the molybdenite, and sometimes the molybdenite was plated with copper deposited electrolytically at the regions where the contact was to be made, but consistent results could not be obtained. It is probable that the change in conductance between B C after going through a temperature cycle is not due to a real change in resistivity but is caused by a mechanical change. The material has a lamellar structure and in the expansions and subsequent contractions a certain disturbance may occur resulting in a change of contact between the sheets making up the strip, and if there is discontinuity in some of these the effective area of the section and therefore the conductance may be changed.

Inset in figure 4 is figure 5 showing the relation between apparent conductance and temperature for B C and A D. The ordinates in the case of A D have been multiplied by five and the numbers given on the y axis are merely proportional to the conductance. The curves show clearly the marked difference in the effect of temperature changes in the two cases. Here, as in a number of trials, the conductance of B C has an approximately linear relation to temperature during the greater part of the rise, but calculations of the temperature coefficient of the conductance from such readings give widely different values in different cases and even with the same specimen in different trials. The values indicated range from 0·003 to 0·009 per degree. The only unvarying result is that the conductance increases with rise of temperature and decreases with fall.

In this work at high temperatures it was found that small differences of temperature between the various contacts with the molybdenite caused considerable trouble owing to thermo-electromotive forces, until this source of error was detected and removed or eliminated by actual determination of the e.m.f., a simple matter with the aid of the potentiometer. It was soon seen that comparatively large e.m.fs. were obtained for small differences between the temperatures of the junctions and an attempt was made to measure this e.m.f. for known differences of temperature of copper and molybdenite junctions. Four junctions of copper and eureka wire were prepared by soldering together the ends of wires of No. 40 gauge of the two materials, the joint being made as small as possible, and the insulation being removed over as small a length as would allow a satisfactory join to be made. These junctions were clamped against four points on a molybdenite strip, the junction being pressed between a small piece of copper foil and the molybdenite. A small brass terminal was clamped on to one end of the molybdenite strip and this was heated by a current passing through a coil of insulated wire wrapped round it. After some time a steady temperature gradient was established along the strip and the e.m.f., between different pairs of copper molybdenite junctions could be measured, readings at the same time being taken of the e.m.f. obtained with each copper-eureka junction, the other junction in this case being at the room temperature outside the enclosure in which the molybdenite was placed. After a calibration was made later the latter readings gave the temperatures of the four junctions. The copper wires of the copper-eureka junctions were used to form the copper molybdenite junctions. These tests were carried out with a number of different heating currents so that the junctions attained different temperatures. The calibration was carried out by raising the temperature of the whole preparation in the electric oven, the heating current at the end of the strip being zero, and measuring the thermo-e.m.f. for each copper-eureka junction, the temperature of the whole being observed with the aid of a mercury in glass thermometer. Such readings were taken at several temperatures, and it was found that the four junctions gave practically the same results. Curves were plotted giving the potentiometer readings for various temperature differences and so the temperatures of the copper molybdenite junction were readily determined with their aid. In all these experiments the room temperature only varied over a range of less than two degrees.

On plotting the thermo-e.m.f. for each pair of copper molybdenite junctions against differences of temperature the curve obtained for any pair is practically a straight line. It was found that the slope varied slightly with different pairs of points on the same strip and with different strips. The maximum difference of temperature in these trials was 80°. For temperatures between 16° C. and 100° C. the e.m.f. for a difference of one degree between two copper molybdenite junctions was found to be 560 micro-volts. This is the mean value obtained from a number of apparently satisfactory trials with several different specimens; the extreme values found are about 10 per cent. greater and less than this. No attempt was made to determine the variation with temperature which was small within this range. The direction of the thermo-electric current is from copper to molybdenite at the hot junction. The thermo-electric height of molybdenite is thus very great, being comparable with those of silicon and selenium. This result is of interest, because it is considered probable that the variation of the contact resistances with size and direction of current, which is the origin of the rectifying property, is due to thermo-electric effects produced by the passage of the current.

The Physical Laboratory,
The University of Sydney.

THE GEOLOGY OF THE GLOUCESTER DISTRICT OF NEW SOUTH WALES.

By C. A. Sussmilch, F.G.S., F.T.C., (Syd.),

With Rock Analyses by W. G. Stone.

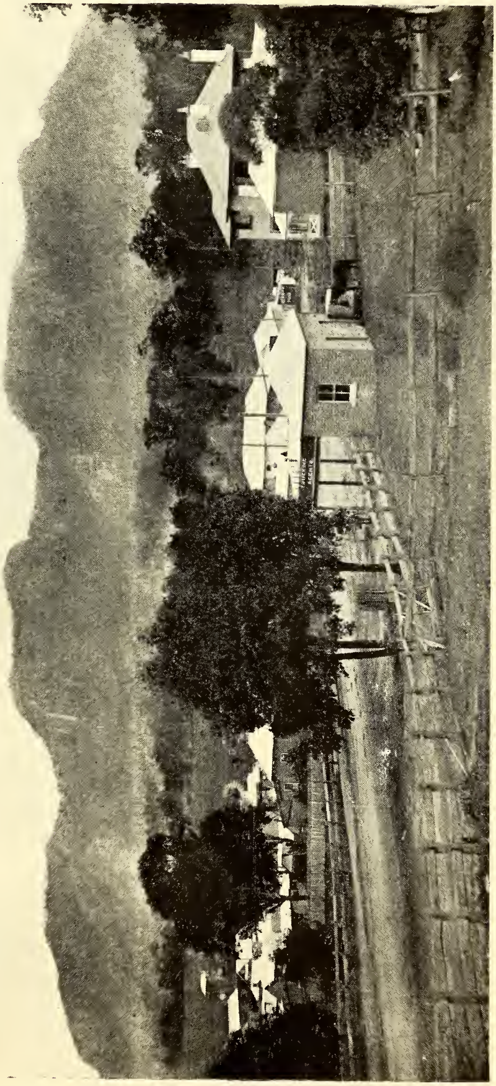
[With Plates XVI - XVIII.]

[Read before the Royal Society of N.S. Wales, December 7, 1921.]

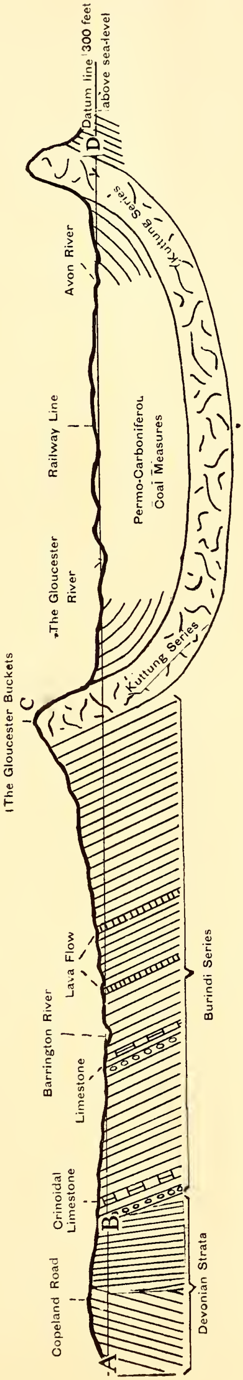
TABLE OF CONTENTS.

Introduction.

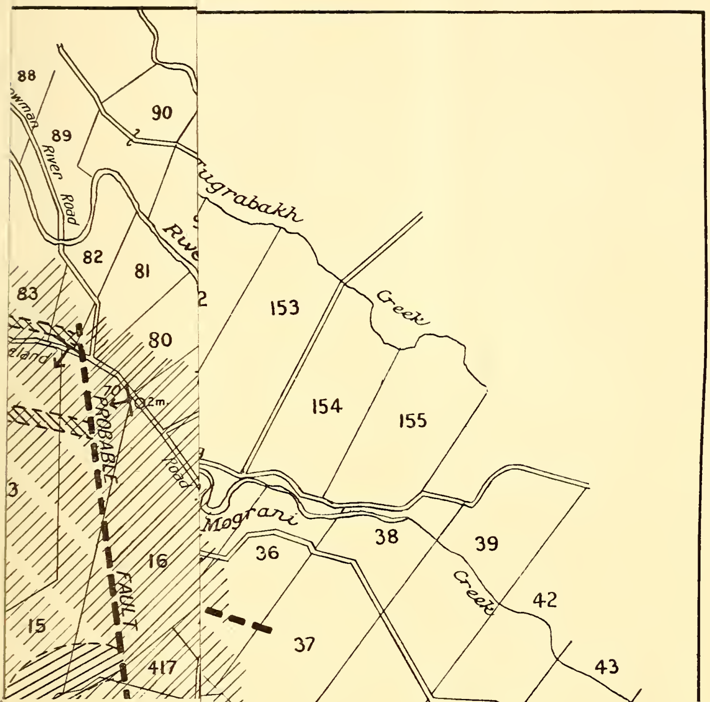
Very little has previously been published about the geology of this district. In 1915, the writer, in company with Professor W. N. Benson, D.Sc., examined the railway cuttings between the Bulliac railway station and the Manning River. A brief note of the observations then

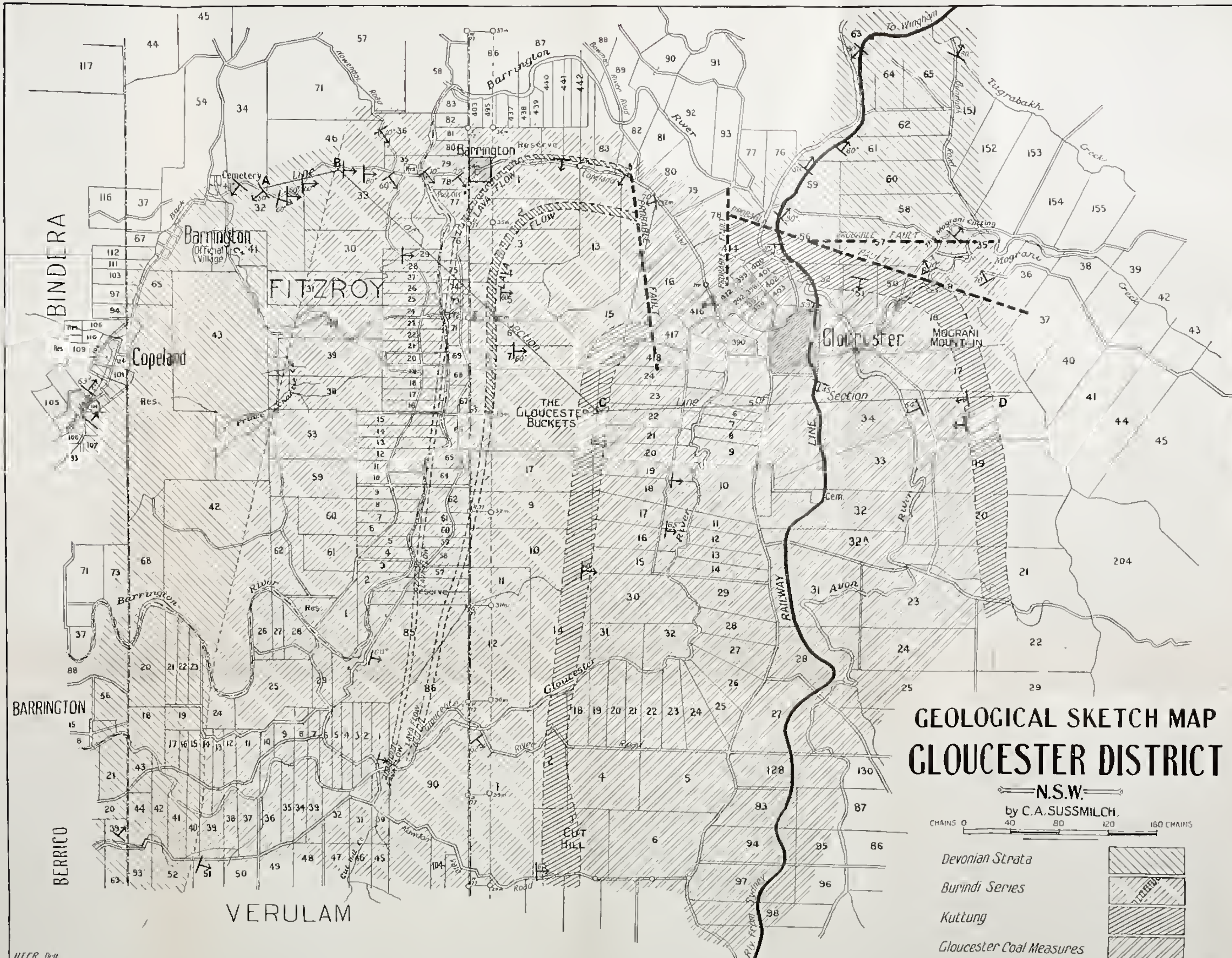


"The Gloucester Buckets"—Carboniferous Rhyolite Flows.



Geological Section along line A B C D on accompany Map, Plate XVIII.


88
90
89
River Road
Tugrabakh
River
Creek
82
81
83
153
80
154
155
PROBABLE
FAULT
Road
Mograni
Creek
36
38
39
16
42
15
37
43
417


GEOLOGICAL SKETCH MAP
GLOUCESTER DISTRICT
N.S.W.
by C.A. SUSSMILCH.
CHAINS 0 40 80 120 160 CHAINS
Devonian Strata
Burindi Series
Kuttung
Gloucester Coal Measures
BINDERA
FITZROY
Barrington
Copeland
Gloucester
MOGRANI MOUNTAIN
THE GLOUCESTER BUCKETS
CUT HILL
BARRINGTON
BERRICO
VERULAM
Barrington River
To Wingham
Tugrabakh
Mograni Creek
Avon River
Gloucester River
RAILWAY LINE
LAVA FLOW
PROBABLE FAULT
Section Line
H.E.C.R. Delt.
112 21

made was contributed to the proceedings of the Geological Section of the Royal Society of New South Wales.[1] Since then, the author has made a number of short field trips to the Gloucester District, mainly for the purpose of working out the succession and thickness of the Carboniferous strata, and their stratigraphical relationship with the underlying Devonian strata. Time did not allow of the making of an accurate detailed geological map, and in the one which accompanies this paper, the boundaries of the various geological formations shown are only approximations. They are, however, sufficiently accurate to reveal the general geological structure of the district. I have to thank Messrs. V. B. Collins, A. F. Newman, and W. Clark for much help in carrying out the field work; and my thanks are due to Mr. W. G. Stone for having kindly made the analyses of the igneous rocks. I have also to thank Prof. Sir Edgeworth David for much kindly advice, when he accompanied me on one of my visits to the district.

Physiography.

The most striking physiographical feature of the district adjoining the town of Gloucester is a majestic group of rocky hills, with precipitous faces, lying to the west of the town, and known as the The Gloucester Buckets. These are made up of Carboniferous lava flows, now tilted on end. Almost equally conspicuous is another rocky range of hills lying to the east of the town, and known as the Mograni Mountain. This, in its geological structure, is similar to the Gloucester Buckets.

The North Coast Railway, from Craven to Gloucester, traverses a relatively low region 300 to 400 feet in altitude, a region about five miles wide and twelve miles long, in a north and south direction. This region has a gently

[1] This Journal, Vol. XLXIX, 1915, Abstract of the Proceedings of the Geological Section, p. xxvii.

undulating surface, but is bounded on both its eastern and western margins by precipitous, rugged ridges ranging up to 2,000 feet in altitude, and striking almost due north and south. These ridges consist of Carboniferous lava flows, whereas the low-lying region in between consists of Permo-Carboniferous Coal Measures. Similar features continue southward from Craven for at least another ten miles. North of Craven this region is drained by the Avon and Gloucester Rivers, as shown on the map in Plate XVIII.

At Gloucester, which lies at the northern end of this region, the lava flows of the eastern range, here known as the Mograni Mountain, swing round to an east and west direction, almost joining on to the western range—the Gloucester Buckets—and almost cutting off the valley of the Avon River at this point.

At first sight, this long, narrow, relatively depressed region might be taken for a rift valley, but a study of the geological structure dispels this view. The Carboniferous and Permo-Carboniferous strata have been folded into a huge synclinal fold, striking north and south. The weak coal-measures which lie in the trough of the fold have been deeply denuded, whereas the Carboniferous lava-flows which flank them on either hand have resisted denudation, and have survived as steep ridges.

In Tertiary times, a peneplain had been developed in this district, and at the end of the Tertiary Period (the Kosciusko Epoch) an elevation of about 2,000 feet took place, converting the peneplain into a tableland. Denudation since then has maturely dissected the tableland; mature valleys have been cut into the weaker geological structures, while the harder, resistant structures still survive as high ridges. The way in which the larger streams cut across the hard and weak structures alike, and the entrenched meanders, notably those of the Barrington River, as well as other features, all suggest that the mainstream channels ante-date the present topography, *i.e.*, they are revived streams.

Some twenty miles to the west of the region here being described lies the Barrington Tableland, 4,000 to 4,500 feet in altitude, its eastern margin being marked by a great fault escarpment. Its surface is part of the same peneplain as that which occurs in the Gloucester District, the two regions being elevated during the same uplift, but while the Gloucester region was uplifted only about 2,000 feet, the region to the west was uplifted 4,500 feet; and the stresses set up as a result of this unequal movement, developed the line (or lines) of faulting which mark the eastern face of the Barrington Tableland.

Geological Formations.

The geological formations represented in the Gloucester District are as follows:—

Post Tertiary	Alluvial Deposits	
Permo-Carboniferous	Gloucester Coal Measures	(? Upper Coal Measures)
Carboniferous	The Kuttung Series	Lava flows, conglomerates mud stones, and tuffs.
	The Burindi Series	Conglomerates, shales, limestones, tuffs, and lava flows.
Devonian	The Barraba Series	Banded shales, mudstones, limestones, and tuffs, with Radiolaria and *Lepidodendron australe*.
	The Tamworth Series	Banded radiolarian cherts intrusive tuffs, and spillite lavas.

A. The Devonian System.

Upon reference to the accompanying map it will be seen that Devonian strata outcrop extensively over the northern and western parts of the area shown. Excellent exposures may be seen in the cuttings along the railway line from Gloucester to the Manning River, starting at a point about one and a quarter miles from the Gloucester Railway Station. The strata in the hills around Copeland are also of Devonian age, and extend eastwards along the Copeland-Gloucester Road to a point about one mile west of the Barrington River Bridge. The whole series is very highly folded, the strata over very large areas being almost vertical; their general strike is about N. 40° West. No attempt has been made to study these Devonian strata in great detail; neither the base nor the top of the formation has been found yet in this district; so that it is impossible to give a complete section here. The main object in studying these beds has been to attempt to work out their stratigraphical relationship with the succeeding Carboniferous formations.

I. *The Tamworth Series.*—These are extensively developed, around the township of Copeland and in the railway cuttings between Gloucester and Bundook. They consist of spillite lavas, tuffs, radiolarian cherts, and mudstones, limestones, and more rarely, quartzites.

(*a*) *The Spillites.*—These do not occur in the immediate neighbourhood of Gloucester but are very extensively developed in the neighbourhood of Bundook. Here they outcrop along the railway line eastwards of Bundook railway station for about two miles. The western end of Kangat Mountain (2,000 feet high) is made up entirely of these lavas. They exhibit in places typical "pillow" structure, and are in places somewhat vesicular. Under the microscope they are seen to contain well-preserved pyroxene and albite felspar. These rocks have undergone a considerable amount of alteration in places, with abundant introduction of quartz and epidote. Similar spillites of Middle Devonian age have already been described in great detail by Prof. W. N. Benson,[1] from the Tamworth-Nundle District, consequently no detailed petrological description will be given here.

[1] Geology and Petrology of the Great Serpentine Belt, Part III, by W. N. Benson, B.A., B.Sc., Proc. Linn. Soc. N.S.W., Vol, XXXVIII, p. 662, 1913.

The width of the outcrop, taken in conjunction with the dip of these spillites in the Bundook neighbourhood, would give a thickness of several thousands of feet for these rocks. Quite probably some strike faulting has taken place, giving duplication of outcrop. Even after allowing for this possibility, their actual thickness must be at least 2,000 to 3,000 feet. Such a great thickness of spillite ("pillow") lavas has not, so far as the writer is aware, been recorded from any other locality; and it at once raises the question as to whether the conditions of deposition usually postulated for such rocks are correct.

(b) *The Tuffs.*—These have a very large development, and are interstratified everywhere throughout this district with the other Devonian sedimentary rocks. They are typically fine-grained in texture, with a greyish-blue colour, and intermediate to subacidic in composition. Both coarser and darker coloured varieties also occur. These tuffs are in general regularly interstratified with the other sedimentary strata, but in many places they are seen to have intrusive relations with the radiolarian cherts and claystones, similar in every way to the intrusive tuffs of the Tamworth District described by Messrs. David and Pittman.[1] Particularly fine examples of these intrusive tuffs can be be obtained from the spoil heaps at the Mountain Maid Mine at Copeland, and excellent examples may also be seen in the railway cuttings between Gloucester and Bundook. The individual layers of tuff vary much in thickness, ranging from less than one inch to upwards of 100 feet in thickness. No really satisfactory explanation of these anomalous "intrusive tuffs" has yet been put forward.

(c) *The Radiolarian Cherts and Claystones.*—These constitute the most abundant of the strata of the Tamworth

[1] "On the Palæozoic Radiolarian Rocks of N.S. Wales, Q.J.G.S., 1899, pp. 16 - 37.

Series, and aggregate several thousands of feet in thickness. They are for the most part well laminated, consisting of alternating lighter and darker layers, the individual laminæ sometimes being very thin; radiolaria are very abundant in some of the layers. Beds of tuff are interstratified with these rocks, and in many places intrude them.

(d) *The Limestones.*—These are not common in this district. The largest bed known to the writer outcrops about four and a half miles N.E. of the town of Gloucester, on the road from that town to Bundook near where it crosses the Tugrabakh Creek. This limestone bed strikes N. 40° E. and stands in a nearly vertical position. It is about 100 feet in width, and is being quarried for use as a flux at the Cockle Creek Smelting Works. This limestone is of good quality, as may be seen from the following analysis:[1]

Calcium Carbonate	98·11%
Magnesium Carbonate	0·49
Ferric Oxide and Alumina	0·80
Gangue	1·09

No recognisable fossils have yet been obtained from this bed of limestone, but it is interstratified with what appear to be, from their petrological character, undoubted Devonian sediments.

(e) *The Quartzites.*—These have been observed only in the Copeland goldfield, where several beds occur, ranging individually up to 10 feet in thickness. One of these was noticed in the underground workings of the Mountain Maid Mine. They are fine-grained.

Fossils.—The only recognisable fossils so far found in the Tamworth Series are radiolaria and stems of the lycopod *Lepidodendron australe.*

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[1] Mineral Resources of New South Wales, No. 25, Department of Mines. The Limestone Deposits of New South Wales, by J. E. Carne.

II. *The Barraba Series.*—The thick series of radiolarian mudstones and tuffs which outcrop on the Gloucester-Copeland road, between the six and seven mile posts, probably belong to this series. They, however, do not make good outcrops, and may possibly be part of the Tamworth Series. They contain abundant radiolaria, while specimens of drift Lepidodendron are not uncommon. Some of the mudstones outcropping on the railway line between Bulliae and Gloucester may also belong to this series.

III. *The Gold Reefs in the Devonian Strata.*—In that part of the district adjacent to the village of Copeland, the Devonian strata are intersected by a number of auriferous reefs. Those examined by the writer, viz., the Mountain Maid reef and Sawyer's reef, strike approximately east and west, and hade to the south.

The reefs are lenticular, varying from 6 to 10 inches in thickness, and the walls display well developed slickensides. The ore consists mainly of quartz, with a little pyrites, and with some angular fragments of country-rock embedded in it in places. The reefs are obviously, therefore, true fissure veins deposited along lines of faulting. The gold occurs in irregular shoots which are sometimes very rich, but which are usually short. These shoots pitch to the east. The gold is free, but the reefs also contain a little auriferous pyrites, and more rarely a little galena. Owing to their small size, and the smallness and irregularity of the shoots, these reefs have not proved very remunerative and not much work is at present being done on them.

B. The Carboniferous System.

The Carboniferous strata occur in the form of a large syncline striking practically due north and south. They are divisible into a lower series of marine origin—the Burindi Series—and an upper series of terrestrial origin—the Kuttung Series. The details of the Carboniferous strata as they occur along the lines B C on the accompanying geological map are as follows :—

The Kuttung Series	The Gloucester Rhyolites ...	1500 feet
	The Rhacopteris Beds	100 ,,
	The Conglomerates	150 ,,
The Burindi Series.	Tuffs and Mudstones (with marine fossils)	3250 ,,
	Productus Barringtonensis Bed...	20 ,,
	Tuffs...	140 ,,
	Quartz Keratophyre(No.3 lava flow)	200 ,,
	Tuffs...	50 ,,
	Quartz Keratophyre(No.2 lava flow)	400 ,,
	Tuffs...	250 ,,
	Marine Mudstones and Tuffs ...	800 ,,
	Oolitic Limestone...	20 ,,
	Mudstone	40 ,,
	Quartz Keratophyre (No. 1 lava flow)	200–400 ,,
	Mudstones	60 ,,
	Conglomerates	150 ,,
	Mudstones and Tuffs	1750 ,,
	Limestone (oolitic in part and tufaceous)	60 ,,
	Mudstones	1900 ,,
	Tuffs...	120 ,,
	Conglomerates	30 ,,
	Mudstones	120 ,,
	Crinoidal Limestone (with Zaphrentis)	80 ,,
	Mudstones and Tuffs	50 ,,
	Conglomerates	20 ,,
	Mudstones	...(?)900 ,,
	Conglomerates	50 ,,
	Total ...	...12410 ,,

The possibility of there being some duplication of strata in the above section has been considered, but no evidence of such being the case has been found.

I. *The Burindi Series.*—The details of this series are shown above. They consist of conglomerates, limestones, mudstones, tuffs, and lava flows, and have a maximum thickness of 10,800 feet. This section has been taken from the valley of the Barrington River, on the western side of the Gloucester Buckets.

(*a*) *The Conglomerates.*—Several beds of conglomerate occur at and near the base of the Burindi Series, ranging individually from 20 to 40 feet in thickness. They contain well waterworn pebbles of quartzite, quartz-porphyry, aplitic-granite, and a dark coloured felspar porphyry; the pebbles ranging up to 12 inches in diameter. A few small pebbles of a cherty rock, not unlike the cherts which occur in the Devonian Series, have also been found. These conglomerates may be seen crossing the Copeland road, about one mile west of the Barrington Bridge, and also along the Nowendoc road, about half a mile north of its junction with the Copeland road. A bed of conglomerate also occurs at the junction of the Copeland and the Bowman River roads. This bed is over 100 feet thick, and contains many large pebbles. Its position is about 5,000 feet above the base of the Burindi Series.

(*b*) *The Mudstones.* —These form the bulk of the Burindi Series, aggregating many thousands of feet in thickness. They are blue-black to greyish-green in colour, very fine grained, and typically thin bedded. Tuffs are frequently interstratified with them. Certain bands contain marine fossils, but these fossiliferous bands appear to be few and far between. The fossils they contain are listed on page 245. At different horizons, fairly abundant fragments of fossil plants are found, including imperfectly preserved stems of Lepidodendron and Archæocalamites. This appears to be drift material.

(*c*) *The Limestones.*—Three distinct limestone horizons occur in this series. The lowest bed, about 80 feet thick, is a coarse, crinoidal limestone, the crinoid stems ranging up to three-quarters of an inch in diameter. It can be seen outcropping on the Nowendoc road, where it immediately underlies a bed of conglomerates. A similar crinoidal limestone outcrops on the stock reserve about two miles out from Gloucester, on the Taree road. Its position here is probably due to faulting. What is probably also the same limestone bed outcrops strongly in Tugrabakh Creek, near Brushy Mountain, about six miles from Gloucester. Here fossil corals *(Zaphrentis)* are associated with the crinoids. The second limestone bed outcrops strongly on the Copeland road, close to its junction with the Nowendoc road (Portions 33 and 35, Parish of Fitzroy). It is a dark, compact limestone, oolitic in places, and apparently devoid of fossils. It is upwards of 60 feet in thickness, and has been observed at intervals for several miles to the south (Port. 29 P. of Fitzroy and Port. 85 P. of Verulan). The third bed of limestone is also oolitic, and has so far yielded no fossils, it outcrops on the Copeland road, half a mile east of Barrington village.

These limestones are for the most part impure, as may be seen from the following analyses. In places they are tuffaceous, and regular bands of lapilli can be seen in them. These analyses have been taken from Mr. J. E. Carne's work on "The Limestones of New South Wales," (Mineral Resources of N. S. Wales, No. 25).

Crinoidal Limestone (No. 1 bed)	$CaCo_3$	$MgCo_3$	F 203 and Al 203	Gangue
Stock Reserve, two miles from Gloucester	79·68	0·97	2·28	15·79
Ditto, ditto	99·17	trace	0·36	0·56
Tugrabakh Creek, 6 miles from Gloucester...	89·30	1·56	1·35	7·75
No. 2 Limestone Bed (Por. 33 35, Parish of Fitzroy) ...	68·81	1·68	1·86	26·34

(*d*) *The Tuffs.*—These are for the most part fine grained, and are interstratified with the mudstones. They have their greatest development in the upper part of the Burindi Series, where they are associated closely with the lava flows, and here they are in some cases fairly coarse. They contain an abundance of quartz and felspar grains, more rarely a little biotite and with occasional fragments of rhyolite.

(*e*) *The Lava Flows.*—Three distinct lava flows have been noted in the Burindi Series, all outcropping in the valley of the Barrington River on the lower north-western and western slopes of the Gloucester Buckets. These lavas are quartz-keratophyres, and are described in detail on page 253. The lowest flow (No. 1) may be seen outcropping on the Copeland road immediately west of its junction with the Bowman River road, from here its outcrop runs just north of and parallel to the Copeland road for over a mile. As the village of Barrington is approached the outcrop swings to the north-west, crosses the road and disappears under the river flats of the Barrington River. Some lava flows outcropping on Portion 57 Parish of Verulam are probably a continuation of this flow. The Nos. 2 and 3 flows, which are higher in the series, outcrop to the south of the Copeland road, and their outcrops follow a similar and parallel course to the No. 1 flow. They have been traced as far south as McCraes farm (Port. 4, A. A. Cos. subdivision). Some similar lava flows which outcrop on the Gloucester River road (Port. 85 Parish of Verulam) are no doubt the southern continuation of these flows.

II. *The Burindi Fossils.*—The following is a list of the fossils so far found in the Burindi Series. Not much attention has been given to the collection of fossils, so that the list given is probably by no means exhaustive:—

Lycopodiales ...	*Lepidodendron* (decorticated stems), (? *L. veltheimiamum*).
Actinozoa ...	*Zaphrentis* sp. ind.

Crinoidea ...	Crinoid stems.
Brachiopoda ...	*Dielasma sacculus.*
	Chonetes c.f. *Hardrensis.*
	Orthis australis.
	Athyris.
	Productus barringtonensis.
	,, *pustulosis.*
	Orthotetes crenistria.
	Spirifera crassa.
	,, sp. ind.
	Reticularia.
Trilobita ...	*Phillipsia* sp. ind.

As is usually the case with the Carboniferous marine fauna in New South Wales, brachiopods largely preponderate, while the individuals are usually quite small. There is, however, one fossil bed on McCrae's farm (Portion 4, A.A. Cos. subdivision), which is crowded with the large brachiopod, *Productus barringtonensis.* The rock is a coarse tuff, 10 to 20 feet thick, and this fossil is the only one found in it.

III. *The Kuttung Series.*—These follow the Burindi Series conformably, and have a total thickness of 1750 feet; they consist mainly of lava flows.

(a) *The Conglomerates.*—These have been taken as the basal beds of the series; they outcrop on the western side of the Gloucester Buckets where they are about 150 feet thick, while the pebbles are small. Further to the south where they cross the Rawdon Vale Road, they are somewhat thicker and the pebbles are coarse averaging from 4 to 6 inches in diameter. These conglomerates are probably the equivalent in this district of the Wallarobba conglomerates previously described for the Wallarobba-Clarencetown district[1] some 50 miles to the south.

[1] Sequence, Glaciation, and Correlation of the Carboniferous Rocks of the Hunter River District, N.S.W., by C. A. Sussmilch and T. W. E. David, this Journal, Vol. LIII, p. 246, 1919.

(b) *The Rhacopteris Beds.*—These are quite thin; they consist of tuffs with some shales, and immediately underlie the Gloucester Buckets rhyolite flows. They contain the following fossil plants:

Fibiales { *Rhacopteris intermedia*
(?) *Aneimites (Rhacopteris) ovata*
Cardiopteris polymorpha
Archæopteris sp. ind.

Equisetales—Calamitean stems.

(c) *The Gloucester Rhyolites.*—These being a very striking development in this district, forming the back-bone of the precipitous ranges which occur both to the east and west of the town. They are particularly well seen in the Gloucester Buckets (see fig.) where they are 1500 feet thick, as also in the Mograni Mountain; good sections may be seen in the railway cuttings immediately north of the railway bridge on the Avon River. A number of flows are included in the above thickness, but they are all very similar in character. This lava is a typical rhyolite, light in colour and frequently with well-marked flow structure. It is described in detail later on.

A comparison of the Kuttung Series of the Gloucester District with that of the Hunter River District some fifty miles to the south reveals the following important differences (*a*) the relatively small thickness of this series in the Gloucester District, as well as the almost entire absence of the conglomerates whose great thickness is such a characteristic feature of the Kuttung Series in the Hunter River area, and (*b*) the apparently entire absence of glacial beds in the Gloucester District. The broad details of the Kuttung Series of the two areas are as follows:

Hunter River District.	Ft. thick.	*Gloucester District.*	Feet.
Seaham Glacial Beds ...	1840	The Gloucester Rhyolites	1500
Paterson Rhyolite ...	300	The Rhacopteris Beds	100
Mount Johnson Beds ...	1950	The Conglomerates ...	150
Martin's Creek Beds ...	2200		
Wallarobba Beds .	2000		
Total ...	8290	Total ...	1750

Several possible explanations for these differences suggest themselves. The Kuttung Series were deposited under terrestrial conditions, and the high land which supplied the sediments may have occurred immediately to the south and south-west of the Hunter River area; if this were so one would expect the thickness of the sedimentation, and particularly of the conglomerates to become proportionally less northwards. On the other hand a considerable thickness of Kuttung strata may have been removed by denudation in the Gloucester District after their deposition and before the Gloucester Coal measures were laid down, as there is a considerable time and interval between the two formations. This might account for the absence of the Glacial Beds and perhaps of the Mount Johnson Beds, but would not account for the absence of the Wallarobba Beds which would normally underlie the rhyolites. These matters cannot, however, be definitely decided until detailed mapping is carried out in the intervening areas.

IV. *Relation of the Carboniferous formation to the Devonian.*—Unfortunately, no actual contacts between the Devonian and Carboniferous strata have been found in this district. In the northern part of the area shown in the map (Plate XVIII) outcrops of the two formations almost come into contact in the railway cuttings a short distance north of the Avon River railway bridge, but this junction is a faulted one, the Tamworth Beds here lying against the Kuttung Series; the whole of the Burindi Series is missing. In the western part of the map (Plate XVIII) a junction of the Devonian and Carboniferous strata is shown running parallel to the Barrington River on its western side, but the position shown is only an approximation. Both the Devonian strata and the lower Burindi Series are weak rocks and give either very poor outcrops or none at all; it is therefore, practically impossible to locate the base of the Carboniferous formation with any degree of certainty. On the Copeland road the base was taken at a bed of conglomerate which crosses the road about one mile west of the Barrington Bridge. Notwithstanding this absence of direct evidence there are some facts which suggest the evidence of an unconformity between the two formations. This evidence is as follows:

1. *The very general difference between the strike of the two formations.*—The strike of the Devonian strata in the area examined varies from due north to north 60° west, the great majority of the readings, however, are in the neighbourhood of north 40° west. The angle of dip is very high, in many places quite vertical. The Devonian strata therefore, have been strongly folded, the axis of folding being about north 40° west. The Carboniferous strata are also highly folded, also approaching the vertical in places, but are not so steep on the average as the Devonian strata. In the district under consideration they have been folded into a huge syncline whose axis strikes practically north and south; the axis of this syncline is opposed to the Devonian lines of folding.

2. *Nature of the strata of the two formations.*—The nature of the Devonian sediments indicates quiet deposition in moderately deep water in a locality far removed from a shore line; there is an entire absence of littoral deposits, and also an absence of a coastal marine fauna. It is true that a terrestrial plant *(Lepidodendron australe)* is fairly common, but this plant is represented by relatively large stems only, which might have drifted long distances from land, before sinking and becoming buried in the Devonian sediments. The Burindi strata on the other hand include such littoral sediments as conglomerates and oolitic limestones, while some of the mudstones and tuffs contain fossils of a coastal marine fauna. It is true that there is a notable absence of sandstone, although some sandy-shales occur,

but this could be due to the nature of the rocks on the land which was being denuded to provide the sediments. If this land consisted largely of Devonian strata the sediments found in the Burindi Series are just what one might expect to find.

3. *Comparison of the Devonian and Carboniferous marine fauna.*—No marine fossils of Devonian age, other than radiolaria have been found in this district, but the Devonian marine fauna from adjoining parts of north-eastern New South Wales is well known. Very few Devonian species have passed upwards into the Carboniferous Period, neither did many of the genera. No passage beds have yet been found. Taking all of the facts into consideration, it may be said that while no angular unconformity has been proved, there is certainly a strong disconformity between the strata of the two periods, and that important crustal movements occurred at the close of the Devonian Period.

C. The Gloucester Coal Measures.

These coal-measures, besides occurring over the area shown on the map, extend southwards past the village of Craven, down the valley of Ward's River to within a few miles of Stroud Road. This southern area has sometimes been referred to as the Ward's River Coal Measures. It will be seen that this coal basin is about 35 miles long, and from five to eight miles wide. No detailed surveys have yet been made of this little known coal basin, and the author himself has made only a cursory examination of the measures in the immediate neighbourhood of Gloucester. Here they consist of shales, sandstones, grits, conglomerates, and coal-seams totalling upwards of 1,000 feet in thickness. A fairly good section of these strata may be seen in the railway cuttings immediately to the north and south of the Gloucester railway station. In the cutting to the north of the railway station numerous coal seams are exposed, with an aggregate thickness of at least 50 feet of coal, and dipping South 30° W., at an angle of 57°.

A shaft has been sunk near Gloucester on one of these seams, near the bank of the Avon River, about one and a quarter miles west of the railway line. This shaft has penetrated a coal-seam 31 feet in thickness. This seam contains several well marked bands of shale, ranging individually up to 10 inches in thickness, and aggregating 4½ feet in thickness, there being 26½ feet of clean coal. An analysis of this coal, made in the Mines Department Laboratory, was as follows:—

Water	1·35	per cent.
Volatile Hydrocarbons	33·92	,,
Fixed Carbon	55·54	,,
Ash	9·19	,,
Total	100·00	

Sulphur ·754

Water converted into steam by 1 lb of coal at 212° F., 13·2

Specific gravity 1·307

Calories 7088

B.T.U. 12·964

The sample from which this analysis was made is said to have been taken across the full width of the seam, but excluding the bands. Good thicknesses of clean coal occur between the bands. The seam here strikes north and south and dips west at an angle of 64°. On the western side of the Gloucester River, however, the coal measures strike north and south, and dip east at about the same angle. From these dips, taken in conjunction with those in the railway cuttings at Gloucester railway station, it would appear that the coal seams, like the surrounding Carboniferous strata, occur in the form of a plunging syncline.

There is an interesting occurrence of these coal measures on Portion 81 close to the junction of the Copeland and Bowman River roads. Here, where they have been brought into direct contact with the middle part of the Burindi Series by faulting, they appear to dip under the Burindi Beds.

I. *Age of the Coal Measures.*—These coal measures contain an abundance of the fossil plant Glossopteris: they are obviously, therefore, of Permo-Carboniferous age. The composition of the coal given in the above analysis is very like that of the Borehole Seam in the Newcastle Coal Measures. The grits and conglomerates associated with the coal measures are very like those of Fassifern, in the Newcastle District. These facts, taken into conjunction with the thickness of the strata (1,000 feet or more), would indicate that these coal measures belong to the Upper or Newcastle Coal Measures, rather than with the Lower or Greta Coal Measures. This basin would appear to be a continuation of that shown by Prof. Sir Edgeworth David to extend northward from the Hunter River District towards Stroud. The two basins were, no doubt, at one time continuous, but have been isolated by folding and subsequent denudation.

II. *Stratigraphical relation to the Kuttung Series:*—If the above conclusion that the Gloucester Coal Measures are the equivalent of the Newcastle or Upper Coal Measures is correct, then the whole of the remaining subdivisions of of the Permo-Carboniferous formations totalling upwards of 10,000 feet are missing in the Gloucester District. If, however, it should be that they are the equivalent of the Greta or Lower Coal Measures, then only the Lower Marine Series would be missing, these latter in the Hunter River District are 4,600 feet in thickness. In either case, therefore, a thick series of strata is missing from between the

Kuttung Series and the Gloucester Coal Measures, and there is therefore a strong disconformity between the two series. The Gloucester Coal Measures, so far as the author's observations have gone, appear, except where they have been interfered with by faulting, to conform to the dip and strike of the Kuttung Series and to form part of the same great synclinal fold. It would appear to be the case, therefore, that the folding which produced this syncline took place after the Gloucester Coal Measures were laid down, *i.e.*, at the end of the Palæozoic Era.

Petrology and Rock Analyses.

A. The Volcanic Rocks.

Lava flows occur in the Carboniferous System in the Gloucester rocks, both in the Burindi Series and in the Kuttung Series.

(a) *The Burindi Lava Flows.*—Three lava flows occur in this series, they are all similar to one another in general characters, and are quartz keratophyres.

No. 1 *Flow.*—This rock in the hand specimen is light-coloured and aphanitic with moderately abundant phenocrysts of felspar; in places, however, the rock is quite glassy, and when so is almost black in colour. Under the microscope the groundmass varies from cryptocrystalline to glassy, and in the glassy examples there is an abundance of small rod-like microlites, frequently grouped into stellite aggregates. The phenocrysts consist almost entirely of felspars, a few of these are orthoclase, but the great majority are plagioclase, all are much corroded. The optical character of the plagioclase indicates a variety close to albite. An occasional small phenocryst of a pale green pyroxene is seen, which appears to be diopside, but is too much altered for accurate determination. Occasional small crystals of titaniferous magnetite also occur; inclusions of this mineral are abundant in the few pyroxene crystals.

Chemical Composition.

	Per cent.		Per cent.
SiO_2	69·82	SO_3	absent
Al_2O_3 ...	12·41	Cl	trace
Fe_2O_3 ...	1·10	S (FeSr) ...	absent
FeO	0·54	Cr_2O_3 ...	absent
MgO	0·29	NiO and CoO	absent
CaO	1·86	MnO	0·03
Na_2O ...	4·63	BaO	0·02
K_2O	1·67	SrO	trace
H_2O (100° C.)	1·05	LiO_2	absent
H_2O (100° C.) +	6·55	V_2O_5	absent
CO_2	0·03		
ZrO_2	0·25	Total ...	100·30
P_2O_5	0·05		
		Specific gravity	2·266

Norm.

Quartz ...	32·46
Orthoclase ...	10·01
Albite ...	38·77
Anorthite ...	8·34
Diopside ...	0·65
Hypersthene...	0·40
Magnetite ...	0·93
Ilmenite ...	0·46
Hematite ...	0·48

Classification.

Class I. Persalane
Order 4 Britannare
Rang 2 Toxanase
Sub-rang 4 Lassenose
Magmatic name *Lassenose.*

The specimen taken for analysis was the glassy variety as this appeared to be the freshest. It will be seen that nearly 90% of this rock consists of quartz and felspar molecules, and that of the latter the albite molecules largely predominate. For a field name quartz keratophyre would appear to be that most suitable.

No. 2 Flow.—This rock in the hand specimen is typically pink in colour, is aphanitic, and usually markedly porphyritic, displaying an abundance of small red phenocrysts of felspar, with a variable number of small quartz phenocrysts. Under the microscope the groundmass varies from crypto-crystalline to glassy, spherulitic structure is commonly present. The quartz phenocrysts are strongly corroded as also are the felspars. Most of the felspar phenocrysts are albite, but some orthoclase phenocrysts also occur. The only ferro-magnesian mineral found is an occasional small phenocryst of a pale green hornblende.

Chemical Composition.

SiO_2	74·56	SO_3	absent
Al_2O_3 ...	12·87	Cl	trace*
Fe_2O_3 ...	1·80	S (FeSr) ..	absent
FeO	0·36	Cr_2O_3 ...	absent
MgO	0·29	NiO and CoO	absent
CaO	0·28	MnO	0·03
Na_2O ...	4·91	BaO	0·04
K_2O	3·43	SrO	trace*
H_2O (100° C.)	0·35	LiO_2	absent
H_2O (100° C.)+	0·91	V_2O_5... ...	absent
CO_2	0·01		
TiO_2	0·40	Total ...	100·28
ZrO_2	absent		
P_2O_5... ...	0·04	Specific gravity	2·622

Norm.

Quartz ...	32·16
Orthoclase ...	20·02
Albite ...	41·39
Anorthite ...	1·39
Corundum ...	0·61
Hypersthene...	0·70
Ilmenite ...	0·76
Hematite ...	1·76

Classification.

Class I. Persalane.
Order 4 Britannare
Rang 1 Liparose
Sub-rang 4 Kallerudose
Magmatic name *Kallerudose*

It will be seen that this rock is not very different from the No. 1 Flow, differing mainly in containing a larger proportion of orthoclase, which however, is still subordinate to the albite. The same field name viz: quartz keratophyre is suggested.

No. 3 Flow.—This rock both in the hand specimen and under the microscope is so similar to the No. 2 Flow that a separate description is unnecessary. It also is a quartz keratophyre. No chemical analysis of this rock has been made.

(b) *The Kuttung Lava Flows.*—These form a thick series ranging up to a maximum thickness of 1,500 feet. This thickness undoubtedly represents many distinct lava flows, but as they are all very uniform in character one general description will serve for all.

In the hand specimen the rock is typically light-coloured, generally greyish-white to cream coloured, where the rock is more decomposed, as for example in the railway cuttings just north of the Avon River bridge, the colour may be greenish or reddish-brown. Flow structure is in many places strongly developed, and in places also a certain amount of contemporaneous brecciation has taken place, just as is the case in similar lava at Pokolbin. The presence of phenocrysts is rare, and when they are present they usually consist of felspar and are small and few in number.

Under the microscope the rock is glassy to cryptocrystalline, flow structure is commonly present, as also is spherulitic structure; the spherulites are small and rarely visible in the hand specimens. Occasional small crystals of plagioclase felspar are seen in most slides; these are usually too much altered to admit of accurate determination by their optical characters, but these characters, as far as they go indicate a felspar close to albite. More rarely small crystals of quartz and orthoclase are seen. All the phenocrysts are much corroded. No ferro-magnesian minerals have been detected, but occasional small patches of chloritic mineral may represent small one-time ferro-magnesian minerals; the total amount of such material is however very small. The chemical analysis given here was made from a specimen obtained in the Gap about a quarter of a mile south of the Gloucester Trig. Station, and from near the top of the Kuttung Series.

Chemical Composition.

SiO_2	77·76	SO_3	absent
Al_2O_3 ...	9·94	Cl	trace*
Fe_2O_3 ...	1·15	S (FeS_2) ...	absent
FeO	0·59	Ca_2O_3 ...	absent
MgO	0·18	NiO and CoO	absent
CaO	0·24	MnO	0·02
Na_2O... ...	0·86	BaO	0·02
K_2O	7·75	SrO	trace*
H_2O (100° C.)	0·38	LiO_2	absent
H_2O (100° C. +)	1·00	V_2O_5 ...	absent
CO_2	0·30		
TiO_2	0·15	Total ...	100·10
Zr_2O_3 ...	absent		
P_2O_5... ...	0·03	Specific gravity	2·582

Norm.		*Classification.*
Quartz ...	42·60	Class I. Persalane
Orthoclase ...	45·59	Order 3 Columbare
Albite ...	7·34	Rang 1 Alaskase
Anorthite	0·28	Sub-rang 2 Magdeburgose
Diopside ...	0·86	Magmatic name *Magdeburgose*
Magnetite ...	1·39	
Ilmenite ...	0·30	
Hematite ...	0·16	

This rock is obviously a typical potash rhyolite and contains nearly 96% of salic molecules. In the table of rock analyses on page 261 analyses of Kuttung lava flows from Mount Bright near Pokolbin and from Paddy's Hill near

Raymond Terrace are included for comparison. A comparison of the norms of these two rocks with that of the Gloucester Buckets is as follows:—

	Gloucester Buckets, *Gloucester.*		Mount Bright,[1] *Pokolbin.*		Paddy's Hill, *Raymond Terrace.*
Quartz ...	42·60	...	44·0	...	31·1
Orthoclase ...	45·59	...	42·8	...	3·3
Albite ...	7·34	...	7·3	...	53·2
Anorthite ...	0·28	...	1·1	...	1·7
Corundum ...	—	...	1·8	...	1·7
Diopside ...	0·86	...	0·9	...	—
Hypersthene	—	...	0·1	...	0·9
Magnetite ...	1·39	...	0·2	...	0·6
Ilmenite ...	0·30	...	—	...	—
Hematite ...	0·16	...	—	...	0·2
Magmatic name	Magdeburgose		Magdeburgose		Westphalose

Both these rocks occur on about the same horizon in the Kuttung Series as the Gloucester rhyolite. It will be seen that the rock for Mount Bright is practically identical with that for the Gloucester Buckets although these two localities are about 70 miles apart. The rock from Paddy's Hill on the other hand differs from the first two in being very rich in potash and correspondingly poor in soda.

B. The Intrusive Rocks.

Some dolerite dykes have been noticed intruding both the Devonian and Carboniferous strata, but these were too decomposed for petrological description. One very interesting (?) intrusive rock was found however, which merits description. This was found associated with the Gloucester rhyolites in the Gap, a valley cut through the Gloucester Buckets Range about a quarter of a mile south of the Gloucester Bucket Trig. Station. It cannot yet be definitely

[1] The Geology of the Eruptive Rocks of Pokolbin N.S.W., by W. R. Browne and A. B. Walkom. This Journal, Vol. xlv, 1911, p. 379 – 407.

stated whether this rock is really intrusive or whether it is a contemporaneous flow, as the field evidence was quite unsatisfactory so far as it was investigated, but it appeared to be an intrusive sill occurring about 500 feet below the top of the Gloucester Buckets rhyolite flows.

In the hand specimens this rock is a fairly dark-coloured compact aphanitic rock, showing under the pocket lens occasional small phenocrysts. Under the microscope the groundmass is seen to be crystalline to microcystalline, and to consist of a felted mass of very small laths of felspar; these felspar laths were too small for optical determination but appeared to be for the most part a plagioclase felspar. A few small phenocrysts of a plagioclase felspar are embedded in this groundmass, but were too much altered for specific determination. These felspar phenocrysts are strikingly marked by zonally arranged iron-oxide inclusions at or near the outer margin of the crystals. There also appears to be a considerable quantity of minute grains of iron oxide scattered through the groundmass.

Chemical Composition.

SiO_2	55·64	SO_3	trace
Al_2O_3 ...	17·70	Cl	absent
Fe_2O_3 ...	7·85	S (FeS_2) ...	absent
FeO	1·75	Cr_2O_3 ...	0·01
MgO	1·46	NiO and CoO	absent
CaO	1·31	MnO	0·25
Na_2O... ...	8·51	BaO	0·01
K_2O	1·20	SrO	trace*
H_2O (100° C.)	0·72	LiO_2	absent
H_2O (100° C. +)	2·24	V_2O_5 ...	trace
CO_2	0·04		
TiO_2	1·45	Total ...	100·25
ZrO_2	—		
P_2O_5... ...	0·11	Specific gravity	2·721

Norm.			*Classification.*
Orthoclase	...	7·23	Class II Dosalane
Albite	...	67·59	Order 5 Germanare
Anorthite	...	5·56	Rang 2 Monzonose
Nephelite	...	2·27	Sub-rang 5 ×
Corundum	...	0·41	
Olivine	...	2·52	
Magnetite	...	2·32	
Ilmenite	...	2·74	
Hematite	...	6·24	
Apatite	...	0·34	

This rock differs strikingly from the Gloucester Buckets rhyolite, first in its very high soda content and corresponding low potash content, and second in the large proportion of iron oxides, particularly hematite. Some nephelite is shown in the "norm," but none of this mineral has been seen in the rock slides. The amount of hematite shown in the "norm" is somewhat unusual, and this probably represents altered magnetite, but owing to the very fine grained texture of the rock this point could not be readily investigated. This magma is evidently a somewhat uncommon one as no magnetic name for this type appears in the quantitative classification table. If no name has yet been applied to this type of magma the writer would suggest that of Gloucesterose.

I. No. 1 Flow, Burindi Series, Analyst W. G. Stone.

II. No. 2 Flow, Burindi Series, Analyst W. G. Stone.

III. Gloucester rhyolite, Kuttung Series, Analyst W. G. Stone.

IV. Rhyolite, Mount Bright, Pokolbin, Analyst J. C. H. Mingaye.

V. Rhyolite, Paddy's Hill, Raymond Terrace, Analyst W. J. Greig.

VI. Keratophyre, The Gap, Gloucester Buckets, Analyst W. G Stone.

Table of Analyses.

	I.	II.	III.	IV.	V.	VI.
SiO_2	69·82	74·56	77·76	77·82	75·06	55·64
Al_2O_3	12·41	12·87	9·94	11·46	14·21	17·70
Fe_2O_3	1·10	1·80	1·15	0·30	1·31	7·85
FeO	0·54	0·36	0·59	0·09	0·27	1·75
MgO	0·29	0·29	0·18	0·23	0·09	1·46
CaO	1·86	0·28	0·24	0·22	0·42	1·31
Na_2O	4·63	4·91	0·86	0·86	6·88	8·51
K_2O	1·67	3·43	7·75	7·19	0·58	1·20
H_2O (100°C.) ...	1·05	0·35	0·38	0·36	0·56	0·72
H_2O (100°C. +)...	6·55	0·91	1·00	1·40	0·62	2·24
CO_2	0·03	0·01	0·03	0·03	—	0·04
TiO_2	0·25	0·40	0·15	0·02	absent	1·45
ZrO	—	absent	absent	—	—	—
P_2O_5	0·05	0·04	0·03	0·04	0·03	0·11
SO_3	absent	absent	absent	0·07	0·11	trace
Cl	trace*	trace*	trace*	—	—	trace
S (FeS_2)... ...	absent	absent	absent	—	—	absent
Cr_2O_3	absent	absent	absent	—	—	0·01
NaO and CoO ..	trace*	absent	absent	—	—	absent
MnO	0·03	0 03	0·02	trace	0·04	0·25
BaO	0·02	0·04	0 02	0·02	—	0·01
SrO	trace†	trace†	trace†	—	—	trace†
LiO_2	absent	absent	absent	trace	absent	absent
V_2O_5	absent	absent	absent	—	absent	trace
Total... ...	100·30	100·28	100·10	100·11	100·18	100·25
Specific gravity ...	2·266	2·622	2·582	—	2·604	2·721

* Less than 0·01% † Spectroscopic reaction only.

Summary.

The Devonian strata which occur in the Gloucester District are similar to those already described from other parts of north-eastern New South Wales by Prof. W. N. Benson, they indicate the deposition of very fine sediments, together with enormous numbers of silicious radiolarian skeletons upon a sea bottom, which may have been fairly deep and was far removed from any shoreline; sub-marine volcanic activity was a pronounced feature during this period. Important crustal movement took place throughout the greater part of New South Wales at the close of the

Devonian Period (The Kanimbla Epoch) and coverted the greater part of this State into dry land; just how far these movements affected the Devonian sediments in the Gloucester District is not yet quite clear, but there is some reason for believing that they were folded and uplifted.

In Lower Carboniferous time (The Burindi Epoch) the Gloucester District was again under marine conditions, but the water was then undoubtedly shallow and not very far removed from a shore-line, as evidenced by the beds of coarse conglomerate which were deposited. A shallow water marine fauna, consisting mainly of brachiopods, trilobites, corals and crinoids, inhabited this sea. The sea floor was slowly subsiding, and upon it was deposited a a great thickness of mudstones, tuffs, limestones and conglomerates, while at times volcanic eruptions resulted in the pouring out of thick lava flows (keratophyres) over the sea bottom.

The long continued subsidence of the Burindi Epoch was finally interrupted by an upward movement, which did not fold the Burindi sediments, but elevated the region into dry land and ushered in the Kuttung Epoch. This new epoch was marked in this district mainly by intense volcanic activity and the pouring out of a thick series of lava flows (rhyolites). From here on there is a considerable gap in the geological record; just what happened is not yet clear, but apparently terrestrial conditions continued, and there may have been considerable removal of the Kuttung Series by sub-ærial denudation. Towards the close of the Permo-Carboniferous Period (the Upper Coal Measure Epoch) part of an extensive freshwater lake covered the Gloucester District, and on the slowly subsiding floor of this lake a thick series of shales, sandstones, conglomerates and coal seams was deposited.

The close of the Palæozoic Era was marked by orogenic earth movements on a grand scale, both the Carboniferous and Permo-Carboniferous strata were strongly folded and a series of high mountain ranges produced.

THE PREPARATION OF CERTAIN FERRIOXALATES.

By G. J. BURROWS and E. E. TURNER.

[*Read before the Royal Society of N. S. Wales, December 7, 1921.*]

SALTS of ferrioxalic acid have generally been prepared by dissolving ferric hydroxide in the required acid oxalate. Whereas the alkali salts are extremely soluble in water, the barium salt is only sparingly so, and this fact suggested a rapid method of obtaining these salts in a pure state, starting from either ferric sulphate or ferric alum. With ferric sulphate as the starting point, barium ferrioxalate is readily obtained by heating in aqueous solution, the calculated quantities of ferric sulphate barium hydroxide, and oxalic acid, and extracting the barium ferrioxalate with boiling water. The salt obtained in this way crystallised in slender pale green needles, and on analysis gave the following results:—

Found: Ba 32·5, Fe 9·02, C_2O_4 41·7 per cent.

$Ba_3[Fe(C_2O_4)_3]_2\ 12H_2O$ requires: Ba 32·4, Fe 8·84, C_2O_4 41·7 per cent.

Hydrates of this compound containing seven, twenty-one, and twenty-two molecules of water have been previously described by various authors.

The barium salt was also obtained in a similar manner from ferric ammonium sulphate. In this case, in addition to the normal barium salt, a barium ammonium ferrioxalate was also obtained by the spontaneous evaporation of the filtrate from the barium salt. In solubility it is intermediate between the barium and ammonium salts, and crystallises in bright green prisms which gave the following results on analysis:—

Found: Ba 26·0, Fe 10·6, C_2O_4 49·6 per cent.

$NH_4Ba[Fe(C_2O_4)_3]$, 3 H_2O requires: Ba 26·0, Fe 10·6, C_2O_4 49·9 per cent.

The sodium, potassium, and ammonium salts are readily obtained from the barium salt by treating the latter with the appropriate sulphate, and were found to crystallise with five, three, and three molecules of water respectively.

The salts of ferrioxalic acid are green in colour, and with the exception of the barium salt are very soluble in water giving solutions which are quite stable in the dark. On exposure to bright light these salts, even in the dry state, are decomposed giving amongst other products, ferrous oxalate. In addition to these salts, iron gives rise to another series of oxalate derivatives, the ferro-oxalates, which are characterised by a yellowish colour both in solution and in the solid state. In this connection, it is interesting to note that ferrous oxalate, unlike most ferrous salts, is yellow in colour, and although insoluble in water, the solution formed by treatment with dilute sulphuric acid is yellow, similar to that of the ordinary $Fe(C_2O_4)''_2$ ion, the depth of colour increasing as the solution is gradually neutralised by ammonium hydroxide or other alkali. This suggests the possibility that so-called ferrous oxalate is not a simple salt, FeC_2O_4 2 H_2O, but probably a ferrous ferro-oxalate, $Fe[Fe(C_2O_4)]$, 4 H_2O.

Barium ferrioxalate was used as the starting point for obtaining certain alkaloid salts whose preparation was undertaken with the intention of endeavouring to resolve a ferrioxalate into its active components. Although satisfactory results were not obtained in this connection, it is interesting to note that since the completion of this work this resolution has been effected through the phenyl ethyl ammonium salt (Thomas, J.C.S. 1921, *119*, 1140), this worker having failed to effect a resolution through the strychnine and brucine salts, as was also the experience of the authors of this communication.

Cinchonine ferrioxalate was prepared by treating the barium salt with (the calculated quantity of) sulphuric acid in dilute solution, and adding the required amount of cinchone. On cooling, a yellowish-green gum separated which later on set solid. The product so obtained dissolved only to a small extent in boiling water, but crystallisation was effected by slowly cooling such a solution, traces of alcohol being added from time to time to prevent the separation of oil. The salt is much more soluble in dilute alcohol than in water. Obtained in this way it crystallises in pale green needles, and can be recrystallised from aqueous alcohol.

Found: Fe 4·24, 4·28. $(C_{19}H_{22}ON_2)_3\ H_3[Fe(C_2O_4)_3], 6\ H_2O$ requires Fe = 4·27 per cent.

The strychnine salt was prepared in a similar manner and was obtained as pale green leaflets.

Found: Fe 3·54, H_2O 14·2 per cent.
$(C_{21}H_{22}O_2\ N_2)_3\ H_3[Fe(C_2O_4)_3]$, 12 H_2O requires Fe 3·63, H_2O 14·1 per cent.

The salt was recrystallised repeatedly from aqueous alcohol. Its insolubility at room temperature rendered a measurement of the optical rotation impossible. The last fraction was therefore converted into the potassium salt by treatment with potassium iodide, but was found on examination to be optically inactive.

The University, Sydney.

ON AN ADDITIONAL BLUE-LEAF STRINGYBARK.

By J. H. MAIDEN, I.S.O., F.R.S., F.L.S.

[*Read before the Royal Society of N. S. Wales, December 7, 1921.*]

E. AGGLOMERATA n. sp.

Arbor mediocris "Stringybark" vocata, ligno pallido durabili; foliis junioribus primum leniter tomentosis deinde hispidis pilis stellatis, sessilibus vel breviter petiolatis, ovatis, marginibus undulatis, venis secundariis tenuibus, venis periphericis margine leniter remotis. Foliis maturis lanceolatis, falcatis, sub-obliquis, petiolatis, crassiusculis, foliis novellis argenteis vel cæsiis; venis patentibus, venis secundariis angulum circiter 30° costa formantibus alabastris angustis, rotundatis, stellatis, in pedunculo applanato; operculo calycis tubum plus dimidio æquante; fructibus parvis compresso-spheroidibus, ad 9 in capitulo, orificio parvo margine nitente, valvis depressis vel interdum leniter exsertis.

The name *agglomerata* refers to the crowded heads of fruits, and was first used by me in connection with this plant (as a variety of *E. eugenioides*) in Agric. Gaz. N.S.W., VII, 268 (1896), subsequently in Proc. Linn. Soc. N.S.W., XXI, 806 (1896). I then dealt with it under *E. capitellata* in my "Critical Revision," Part VIII, p. 215, and in the same work, Part XLV, p. 151, under *E. Blaxlandi*, and the tree has now reached its true position.

Illustrations.—It has been figured as regards juvenile leaves and fruits, at 6a and 6b of Plate 38, Part VIII of my "Critical Revision," and it will be additionally illustrated in that work.

A well-shaped tree of 50—80 feet, and 4—6 feet in diameter at 3 feet from the ground. A Stringybark. The timber pale brown, reddish towards the centre, of high repute for durability. The whole plant has a somewhat strong peppermint-like odour.

Juvenile leaves.—Only the first two or three pairs opposite, at first softly tomentose with stellate hairs, eventually becoming markedly hispid on both surfaces; sessile to shortly petiolate, ovate, acute, paler on the lower surface, the margins undulate; secondary veins fine, looping and forming a moderately distant intramarginal vein; 4 – 7 cm. long, 2 – 4 cm. broad.

Intermediate leaves alternate, smooth, from paler beneath to dark green on both surfaces, narrow lanceolate to broadly, and obliquely lanceolate, the apex mucronate to shortly acuminate, 5 – 8 cm. long, 2 – 4 cm. broad.

Mature leaves lanceolate, falcate, attenuate, somewhat oblique, occasionally oblong lanceolate, from 10 – 15 cm. long, and 2 to 3½ cm. broad; petiolate, thickish, equally green on both sides, but particularly in the upper part of the tree, having a steel-grey or "silver-leaf" cast, hence the vernacular name. Venation spreading, the secondary veins making an angle of about 30° with the midrib, the intramarginal vein not close to the edge.

Flowers.—Buds narrow, rounded, or only very slightly angled, stellately arranged, pinkish or brownish at the base when fresh, up to 14 in the head, sessile or nearly so, on an elongated flattened peduncle. Operculum pointed, more than half the length of the calyx-tube.

Fruits small, under 8 mm. in greatest diameter, compressed spheroid, with a comparatively small orifice, the rim shining, reddish-brown, the valves well sunk, or sometimes very slightly exsert; up to 9 in a dense head.

Range.

Type from Hill Top, New South Wales (J.H.M., January, 1896).

In Part XLV, p. 151, (under *E. Blaxlandi*) the following specimens should be referred to *E. agglomerata*:—

Waterfall (with *E. capitellata*), Woronora, Hill Top, Berrima, Berrima on Mittagong Road, Wombeyan Caves, Taralga Road (with slightly exsert valves); (ibid., p. 152), Goulburn, near Goulburn, Eden, Popran, Yarramalong, near Booral.

In addition to the above, the following are new records: "Blue-leaved Stringbark," Cut Hill, Mittagong (D. W. Shiress). "Blue-leaved Stringy Bark, sometimes up to 5 feet in diameter. About 12 miles west of Sutton Forest, towards Arthursleigh," (R. H. Cambage, No. 4349). "White Stringybark."—Tall trees, white bark, good timber, leaves bluish tint, easily determined from "red" (Stringybark) in the bush by the more robust growth." Nye's Hill, Wingello (J. L. Boorman, August, 1899). Same locality (J.H.M. and J. L. Boorman, September, 1899), when I determined it "*E. capitellata*, small fruited form."

Nelligen (J. L. Boorman, June, 1906), "The most useful of all the Stringybarks, being cut for all purposes, especially for weatherboards and fencing. Attains large size and height." Clyde. near Nelligen (J. L. Boorman, March, 1909); "On a sedimentary deposit at about 900 feet, a few miles east from between Nelligen and Reidsdale. Locally known as Stringy bark" (F. W. Wakefield, No. 27, 1918).

Summing up these records, the species is at present known only from the coastal districts and coastal tablelands of New South Wales, from Booral (Port Stephens district) southward to the Victorian border. It can be confidently predicted to occur in Gippsland, Victoria, and to occur much further north in New South Wales.

Affinities.

It may be compared with certain other Stringybarks as follows:—

1. With *E. Blaxlandi* Maiden and Cambage. In the early juvenile leaves, which are rather larger in *E. agglomerata*, and in the stellate buds and smaller closely capitate fruits. The buds of *E. Blaxlandi* are clavate. In outward appearance both species have much in common.

2. With *E. capitellata* Sm. *E. agglomerata* appears to differ in the following characters:—

(i.) Smaller and more stellate juvenile leaves, the margins of which are undulate or crenulate. They are also less cordate. They appear to be intermediate between those of *E. Blaxlandi* and *E. capitellata*, *i.e.*, larger than the former, smaller than the latter.

(ii.) In the *E. eugenioides*-like buds, with its longer operculum.

(iii.) In the smaller and more contracted fruits.

3. With *E. eugenioides* Sieb. The juvenile leaves are intermediate between *E. eugenioides* (which have the narrowest of the Stringybarks) and *E. Blaxlandi*, but nearer the latter, and considerably smaller than those of *E. capitellata*. The buds more closely resemble those of *E. eugenioides* than those of *E. capitellata*. They are stellate like the former.

In the type locality, *E. eugenioides* grows in flatter country.

4. With *E. lævopinea* R. T. Baker. They are both Blue-leaf Stringybarks. With *E. lævopinea* the affinity is not quite so close as in the three preceding species, nevertheless, the general facies of *E. lævopinea* is reflected in the essential morphological characters of the new species, with varying degrees of similarity. For example, at one stage, the buds of *E. lævopinea* are between stellate and clavate, while the fruits, though invariably rounded, vary from truncate to domed with slightly exsert valves, but, at the same time showing a tendency towards abbreviated and elongated pedicels. The juvenile leaves too, though not conspicuously stellate, as in *E. agglomerata*, are inclined to broadness.

THE ESSENTIAL OIL OF THE LEAVES OF *DORYPHORA SASSAFRAS* (ENDLICHER). PART I.

By A. R. PENFOLD, F.C.S.
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[*Read before the Royal Society of N. S. Wales, December 7, 1921.*]

THE Botany of this tree is described by Endlicher, (Iconogr. t. 10), in "Flora Australiensis, Vol. v, page 283, and also Maiden's "Forest Flora of New South Wales," Vol. I, page 42. It is the well known Sassafras tree of New South Wales found growing in the good soil of the gullies of the brushes of this State, extending from the south of Queensland down to almost the Victorian border. It attains an average height of about 50 to 80 feet. It is the characteristic sassafras tree of this State just as is *Atherosperma moschatum* that of Victoria, both of which belong to the natural order Monimiaceæ. It is one of the commonest of our brush trees, and has glossy coarsely serrate leaves, which on crushing give the characteristic odour so well known to all as "sassafras." Dr. J. M. Petrie, D.Sc., F.I.C., in a paper on "The chemistry of *Doryphora sassafras*,"[1] mentioned that an essential oil was present both in the bark and leaves of this tree, but probably on account of the small amount of material, 100 grams, he did not examine the oil of the leaves, although some chemical and physical data are given in connection with the bark oil. A complete examination of the oil of the bark is at present being conducted, the results of which will be communicated at a later date.

During the month of October, 1920, Mr. C. A. Colemane of Clyde road, viâ Braidwood, commenced the distillation

[1] Proc. Linn. Soc. N.S.W., Vol. XXXVII, (1912) p. 139–156.

of the oil of the leaves for commercial purposes, and he kindly supplied the first lot of material for this investigation in order that its composition and value might be determined.

As shown under "Experimental," the examination of this first lot of oil gave favourable results, the yield being 1·05%, but the publication of the work was delayed, not only in order to obtain confirmation of the percentage yield, but for comparisons to be made with material collected at other periods of the year, and from different localities. The second lot of material came from the same locality as the first, but in the month of May 1921, when the percentage yield of oil was only 0·1%. When a further collection was made in November 1921, the percentage yield was 0·85%.

This last distillation confirmed the original results obtained the year before. A complication, however, has arisen, as a collection of leaves made at Currowan, about 15 miles away from the other locality (Monga) differs somewhat in the composition of its oil, inasmuch as it is lighter than water, high in content of camphor, low in safrol, and contains apparently a fair percentage of the methyl ether of eugenol, whilst the first named is heavier than water, contains usually about 60% safrol without the eugenol ether and a much lower amount of camphor. In the writer's opinion the difference is probably due to different conditions of environment, but further comment is deferred until he has an opportunity of making a thorough examination in the field.

The publication of the results, so far obtained, however, cannot be further delayed, on account of their economic influence, and the fact that various distillers are eagerly waiting to secure their leases of country.

In Part II communication the result of the examination of the leaves from other localities, together with an explanation of the variation in composition of oil at present existing will be given, but meanwhile this publication will serve as a warning to those about to secure leases to first have average selections of material made from off the country about to be taken up, and the oil therefrom examined.

The oil which just at present is finding its way to the market is the heavier than water type, and contains about 60 – 65% safrol. It should find a ready sale as NEW SOUTH WALES SASSAFRAS OIL, and not as Australian, which latter naming would include the oil of *Atherosperma moschatum* which contains only a small percentage of safrol.

The Essential Oil.

The oil thus obtained from this tree by steam distillation is usually of a deep yellow to dark brown colour, with the usual pleasant fragrant odour so well known as that of "sassafras." The leaves that so far have been distilled were procured from Monga and Currowan, both of the South Coast district of this State, and were put through within a few days of cutting.

Altogether 1,225 lbs. weight of leaves and terminal branchlets, cut as for commercial distillation were distilled, and gave an average percentage yield of 0·84%, with the exception, of course, of that distilled during the month of May 1921, when the yield was but 0·1%, probably due to time of season.

The principal constituents of the oil from Monga, so far identified, are as follows, viz:—

	Per cent.		Per cent.
1. Safrol	60 – 65	4. Sesquiterpenes	10
2. Camphor ...	10 – 15	5. Eugenol ...	1
3. d-α, Pinene ...	10		

(Eugenol methyl ether could not be detected.)

The sample of lighter than water oil from Currowan contains:—

	Per cent.
1. Safrol about ...	30
2. Camphor about ...	30
3. d-α, Pinene about...	10
4. Eugenol methyl ether, sesquiterpenes, and alcoholic bodies about	26
5. Eugenol	$3\frac{1}{2}$

Experimental.

The 1,225 lbs. weight of leaves and terminal branchlets, collected at different periods and in various districts, yielded on distillation with steam, crude oils, which on examination gave the chemical and physical characters shown in the table, page 274.

On distilling the crude oil of the first collection, 12/10/20, 12% came over between 175 – 210° C., 22% at 210 – 223° C., 50% at 223 – 235° C., 12% at 235 – 250° C., and 3% at 250 – 265° C.

For the isolation and identification of the principal constituents, 600 ccs. of the crude oil were taken and separated into 16 fractions by repeated fractional distillation at 10 mm. pressure.

Determination of Terpenes.—The first three fractions boiling between 50 – 60° C. at 10 mm. were redistilled at 755 mm. through a 4-pear column, and yielded the following distillates, viz:—

No.	Boiling Point	Specific gravity at 15° C.	Optical rotation, degrees.	Refractive index at 20° C.
1	155 – 157° C. at 760 mm.	0·8650	+ 64·22	1·4678
2	157 – 168 ,,	0·8679	+ 64·55	1·4688
3	158 – 160 ,,	0·8661	+ 62·30	1·4688

These fractions on mixing with an equivalent quantity of lævo pinene, $[\alpha]_D$ 20° C. – 50·18°, readily gave an excellent yield of nitrosochloride, which after careful purification melted and decomposed at 109° C. The principal terpene is, therefore, d-α pinene.

Table.

Date.	Weight of Leaves.	Percentage yield of Oil.	Specific Gravity at 15° C.	Optical Rotation.	Refractive Index 20° C.	Ester No. Hot 1½ hours.	Ester No. Hot 1½ hrs. after acetylation.	Solubility of Oil in 70% alcohol by weight.	Remarks.
	lbs.	%		°					
12/10/1920	361	1·05	1·0268	+16·02	1·5126	4·8	30·62	1 in 8 vls	Leaves kindly furnished by Mr. C. A. Colemane, of Clyde Road, via Braidwood.
12/5/1921	173	0·1	1·0210	+16·2	1·5091	—	—	1 in 8 vls	Leaves from Monga.
8/11/1921	324	0·85	1·0131	+22·2	1·5058	4·6	32·97	1 in 9 vls	Ditto, ditto
20/10/1921	367	0·62	0·9808	+28·2	1·4998	5·95	48·76	1 in 1·3 vls	Leaves from Currowan.
A sample of oil distilled by Mr. C. A. Colemane himself gave the following results :—									
21/10/1921	800	0·75	1·026	+18·6	1·5089	4·1	22·28	1 in 8 vls	

Determination of Camphor.—The portion boiling at 200 – 219° C. at 762 mm. was placed in a freezing mixture, and the separated camphor pumped off, drained on a porous plate, and purified by sublimation and recrystallisation from alcohol. Over 40 grams of solid camphor were obtained in this way. As thus separated, the purified material possessed the following characters, viz:—

Boiling point, 760° mm. 207° C.
Melting point 176° C.
2·2318 grams in 10 ccs. absolute alcohol gave $[a]_D$ 20° + 42°
Oxime, melting point. 118 – 119° C.

Determination of Safrol.—The remaining fractions distilling between 104 – 120° C. at 10 mm. were placed in a bath of solid carbon dioxide, and the frozen mass transferred to a buchner filter funnel surrounded with a mixture of ice and salt. On continued repetition of this process about 250 ccs. of purified safrol were thus obtained. It was washed with 3% sodium hydroxide solution to remove phenols, and again frozen, and subjected to distillation at 10 mm. On examination it gave the following characteristics, viz:—

Melting point + 11° C.
Boiling point 109 – 110° at 10 mm.
Specific gravity at 15° C. 1·103
Optical rotation + 0·30° (due to slight impurity)
Refractive index 20° C. 1·5375

Its identity was confirmed by the preparation of the following derivatives, piperonylic acid and heliotropine, viz:

(1) 10 grams were shaken with 22 grams powdered potassium permanganate and 3 grams potassium hydroxide, 700 ccs. water and 700 grams ice. On completion of the reaction, removal of manganese sludge, and concentration of the liquor, crystals of piperonylic acid were obtained in excellent yield, on acidification with dilute sulphuric acid. On recrystallisation from alcohol they melted at 228° C.

(2) About 20 grams of the safrol were boiled for some hours with concentrated alcoholic potash solution in order to convert it into iso-safrol, and this crude compound was then oxidised with chromic acid in glacial acetic acid solution.

From the reaction product heliotropine was obtained, which on purification through the bisulphite compound and recrystallisation from alcohol, melted at 37° C.

Determination of the Sesquiterpenes.—From the liquors remaining after the removal of safrol, and the original residue of 85 ccs. remaining after the fractionation of 600 ccs., a mixture of sesquiterpenes was obtained boiling at 121 – 145° C. at 10 mm. On repeated fractional distillation over sodium it was resolved into two portions, viz:—

	No. 1.	No. 2.
Boiling point at 10 mm.	125 – 138° C.	140 – 148° C.
Specific gravity, 15° C.	0·9723	0·9547
Optical rotation	– 2°	– 1·2°
Refractive index, 20° C.	1·5130	1·5090

Neither fraction would give any of the well known derivatives for sesquiterpenes, but the colour reactions given by the sesquiterpenes present in the essential oils of the Myrtaceæ were readily obtained. The author was unable to obtain these sesquiterpenes in anything like a condition of purity.

Determination of Eugenol and Heliotropine.—The crude oil on treatment with 3 to 5% solutions sodium hydroxide yielded $1\frac{1}{4}$% phenol. On purification it had:—

Specific gravity at 15° C. 1·07
Refractive index, 20° C. 1·542
Gave with ferric chloride in alcoholic solution the characteristic blue colouration.
Benzoyl compound, melting point 69 – 70° C.

These characters confirm the identity of the phenol with eugenol. On treatment with sodium bisulphite solution a a mere trace of aldehyde was obtained which proved to be identical with heliotropine.

Examination of lighter than Water Oil from Currowan. The examination of this oil was similarly conducted, but the amount of safrol present did not exceed about 30%, whilst the camphor was present in about equivalent amount. The latter on purification melted at 178° C., and with 2·1114 grams dissolved in 10 ccs. absolute alcohol it had a specific rotation of +40·97°.

A much larger fraction, equal to about 30% was also obtained boiling at 248–255° C. at 762 mm. It could not, however, be satisfactorily separated into its components as it appeared to form a constant boiling mixture of sesquiterpenes, eugenol methyl ether and alcoholic bodies. A small fraction boiling at 250–253° C. on oxidation with potassium permanganate solution yielded veratric acid in good quantity of melting point 178–179° C., which tends to show the presence of eugenol methyl ether. Very little further can be done in this matter just at present until a method is devised for separating this ether in a purer condition. About 3·5% phenol was separated from the crude oil with dilute sodium hydroxide solution, and the determination of its physical characters showed its identity with eugenol. The benzoyl compound melted at 69–70° C.

It may be mentioned here that the colour reactions obtained with the eugenol from this oil varied according to the conditions of the experiment. In alcoholic solution on spot plate, the addition of one drop E. solution ferric chloride solution gave a bright emerald green colouration. When carried out in a test tube with very dilute ferric chloride solution the usual violet colouration was obtained.

In conclusion I have to express my thanks to Mr. F. Morrison, Assistant Chemist, for his usual kindly assistance in these investigations.

ON THE PRODUCTION IN AUSTRALIA OF THE AECIDIAL STAGE OF *Puccinia graminis* Pers.

By W. L. WATERHOUSE, M.C., B.Sc., Agr. (Syd.), D.I.C. (Lond.)

With Plate XIX.

[*Read before the Royal Society of N. S. Wales, December 7, 1921.*]

Introduction.

There are several kinds of rust which attack the cereals and grasses, but in Australia the one which does most damage is the black stem rust, *Puccinia graminis* Pers. In some seasons the losses it causes to wheat-growers are enormous. In 1916, the losses in the United States and Canada were estimated at 280,000,000 bushels of wheat, or one-third of the entire crop.(1) Indeed the ravages of the rust have become so great in these countries as to constitute, in parts, the limiting factor in wheat production. The damage done in Australia is not so great. McAlpine (2) states that the loss to Australia in 1889 was estimated at between £2,000,000 and £3,000,000. More recent figures concerning New South Wales are available. Mr. A. H. E. McDonald, Chief Inspector of Agriculture, estimates that in 1903 the losses in the North-Western and Northern Tableland Districts reached 3,000,000 bushels valued at over £400,000. In 1916 he estimates the losses in New South Wales at £2,000,000. All these are losses occasioned in "epidemic years" when the weather conditions are particularly favourable to the parasite. But in ordinary seasons the rust is to be found in most districts, and is probably responsible for a depleted grain yield of perhaps five to ten per cent. of the crop. Such immense losses have led to a very careful investigation of the fungus by numerous workers.

Life History of the Rust.

In the 18th century farmers in Europe associated the presence of the common barberry *(Berberis vulgaris* L.) with the spread of rust on wheat. But it remained for De Bary[3] to prove in classic fashion that the relation between the two was causal. He worked out the complete life history of the rust. Teleutospores on wheat straw that has been exposed to winter conditions germinate in the following spring and produce sporidia. If these sporidia fall upon the young growth of the barberry or several allied plants, they bring about infection and the production of the spermagonial and the aecidial or "cluster-cup" stage of the parasite. Aecidiospores from the barberry will infect wheat and lead to the production of the uredospore or "red-rust" stage. Later in the summer the same uredo mycelium in wheat may give rise to the teleutospore stage, thus completing the life history.

The proof of this connection of the barberry with cereal rust led to the eradication of the plant in parts of Europe. In U.S.A., a vigorous Barberry Eradication Campaign has been in progress since 1918. A sum of $200,000 annually is being spent on this work. In these countries the absence of the barberry has been found to decrease the amount of rust on wheat. For example, in Denmark[4] a gradual disappearance of the stem rust has been contemporaneous with the destruction of the barberry. But it does not always follow that the elimination of the barberry will necessarily get rid of the rust. The uredo-spore stage is capable, under some conditions, of keeping the fungus alive on stray wheat plants and certain grasses until the next season's wheat crop is grown.

Previous Work in Australia.

In Australia no native species of *Berberis* are known. But several introduced species are present in the cooler parts where they have been planted for ornamental purposes. Up to the present the aecidial stage of the rust has not been found in this country, although repeated attempts have been made to produce it.

Cobb[5] states that the aecidial stage is unknown in Australia.

McAlpine[2] made numerous attempts to infect barberries from rusted wheat straw. In 1892 and succeeding years various means were adopted. In some cases, rusted straw was scattered round the barberry plants or tied on to them. In others, susceptible wheat was sown round barberries, and after it had become severely rusted, was allowed to die down on the spot. In yet other instances, "germinating spores were applied directly to the leaves." McAlpine states that "some plants were kept under bell-jars, others were exposed, and all were attended to and watered freely. . . . . . Not the slightest trace of any fungus appeared on any of the barberry leaves." He also forwarded rusted wheat straw to Dr. C. B. Plowright in England to be there tested on barberries. But in all cases the teleutospores failed to germinate upon arrival in England.

McAlpine concludes that as far as Australia is concerned, "the rust apparently has no intermediate stage." This has led most workers to consider that the teleutospore stage is merely vestigial. For example Butler[6] states that the aecidial stage has been completely lost in Australia. Similarly Levine[7] says that the Australian rust has lost the power of infecting the barberry.

In South Africa and in Ecuador, it is reported that the aecidial stage has similarly been lost. But in the light of the results herein reported, further experimental work in these countries would appear desirable.

The form of stem rust which occurs in Australia has been determined by Eriksson,[2] and other authorities as

Puccinia graminis Pers. But if the aecidial stage on the barberry cannot be produced, and if this feature is a requisite[8] in the determination, then as McAlpine suggests its identity with *Puccinia graminis* Pers. is not proved.

Inoculation Experiments.

(a) *British Material.*

It was planned to attempt the barberry infections in 1919. In July of that year a number of species of *Berberis* were kindly supplied by Mr. J. H. Maiden, F.R.S., Director of the Sydney Botanic Gardens, and planted as a hedge at the Sydney University; a few were also planted at certain of the Government Experiment Farms. It was not until the present year, however, that the work became possible. In the meantime the plants had been attended to and had become well established.

In 1920, while the writer was at the Imperial College of Science and Technology at South Kensington, attempts were made to get Australian teleutospore material to germinate in order to test it on barberries there. Rusted straw was kept in a cool cabin during the voyage and other material was sent through the post in the usual way. But in all cases the spores failed to germinate upon arrival in England. These results are in accord with those reported by Plowright.[9]

In March 1921, rusted wheat straw from Pembrokeshire, Wales, was collected and forwarded by Mr. A. D. Cotton of the Institute of Plant Pathology at Harpenden. It showed abundant teleutosori of *Puccinia graminis* on the sheaths and stems, and was in a viable condition upon arrival in Sydney at the end of April. At this time two plants of *Berberis vulgaris*, which had been cut back a short time before, were putting out fresh young growth. Small bundles of the rusted straw were suspended over one of the plants. The straw and both plants were sprinkled with water daily for a week.

No case of rust infection occurred. This negative result was expected, because the same method had been tried and had failed in England where better conditions for infection—a higher humidity—prevailed.

A successful method which had been worked out at South Kensington was then tried. It was there noted that more abundant teleutospore germinations appeared to be obtained by leaving the spores intact in the sori than by separating the teleutospores by scraping them off the straw.

Fragments of the straw on which teleutosori were present were soaked in tap-water for five minutes. The barberry plants were sprinkled with water and the soaked fragments of straw placed on young leaves. The whole shoot was then enclosed in a glass cylinder (a lamp chimney) which was then lightly packed with cotton wool at the top and bottom, and then supported by a stake. (Plate XIX, fig. 1.) A very humid atmosphere was thus maintained within the cylinder. The shoot was kept enclosed for 24 hours in some cases, and for 36 hours in others; there was no discernible difference in the results.

In each case, after four to five days, discoloured spots appeared on the upper surfaces of the inoculated leaves. In addition, in some cases, dead areas occurred, mainly at the edges of the leaves. The causal agents were not determined, but similar necrotic areas were also present on control shoots which had not been enclosed in the cylinders. It appears, therefore, that the teleutospore inoculation was not the cause of the necrosis.

After 8 to 10 days yellowish spermagonia became visible on the upper surfaces of the leaves. Aecidia were produced on the lower surfaces 4 to 5 days later. Aecidiospores were taken from them to inoculate wheat plants and produced typical uredosori. By means of uredospores the British rust is being kept in culture for further study and comparison with Australian forms.

It was thus shown that the two particulur plants of *Berberis vulgaris* were susceptible, under the set conditions, to sporidia of *Puccinia graminis* obtained from England.

(b) *Australian Material.*

Numerous unsuccessful attempts were made to obtain viable teleutospores from straw of the 1920-1921 wheat crop; some was kept at the Sydney University and some at the Hawkesbury Agricultural College and forwarded at intervals by Mr. W. M. Carne. In September 1921, Mr. L. G. Little, Experimentalist of the Glen Innes Experiment Farm, sent specimens of rusted wheat straw of the 1920-1921 crop which had been harvested in January 1921. Some of the varieties were almost destroyed by the stem rust in this season. Straw of these had been allowed to remain undisturbed on the ground during the winter months, when heavy frosts were frequent. Teleutosori were abundant on the stems and leaf-sheaths. The teleutospores germinated in hanging-drops of tap-water at room temperature (about 17 – 20° C.). An abundance of sporidia was produced overnight from each sorus.

On the 29th September and on several occasions during October, inoculations with soaked teleutosori were made on soft young leaves of the same two plants of *Berberis vulgaris* which had been tested with the British rust. The method of enclosing inoculated shoots in glass cylinders as already described was adopted. The method of merely suspending the rusted straw over the plants was not again tried.

The shoots were kept in the glass cylinders for 24 and 36 hours, again with no appreciable difference in the result obtained. After the removal of the glass cylinders, the plants were watered from time to time when the weather was dry.

After four to five days dark spots became visible on the upper surface of the leaves. As had happened when working with the British rust, sharply defined necrotic areas occurred on some of the inoculated as well as on control shoots. Similar diseased areas were present on leaves of other species of *Berberis* growing close by.

Spermagonia appeared on the upper surface of the inoculated leaves after 8 to 10 days (Plate XIX, fig. 2). Four to five days later, aecidia were produced on the under surfaces (Plate XIX, fig. 3). Aecidiospores were used to inoculate wheat seedlings. Uredo pustules were produced on the seedling leaves of Hard Federation wheat in 12 days. By means of uredospores the rust is being kept in culture for study.

Aecidiospore measurements were made of 50 spores shaken from an infected barberry leaf. The arithmetic mean was $19{\cdot}1\,\mu \times 16{\cdot}7\,\mu$ and the range from $24{\cdot}2\,\mu \times 18{\cdot}6\,\mu$ to $14{\cdot}9\,\mu \times 14{\cdot}9\,\mu$. Grove[(10)] gives the measurement as varying from 14 to $26\,\mu$ in diameter. There is therefore no notable difference in the size of the Australian aecidiospores.

Sections were cut through infected leaves (Plate XIX, figs 4 and 5). A comparison of these slides with others of similar material prepared in England again fails to reveal any differences of note.

General Discussion.

The results obtained show that it is not true that *Puccinia graminis* as it occurs on wheat in Australia has lost the power of producing the aecidial stage on the barberry. This may be true for teleutospores kept in hot dry districts where they lose their power to germinate. But in some cases at least the complete life-history of the fungus can be gone through under Australian conditions. Further work is planned to try and ascertain the conditions which are requisite.

The infections here recorded were obtained under extremely artificial conditions. But careful observations of barberry bushes growing in the cooler areas of the State should be made to determine whether infection may not also take place under natural conditions.

European and American observations have shown that the aecidial stage is of great importance in starting the early rust attack of cereals. Further, recent work of Dr. E. C. Stakman and his co-workers at Minnesota, U.S.A., has led him to believe that the aecidial stage on the barberry may be very important in multiplying the number of biologic forms of the rust. His theory is that infection at a spot of a barberry leaf may be brought about by sporidia of two different biological forms. Each gives rise to a uninucleate mycelium. It is possible that the two mycelia may intermingle. In the derivation of the binucleate aecidiospores at the base of an aecidium, one nucleus may be contributed from each mycelium. Such an aecidiospore, having a different nuclear constitution to that of aecidiospores of either of the two biologic forms, may be expected to behave differently, and probably to constitute a new biologic form.

It has already been stated that no species of *Berberis* are native to Australia but that barberry plants have been distributed throughout the country. In view of the proof that infection may be brought about, this distribution should cease. It is true that the positive results were obtained under artificial conditions, but it is by no means impossible for the requisite conditions for infection to occur in Nature.

A further reason for urging that the barberry should be restricted is that American fodder is sometimes imported into Australia. If teleutospores of *Puccinia graminis* should be present on it and the sporidia find their way on to a barberry, the resultant infection might lead to the spread in Australia of a virulent American biologic form of the rust.

The greatest danger is present in the cool districts. It is difficult to understand why the place of the barberry should not be filled by one or other of our many harmless native shrubs. If this be not desired, then at least the distribution of barberries should be restricted to *Berberis Thunbergii*, which is immune to the rust.

Summary.

1. Under set conditions for inoculation, two plants of *Berberis vulgaris* were proved to be susceptible to sporidia of *Puccinia graminis* obtained from rusty British wheat.

2. Inoculations of the same plants under similar conditions with viable teleutospores obtained from Glen Innes, New South Wales, gave numerous infections.

3. Spermagonia and aecidia were produced, and from the latter aecidiospores were used to reinfect wheat.

4. The aecidial stage produced by the Australian rust shows no marked differences to the British rust.

5. The distribution of barberry plants should be discontinued.

Literature Cited.

(1) 1918—Stakman, E. C. "The Black Stem Rust and the Barberry." Yearbook of U. S. Department of Agriculture, p. 4.

(2) 1906—McAlpine, D. "Rusts of Australia," p. 64 *et seq.*

(3) 1865—DeBary, A. Neue Untersuchungen ueber die Uredineen, ins besondere die Entwickelung der *Puccinia graminis* und den Zusammenhang derselben mit *Aecidium berberidis.* Monatsber. K. Acad. d. Wiss, p. 25.

(4) 1915—Lind, J. "Effect of Destruction of the Barberry *(Berberis vulgaris)* on the Common Rust of Wheat *(Puccinia graminis)* in Denmark. Inter. Rev. Sci. Prac. Agr. Year VII, No. 3, p. 442.

(5) 1892—Cobb, N. A. "Contributions to a Knowledge of Australian Rusts." Agr. Gaz. N.S.W., Vol. III, p. 57.

(6) 1918—Butler, E. J. "Fungi and Disease in Plants," pp. 154 and 159.

(7) 1919—Levine, M. N. "The Epidemiology of Cereal Rusts." U.S. Dept. Agr. Bureau of Plant Industry (Mimeog) p. 10.

(8) 1904—Fischer, Ed. "Die Uredineen der Schweiz." Beitrage zur Kryptogamenflora der Schweiz. (Heft II.)

(9) 1898—Plowright, C. B. "Barberry and Wheat Mildew." Gardeners' Chronicle, Vol. XXIII, p. 45.

(10) 1913—Grove, W. B. "British Rust Fungi," p. 250.

Explanation of Plate.

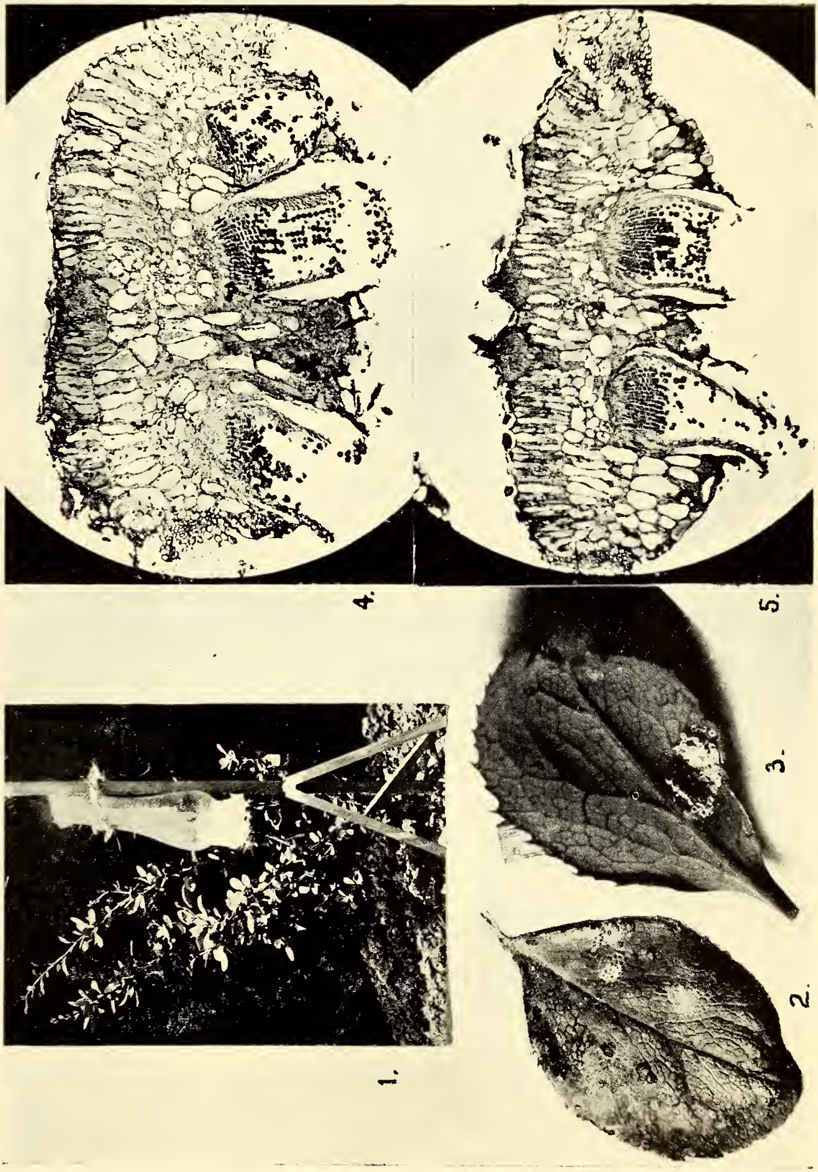
Photographs 2 and 3 and photomicrographs 4 and 5 by H. Gordon Gooch.

1. A plant of *Berberis vulgaris* with a young shoot enclosed in a glass cylinder during inoculation.

2. Showing spermagonia on the upper surface of a barberry leaf infected with sporidia of an Australian form of *Puccinia graminis* on wheat. × 2·5.

3. Aecidia on lower surface of a barberry leaf infected with Australian rust. × 1·4.

4 and 5. Sections through infected leaves showing spermagonia and aecidia. Fixed in Flemming's Solution and stained with Orange G. and Gentian Violet. × 60.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ABSTRACT OF PROCEEDINGS

S—December 7, 1921.

ABSTRACT OF PROCEEDINGS

OF THE

Royal Society of New South Wales.

MAY 4TH, 1921.

The Annual Meeting, being the four hundred and twentieth General Monthly Meeting of the Society, was held at the Society's House, 5 Elizabeth Street, Sydney, at 8 p.m.

Mr. James Nangle, President, in the Chair.

Fifty-six members and five visitors were present.

The minutes of the General Monthly Meeting of the 1st December, 1920, were read and confirmed.

The President tendered a welcome to Professor E. H. Wilson, M.A., V.M.H., of Harvard University, Deputy Director of the Arnold Arboretum, who was present as a visitor.

The certificates of thirteen candidates for admission as ordinary members were read: six for the second and seven for the first time.

Messrs. A. J. Sach and A. D. Ollé were appointed Scrutineers, and Mr. W. S. Dun deputed to preside at the Ballot Box.

The following gentlemen were duly elected ordinary members of the Society, Guillaume Daniel Delprat, Gordon Hay Godfrey, William Lloyd Hindmarsh, Frederick Henry Jackson, Warwick Lloyd, and Varney Parkes.

The following gentleman was duly elected an Honorary Member of the Society:—Sir Richard Threlfall, K.B.E., M.A., F.R.S., lately Professor of Physics in the University of Sydney.

The Annual Financial Statement for the year ended 31st March, 1921, was submitted to members, and on the motion of Professor H. G. Chapman, seconded by Mr. R. T. Baker, was unanimously adopted:—

GENERAL ACCOUNT.

Receipts.	£ s. d.	£ s. d.
To Balance, Cash on hand and at Bank, 1st April, 1920		18 16 8
,, Subscriptions—		
Annual		644 14 0
,, Rents—		
Offices	301 15 0	
Hall and Library	203 2 0	
		504 17 0
,, Sundry Receipts		31 9 1
,, Government Subsidy for 1920...		399 19 10
,, Bookbinding Fund		100 0 0
,, Building Investment Fund Loan		20 0 0
		£1719 16 7

Payments.	£ s. d.	£ s. d.
By Salaries and Wages—		
Office Salary and Accountancy Fees ...	233 15 0	
Assistant Librarian	48 0 0	
Caretaker	234 19 2	
		516 14 2
,, Printing, Stationery, Advertising, Stamps, etc.—		
Stamps and Telegrams	65 2 3	
Office Sundries, Stationery etc.	8 15 6	
Advertising	14 15 0	
Printing	60 8 0	
		149 0 9
,, Rates, Taxes and Services—		
Electric Light	44 13 9	
Gas	12 10 4	
Insurance	23 14 1	
Rates	77 12 6	
Telephone	9 13 8	
		168 4 4
,, Printing and Publishing Society's Volume—		
Printing, etc....	316 6 6	
Binding	43 15 0	
		360 1 6
Carried forward		1194 0 9

Payments—*continued.*	£	s.	d.	£	s.	d.
Brought forward				1194	0	9
By Library—						
Books and Periodicals	75	9	8			
Binding	99	16	0			
				175	5	8
„ Conversazione				99	11	6
„ Sundry Expenses—						
Repairs...	4	11	0			
Lantern Operator	19	13	6			
Bank Charges...	0	15	0			
Sundries	28	15	11			
				53	15	5
„ Building and Investment Fund—						
Interest on Mortgage				138	0	0
„ Clarke Memorial Fund—						
Repayment of Loan...	50	0	0			
Interest thereon	0	15	0			
				50	15	0
„ Balance—						
Credit Balance at Union Bank of Australia Limited	5	6	0			
Cash on Hand...	3	2	3			
				8	8	3
				£1719	16	7

Compiled from the books and accounts of the Royal Society of New South Wales, and certified to be in accordance therewith.

HENRY G. CHAPMAN, M.D., *Honorary Treasurer.*

W. PERCIVAL MINELL, F.C.P.A., *Auditor.*

SYDNEY, 18TH APRIL, 1921.

BUILDING INVESTMENT LOAN FUND.

BALANCE SHEET AS AT 31ST MARCH, 1921.

Liabilities.	£	s.	d.
Loan on Mortgage—			
Amount due to the Australasian Association Advancement of Science	2300	0	0
	£2300	0	0

Assets.	£	s.	d.	£	s.	d.
Cash, Government Savings Bank				274	0	0
Commonwealth War Loan				100	0	0
Loan to General Fund				20	0	0
Balance as at 31st March, 1920	1921	0	0			
Less: Interest received during the year...	15	0	0			
				1906	0	0
				£2300	0	0

Statement of Receipts and Payments, 31st March, 1921.

Receipts.	£ s. d.	£ s. d
To Balance, 31st March, 1920, Government Savings Bank		179 0 0
,, Clarke Memorial Fund—Amount in respect of Commonwealth War Loan		100 0 0
,, Interest—Commonwealth War Loan... ...	5 0 0	
Government Savings Bank... ...	10 0 0	
		15 0 0
,, Amount received from General Fund... ...		138 0 0
		£432 0 0

Payments.	£ s. d.
By Interest paid to the Australasian Association Advancement of Science	138 0 0
,, Loan to General Fund	20 0 0
,, Balance, Government Savings Bank	274 0 0
	£432 0 0

CLARKE MEMORIAL FUND.

Balance Sheet, 31st March, 1921.

Liabilities.	£ s. d.	£ s. d.
Accumulation Fund—		
Balance as at 31st March, 1920		736 16 7
Additions during the year—		
Interest Savings Bank of N.S.W. ...	1 1 9	
,, Government Savings Bank ...	1 0 11	
,, Commonwealth Savings Bank	0 16 2	
,, Loan—General Fund... ...	0 15 0	
,, Commonwealth War Loan ...	35 0 0	
		38 13 10
		£775 10 5

Assets.	£ s. d.	£ s. d.
Commonwealth War Loan...		700 0 0
Cash Savings Bank of N.S.W.	30 10 10	
,, Government Savings Bank	16 8 4	
,, Commonwealth Savings Bank	28 11 3	
		75 10 5
		£775 10 5

Statement of Receipts and Payments, 31st March, 1921.

Receipts.	£ s. d.	£ s. d.
To Balance 31st March, 1920.		
Savings Bank of N.S.W.	29 9 1	
Commonwealth Savings Bank	27 15 1	
Government Savings Bank...	29 12 5	
		86 16 7
,, Repayment of Loan from General Account...		50 0 0
,, Interest to date—		
Savings Bank of N.S.W.	1 1 9	
Government Savings Bank...	1 0 11	
Commonwealth Savings Bank	0 16 2	
Loan to General Fund	0 15 0	
Commonwealth War Loan...	35 0 0	
		38 13 10
		£175 10 5

Payments.	£ s. d.	£ s. d.
,, Balance at date—		
Savings Bank of N.S.W.	30 10 10	
Commonwealth Savings Bank	28 11 3	
Government Savings Bank...	16 8 4	
		75 10 5
,, Building Investment Fund—		
Amount paid in respect of Commonwealth War Loan		100 0 0
		£175 10 5

On the motion of Mr. W. Poole, Mr. W. P. Minell was duly elected Auditor for the current year.

It was announced that the Council had awarded the Clarke Memorial Medal to Mr. Joseph James Fletcher, M.A., B.Sc. and the President then made the presentation. Mr. Fletcher expressed his appreciation of the Council's action in making the award.

A report on the state of the Society's property and the annual report of the Council were read:—

Annual Report of the Council for the Year 1920-21.

(1st May to 27th April.)

The Council regret to report the loss by death of five ordinary members. Thirteen members have resigned. On the other hand, thirty-two members have been elected during the year.

To day (27th April, 1921) the roll of members stands at 362.

During the Society's year there have been eight monthly meetings and nine ordinary and three special Council meetings.

Four Popular Science Lectures were given, namely:—

June 17—"The Ectoparasites of Man," by Professor S. J. Johnston, D.Sc.

July 15—"The Romance of Broken Hill," by E. C. Andrews, B.A., F.G.S.

August 19—"Bovine Tuberculosis and the necessity for its repression," by Professor J. D. Stewart, B.V.Sc., M.R.C.V.S.

September 16—"Einstein's Theory of Space and Time," by Mr. E. M. Wellish, M.A.

Meetings were held throughout the Session by the Sections of Geology, Agriculture and Industry.

Twenty papers were read at the Monthly Meetings and these, with a good number of exhibits, afforded much instruction and interest to members of the Society.

The Council has awarded the Clarke Memorial Medal to Joseph James Fletcher, M.A., B.Sc.

In connection with the visit of His Royal Highness the Prince of Wales to Australia, an address of welcome from the Society was presented to His Royal Highness at Government House, Sydney, on the 17th June, 1920.

The following members were honoured during the year: Professor T. W. E. David, K.B.E.; Mr. James Nangle, O.B.E.; Mr. G. F. Earp, C.B.E.; Mr. R. T. Baker, awarded the Mueller Memorial Medal.

The Annual Dinner took place at "The Burlington Cafe," George Street, on 29th April, 1920, when we were honoured by the company of the Hon. Sir Henry Braddon, M.L.C., late Commissioner of Australia in U.S.A., and the Presidents of several societies.

A Conversazione was held by the Society at the University of Sydney on 10th September, 1920, when we were honoured by the company of His Excellency Sir Walter Davidson and Dame Margaret Davidson, also of Sir William Cullen, Chief Justice of New South Wales and Chancellor of the University of Sydney, and Lady Cullen.

A varied and most interesting collection of exhibits was shown and lecturettes were given on special topics. To those members and friends who contributed to the success of the evening the thanks of the Council are most cordially given. It is to be regretted that the opportunities afforded to members and their friends by these social meetings were not more widely appreciated.

The work of shelving the books in the library was completed during the early part of the year, and on making a complete revision of the old catalogue it was found that only four books are missing. These may possibly be found later.

For a number of years it has been the practice to store parcels of University theses received from Germany in the store room adjoining the main Hall. On examining these it has been found that they comprise a fairly complete set of theses published by the University of Marburg extending from the year 1877 to 1913, and a small collection published by the Technical High School at Karlsruhe near Berlin. The Marburg dissertations cover subjects in Science, Medicine, Jurisprudence, Literature and Theology, many of them being of great value to students. Those of

Karlsruhe deal mainly with Engineering and Applied Science subjects.

These have been arranged each year as a separate volume divided into subjects, and placed alphabetically according to authors. At the Sydney University there is a series of catalogues published yearly setting forth the subjects and authors of dissertations in each German University, so that when the Royal Society's set of Marburg dissertations is bound, it will be possible in a few moments to locate any thesis a member may desire to consult.

The Commonwealth Government having during the year removed restrictions on the receipt of scientific books from enemy countries, invitations to resume exchange were sent from the Society to 72 German and Austrian scientific institutions on the exchange list before the war. Up to date answers have been received from twenty societies, eighteen have accepted the invitation, while two have not resumed publication owing to high cost of material.

During the year 335 volumes of periodicals were bound at a cost of £100. There still remains a vast amount of unbound journals to be dealt with.

Congestion has become more acute in the library during the past year, but it is hoped that in the near future alterations will be made enabling the shelving of the books to be extended with advantage and comfort to those consulting them.

The donations to the library have been as follows:—1508 parts, 100 volumes, 54 reports and 1 calendar.

Owing to the greatly restricted library space the purchase of the following periodicals has been discontinued:— Annales de Chemie et de Physique, Electrical Review, Engineer, Engineering, Engineering and Mining Journal, Engineering News Record, Journal of Institute of Electrical Engineers, Knowledge, Mining Journal, and Notes and Queries. These journals are readily available in other libraries in Sydney and were rarely consulted in our library.

Throughout the year the Council has had under consideration the question of making alterations to the Society's House. After long discussion plans were prepared. On tenders being called the design submitted was found to be too costly for the Society to finance. An amended scheme is now under consideration. This plan provides for library space occupying the whole of the basement as in the larger scheme; for underpinning the front wall and rendering the lower rooms waterproof; for enlarging the hall except in respect to the gallery; for using the Caretaker's quarters for offices; for building new quarters for the caretaker on the roof; and for renovating certain rooms.

* * * * *

It was announced that the following members had died during the recess:—Mr. F. H. Dangar, Dr. S. T. Knaggs, and Rev. Moore White.

The following donations were laid upon the table:—413 parts, 12 volumes, 16 reports and 1 calendar.

The President, Mr. James Nangle, then delivered his address.

As more than the necessary number of members of Council had been nominated, a ballot was taken, after which the President declared the following gentlemen to be Officers and Council for the coming year:—

President:

E. C. ANDREWS, B.A., F.G.S.

Vice-Presidents:

J. H. MAIDEN, I.S.O., F.R.S., F.L.S. | Prof. C. E. FAWSITT, D.Sc., Ph.D.
W. S. DUN. | J. NANGLE, O.B.E., F.R.A.S.

Hon. Treasurer:

Prof. H. G. CHAPMAN, M.D.

Hon. Secretaries:

R. H. CAMBAGE, F.L.S. | J. A. POLLOCK, D.Sc., F.R.S.

Members of Council:

C. ANDERSON, M.A., D.Sc.	F. H. QUAIFE, M.A., M.D.
Prof. Sir EDGEWORTH DAVID, K.B.E., C.M.G., D.S.O., F.R.S., D.Sc.	Prof. J. READ, M.A., PH.D., B.Sc.
CHARLES HEDLEY, F.L.S.	H. G. SMITH, F.C.S.
T. H. HOUGHTON, M. INST. C.E.	C. A. SUSSMILCH, F.G.S.
Rev. E. F. PIGOT, S.J., B.A., M.B.	Prof. R. D. WATT, M.A., B.Sc.

Mr. James Nangle, the out-going President, then installed Mr. E. C. Andrews as President for the ensuing year, and the latter briefly returned thanks.

On the motion of Professor Fawsitt a hearty vote of thanks was accorded to the retiring President for his valuable address.

Mr. Nangle briefly acknowledged the compliment.

JUNE 1ST, 1921.

The four hundred and twenty-first General Monthly Meeting was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Mr. E. C. Andrews, President, in the Chair.

Forty-one members and two visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of twelve candidates for admission as ordinary members were read: seven for the second, and five for the first time.

Messrs. A. D. Ollé and R. W. Challinor were appointed Scrutineers, and Mr. C. A. Sussmilch deputed to preside at the Ballot Box.

The following gentlemen were duly elected ordinary members of the Society:—Harold Napier Baker, James Towers Bull, George Davenport Osborne, Charles Wilfrid Roberts Powell, Alfred Ernest Oswald Sellers, George Henry Starr, and Robert Vicars.

The President announced the death of Mr. P. W. Rygate.

The President announced that a Popular Science Lecture entitled "The Aborigines of Central Australia," would be delivered by Captain S. A. White, on Tuesday, 7th June, 1921.

The President, supported by Mr. J. H. Maiden and Mr. J. Nangle, presented to Mr. R. T. Baker the Mueller Memorial Medal which had been awarded by the Australasian Association for the Advancement of Science, at the Annual Congress held in Melbourne last January, for his eminent services to Botany, particularly in regard to the genus Eucalyptus.

The following donations were laid upon the table:—23 volumes, 274 parts and 6 reports.

THE FOLLOWING PAPER WAS READ:

"On the Occurrence of a New Phenol in the Essential Oil of the 'Leptospermum,'" by A. R. Penfold, F.C.S. Remarks were made by Mr. H. G. Smith.

EXHIBITS:

1. Mr. E. G. Bishop exhibited a series of steel specimens showing the effect of heat treatment on case-hardened mild steel, and pointed out the importance of the proper heat treatment for case-hardened articles.

2. Mr. J. H. Maiden exhibited two photographs taken by Mr. R. Stewart, of Tyrie Station, Dandaloo, in April last, of (*a*) Richard Cunningham's tomb and its surroundings, (*b*) the inscription on the slab.

The following note was contributed:—

Richard Cunningham was Superintendent of the Botanic Gardens, and botanist to Major Mitchell's Expedition. He was murdered by the blacks near the modern Dandaloo in April, 1835. The facts have been stated by Mitchell, and as the inscription has only once been published, viz., in the Public Service Journal of

September 1903, I give it herewith, especially as the excellent photograph enables a correction to be made:—"Richard Cunningham, Government Botanist of this Colony, attached to an exploring expedition under command of Major Mitchell, Surveyor General, wandered in his enthusiasm for botanical investigation from his companions, and losing himself in this locality of the Bogan River, fell into the hands of the aboriginals, by whom he was unfortunately killed, about 25th of April, 1835, in the 42nd year of his age. This tablet is erected to his memory by a vote of the Parliament of New South Wales through the C.C. of (Commissioner of Crown) Lands by S. R. Daniel, C.C.L. (Commissioner Crown Lands) of the Wellington District."

JULY 6TH, 1921.

The four hundred and twenty-second General Monthly Meeting was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Mr. E. C. Andrews, President, in the Chair.

Thirty-eight members and two visitors were present.

The minutes of the preceding meeting were read and confirmed.

The President tendered a welcome to Dr. W. K. Gregory and M. H. C. Raven, both of the American Museum of Natural History, New York, who were present as visitors.

The certificates of eight candidates for admission as ordinary members were read: five for the second and three for the first time.

Messrs. C. A. Sussmilch and W. Poole were appointed Scrutineers, and Mr. W. S. Dun deputed to preside at the Ballot Box.

The following gentlemen were duly elected as ordinary members of the Society:—Joseph James Fletcher, Ethelbert Ambrook Southee, Henry Montague Stephen, John Kingsley Taylor, and Thomas Griffith Taylor.

The President announced the death of Sir John Russell French who was elected a member in 1899.

The President announced that a Popular Science Lecture entitled:—"The Economics of the Australian Vegetation irrespective of Timber," would be delivered by Mr. H. G. Smith, F.C.S., on Thursday, 21st July, 1921.

The following donations were laid upon the table:—3 volumes, 260 parts and 14 reports.

THE FOLLOWING PAPERS WERE READ:

1. "Note on the Relation of Streams to Geological Structure with special reference to Boat-hook Bends," by W. R. Browne, B.Sc. Remarks were made by Professor Griffith Taylor, Mr. C. W. Mann, and the President.
2. "Notes on the Cassiterite Crystals from the New England District of New South Wales, and Stanthorpe, Queensland," by Miss Marie Bentivoglio, B.Sc., (communicated by Acting-Professor L. A. Cotton, M.A., D.Sc.)
3. "The Decomposition of Dimethyl Oxalate by Acetic Acid," by E. E. Turner, B.A., D.Sc., A.I.C., and F. H. Wilson.
4. "The Kurrajong Earthquake of August 15th, 1919," by Acting-Professor L. A. Cotton, M.A., D.Sc. Remarks were made by Rev. E. F. Pigot and Professor Griffith Taylor.

Mr. J. H. Maiden contributed the following note:—

"THE PHILOSOPHICAL SOCIETY OF AUSTRALASIA, 1821.

If members will turn to my contribution to a history of our Society, as contained in our Journal, Vol. LII, page 215, they will see on page 218 a list of some of the members. It has, however, always been something of a mystery as to what caused the discontinuance of the Society, and I have made a reference to the possible cause on pages 222 and 223.

The appearance of the "Historical Records of Australia," Series I, Vol. xi, which deals with Sir Thomas Brisbane's governorship, throws light on the bad feeling that existed amongst some of the members, and I would suggest that Governor Brisbane, withdrew his support for these personal reasons.

My reference to the Historical Records, which I now proceed to quote, are not exhaustive, but seem sufficient for the purpose in hand. The pages are those of the volume in question. I will take the names of the members seriatim.

Dr. H. G. Douglass, Treasurer and Secretary. If the whole volume be perused, it will be seen what a storm centre he was. He was reported on to the Secretary of State by Brisbane on more than one occasion, and his removal from the Magistracy by the Secretary of State was with Brisbane's concurrence—p. 307.

Brisbane was bitterly opposed to Barron Field, whom he reported to the Secretary of State for misconduct—p. 199. Brisbane accused Field of being the author of an anonymous attack on him in a London newspaper—p. 519. At p. 613 he reports to the Secretary of State that Field "has embraced every opportunity of falsely and foully slandering me and my government."

Brisbane was very severe on Rumker, the Astronomer, whom he had personally employed and whom he accused of having abandoned science—p. 613.

Goulburn, the Colonial Secretary, gave evidence at an inquiry into an accusation against H. G. Douglass, and supported him —p. 784. Brisbane charged Goulburn with neglect in carrying out his instructions—see pp. 253 - 255. At p. 556 he reported on Goulburn's want of co-operation with himself in official matters.

These were perhaps the most prominent members of the little Society, and the evidence seems to me to be overwhelming as to the cause of the break up.

Of the other members, I find that Capt. P. P. King was friendly with Brisbane—see p. 314. Howe, p. 791, supports Douglass in regard to the charge which was preferred against him. Of

Hill, Irvine and Oxley I can find nothing to throw light upon their relations with Brisbane. Berry and Wollstonecraft displayed no antagonism to Governor Brisbane, who granted them 10,000 acres of land."

AUGUST 3RD, 1921.

The four hundred and twenty-third General Monthly Meeting was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Mr. E. C. Andrews, President, in the Chair.

Thirty-three members were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of five candidates for admission as ordinary members were read: three for the second and two for the first time.

Messrs. R. W. Challinor and A. D. Ollé were appointed Scrutineers, and Dr. C. Anderson deputed to preside at the Ballot Box.

The following gentlemen were duly elected as ordinary members of the Society:—Albert Morris, Frederick Arnold Robertson and Gustavus Athol Waterhouse.

The President announced the deaths of Mr. J. M. Sandy and Mr. E. J. Statham.

Letters were read from Lady French and Mrs. P. W. Rygate expressing thanks for the Society's sympathy in their recent bereavements.

The President announced that a Popular Science Lecture entitled, "Flies as Disease Carriers," would be delivered by Dr. E. W. Ferguson, on Thursday, 18th August, 1921.

The following donations were laid upon the table:—5 volumes, 117 parts and 11 reports.

THE FOLLOWING PAPERS WERE READ:

1. "Acacia Seedlings," Part VII, by R. H. Cambage, F.L.S. Remarks were made by Mr. J. H. Maiden and the President.

2. "A preliminary examination of the late Palæozoic folding in the Hunter River District, New South Wales," by G. D. Osborne, B.Sc.

3. "Note on the position of the double linkage in Piperitone," by A. R. Penfold, F.C.S. Remarks were made by Mr. H. G. Smith and Mr. R. W. Challinor.

4. "Earth Movements at Burrinjuck as recorded by Horizontal Pendulum Observations," by Assistant-Professor L. A. Cotton, M.A., D.Sc. Remarks were made by Mr. R. H. Cambage.

SEPTEMBER 7TH, 1921.

The four hundred and twenty-fourth General Monthly Meeting was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Mr. E. C. Andrews, President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The certificates of eight candidates for admission as ordinary members were read: two for the second and six for the first time.

Messrs. W. M. Doherty and W. Welch were appointed Scrutineers, and Mr. T. H. Houghton deputed to preside at the Ballot Box.

The following gentlemen were duly elected as ordinary members of the Society:—Hugh Robert Denison and George Henry Olding.

Letters were read from Mr. C. Statham and Mr. H. Sandy expressing thanks for the Society's sympathy in their recent bereavements.

A letter was read from Sir Richard Threlfall expressing his appreciation of the honour which the Society had conferred upon him in electing him an Honorary Member.

The President announced the death of Mr. H. D. Walsh who was elected a member in 1891, and was President of the Society in 1909.

The President announced that a Popular Science Lecture entitled:—"Calculating Machinery," would be delivered by Mr. G. A. Julius, B.Sc., on Thursday, 15th September, 1921.

The following donations were laid upon the table:—5 volumes, 190 parts, 12 reports and 1 calendar.

THE FOLLOWING PAPERS WERE READ:

1. "The Ocean Currents around Australia," by G. H. Halligan, F.G.S., which in his absence was read by Mr. W. R. Browne. Remarks were made by Mr. Charles Hedley, Mr. Wm. Poole, and the President.
2. "Records of Australian Botanists" (Second Supplement) by J. H. Maiden, I.S.O., F.R.S., F.L.S., which in his absence was read by Mr. R. H. Cambage. Remarks were made by Mr. A. A. Hamilton.

EXHIBITS:

1. Mr. H. Selkirk, a visitor, exhibited a hybrid daffodil named Killara. The plant, strictly a Tazzetta hybrid, is a cross between a Polyanthus Narcissus, the Grand Monarque, and the trumpet daffodil Empress, and produces from three to five flowers, instead of one, on each stem.

2. Mr. H. H. Hinds exhibited portion of a branch, upwards of one inch in diameter, of *Cinnamomum camphora* from which the bark, for three and a half inches, had been entirely removed, no cambium being left. The branch had remained green, and callus had formed at each end of the denuded length.

OCTOBER 5TH, 1921.

The four hundred and twenty-fifth General Monthly Meeting was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Mr. E. C. Andrews, President, in the Chair.

Twenty-eight members and three visitors were present.

The minutes of the preceding meeting were read and confirmed.

The President referred to the death of the Premier and the following resolution was carried, the members standing:

"That the members of the Royal Society of New South Wales assembled at their general monthly meeting desire to place on record their profound sorrow at the death of the Hon. John Storey, M.L.A., Premier of this State, also their deepest sympathy with Mrs. Storey and family in their sad bereavement."

The President welcomed Mr. H. D. Tiemann, M.E., M.F., of the United States Forest Service who is visiting Australia on problems relating to timber and forestry, and who was present as a visitor.

The certificates of six candidates for admission as ordinary members were read for the second time.

Messrs. E. Cheel and W. R. Browne were appointed Scrutineers, and Mr. W. S. Dun deputed to preside at the Ballot Box.

The following gentlemen were duly elected ordinary members of the Society:—John Honeyford Campbell, John Arthur Cresswick, Henry Gordon Farnsworth, Alexander Hugh Earle McDonald, Harold Wenholz, and Thomas Lindsay Willan.

A letter was read from Mrs. M. G. Shelley expressing thanks for the sympathy extended to her family in the death of her father, Mr. H. D. Walsh, a former President of this Society.

The following donations were laid upon the table:—9 volumes and 109 parts.

THE FOLLOWING PAPERS WERE READ:

1. "The Essential Oil of *Leptospermum flavescens* (Smith)" by A. R. Penfold, F.C.S.

2. "A note on the Chemistry of Kurrajong Seed," by J. K. Taylor. Remarks were made by Messrs. J. H. Maiden, A. R. Penfold, Judge Docker, Dr. Harker, and Mr. R. W. Challinor.

3. "Preliminary note on the Occurrence of Porphyritic Intrusion at Yass, New South Wales," by C. W. Mann. Remarks were made by Mr. C. A. Sussmilch and the President.

EXHIBITS:

1. Mr. G. Hooper sent for exhibition a specimen of *Thinnfeldia odontopteroides* with somewhat pointed pinnules from the Wianamatta Shales in the Homebush district.

2. Mr. E. Cheel exhibited live plants raised from seeds and cuttings of nine species of "Tea-trees" (Leptospermum) which are being cultivated at Ashfield and Hill Top for the purpose of testing variation in the character of growth, and variation in their essential oils.

3. Mr. J. E. Bishop exhibited samples of wall-paper where the Waratah *(Telopea speciosissima)* and the Wattle (Acacia species) had been used as subjects in the design.

4. Mr. M. B. Welch exhibited a specimen of *Clianthus Dampieri* from Gunbar, New South Wales, having a white flower.

NOVEMBER 2ND, 1921.

The four hundred and twenty-sixth General Monthly Meeting was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Mr. E. C. Andrews, President, in the Chair.

Sixty-seven members and three visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of two candidates for admission as ordinary members were read for the first time.

The President announced that at the December meeting reference would be made by several speakers to the formation of the first scientific Society in Australia, the Philosophical Society of Australasia, which was founded in 1821, and was the forerunner of the Royal Society of New South Wales.

The following donations were laid upon the table:—4 volumes, 316 parts and 2 reports.

THE FOLLOWING PAPERS WERE READ:

1. "Two Pinnate Leaf Boronias and their Essential Oils, with description of a new species," by A. R. Penfold, F.C.S., and M. B. Welch, B.Sc., A.I.C. Remarks were made by Mr. Maiden.

2. "The Occurrence of Rutin in the leaves of the Boronia (N.O. Rutaceæ)," by F. R. Morrison, (communicated by A. R. Penfold, F.C.S.). Remarks were made by Mr. Challinor.

3. "Notes on the Occurrence in New South Wales, Australia, of the perfect stage of a Sclerotinia causing brown rot of fruits," by T. H. Harrison, (communicated by W. L. Waterhouse, B.Sc.). Remarks were made by Mr. C. O. Hamblin.

Lecturette.—Professor Sir Edgeworth David gave an interesting lecturette on "Problems in the Geology of South and Western Australia," and on the motion of Mr. C. A. Sussmilch was accorded a most cordial vote of thanks.

EXHIBITS:

1. Mr. W. S. Dun exhibited specimens of the dentary plates of *Neo-ceratodus* obtained from a well near Wentworth, New South Wales. The specimens were obtained by Mr. A. MacDonald from a depth of 60 feet, associated with remains of extinct marsupials and birds. The existing form occurs in the Burnett River, Queensland.

2. Mr. E. Cheel exhibited a specimen of *Acacia intertexta* Sieb., collected on the Comboyne viâ Wingham, a fortnight previously, showing buds, which should be in full bloom about January next, thus corresponding with plants of the same species found plentifully on the Blue Mountains and at Hill Top (Main Southern Line). He pointed out that a seedling exhibited at a meeting of this Society (vide these Proceedings XLVIII, (1914), xxii), raised from the Hill Top plants and planted in the lower gardens (Botanic Gardens) is now also in bud, and should be in full flower about January next, the first time it has flowered since it was planted, thus showing the same characteristics and flowering period of the parent plant.

3. Judge Docker exhibited several roots from Central Queensland which resembled caterpillars a few inches long.

DECEMBER 7TH, 1921.

The four hundred and twenty-seventh General Monthly Meeting was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Mr. E. C. Andrews, President, in the Chair.

Sixty-six members and eight visitors were present.

The minutes of the preceding meeting were taken as read and confirmed.

THE FOLLOWING PAPERS WERE READ BY TITLE ONLY:

1. "The Geology of the Gloucester District, N.S.W.," by C. A. Sussmilch, F.G.S.

2. "The Conduction of Electricity in Molybdenite," by Assoc. Professor O. U. Vonwiller, B.Sc.

3. "The Preparation of certain Ferrioxalates," by G. J. Burrows, B.Sc., and E. E. Turner, B.A., D.Sc.

4. "An Additional Blue-leaf Stringybark," by J. H. Maiden, I.S.O., F.R.S., F.L.S.

5. "The Essential Oil of the leaves of *Doryphora sassafras* (Endlicher) Part I," by A. R. Penfold, F.C.S.

6. "On the Production in Australia of the Aecidial Stage of *Puccinia graminis* Pers.," by W. L. Waterhouse, M.C., B.Sc. (Agr.), D.I.C. (Lond.).

The certificates of three candidates for admission as ordinary members were read: two for the second, and one for the first time.

Professor L. A. Cotton and Mr. W. R. Browne were appointed Scrutineers, and Dr. C. Anderson deputed to preside at the Ballot Box.

The following gentlemen were duly elected ordinary members of the Society:—Stephen Henry Smith and Guy Carrington Yates.

* * * *

This meeting was specially devoted to commemorating the formation in 1821, of the Philosophical Society of Australasia, the first scientific Society in Australia, and the forerunner of the Royal Society of New South Wales.

A letter was read from the Royal Society of South Australia congratulating this Society on the fact that it was celebrating the centenary of the foundation of scientific work in Australia.

His Excellency Sir Walter Davidson was present and spoke in appreciation of the work of Australian scientists.

Addresses were then delivered, as given below, by speakers who had been asked to discuss subjects which were dealt with by the Philosophical Society of Australasia.

ASTRONOMY.—Professor W. E. Cooke, M.A., F.R.A.S., contributed the following:—Sir Thomas Brisbane arrived in Australia as Governor of New South Wales in November 1821. Prior to his departure from England he endeavoured to persuade the British Government to establish an Observatory in the new Colony, but it had already been decided to found one at the Cape of Good Hope, and the Government was not disposed to subsidise two such institutions in the Southern Hemisphere. Therefore, Sir Thomas decided to equip one at his own expense, purchased an outfit of books and instruments, and engaged two astronomical assistants, viz., Charles Rumker and James Dunlop. The former had already attained a position as a good astronomer and mathematician; and the latter, though untrained, was young and enthusiastic, with great natural ability for mechanics.

A site for the Observatory was selected, close to the Governor's residence at Parramatta, and the work of building was at once commenced. The Observatory was completed in April 1822, and then commenced that extraordinary partnership of three utterly dissimilar persons, Brisbane, Rumker, and Dunlop, disliking each other intensely, and yet banded together by their absorbing passion for the sublime science.[1] Before leaving England it was Rumker whom Sir Thomas always asked to assist in the pendulum observations. In Australia this same work appears to have been assigned to Dunlop. The friction between Brisbane and Rumker became so great that the latter severed his connection and left the Observatory in

[1] See letter from Deputy-Assistant Commissary-General Boyes. Mitchell Library.

the middle of 1823, after little more than a year's work.[1] From the time of Rumker's retirement the main work was carried on by Dunlop, with even an increase of enthusiasm. Altogether a marvellous output was presented to the world, through the home societies, including the famous Parramatta Star Catalogue, observations of Encke's comet at its first predicted return (seen nowhere else in the world), catalogues of nebulæ and star-clusters, determinations of latitude and longitude, etc.

In the whole scientific history of New South Wales I doubt if we can find any period to which we can point with greater pride than to the first four years after the foundation of the Philosophical Society. The Governor's establishment at Parramatta was the home of a scientific enthusiasm and activity rarely equalled, and it is a remarkable fact that each of the three astronomers was at different times awarded the Gold Medal of the Royal Astronomical Society.[2]

ANTHROPOLOGY.—Mr. C. Hedley said; The subject of the aboriginal population presents itself to us under two aspects, first the rapid decrease of this people pointing to their extinction at an early date, and secondly the negligence with which their fate is regarded by our scientific institutions. Early explorers found a large population here; a surveyor, engaged in making the first map of Sydney Harbour, relates how he encountered eighty or ninety armed men in one party. It was estimated by Governor Phillip that the coast between Botany Bay and Broken Bay, now occupied by suburban Sydney, then supported a population

[1] Rumker appears to have acquired 1000 acres of land near Picton, and on the Parish Map of Picton is the following:—Portion 145, "Stargard," Charles Luis Rumker.—[*Editors*].

[2] See Aust. Assoc. Adv. Science, Vol. I, p. 4. Also Hist. Rec. Aust., Series I, Vols. X and XI. Also Reminiscences of General Sir Thomas Makdougall Brisbane, Edinb. 1860, pp. 13, 14 and 43.

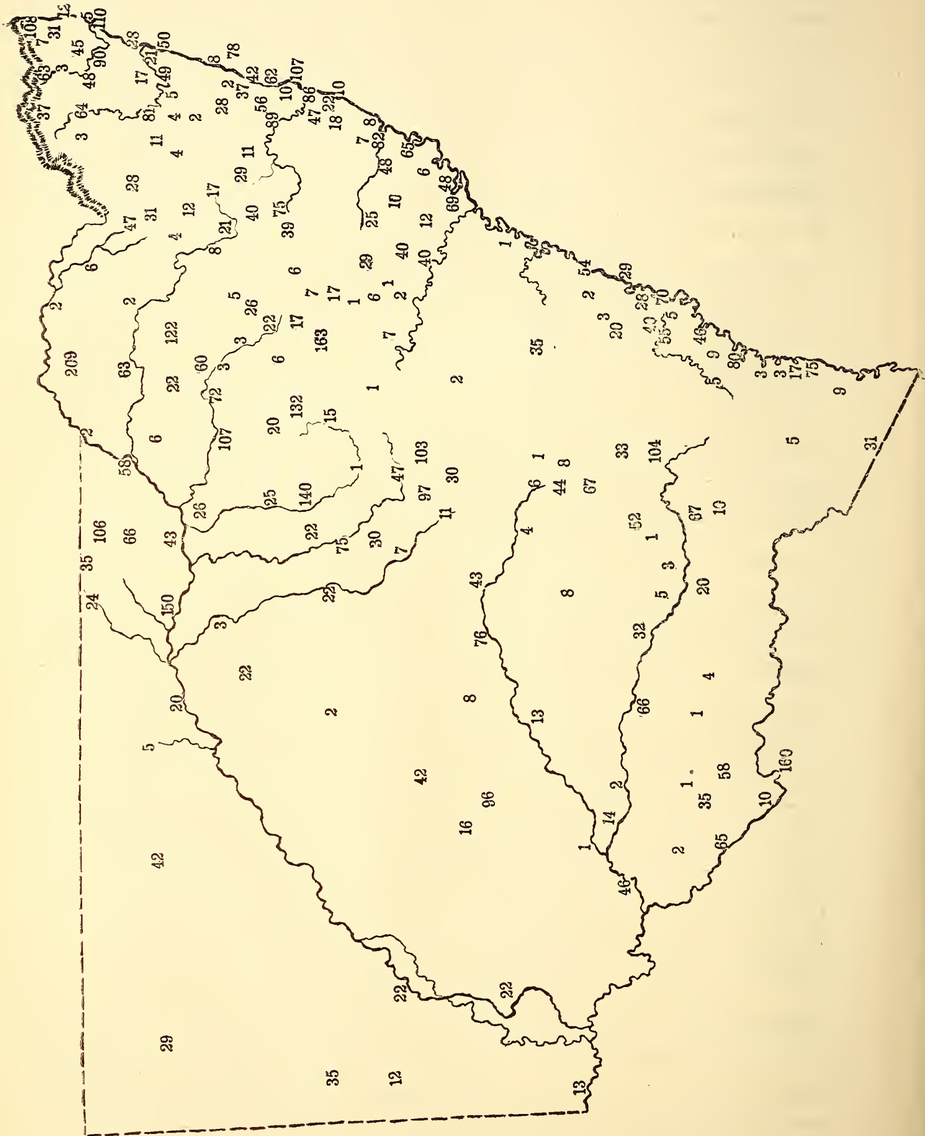
of fifteen hundred natives. Including the country for twenty-five miles inland, a later authority considered that there would be about three thousand people there. No accurate enumeration of the blacks was made until recent years. The Secretary of the Board for Protection of the Aborigines, Mr. A. C. Pettit, has kindly supplied me with the following figures and with a map showing the present distribution of aboriginals of New South Wales, as located by the Census of 12th May, 1920.

In 1882	there were	6540	full-blooded	natives in	N.S. Wales
1892	,,	4458	,,	,,	,,
1902	,,	2880	,,	,,	,,
1912	,,	1917	,,	,,	,,
1921	,,	1281	,,	,,	,,

The native people were not destroyed by war, famine, pestilence or any violence; they simply withered away slowly under the blight of European contact.

Judge Barron Field wrote a paper on the aborigines for the Philosophical Society, but did not appreciate that the ragged and despised blackfellow at his kitchen door was a treasury of ethnological information. If he had, he could have given aid to science and might have set a fruitful example, but he gleaned his matter from books and travellers and so produced a trashy and pedantic memoir. Here, as in America, the French travellers took more interest in the natives and wrote better descriptions of them than our own people did. Indeed it was the lowest, most illiterate and vicious of the white residents that knew most about the blacks. And the blacks knew far more of the language, social system and religion of the Europeans than the educated whites knew of theirs. During the century that has elapsed since Barron Field wrote, ethnological study in this State has been generally neglected. What is known of the native race is due chiefly to investigators in Victoria, South Australia and Queensland.

Distribution of Aborigines in N.S. Wales according to Census of 1920.



And now I come to the end of my sad story. My colleagues whom you appointed to speak on astronomy, on geology and on botany have laid before you their profits, the harvest of a hundred years. Ethnology has only losses to report. Within our recollection the blacks have decreased in number from about seven thousand to scarcely more than one thousand. Children of to-day, perhaps even adults, will live to see the end of the last black man and the last black woman of New South Wales.

To-day no scientific body or institution in the State has a care for Australian Ethnology and there is not a single scientific student at work on it; indifference and neglect were never worse. The primitive life of these aboriginals, so like that of our own palæolithic ancestors; their profound knowledge of beasts and birds, of herbs and trees; their complex and efficient social system; their marriage laws and their sign language, all have gone without record, and without regret.

AUSTRALIAN BOTANY A CENTURY AGO, by J. H. Maiden, I.S.O., F.R.S.—The central local Australian botanical figure, Allan Cunningham, had been sent to Australia at the instigation of Sir Joseph Banks. He was one of two botanists originally despatched to collect seeds and plants for the Royal Garden at Kew, and, incidentally, for Royalties and other Botanic Gardens on the continent of Europe. He was trained at Kew, and had had two years successful experience in Brazil. He arrived in Sydney on the 21st December, 1816, and his journal informs us that within two days, he started collecting at Woolloomooloo, then some little distance out of Sydney, and reputed to be an excellent collecting ground. In April of the following year he joined Oxley's Expedition to the Lachlan and Macquarie, and most of his plants are still extant, though only fragments are available in Sydney through the kindness of Kew and the British Museum.

Cunningham then started on six botanically more or less important coastal voyages, which came to an end shortly after the event we celebrate to-night, although most of his botanical and exploratory work was still in the future. His Commander was Lieut. (afterwards Admiral) P. P. King, R.N., who attained considerable botanical knowledge. The first voyage was viâ Bass's Strait all round the coast to Timor, stopping at a number or places, and home again viâ Bass's Strait. The second was to Tasmania, when Macquarie Harbour was visited. The third voyage started in May 1819, and commenced a running survey of the east coast. Port Macquarie and the Hastings were made in company with the "Lady Nelson," Colonial Brig, and assisted by Lieut. Oxley, R.N., the Surveyor General of the colony (with whom Cunningham had been to Bathurst and further west in 1817). The "Lady Nelson" then returned with Oxley to Port Jackson, while King in the "Mermaid," with Cunningham aboard, went to north-western Australia, and returned to Port Jackson from Timor. The fourth voyage started in June, 1820. Port Jackson was left for Queensland and the Gulf of Carpentaria, and in December, 1820, Cunningham returned to Port Jackson, having circumnavigated the continent. The fifth voyage was taken in H. M. Storeship "Dromedary," re-christened the "Bathurst," the "Mermaid" having been condemned as unseaworthy. She left Port Jackson on 26th May, 1821, circumnavigated Australia, and returned to Port Jackson, which was reached on 25th April, 1822.

His original journal, full of descriptions of plants and other botanical observations and topographical memoranda, is in the Mitchell Library (presented to the Public Library by Kew about 1890).

Charles Fraser, the first Superintendent of the Botanic Gardens, accompanied Cunningham on some of the inland excursions, and generally assisted him. He was a useful collector, but he was a man of very little education, and had been a private soldier in Macquarie's Regiment (the 72nd), with horticultural training before he enlisted. He was industrious until his health became impaired.

With regard to publications a century ago local workers had, of course, the works of Linnæus, which were relied on to an extent difficult to realise at the present day.

In "Trans. Linn. Soc." there were papers describing genera of interest to Australian botanists, beginning with Vol. I (1791). *Goodenia* and *Platylobium* were established by Sir J. E. Smith in Vol. II (1794), and in Vol. III (1797) he described a number of Myrtaceæ, including a dozen Eucalypts. The same botanist in Vol. IV (1798) described twenty new genera of plants, the whole "locus Australasia" with the exception of a South African genus. Vol. V (1800) has a less important paper from his pen *(Sowerbœa)*, while in Vol. VI (1802) Correa de Serra has a paper on *Doryanthes*, and Smith one on Four Myrtaceæ. Then in Vol. VIII (1807) Smith described three Boronias, and Rudge illustrated and described seven new species of plants. In Vol. IX (1808) Smith has a paper on *Conchum* (Proteaceæ), and one on the Decandrous Papilionaceæ, both important. In Vol. X (1811) we have the classical paper of Robert Brown "On the Proteaceæ of Jussieü, while Rudge continued his work and Smith described *Brunonia*, in honour of Robert Brown. In Vol. XI (1815) Rudge had a further illustrated paper, bringing his list up to 26 plates, and this is the last paper in the Transactions available a century ago.

Going back a few years to consider Robert Brown's work on Australian plants (he had been here from 1800-04, and left his assistant, Caley, to 1810), we have "General Remarks on the Botany of Terra Australis," being an appendix to "Flinders' Voyage," 1814, with ten of Bauer's beautiful plates. This valuable paper chiefly refers to groups or families, but every line is worth reading even now. His classical paper on "Kingia" (a Western Australian Grass-tree) was not published till 1827. He also published a paper "On the Asclepiadaceæ" in the Memoirs of the Wernerian Natural History Society, published at Edinburgh in 1811. This is valuable to the Australian botanist, although representatives from other regions of the world are included. Then we have his "Observations on the Natural Family of Plants called Compositæ" in Trans. Linn. Soc., 1817, and similar works on certain genera and species of Cruciferæ, Leguminosæ, Myrtaceæ, Compositæ and Orchideæ, in Hortus Kewensis (2nd Edition), all of which contain descriptions of some Australian plants, and were available a century ago.

My "Records of the earlier French Botanists as regards Australian Plants" in Vol. XLIV of our Journal, p. 123 (1910), give botanical bibliographies of the publications (some of them *de luxe*) embodying the results of these expeditions, together with notes on the botanists concerned so that it is easy to pick up the excellent French researches to which Australian botanists are especially indebted.

Thus our workers a century ago knew not only of La Perouse, but also of Bruny d'Entrecasteaux, Nicholas Baudin and Louis de Freycinet in the ranks of Commanders, and Bossieu de la Martinière, Prévost, Labillardière, Riche, Ventenat, Leschenault de la Tour, Desfontaines, Bonpland and Adrien de Jussieu, to mention only the principal botanists concerned with the botanical treasures brought home by the French. And so, in the brief portion of time that could be allotted to me at this symposium I offer some account of the botanical workers, and the principal works available to them, about a century ago.

GEOLOGY.—Sir Edgeworth David, K.B.E., D.S.O., F.R.S., referred to the great work carried out by early geologists, and particularly mentioned S. Stutchbury, Professor A. M. Thompson, P. de Strzelecki, Rev. W. B. Clarke, and C. S. Wilkinson.

Early Records.—Dr. J. F. Watson, through the courtesy of Mr. E. B. Harkness, Under Secretary, Chief Secretary's Department, exhibited the original minute book of the Philosophical Society of Australasia, and quoted items of special interest therefrom. This minute book has been preserved at the Chief Secretary's Department, but its existence was not known to members of this Society until reported by Dr. Watson. (A complete copy of the minutes will be found as an appendix to this volume).

Biographical Sketches of some of the Members of the Philosophical Society of Australasia,

By R. H. Cambage, F.L.S.

Alexander Berry (1781 – 1873). He was born in Fifeshire, Scotland, on the 30th November, 1781, and attended St. Andrews University and the University of Edinburgh, where he passed through a course of study in preparation for the medical profession.[1] He obtained an appointment in India and spent some years there in the service of the East India Company. Entering on mercantile enterprise he visited Australia, New Zealand, etc. On 13th January, 1808, he first came to Port Jackson as owner of the ship "City of Edinburgh." In the latter part of 1809 he visited the coast of New Zealand, reached Whangaroa, and rescued a boy Davidson or Davison, a woman (Mrs. Moseley) and infant daughter, and a little girl, the daughter of Commissary Broughton. In 1810 Berry met

[1] "Reminiscenses of Alexander Berry," p. 112

Edward Wollstonecraft and later they entered into partnership. In 1819 they decided to settle in Australia, and chartered a vessel and brought out a cargo to Sydney. Berry returned and chartered another ship, the "Royal George" of 500 tons and brought out Sir Thomas Brisbane with his family and staff, arriving at Sydney on 7th November, 1821.

On the 6th March, 1822, he read a paper before the Philosophical Society of Australasia on "The Geology of the Coastland between Newcastle and Bateman's Bay." (See Field's New South Wales, p. 233). He was one of the Secretaries of the Agricultural Society of New South Wales in 1822, and was also a member of the Council of the Australian College (N.S.W. Calendar, p. 267, 1834). He settled at Coolangatta, Shoalhaven in 1822 and had a canal cut from an arm of Crookhaven to the Shoalhaven River. This canal, which was the first in Australia, appears to have since been swept away.

Butter was sent from Shoalhaven to Sydney at an early date as shown by the following extract from a letter dated 18th September, 1824, from Overseer Souter to Berry and Wollstonecraft at Sydney:—"In the sloop you will find 2 jars butter wt. 78lbs. and also 100 Bushels Maize to be ground down into Meal for the Farm."[1] Berry married Elizabeth, the only sister of Edward Wollstonecraft. In 1845 Mrs. Berry died, at the age of 63, leaving no children, and was buried at St. Thomas' cemetery, North Sydney. Berry became a nominee member of the Legislative Council, and on 13th May, 1856, was appointed a member under the quinquennial system, and resigned on 10th May, 1861, or three days before the lapse of term.

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[1] Berry Estate Papers.

Berry died on 17th September, 1873, at the age of 92, and was buried beside his wife in St. Thomas' cemetery, North Sydney.

James Bowman, J.P., entered naval service as Assistant Surgeon in 1806, and was appointed Surgeon in 1807. On the 26th September, 1819, he took up duties as Principal Surgeon at Sydney, and in 1823 married Mary, the second daughter of John Macarthur of Camden,[1] and has left many descendants. He secured a large area of land at Ravensworth, in the Parishes of Liddell and Vane, County of Durham, between Singleton and Muswellbrook.

Henry Grattan Douglass, M.D., Treasurer and Secretary, (1791–1865). As a young man he was in charge of a regiment in the Peninsular War. Then he saw service in the West Indies until 1812, when he returned to his native Ireland.[2] He arrived in Sydney about 1821, was appointed a magistrate, also Assistant Surgeon, and officer in charge of the Colonial General Hospital at Parramatta in 1821.[3] It seems clear that as the years passed, one of the chief objects of Dr. Douglass was the foundation of a University at Sydney, and he discoursed on it frequently and earnestly. He appears to have influenced Mr. W. C. Wentworth to take the matter up, after which it was brought to fruition. He was a member of the Senate of the University of Sydney from 1853 to 1865, and a member of the Legislative Council from 27th November, 1856 to 13th May, 1861, the end of the quinquennial period which terminated the first appointments.

[1] Hist. Rec. Aust., Series I, Vol. xi, 931.

[2] Record of the Jubilee Celebrations of the University of Sydney, by Professor T. P. Anderson Stuart, p. 63, 1902,

[3] Hist. Rec. of Australia, Vol. x, 538.

His connection with scientific effort in Australia was very important. He was Honorary Secretary of the Philosophical Society of Australasia founded in 1821, of the Australian Philosophical Society formed in 1850, and of the Philosophical Society of New South Wales formed in 1855, and which became the Royal Society of New South Wales in 1866. He presided at the sixteenth monthly meeting of the Society as late as the 9th December, 1857, was Hon. Secretary in 1857-8, and a member of Council in 1858-9, so that he must be regarded as a most important link between the first scientific society in Australia and our Society today. Dr. Douglass practised his profession at Parramatta and Sydney. He appears to have had various disagreements with the authorities of the day.

According to the "Sydney Morning Herald" of December 2, 1865, Dr. Douglass, of Douglass Park, Camden, died on December 1, 1865, at his residence, Ocean Street, Woollahra, near Sydney. It may thus be seen that Dr. Douglass, a member of the first scientific society in Australia, lived just long enough to see the present name of Royal Society about to be adopted for the Society to which he last belonged, for the resolution to change the name was passed on 1st November, 1865, and confirmed on 6th December, 1865, to take effect from the 1st May, 1866.

In the "Sydney Morning Herald" of December 2, 1865, is the following:—

. . . . "Dr. Douglass was a fluent speaker in his best days, and took great pleasure in legislative debates. He was from position, and certainly from inclination, on the side of authority, not without a moderate leaning to all popular ideas. Dr. Douglass initiated and followed up several important reforms. He introduced into this colony, before it was adopted in England, the

Law of Limited Liability in commercial partnerships. He also obtained the abolition of public executions by an Act now copied in the other colonies, an amelioration which he hoped would lead to abolition of capital punishment, to which he was opposed from early conviction. . . . . There are few of our educational or charitable institutions in the organisation of which Dr. Douglass has not a distinguished part. The last visit he paid us was to enlist sympathy in a project for taking better care of the blind. His health, however, totally failed; his work was done."

Judge Field (1786–1846). Barron Field was the son of Henry Field, a surgeon to Christ's Hospital, and was born on the 23rd of October, 1786. He was educated as a barrister, and was called to the Inner Temple on the 23rd of June, 1814. About this period, he devoted himself to literature, compiled an analysis of Blackstone's "Commentaries," and was theatrical critic to the London "Times." He was an intimate friend of Charles Lamb, who introduced him to the select literary coterie then in London. Finding that the pursuit of literature was unremunerative, he accepted a commission, bearing date 14th May, 1816, as judge of the supreme court in New South Wales. He arrived in the colony on the 24th of February, 1817. His tenure of office was marred by his participation in party strife. He left the colony on the 4th of February, 1824, and was subsequently appointed judge at Gibraltar. He died on the 11th of April, 1846. Whilst resident in the colony, he wrote the "First Fruits of Australian Poetry," published in 1819. In 1825, under his editorship, a volume, entitled "Geographical Memoirs of New South Wales by various hands'" was published. He subsequently contributed many articles to magazines. His prose was considered good, but his verse very poor.[1]

[1] Hist. Rec. of Australia, Series I, Vol. IX, 866.

His "Geographical Memoirs" contain papers read before the Philosophical Society of Australasia. He was President of the Agricultural Society of New South Wales in 1822.

Major Frederick Goulburn (1788–1837) was a son of Munbee Goulburn of Portland Place, London, and was born in 1788. At the age of seventeen he was appointed a cornet in the 23rd Dragoons, and later was present at the battle of Waterloo. He was appointed Colonial Secretary, and arrived in Port Jackson on the ship "Hebe," on the 31st December, 1820.[1] His elder brother was the Right Hon. Henry Goulburn, Under Secretary for the Colonies, after whom Surveyor James Meehan named Goulburn Plains in 1818.

From the "Sydney Gazette" of December 15, 1821, we learn that Frederick Goulburn was elected President of the Benevolent Society. He kept a meteorological diary from May 1, 1821, to April 30, 1822, a copy of which was published in Barron Field's book. He was Vice-Patron of the Agricultural Society of New South Wales formed July 5, 1822. He was President of the Sydney Institution, a society formed for the purpose of procuring periodical publications from Great Britain. (Sydney Gaz. June 28, 1822).

Patrick Hill, J.P., Surgeon, R.N. (1794–1852). Dr. Hill was the Surgeon and Superintendent of the ship "Atlas" which arrived at Sydney on July 22, 1816, with 187 prisoners only one having died, He also came by the Earl St. Vincent which arrived at Sydney in 1820.[2] By February, 1821, he was appointed Assistant Surgeon at Liverpool by Governor Macquarie. He accompanied Commissioner John Thomas Bigge and Surveyor General John Oxley from Bathurst

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[1] Hist. Rec. of Australia, Series I, Vol. x, 295.

[2] Hist. Rec. of Australia, Series I, Vol. x, 365.

to Lake Bathurst in October, 1820, where they joined Governor Macquarie and journeyed to Lake George. He married a niece of Dr. Charles Throsby and sister of Charles Throsby the ancester of the present Throsby families. Later he secured several large areas of land to the south of Wingello in the Parish of Bumballa, County of Camden. He died on 13th March, 1852, aged 58, and was buried in the Bong Bong Cemetery near Moss Vale.

William Howe, J.P. (1777 – 1855). He was married on 21st September, 1802 at Calversholm, Annandale, County Dumfries, in the south of Scotland, and from 1810 to 1815 was an officer in the army operating in Europe during the Napoleonic wars. He and his family arrived in Sydney, by the ship "Atlas" on July 22, 1816, and later settled at Glenlee between the modern towns of Campbelltown and Camden, where he received a grant of 3,000 acres of land on 13th January, 1818. On the recommendation of Commissioner J. T. Bigge, dated 10th November, 1819, he was appointed a magistrate by Governor Macquarie.

John Dunmore Lang wrote[1]:—"There is a large extent of cleared land on the Glenlee estate, the greater part of which has been laid down with English grasses, the paddocks being separated from each other by hedges of quince or lemon-tree. . . . Glenlee House—a handsome two-story house, built partly of brick and partly of a drab-coloured sandstone." This house is still standing (1921) and is in excellent order.

William Howe was a member of the Agricultural Society of New South Wales, formed on July 5, 1822, and the butter he made, in a dairy which is still in good order, was famous

[1] An Historical and Statistical Account of New South Wales, Second Edition, 1837, Vol. II, 131.

for its fine quality. Mr. and Mrs. Howe were presented with their portraits by residents of Campbelltown. He died on August 1, 1855, at Glenlee, aged 78, and was buried in the Presbyterian Cemetery, Campbelltown, and has left many descendants.

Captain F. Irvine was a Captain of the 11th Bengal Native Infantry. In the "Sydney Gazette" of August 25, 1821, is the following notice:—"Birth—On the 25th instant the Lady of Captain F. Irvine, etc. . . of a son." On December 8, 1821, his house in O'Connell Street was to let while on March 1, 1822 a notice appears of a lost letter, addressed to Capt. F. Irvine, Elderslee, Upper Minto. On October 3, 1820, John Oxley sold the estate called Elderslee near Camden to Francis Irvine, and on May 15, 1823, Francis Irvine and Sophia Irvine his wife sold it to Thomas Cuthbert Harrington.

Rear-Admiral Philip Parker King, F.R.S., F.L.S. (1793–1856).[1] He was born on 13th December, 1793, being the first child of European parents born on Norfolk Island. He was a son of Philip Gidley King, a former Governor of New South Wales. In 1817 Captain P. P. King was put in charge of the "Mermaid," a cutter of 84 tons with directions to complete the survey of the coasts of Australia which had been begun by Flinders. He was accompanied by Allan Cunningham the famous botanist and others.[2] For a record of these journeys see notes by J. H. Maiden, p. xxx. *supra.* He died at "Grantham," North Sydney, 25th February, 1856, and was buried at St. Mary's, South Creek, N. S. Wales.

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[1] Records of Australian Botanists, by J. H. Maiden, this Journal Vol. XLII, 107, (1908).

[2] Journ. and Proc. Roy. Soc. Western Australia, Vol. I, 115, (1915).

Donald Macleod, J.P., Staff Surgeon. He was Police Magistrate at Parramatta and Superintendent of the Female Factory.[1] He appears to have returned to England, and in about 1828, came back to Sydney,[2] and obtained land at "Benera" near Liverpool, and at Gundaroo. [A Donald McLeod died 3rd August, 1851, at Tilkai, aged 52 years (Farmer)].

Lieutenant John Oxley, R.N., J.P. (178? – 1828). He was born at Kirkham in Yorkshire, England, and died on 28th May, 1828, at his home, Kirkham, near Camden, N.S. Wales, where he had been carrying on agricultural pursuits. He visited Australia several times prior to 1812, from which year to the time of his death in 1828 he was Surveyor General. He was a member of the Agricultural Society of New South Wales in 1822.

Oxley won fame as an Australian explorer. In 1817 he travelled down to the lower Lachlan, then crossed north-easterly over the upper Bogan to the Macquarie at Wellington, returning to Bathurst. In 1818 he followed down the Macquarie to where it enters the reed beds, he then turned easterly past the Warrumbungle Mountains, across the northern portion of Liverpool Plains to the Walcha district, thence down the Hastings River to Port Macquarie. In 1819 he visited Shoalhaven and Jervis Bay. In 1823 he went to Port Curtis, calling at Moreton Bay on his way back when he explored the Brisbane River.

Robert Townson, LLD., F.R.S.E. (1763 – 1827). He arrived in Sydney on 27th July, 1807, in the Duke of Portland.[3]

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[1] Hist. Rec. of Australia, Vol. XII, 499.
[2] Hist, Rec. of Australia, Vol. XIII, 767.
[3] Hist. Rec. of Australia, Vol. IX, 877.

He was the author of the "Philosophy of Mineralogy," "Travels in Hungary," and "Tracks in Nat. Hist."[1] He was nominated for membership on 7th August, 1822, but there are no minutes to show whether he was elected. He settled at "Varroville," on Bunburry Curran Creek, near Campbelltown, and died on 2nd July, 1827, aged 64 years.

Edward Wollstonecraft, J.P. (1783 – 1832). He was born in England, but Alexander Berry first met him at Lisbon in 1810.[2] Berry wrote:—"A tall, formal-looking young man, dressed in black, came on board." Wollstonecraft was a nephew of the famous Mary Wollstonecraft, whose daughter married the poet Shelley. Wollstonecraft was essentially a business man and entered into partnership with Alexander Berry. He arrived in Sydney by the ship "Canada," on 1st September, 1819. In the "Sydney Gazette" of December 15, 1821, the following item appears in connection with the Benevolent Society:—"The Treasurer, H. C. Antill, Esq., having also necessarily resigned, owing to his future permanent residence at Liverpool, the House of Berry and Wollstonecraft has kindly undertaken the duties of that department." By May, 1822, Wollstonecraft was Senior Director of the Bank of New South Wales.[3] He was also Chairman of the first Chamber of Commerce founded in Australia.[4] In addition to land secured as a grant at Shoalhaven, he also obtained a grant of 524 acres, exclusive of rocks and sand, on the north shore of Port Jackson, and erected a small cottage called the "Crows

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[1] Hist. Rec. of N.S. Wales, Vol. VI, 573.

[2] Reminiscences of Alexander Berry, p. 137, (1912).

[3] Hist. Rec. of Australia, Vol. X, 738.

[4] Aust. Hist. Society, Vol. III, Part VI, 235.

Nest" from its commanding situation. Wollstonecraft died on 7th December, 1832, aged 49 years, and was buried at the Sydney Burial ground. In March, 1848, his remains were removed to St. Thomas' Cemetery, North Sydney, and deposited in the tomb of his sister, Mrs. Alexander Berry.

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The President on behalf of the Council invited members to visit Kurnell, on Saturday, the 10th December, 1921, and view the brass tablet which the President and members of the Philosophical Society of Australasia had erected on the cliffs in memory of the landing of James Cook and Joseph Banks.

Mr. J. H. Maiden contributed the following notes:—Little more than a quarter of a century ago the memorial plate of the Philosophical Society of Australasia at Botany Bay (see this Journal, Vol. LII, p. 218) had been practically forgotten. In October, 1895, attention was drawn by Mr. Joseph Pyett to the existence of this plate, and I had a plaster impression taken of it and specimens of the cast placed with the Royal Society, the Public Library, the University and the Technical College. Our specimen is before you, and the reproduction is excellent.

Through the generosity of the British Museum, the National Herbarium has a fine collection of the plants collected by Banks and Solander at Kurnell (see the Annual Report of the Botanic Gardens for the year 1905, presented to Parliament, for a complete list; see also this Journal XXXIX, 34, for an account of the British Museum publication concerning them).

It was April when the circumnavigators were here, and although they made a remarkable collection of plants in flower and fruit, they could not make a complete one. During the last twenty years, I, and the collector of the National Herbarium, have made up the deficiencies as far as possible. We now know very accurately the details of the Kurnell flora when the white man first visited these shores. The collection of these data is very important because those who attend the next Centenary meeting of the Philosophical Society of Australasia will see a different vegetation. Already I have noticed changes in the flora of Kurnell, owing to the wear and tear caused by visitors and the planting of other Australian species by the Trustees, also introductions caused by the conveyance of seeds by the wind, by birds and by animals.

On the motion of Dr. J. V. Daněs seconded by Judge E. B. Docker, a cordial vote of thanks was passed to His Excellency the Governor for his attendance.

GEOLOGICAL SECTION.

ABSTRACT OF THE PROCEEDINGS

OF THE

GEOLOGICAL SECTION.

Monthly Meeting, 16th March, 1921.

Professor Sir Edgeworth David in the Chair.

Thirteen members and four visitors were present.

Professor David and Mr. W. R. Browne were re-elected Chairman and Honorary Secretary respectively.

EXHIBITS:

1. By Mr. W. S. Dun:—Fossil sponges from the Upper Marine Permo-Carboniferous of Ulladulla.

2. By Mr. Simpson:—Post-Tertiary fossils from Peppermint Grove, Swan River, W.A., occurring about 15 feet above present sea-level, also Corals (*Priónastrœa virens*) collected *in situ* at Busselton, 150 miles south of Perth, at 15 feet above sea-level.

DISCUSSION:

A discussion on "The nature and chronology of the post-Tertiary movements of the strand-line in Australia" was opened by Prof. L. A. Cotton, who gave details of an investigation into the chronology of the apparent uplifts and subsidences along the coast of New South Wales.

The Chairman dealt with strand-line movements generally, with special reference to Daly's theory of glacial control.

The discussion was continued by Messrs. Sussmilch, Poole and Halligan, and was eventually adjourned till the next monthly meeting.

Monthly Meeting, 13th April, 1921.

Professor Sir Edgeworth David in the Chair.

Eleven members and four visitors were present.

EXHIBITS:

1. From the Australian Museum:—(*a*) Quartz containing wolfram and molybdenite in association, from Glen Eden, near Glen Innes; (*b*) Tin ore from the Gulf Mine, Emmaville.

2. From the Mining Museum: (*a*) Specimens of *Tribrachiocrinus corrugatus* from the upper beds of the Upper Marine Permo-Carboniferous of Bundanoon; (*b*) Specimens illustrating the occurrence of amosite, an amphibole asbestos, in association with crocidolite, from the Transvaal; (*c*) Crystals of crude salt from Kangaroo Island, S.A.

3. By Mr. T. L. Willan: Garnet-sillimanite gneiss from the 1000-foot level, Broken Hill Proprietary Mine, Broken Hill.

4. By Judge Docker: Ironstone concretions from Beaumaris, Victoria, having the appearance of replacements of tree stems and roots.

5. From Dr. W. G. Woolnough: Fossil wood of Tertiary age from Malacoota Inlet, Victoria, and of doubtful age from Merimbula, New South Wales.

6. By Mr. W. R. Browne: "Sand-pipes," or pseudo-fulgurites from Torquay, Victoria.

DISCUSSION:

The adjourned discussion on Post-Tertiary movements of the strand-line in Australia was resumed.

Geological sections at Adelaide and in Sydney Harbour were exhibited by the Chairman. Contributions to the discussion, including remarks on the significance of the Sydney Harbour section, and on strand-line movement in

Queensland, the Bassian Islands, Victoria and the South Coast of New South Wales, were made by Messrs. Dun, Halligan, Waterhouse, Browne, Dr. Walkom and Judge Docker. Prof. Cotton having replied to some criticisms of his views, the Chairman in summing up expressed the opinion that the evidence pointed to a eustatic negative movement of the strand-line having occurred around Australia, but modified in places by actual movements of the land.

It was decided that future meetings should be held on the third Monday of the month.

Monthly Meeting, 16th May, 1921.

Professor Sir Edgeworth David in the Chair.

Thirteen members and nine visitors were present.

In view of the Chairman's projected geological tour of the other States, Mr. E. C. Andrews was elected to fill the chair in Professor David's absence.

EXHIBITS:

1. By Mr. Varney Parkes: A collection of original drawings of Permo-Carboniferous fossils, also a number of marine Permo-Carboniferous fossils showing interesting and unusual features.

2. From the Mining Museum: A number of specimens from various parts of the State, illustrating the occurrence and associations of tin, wolfram and other minerals.

PAPER:

The abstract, by Mr. Waterhouse, of Dr. Morrow Campbell's paper on the origin of primary ore deposits was in Mr. Waterhouse's absence delivered by the Hon. Secretary. According to Dr. Campbell, tin, wolfram, bismuth, etc. are not really products of pneumatolysis, but have been deposited from solution, the medium being silicic acid.

Comments were made by a number of those present, and the discussion was eventually adjourned to the following meeting.

Monthly Meeting, 20th June, 1921.

Mr. E. C. Andrews in the Chair.

Ten members and eight visitors were present.

EXHIBITS:

1. From the Mining Museum: An australite from Menindie, showing fluxional markings.

2. By Mr. Dun for Mr. Parkes: Permo-Carboniferous fossils, and a series of original drawings of cliff-strata at Ulladulla showing peculiar contortions.

The discussion on Dr. Morrow Campbell's paper, adjourned from the previous meeting was continued by Messrs. Waterhouse, Poole, Harper and Browne, and Dr. Anderson.

Monthly Meeting, 18th July, 1921.

Mr. E. C. Andrews in the Chair.

Twelve members and four visitors were present.

EXHIBITS:

1. From the Mining Museum: Detrital gold in a pebble from the Macquarie River.

From the Australian Museum: An australite, dumb-bell shaped, from Wee Elwah, Hillston District, which had been used by aborigines as a nose-auger.

3. By Mr. Mann: Specimens of *Mucophyllum crateroides* from Yass.

A symposium on "The Isolation of Australia in Cretaceous and Post-Cretaceous Times" was initiated by the Chairman, who examined the evidence afforded by the geological structures. His conclusion was that Australia has been separated from Asia from at least Upper Cretaceous times.

Prof. Taylor dealt with the ethnological and late geological history of the East Indies. With the aid of a large block-diagram he indicated the two old land-levels which may have served as "corridors" for the Australian aboriginals. A series of ethnological lantern views illustrated the zones of migration between the very primitive Tasmanian and the highly evolved Chinese races by way of the Australian, Melanesian, Malay and Polynesian peoples.

Mr. Hedley, dealing with the biological aspect of the matter, maintained that there was evidence of former land connections between Australia and South America, Borneo, Celebes, New Guinea, South Africa and Antarctica. Some of these land connections may have been in existence in early Tertiary times.

Mr. Cambage urged the importance of the climatic and altitude factors in regard to plant migration by land and the possibility of plant distribution by sea.

Dr. Anderson having spoken on the origin of the marsupials and the date of their advent in Australia, the discussion was adjourned.

Monthly Meeting, 15th August, 1921.

Mr. E. C. Andrews in the Chair.

Twenty-one members and twelve visitors were present.

Professor Sir Edgeworth David delivered a lecture descriptive of his recent journey into Central Australia, and dealt with many features of it, particularly with the evidences of glaciation at Yellow Cliff. Matters of geographical, anthropological and botanical interest were also touched upon.

The lecture was illustrated with a large collection of specimens, and with a series of lantern views from photographs by the lecturer.

Monthly Meeting, 19th September, 1921.

Dr. C. Anderson in the Chair.

Thirteen members and one visitor were present.

EXHIBITS:

1. From the Mining Museum: (*a*) A specimen of crysotile asbestos from West Australia enclosing a small angular fragment of country rock. (*b*) On behalf of Mr. W. T. W. Brown, a large crystal of pyrites from Charters Towers.

2. From Mr. Waterhouse: Pebbles from Thirroul beach exhibiting faulting and silicification along the fault-planes.

3. By Dr. Walkom: (*a*) *Rhacopteris* from the Herberton District, Queensland; (*b*) Leaf-whorls of *Phyllotheca* from the Dawson River, Queensland; (*c*) *Equisetites rotiferum* from Sugarloaf Mine, Oaky-Cooyar, Queensland; (*d*) *Osmundites* from Mount Playfair, Queensland.

4. By. Prof. Cotton: (*a*) Trilobites (*Dalmanites*) from the Hume Beds, Yass; (*b*) What is probably a seed-pod of *Glossopteris* from Newcastle.

5. By Mr. Osborne: Photographs of a glaciated pavement, and of a rubbing of the same, from the Kuttung series in the Parish of Wolfingham, Maitland District.

DISCUSSION:

The discussion on the geological age of the isolation of Australia, adjourned from the July meeting was resumed.

Prof. Cotton pointed out that the Tertiary was a period of great diastrophism, which is still in progress. Australia is being protected from the effects of this by a submarine plateau, while the outlying island arcs have been experiencing folding ever since the Cretaceous. He considered that the evidence supported Prof. Taylor's view that the isolation of the continent took place much later than the Cretaceous.

Mr. Dun dealt with the distribution of the marsupials and their progenitors. The Australian stocks probably came through Eurasia, and the forms found in Patagonia represent relics of a dying fauna.

Dr. Walkom considered the evidence from the Tertiary fossil plants indecisive. In Cretaceous (probably Upper Cretaceous) times, Australia was divided by a sea from North to South, and it is a matter of doubt whether the land connection with Eurasia was to Western or to Eastern Australia.

Dr. Daněs appealed for more study of the climatic factor in the matter of migrations.

After remarks by other members the results of the discussion were briefly summed up by the Chairman.

Monthly Meeting, 17th October, 1921.

Professor Sir Edgeworth David in the Chair.

Eighteen members and two visitors were present.

EXHIBITS:

1. By Mr. Osborne: Specimens of basic and ultra-basic plutonic rocks occurring as inclusions in the volcanic neck at the Basin, Mulgoa.

2. By Mr. Parkes: Specimens of Pleistocene and Recent shells cemented by calcareous matter, dredged from the bed of the Shoalhaven Bight.

ADDRESS:

Mr. Andrews gave an address on "Recent Advances in our knowledge of the Geology of the Great Artesian Basin," in which he dealt with some of the phenomena connected with artesian water observed during the recent conference in South Australia. The mound-springs, a characteristic feature of the edge of the Artesian Basin, indicate at least three periods of variation in the amount of "head" developed, possibly as a result of varying rainfall, in the past.

Prof. David supplemented Mr. Andrews' address with remarks on the possible causes of the convergence of the hydraulic grades on Lake Eyre.

Mr. Poole also spoke briefly on the same subject.

Special Meeting, 27th October, 1921.

Mr. Andrews in the Chair.

About thirty-six members and visitors were present.

This meeting was convened to enable the section to hear and see something of the results of Prof. David's recent journey to South Australia and West Australia.

The lecture, which was illustrated by lantern views and by a large collection of specimens, dealt principally with features of geological interest in the Nullarbor Plains, the Irwin River Coal-field of West Australia, the Proterozoic rocks of the Pilbara region, and the salt-lake region of the south-west of South Australia.

Monthly Meeting, 21st November, 1921.

Mr. E. C. Andrews in the Chair.

Seventeen members and seven visitors were present.

EXHIBITS :

1. By Mr. Dun : Teeth of a *Ceratodus* from late Tertiary deposits at Wentworth.

2. From the Australian Museum : A specimen of native tin, a very rare mineral, from Nigeria.

3. By Mr. Milson (a visitor, of the U.S.A. Geological Survey): Photographs of oil-wells in America.

ADDRESS:

Dr. S. S. Visher, Professor of Geography in the University of Indiana, U.S.A., gave an address on the hurricanes of the Pacific, with special reference to the possibility of their throwing light on the problem of the migration of life in the Pacific.

The address was discussed by Mr. Hedley, Prof. Wood Jones of Adelaide, and Mr. Halligan.

Mr. Milson gave a short account of recent views as to the origin of petroleum.

Monthly Meeting, 19th December, 1921.

Mr. E. C. Andrews in the Chair.

Eleven members and one visitor were present.

EXHIBITS:

1. From the Mining Museum: A very comprehensive and interesting suite of specimens from South Africa, illustrating the occurrence of corundum in the rock Plumasite.

2. By Mr. L. F. Harper: Magnesite nodules occurring in association with a coal seam at Ravensworth Colliery.

3. From the Australian Museum: (*a*) Obsidianites from Ooldea, South Australia; (*b*) Tourmaline from 15 miles S.W. of Uralla, showing cross fracture and re-cementation; (c) Nephrite from Baryulgil, N.S.W.

4. By Prof. Cotton: Small button-shaped masses, ranging from the size of a pea to that of a large marble and probably representing the result of pressure, from the Wianamatta Shale at St. Peters.

5. By Mr. Dun: Corals from the Cretaceous beds of Ooldea, collected by Messrs. Trouton and Wright, Australian Museum. These are the first solitary corals found in that region, and they represent forms intermediate between rugose corals and the Hexacoralla.

6. By Mr. Osborne: (*a*) A striated pebble found about 150 feet below the top of the Kuttung Series at Seaham; (*b*) Contorted varve rock from a new horizon in the Kuttung Series at Oakendale, near Seaham.

PAPER:

Mr. Osborne described some of the results of his recent investigations on the Carboniferous of the Seaham, Paterson and Clarencetown areas. The result of a detailed survey serves to confirm, with some modifications, the sequence originally established by Mr. Sussmilch. The mapping indicates the presence of a number of faults which have considerably complicated the original structures. The paper was illustrated by a collection of rock specimens.

Remarks were made by the Chairman, and by Messrs. Browne, Sussmilch, and Dun.

SECTION OF AGRICULTURE.

ABSTRACT OF THE PROCEEDINGS

OF THE

SECTION OF AGRICULTURE.

Monthly Meeting, 2nd May, 1921.

Mr. J. H. Maiden in the Chair.

The election of officers resulted as follows:—*Chairman* Professor R. D. Watt. *Vice-Chairmen*, Sir J. Carruthers, Professor Stewart, Messrs. Stephen and Potts. *Secretary* Mr. P. Hindmarsh. *Committee*, Dr. Dodd, Messrs. Cheel, Hamilton, Ollé, Sachs, Watts, MacDonald, Waterhouse, Southee, Ward and Breakwell.

A hearty vote of thanks was carried to the retiring Chairman Sir Joseph Carruthers and the Secretary Mr. E. Breakwell.

Mr. E. H. Wilson of the Arnold Arboretum addressed the meeting upon the origin of our chief horticultural plants.

Monthly Meeting, 13th June, 1921.

Professor Watt in the Chair.

Principal Southee of Hawkesbury College spoke on Plant Breeding at Cornell University. Investigations were based upon (1) development of better yielding strains, (2) scientific studies, comparison of varieties, pure line selection, hybridisation, mendelian studies. Work upon cereals was begun in 1907. Wheat, oats, rye, maize, timothy grass, potatoes, beans, cabbage, lettuce, etc., all have furnished material for the plant breeding work.

A discussion upon "Genetics in relation to plant breeding" followed.

Monthly Meeting, 11th July, 1921.

Professor R. D. Watt in the Chair.

Continuation of the discussion upon "Genetics in relation to Plant Breeding."

Mr. A. A. Hamilton exhibited specimens of deformities in Dipsacus and Foxglove.

Mr. C. O. Hamblin exhibited six sorghum diseases.

Monthly Meeting, 8th August, 1921.

Professor R. D. Watt in the Chair.

The resignation of Mr. Sachs from the Committee was received with regret and Mr. R. G. Downing elected to fill the vacancy.

The report upon the "Fecundity in Fowls" experiment at Hawkesbury College was received.

Mr. Stephen exhibited a specimen of the "Rose of Jericho."

The debate upon the topic of "Genetics in relation to Plant-breeding" was concluded.

Mr. B. J. Tollis spoke upon the subject of "The Long System of Pruning."

Monthly Meeting, 12th September, 1921.

Professor R. D. Watt in the Chair.

Mr. W. L. Waterhouse spoke upon "Some Aspects of the Wheat Rust Problem." *Puccinia glumarum* is the common English rust. Biffen did valuable plant breeding in connection with this rust. *Puccinia triticina* should be watched here. *Puccinia graminis* is our serious rust. There was considerable danger in the distribution of the barberry in N. S. Wales; America is spending yearly 150,000 dollars in eradicating this plant. Uredospores can probably overwinter in the warmer parts. Dr. Stakman's work upon *P. graminis* revealed 35 biologic strains.

Monthly Meeting, 10th October, 1921.

Professor R. D. Watt in the Chair.

Mr. T. H. Harrison exhibited apothecia of Sclerotinia causing brown rot of apricots.

Mr. W. W. Froggatt spoke upon "Australian Bird Life." He emphasized the need of a biological survey to deal with (1) Protection of Game Birds; (2) Migration of Birds; (3) Introduction of Useful Birds; (4) Protection against Noxious Birds.

Monthly Meeting, 13th November, 1921.

Professor R. D. Watt in the Chair.

Mr. J. K. Taylor spoke upon the "Chemistry of the Kurrajong Seed."

Mr. Shelton spoke upon his experiences at Cambridge University with Professor Biffen and at Minnesota University with Dr. Stakman and Dr. Hayes.

Monthly Meeting, 12th December, 1921.

Professor R. D. Watt in the Chair.

Exhibit of stereoscopic views taken at the Warragamba Excursion by Judge Docker.

Mr. Cheel exhibited examples of timber-destroying Fungi and spoke at length concerning them.

Mr. Davis read a paper upon "Feeding Experiments with *Macrozamia*."

Mr. Cook's paper upon the "Tannin content of Acorn Cups" was also read.

SECTION OF INDUSTRY.

ABSTRACT OF THE PROCEEDINGS

OF THE

SECTION OF INDUSTRY.

Monthly Meeting, 18th May, 1921.

Mr. J. E. Bishop in the Chair.

Mr. Harold Tindale read a paper on "The use of Tar for Road Construction." The paper was illustrated by lantern slides.

Monthly Meeting 15th June, 1921.

Mr. J. E. Bishop in the Chair.

A lecturette, illustrated by lantern slides, on "Science and Industry in the Hawaiian Islands" was given by Mr. C. A. Sussmilch, F.G.S.

Monthly Meeting, 20th July, 1921.

Mr. J. E. Bishop in the Chair.

1. A paper entitled "Power Alcohol an Australian Necessity," communicated by Mr. W. Poole, B.E., M.I.C.E., was read by Mr. R. W. Challinor.

2. A paper by Mr. Edward Elliot, on "Some notes on Schemes for better relations between Employer and Employees" was contributed.

Monthly Meeting, 17th August, 1921.

Mr. J. E. Bishop in the Chair.

A paper was given by Mr. Chas. Donald on "The Leather Industry."

W—December 7, 1921.

Monthly Meeting, 21st September, 1921.

Mr. J. E. Bishop in the Chair.

A lecture and film display was given by Mr. Donald H. Bourke, on "A film version of the value of better working conditions and surroundings showing the practical ideals of the National Cash Register Co. Ltd. of Dayton, U.S.A."

Monthly Meeting, 19th October, 1921.

Mr. J. E. Bishop in the Chair.

A lecture was given by Mr. Alick McNeill, on "The Motor Car and its significance in Industry."

Monthly Meeting, 16th November, 1921.

Mr. J. E. Bishop in the Chair.

Lecture by Mr. S. Keir, on "Felt Hat Manufacture and Fur Fabric," illustrated by lantern slides and exhibits, showing the various stages in the manufacture of felt hats.

APPENDIX.

A copy of the complete minutes of the Philosophical Society of Australasia, 1821-22.

27th June, 1821.	4th July, 1821.
At Mr. Field's,	At Major Goulburn's,
Present,	Present,
Mr. Bowman,	Mr. Bowman,
Dr. Douglass,	Dr. Douglass,
Mr. Field,	Mr. Field,
Major Goulburn,	Major Goulburn,
Capt. Irvine,	Capt. Irvine,
Mr. Wollstonecraft.	Mr. Oxley,
	Mr. Wollstonecraft.

Upwards of thirty years have now elapsed, since the colony of New South Wales was established in one of the most interesting parts of the world,—interesting as well from the novel and endless variety of its animal and vegetable productions, as from the wide and extending range for observation and experiment, which its soil and climate offer to the agriculturist. Yet little has been done to awaken a spirit of research or excite a thirst for information amongst the Colonists. When we consider that we are speaking in the nineteenth century, and reflect on the progression of science for nearly three thousand years, the rejection and adoption of various systems in every branch of natural history, and the security which it was fancied that scientific arrangement had at last attained, we are almost inclined to believe that Nature has been leading us through a mazy dance of intellectual speculation, only to laugh at us at last in this fifth continent. Be that as it may, however, this country affords an opportunity to an enlightened people, of putting into practice, with all the advantages of salubrity of climate and fertility of soil, the knowledge which has been obtained, by the experience of many ages, in every branch of agriculture, commerce and the useful arts; but in order to render that stock of information effective, we should be well acquainted with the present physical state of the country, its capabilities and resources; and here we are compelled to admit we are lamentably deficient. Yet we are of opinion that our ignorance arises in a great measure from the want of some nucleus, which might gather round it the many valuable facts, that are floating about, and which, if collected and embodied in a proper shape, might be offered with advantage to the public. Existing circumstances call loudly for such a point of attraction: the spirit of enterprize is increasing and the tide of emigration is flowing rapidly towards this colony. To direct this spirit and assist this tide, would, we conceive, be performing a public service, which cannot be effected by individual exertion.

It is therefore proposed to form a Society, for the purpose of collecting information with respect to the natural state, capabilities, productions, and resources of Australasia and the adjacent regions, and for the purpose of publishing, from time to time, such information as may be likely to benefit the world at large.

The undersigned individuals therefore subscribe their names as original Members of a Society, to be called THE PHILOSOPHICAL SOCIETY OF AUSTRALASIA, and agree upon the following Regulations thereof.

I. It shall be imperative upon each Member, in the following rotation of lot, to produce a monthly paper, upon some subject connected with the objects of the Society, under penalty of Ten pounds.

Dr. Douglass,
Mr. Wollstonecraft,
Major Goulburn,
Capt. Irvine,

Mr. Oxley,
Mr. Bowman,
Mr. Field.

II. Polemical divinity and party politics shall be excluded from such papers.

III. No paper shall be printed without the authour's permission. The selection of papers for publication shall be determined by ballot—two black balls to exclude.

IV. The papers shall be read by the authour, or such other Member as he shall procure.

V. The Society shall meet every Wednesday at each other's Houses in Sydney, alphabetically, at 7 o'clock in the evening. Fine for non-attendance at a quarter of an hour after that time, five shillings. No excuse to be allowed but sickness, public business, or non-residence in Sydney.

VI. The imperative papers shall be read on the first Wednesday in every month.

VII. No refreshment to be introduced, except tea and coffee, under penalty of Five pounds.

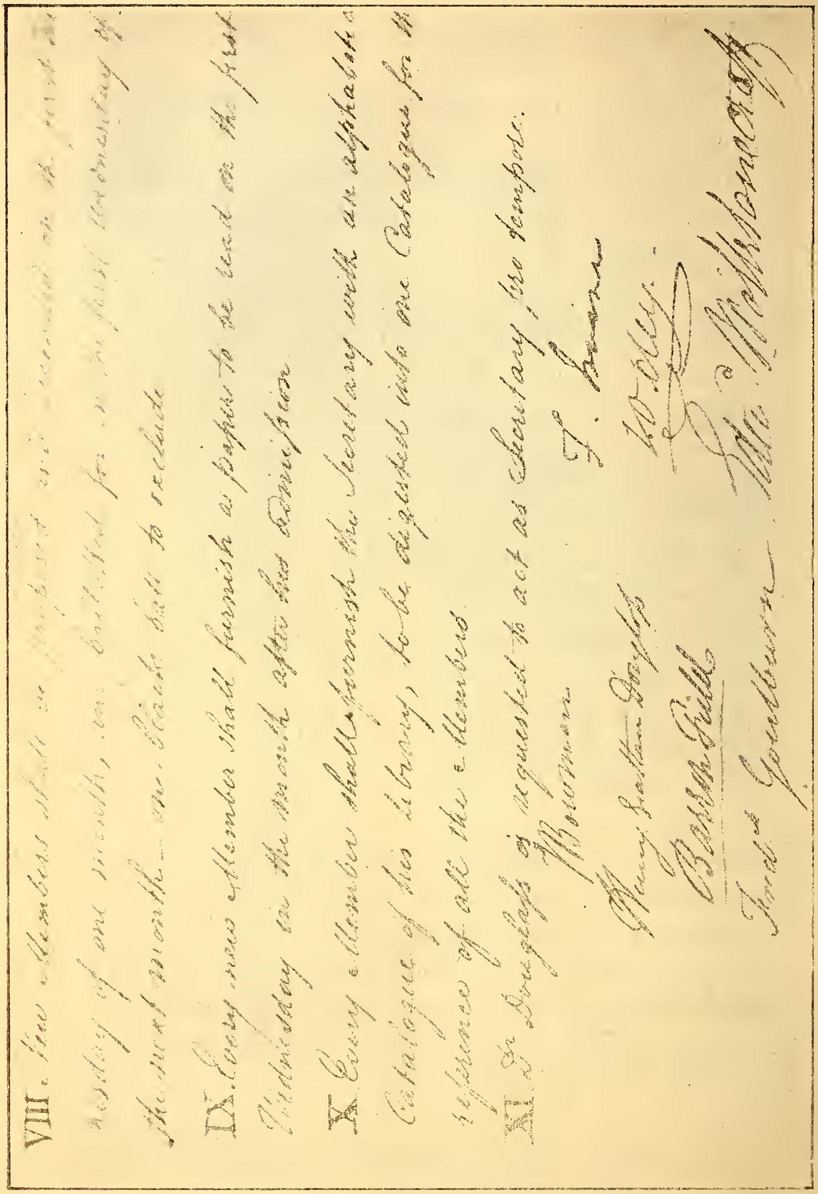
VIII. New Members shall be proposed and seconded on the first Wednesday of one month, and ballotted for on the first Wednesday of the next month—one black ball to exclude.

IX. Every new Member shall furnish a paper to be read on the first Wednesday in the month after his admission.

X. Every Member shall furnish the Secretary with an alphabetical Catalogue of his library, to be digested into one Catalogue for the reference of all the Members.

XI. Dr. Douglass is requested to act as Secretary pro tempore.

(Signed) J. Bowman — F. Irvine
Henry Grattan Douglass — J. Oxley
Barron Field
Fred[ck.] Goulburn — Edw[d.] Wollstonecraft.


VIII. The Members shall [illegible] … of one month, [illegible] … the next month [illegible] … to exclude

IX. Every new Member shall furnish a paper to be read on the first Wednesday in the month after his admission

X. Every Member shall furnish the Secretary with an alphabetic Catalogue of his library, to be digested into one Catalogue for the reference of all the Members

XI. Dr Douglass is requested to act as Secretary, pro tempore.

J. Bowman
Henry Grattan Douglass
Barron Field
Fred. Goulburn
F. Forbes
J. Oxley
E. Wollstonecraft

Photograph of signatures of original members of the Philosophical Society of Australasia. Nearly three-fourths original size.

11th July, 1821.

At Mr. Bowman's.

Present,

Mr. Bowman,

Dr. Douglass,

Mr. Field

Major Goulburn,

Capt. Irvine,

Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Resolved XII. That the papers of the Society, after having been read, shall be handed round in an alphabetical rotation, beginning from the authour, for the purpose of consideration out of doors, and shall be discussed on the next Wednesday after they shall be returned to the authour.

XIII. That each Member do pay into the Treasurer's hands the sum of Five pounds, for the purpose of forming a fund to defray the expenses of fitting up a Museum, purchasing a few Books of reference and other incidental expenses.

XIV. That the Secretary be requested to act as such Treasurer pro tempore.

Major Goulburn having offered the use of a room in the Colonial Secretary's Office for the Society's Museum and Library,

Resolved, That the same be thankfully accepted, and that he and the Treasurer and Secretary be a Committee for the purpose of fitting up the same.

18th July, 1821

At Major Goulburn's (for Dr. Douglass)

Present,

Mr. Bowman,

Dr. Douglass,

Mr. Field,
Major Goulburn,
Capt. Irvine,
Mr. Oxley.

The Minutes of the last Meeting were read and confirmed.

The Museum Committee report that they have contracted with a tradesman for the fitting up of the room in the Colonial Secretary's Office for the sum of £9.

Confirmed.

Mr. Wollstonecraft sent an excuse for non-attendance, vizt. that he was engaged to dine at Government House.

Resolved, That such excuse is not sufficient.

Mr. Field laid before the Society a Latin Inscription by a friend, commemorating the landing of Capt. Cook and Sir Joseph Banks, K.B. on this coast, for the purpose of being engraved on brass and erected on the spot, by this Society.

Ordered to be taken into consideration at the next Meeting.

Mr. Bowman proposes, and Mr. Oxley seconds, as a Member of this Society, Mr. Patrick Hill, Surgeon of the Royal Navy.

Resolved XV. That every experiment, related in any paper laid before the Society, shall (if possible) be performed and verified at the reading of the paper, or if not possible at the time, that the Society shall take the best means to determine the truth and value of such experiment, and that the means and result of such verification be deposited in the Society's Museum.

25th July, 1821.

At Capt. Irvine's (out of turn by consent)

Present,
Mr. Bowman
Dr. Douglass

Mr. Field
Major Goulburn,
Capt. Irvine.

The Minutes of the last Meeting were read and confirmed.

Mr. Field proposes and Major Goulburn, seconds, as a Member of this Society, the Rev^{d}. Samuel Marsden.

Mr. Field read a Letter addressed to him by Capt. Irvine on the subject of the Inscription to the Memory of Capt. Cook, and generally on the objects of the Society.

Resolved, That the same be handed round the Members for consideration, out of doors.

Resolved, That the Secretary do prepare the draught of a circular letter to the following Literary and Philosophical Societies, relating the objects and views of this Society, and requesting their co-operation, communications and correspondence

Royal Society
Linnean Society
Royal Society of Edinburgh
Royal Irish Academy
Royal Institution of Paris
Academy of Geneva
——— Vienna
——— Stockholm
Academy of Berlin
Imperial Society of St. Petersburgh
Asiatic Society of Calcutta
Madras
Bombay
New York
Philadelphia
Boston
Milan
Copenhagen
Java
Ceylon.

1st August, 1821

At Mr. Field's,

Present,

Mr. Bowman
Dr. Douglass,
Mr. Field
Major Goulburn
Capt. Irvine
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Mr. Wollstonecraft offers as an excuse for non-attendance at the last Meeting, that he was called upon to attend the funeral of a friend in the country.

Resolved, That such excuse be admitted.

Mr. Oxley sent an excuse for non-attendance at this meeting viz[t]. sickness.

Dr. Douglass and Major Goulburn were fined for non-attendance at a quarter past 7 o'clock.

Resolved XVI. That the Mover or Seconder shall, upon the proposal of any new Member, state his qualifications for such membership; and that the proposal of new members shall stand last in the order of the Society's business.

8th August, 1821.

At Major Goulburn's

Present,

Mr. Bowman,
Dr. Douglass,
Mr. Field,
Major Goulburn,
Capt. Irvine,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Mr. Field was fined for non-attendance at a quarter past 7 o'clock.

Resolved, That Mr. Bowman be added to the Museum Committee.

Captain Irvine's letter to Mr. Field, and Postscript, having been circulated round the Society,

Resolved, That an English Inscription to record the first landing of Capt. Cook, and Sir Joseph Banks on the eastern coast of New Holland, would be preferable; and that each Member be invited to produce such an Inscription at the next Meeting, for the judgment of the Society.

15th August, 1821.

At Mr. Oxley's.

Present,

Mr. Bowman,
Dr. Douglass,
Mr. Field,
Major Goulburn,
Capt. Irvine,
Mr. Oxley.

The Minutes of the last Meeting were read and confirmed.

Mr. Hill was ballotted a Member of the Society, and introduced at this Meeting.

The following Inscription to record the first landing of Capt. Cook and Sir Joseph Banks, on the east coast of New Holland. was produced by Major Goulburn, and adopted by the Society.

"Under the Auspices of British Science,
"These shores were discovered in the year of our Lord
"by MDCCLXX,
"James Cook and Joseph Banks,
"The Columbus and Mæcenas of the Georgian Age.

"This Spot then saw them land, ardent in the pursuit of Knowledge;
"Now
"To their Memory this Tablet is inscribed,
"In the first Year
"of
"The Philosophical Society of Australasia.
" President.
"A.D. MDCCCXXI."

Resolved, That the thanks of the Society be given to Major Goulburn, as the only producer of such an Inscription.

Resolved, That Mr. Field and Mr. Oxley form a Committee to procure the Inscription to be engraven on brass, with a view to its erection by the Society, against a rock, on the south shore of Botany Bay.

22nd August, 1821.

At Mr. Wollstonecraft's.

Present,

Mr. Bowman,
Dr. Douglass,
Mr. Field,
Major Goulburn,
Capt. Irvine,
Mr. Oxley,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed, with the exception of the Inscription.

Resolved, That the language of that Inscription be taken into further consideration at the next Meeting.

Dr. Douglass and Major Goulburn were fined for non-attendance at a quarter past 7 o'clock.

Resolved, That the ballot for Mr. Marsden as a Member of this Society be postponed, at the request of his Proposer.

29th August, 1821.

At Mr. Bowman's.

Present,

Mr. Bowman,
Dr. Douglass,
Mr. Field,
Major Goulburn,
Capt. Irvine,
Mr. Oxley,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

The language of the Inscription was finally settled as follows:—

A.D. MDCCLXX.
Under the auspices of British Science,
These Shores were discovered
by
James Cook and Joseph Banks,
The Columbus and Mæcenas of their time.
This Spot once saw them, ardent in the pursuit of Knowledge
Now
To their Memory this Tablet is inscribed,
In the first year
of
The Philosophical Society of Australasia.
, President.
A.D. MDCCCXXI.

Resolved, That no notice of a Motion be recorded in the Minutes of the Society.

Mr. Bowman reported the Museum-room to be now ready for the reception of contributions.

Mr. Wollstonecraft informed the Society that Capt. Raine of the Ship Surry was about to sail for Macquarie Island,

and had offered to further the enquiries of the Society, as far as lay in his power.

Resolved, That Mr. Field and Mr. Wollstonecraft do form a Committee to prepare written Instructions and Queries for Capt. Raine, and that every Member of the Society be requested to send materials for that purpose to the Committee.

Dr. Douglass and Major Goulburn were fined for non-attendance at a quarter past 7 o'clock.

5th September, 1821.

At Mr. Field's.

Present,

Mr. Bowman,
Mr. Field,
Major Goulburn,
Capt. Irvine
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Mr. Wollstonecraft laid before the Society a Copy of the written Instructions and Queries which had been furnished to Capt. Raine and Dr. Ramsay of the Surry.

Resolved, That the same be inserted in the Society's Letter-Book.

A letter from the Rev^{d}. Mr. Marsden to the Secretary, declining for the reasons therein mentd. to become a Member of the Society, was read.

Resolved, That Mr. Marsden's name be withdrawn, at his own request.

Capt. Irvine was fined for non-attendance at a quarter after 7 o'clock.

12th September, 1821.

At Major Goulburn's,

Present,

Mr. Bowman,
Dr. Douglass,
Mr. Field,
Major Goulburn,
Capt. Irvine,
Mr. Oxley,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

It having been intimated to the Society that a small general Mineralogical Collection is likely to be offered for sale,

Resolved, That Messrs. Oxley and Wollstonecraft be appointed a Committee to enquire into and report upon the same to the Society.

Resolved, That all propositions, which have been regularly moved and seconded, be recorded in the Minute Book, whether they ultimately pass in the affirmative or the negative.

Mr. Oxley was excused from attendance at the last Meeting, by reason of public business.

19th September, 1821.

At Mr. Oxley's

Present

Mr. Field,
Major Goulburn,
Mr. Oxley.

The Minutes of the last Meeting were read and confirmed.

Capt. Irvine sent an excuse for non-attendance viz^{t}. sickness.

Major Goulburn was fined for non-attendance at a quarter past 7 o'clock.

26th September, 1821.

At Mr. Wollstonecraft's

Present

Mr. Bowman
Dr. Douglass
Mr. Field
Major Goulburn
Mr. Hill
Mr. Oxley
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Mr. Bowman was excused from non-attendance at the last Meeting, by reason of public business.

The Secretary laid before the Society the following draught of a circular letter to the several scientific Societies of the different quarters of the globe.

"Sir, Sydney, New South Wales, 1821

"I am desired by the Philosophical Society of Australasia, to acquaint you with its institution in the month of June last.

"This Society has been formed with a view of inquiring into the various branches of Natural History of this vast continent and its adjacent regions; and the mineralogical and geological state of these countries form primary objects of the Society. These interesting and important pursuits demand much time and industry before they can be given with due consideration and advantage to the public; and, in the meantime, the Society are anxious to express their readiness to receive any suggestions or enquiries that your learned body may wish to have acted upon or examined into. The Society have opened a Museum at Sydney, in which they intend to deposit specimens of the results of their researches into the different Kingdoms of Nature; and of these I am desired to say that duplicates shall from time to time be transmitted to your care. It would be desirable to compare these specimens with others resulting from the same natural kingdoms in different parts of the world; and therefore the Australasian Society would feel much gratified in receiving from the duplicates of such specimens as they may possess; an interchange that may tend to further and elucidate the objects of enquiry of each body.

"The names and rank of the Members of our Society are annexed.

"I have the honour to be," etc.

Resolved, That the above Letter be adopted.

Resolved, That the Secretary be desired to prepare the draught of a Letter to be presented to Sir Thomas Brisbane, on his arrival in New South Wales, inviting him to become the President of this Society; and that the said Letter be accompanied with this Minute Book.

Resolved, That the Museum Committee be requested to open a Book for the purpose of entering a Catalogue of the Specimens and other Donations presented to the Society, together with the names of the Donors, leaving a column for such remarks as may be deemed necessary to illustrate the locality and nature of such specimens; and that the said Book be laid on the Society's table, at every meeting.

3rd October, 1821.

At Mr. Bowman's

Present,

Mr. Bowman
Dr. Douglass
Mr. Field
Major Goulburn
Mr. Oxley.

The Minutes of the last Meeting were read and confirmed.

The Secretary laid before the Society a Letter handed to him by Major Goulburn, and received by him from Capt. Irvine on the subject of a notice of motion of his now on the Society's table, together with Major Goulburn's reply thereto.

Resolved, That these papers do lie on the table.

The Mineralogical Committee reported that there is no collection for sale in the Colony.

Dr. Douglass proposed, and Major Goulburn seconded, William Howe, Esq. as a Member of this Society.

Major Goulburn was fined for non-attendance at a quarter past 7 o'clock.

10th October, 1821.

At Capt. Irvine's.

Present,

Mr. Bowman,
Mr. Field,
Major Goulburn,
Capt. Irvine,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Captain Irvine informed the Society of the existence of a mineralogical collection, made by Mr. Youl at Port Dalrymple, and now in the possession of Mr. Wm. Smith, Teacher of the Public School.

Resolved, That it be referred to the Mineralogical Committee to enquire into the same, and to report thereon.

Resolved, That Major Goulburn be added to the said Committee.

Resolved, That it be also referred to the said Committee, to collect and deposit in the Museum, the mineralogical specimens, brought from Port Macquarie by Mr. Oxley, and to request of Assistant Surgeon Fenton, now detached there, specimens of the timber and natural history of that port, and to make other enquiries in physical science of that gentleman.

Mr. Wollstonecraft informed the Society that Mr. Kent of the Colonial Marine, was about to sail for the Sandwich Islands, and had offered to further the enquiries of the Society.

Resolved, that Capt. Irvine and Mr. Wollstonecraft do form a Committee, for the purpose of preparing written Instructions and Queries for Mr. Kent.

Resolved, That the first sentence of the Society's Letter to the various Philosophical Institutions of the Globe, be altered as follows: vizt.

"This Society has been formed with a view of enquiring into the various branches of physical science of this vast continent, and its adjacent regions—the history and character of man, together with the diversities of his language. These interesting and important pursuits," &c.

17th October, 1821.

At Mr. Field's,
Present
Mr, Bowman,
Mr. Field,
Mr. Oxley.

The Minutes of the last Meeting were read and confirmed.

Major Goulburn was excused from attending, by reason of public business.

Mr. Oxley was fined for non-attendance at a quarter past seven o'clock.

24th October, 1821.

At Captain Irvine's

Present,

Major Goulburn,
Capt. Irvine,
Mr. Oxley,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Mr. Bowman resigned his situation as a Member of this Society.

31st October, 1821.

At Major Goulburn's.

Present,

Mr. Field
Major Goulburn
Capt. Irvine

The Minutes of the last Meeting were read and confirmed.

Capt. Irvine was fined for non-attendance at a quarter past 7 o'clock.

7th November, 1821.

No Meeting, on account of the arrival of Major General Sir Thomas Brisbane, K.C.B.

14th November, 1821.

At Mr. Field's.

Present,

Dr. Douglass,
Mr. Field
Major Goulburn,
Mr. Hill,
Mr. Oxley.

The Minutes of the last Meeting were read and confirmed.

Major Goulburn was fined for non-attendance at a quarter past seven o'clock.

Mr. Howe was balloted a Member of the Society.

The Secretary laid before the Society the draught of a Letter to Major General Sir Thomas Brisbane, which he had prepared in pursuance of the Resolution of 26th September.

Resolved, That the Letter be adopted as follows:

" Sir,

I have the honour to acquaint you that, early in the month of June last, a few Individuals of this Colony, anxious to obtain information, in the several branches of science and natural history, which this extensive and interesting quarter of the globe offers to industry and research, agreed to meet and form a Society for the attainment of that sole object, under the title of the Philosophical Society of Australasia. The names of the Members I have the honour to subjoin.

"I am directed, Sir, to express the anxious wish of this Society, that you would accept the Presidency of their infant body; and in order that their views may be more clearly understood, I am directed to forward the book; containing their proceedings.

"I beg, Sir, you will permit me to express the sincere gratification, which I shall have, in being the organ of communicating to the society that you are pleased to accede to their request.

"I have," &c.

Resolved, That the first peremptory paper be produced and read, on the first Wednesday in January next.

Resolved. That Mr. Bowman having resigned his situation as a Member of the Society, and Dr. Douglass, having from his residence in the country, resigned the trust of the Museum Committee, that Mr. Field and Mr. Oxley be joined with Major Goulburn, as Members of the said Committee.

Lieut. Phillip Parker King, R.N. was proposed by Major Goulburn and seconded by Mr. Field, and Alexander Berry, Esq. was proposed by Mr. Oxley, and seconded by Dr. Douglass, as Members of the Society.

21st November, 1821.

At Major Goulburn's,

Present,

Dr. Douglass,
Mr. Field,
Major Goulburn,
Mr. Howe.

The Minutes of the last Meeting were read and confirmed.

The Secretary read an answer from Sir Thomas Brisbane, accepting the office of President of the Society.

Resolved, that such Letter be entered on the Minutes as follows:

"Government House, Parramatta
16th November 1821.

"Sir,

I have the honour to acknowledge the receipt of your Letter of yesterday's date, soliciting me to become President of the Philosophical Society of Australasia, and beg you will express how highly I appreciate this mark of their consideration, and which I shall accept with pleasure, although with much deference, arising from the humble opinion I entertain, in the first place, of my own talents to do justice to such situation, and next from the consideration, that the public service may require so much of my time, that I shall not have sufficient left to devote to the laudable objects of the society, which would be highly gratifying to me.

"I return the Book containing the Rules and Regulations, together with the Proceedings, which I have read and highly approve of.

"I have the honour to be,
Sir,
Your obedient humble servant,
Thos. Brisbane."

"H. G. Douglass, Esqr. M.D.
&c. &c. &c."

Resolved, That the Secretary be directed to draw up a Letter of thanks to Sir Thomas Brisbane, for having accepted the office of President of the Society.

Capt. Irvine and Mr. Oxley were excused from attendance on account of sickness.

Capt. Irvine transmitted to the Meeting an answer to Major Goulburns's comments on the Captain's Letter to the Society, on the subject of his notice of motion, now pending.

Resolved, That the same do lie on the table.

28th November, 1821.

At Mr. Oxley's,
Present
Dr. Douglass,
Mr. Field,
Major Goulburn,
Capt. Irvine,
Mr. Oxley,
Mr. Wollstonecraft

The Minutes of the last Meeting were read and confirmed.

The Secretary laid before the Society, the draught of a Letter of thanks to Sir Thomas Brisbane, for accepting the office of President.

Resolved, That the same be adopted as follows:

Resolved, That the several Members of the Society be requested to transmit to the Museum, specimens of the different soils in their respective districts of the country, noting the depth at which each specimen was taken, and such other particulars as they may deem proper.

Captain Irvine was fined for non-attendance at a quarter past seven o'clock.

5th December, 1821,

At Mr. Field's,

Present,

Mr. Field,
Major Goulburn,
Mr. Oxley,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Capt. King and Mr. Berry were ballotted Members of the Society.

Major Goulburn was fined for non-attendance at a quarter past seven o'clock.

12th December 1821.

At Major Goulburn's,

Present,

Mr. Berry,
Major Goulburn,
Mr. Oxley.

The Minutes of the last Meeting were read and confirmed.

19th December, 1821.

At Mr. Wollstonecraft's,

Present,

Mr. Berry,
Mr. Field,
Major Goulburn,
Mr. Wollstonecraft.

Read the Journal of an Expedition from Lake Bathurst to the Pigeon House, on this Coast, performed last month by an European Native of the Colony, Mr. Hamilton Hume.

Mr. Wollstonecraft informed the Society, that Mr. Hume reported the existence in Lake Bathurst, of an animal, supposed from his description to be the manatee or hippopotamus.

Resolved, That Mr. Wollstonecraft be authorized to reimburse Mr. Hume any expense he may incur, on the part of himself or any black natives, in food or labour, for the purpose of procuring a specimen of the head, skin or bones of this animal; and that the Treasurer do make good the same.

Resolved, That a self-registering weather-cock be provided at the Society's expense; and that it be referred to Mr. Berry and Major Goulburn to treat with Mr. Oatley, the watchmaker, for the construction and cost of the same, and to report thereon to the Society.

Mr. Field was fined for late attendance.

26th Decr. 1821.

At Major Goulburn's

Present,

Mr. Berry,
Mr. Field,
Major Goulburn,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Read the Journal of a Tour to Jervis's Bay from the County of Argyle, performed by Charles Throsby, Esqr. in November last and December instant.

Resolved, That Mr. Berry be added to the Museum Committee.

Mr. Berry and Mr. Wollstonecraft were fined for late attendance.

2d January, 1822.

At Dr. Douglass's

(Paramatta, by consent to waive fines for non- or late-attendance)

Present,

Sir Thomas Brisbane, Prest.

Mr. Berry,
Dr. Douglass,
Mr. Field,
Major Goulburn,
Mr. Hill,
Mr. Howe.

The Minutes of the last Meeting were read and confirmed.

Resolved, That the following paragraph be added to the Society's intended circular Letter to the different Scientific Institutions, throughout the world:

"I am desired to add, that quarterly meteorological tables, together with astronomical observations, will be regularly transmitted to you."

Mr. Berry, who stood first in order of the Society's Rules to furnish a paper to be read before the Society, not being prepared to do so, Mr. Field read a paper on the Aborigines of New Holland and Van Diemen's Land, and it was consented that Mr. Berry's turn should be postponed till the first Wednesday in next month.

Dr. Douglass proposed the following Gentlemen, as Members of this Society:

M. C. Rumker, Esqr. and Donald Macleod, Esqr. Staff Surgeon in the Army; the former was seconded by Major Goulburn, and the latter by Mr. Field.

9th January, 1822.

At Mr. Field's,

Present,

Mr. Field,

Major Goulburn.

The Minutes of the last Meeting were read and confirmed.

16th January 1822.

At Major Goulburn's,

Present,

Mr. Field

Mr. Goulburn,

Mr. Hill,

Mr. Oxley.

23d. January, 1822.

At Mr. Field's,

Present,

Dr. Douglass,

Mr. Field

Major Goulburn,

Mr. Oxley.

The Inscription Committee reported that the Tablet was now ready, and that they had ascertained a proper place, for its erection; and they therefore requested the honour of the company of the President and Members to a little collation on the spot, upon the affixing of the Inscription, on such day as the President and Members shall appoint.

30th January, 1822.

At Mr. Field's,

Present,

Mr. Field.

The Minutes of the last Meeting were read and confirmed.

7th February, 1822.

At Major Goulburn's,

Present,

Dr. Douglass,

Mr. Field,

Major Goulburn,

Mr. Wollstonecraft.

Mr. Rumker and Mr. Macleod were ballotted Members of the Society.

Resolved, That it be referred to the Museum Committee to report what specimens of natural history the Society can spare to the Museum of Trinity College, Dublin.

Mr. Berry, whose turn it was to read a paper before the Society, was reported as unaccountably detained on an exploratory voyage to Bateman's Bay, the result of which he intended to make the subject of his paper.

13th February, 1822.

At Mr. Berry's,

Present,

Mr. Berry,

Mr. Field,

Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Mr. Berry read a Narrative of his late Voyage of Discovery to Jervis's and Bateman's Bays.

Resolved, That by reason of Mr. Berry's detention from the last Meeting by the perils of the seas, his paper be now accepted as a satisfaction for his fine.

20th February, 1822.

At Mr. Wollstonecraft's,

Present,

Mr. Berry,

Mr. Field,

Mr. Oxley,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Major Goulburn was excused from attendance at the last Meeting, by reason of public business.

27th February, 1822.

At Mr. Oxley's,
Present,
Mr. Berry,
Dr. Douglass,
Mr. Field,
Major Goulburn,
Mr. Oxley.

The Minutes of the last Meeting were read and confirmed.

Mr. Wollstonecraft was excused from attendance this evening by reason of sickness.

Major Goulburn was fined for late-attendance.

6th March, 1822.

At Dr. Douglass's.
Present,
Sir Thomas Brisbane, President,
Mr. Berry,
Dr. Douglass,
Mr. Field,
Mr. Rumker.

The Minutes of the last Meeting were read and confirmed.

The day for affixing the tablet, commemorative of the first landing of Captn. Cook and Sir Joseph Banks was appointed.

Resolved, on the motion of the President, that the thanks of the Society be given to Mr. Field for his valuable paper on the Aborigines of New Holland.

Mr. Berry read a paper on the Geology of the Coastland between Newcastle and Bateman's Bay.

13th March, 1822.

At Major Goulburn's,
Present,
Sir Thomas Brisbane, President,
Mr. Berry,
Dr. Douglass,
Mr. Field,
Major Goulburn,
Capt. Irvine,
Mr. Macleod,
Mr. Rumker,
Mr. Wollstonecraft.

The Minute Book being accidentally left at Paramatta, the proceedings of the last Meeting were not read.

Mr. Rumker read a paper on the importance of astronomical observations in the southern hemisphere.

Major Goulburn laid before the Society a letter from the Revd. John Youl, Assistant Chaplain, Port Dalrymple, offering to present to the Society a variety of fossils, petrifactions, &c.

Resolved, That the Secretary be directed to write the Reverend Gentleman a letter of acceptance, with thanks.

Messrs. Berry and Wollstonecraft were fined for late attendance.

20th March, 1822.

At Mr. Berry's.
Present,
Mr. Berry
Mr. Macleod.

27th March, 1822.

At Mr. Berry's,

Present

Mr. Berry,

Dr. Douglass,

Major Goulburn,

Mr. Wollstonecraft.

Adjourned Meeting.

The Minutes of the last two Meetings were read and confirmed.

The Inscription Committee reported that the President and Members were engaged all day on Wednesday last, in affixing the tablet to the memory of Cook and Banks, at the South head of Botany Bay, and that the Society had the honour to be assisted in that duty by Captain Gambier, and several of the Officers of His Majesty's Ship Dauntless, now refreshing at this port, on her way from South America to India, with specie. They reported the tablet to be pinned and soldered into a beetling rock, twenty-five feet above the level of the sea, and to bear from Cape Banks, . . . , and from the Barrack Tower on the north shore,

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3rd April, 1822.

At Major Goulburn's,

Present,

Major Goulburn,

Mr. Oxley.

The Minutes of the last Meeting were read and confirmed.

10th April, 1822.

At Mr. Field's,

Present,

Sir Thomas Brisbane, Prest.

Mr. Berry,

Dr. Douglass,
Mr. Field,
Major Goulburn,
Mr. Oxley,
Mr. Wollstonecraft.

A Letter from the President to the Secretary, presenting to the Society various Memoirs and Tables of astronomical and other calculations, was read.

Resolved, That the Secretary be directed to write a Letter of thanks to the President for the same.

Mr. Macleod not having laid before the Society a paper, according to the laws of rotation, and having, by this default, incurred a fine of Ten pounds,

Resolved, That, for special reasons, the said fine be remitted upon the production of the paper on the first Wednesday in the next month.

Mr. Field presented the Society's Museum with two Peruvian bottles of great rarity and antiquity.

Resolved, That the thanks of the Society be presented to Mr. Field for his valuable donation.

Mr. Wollstonecraft was excused from attendance at the last Meeting by reason of sickness, and Major Goulburn was fined for late-attendance at this.

17th April, 1822.

At Mr. Wollstonecraft's,
Present,
Mr Berry,
Mr. Field,
Mr. Mçleod,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Mr. Field was fined for late attendance.

24th April, 1822.

At Major Goulburn's

Present,

Mr. Berry

Major Goulburn,

Mr. Wollstonecraft

The Minutes of the last Meeting were read and confirmed.

1st May, 1822.

At Dr. Douglass's,

Present,

Sir Thomas Brisbane, P.

Dr. Douglass,

Major Goulburn,

Capt. King,

Mr, Mçleod.

Major Goulburn reported that he had received a Letter from the Rev. Mr. Youl of Port Dalrymple, accompanying a collection of minerals. Also a box from Major Morisset, Commandant of Port Hunter, containing specimens of the different stratifications of coal from that Settlement.

The question of Mr. Mçleod's paper was adjourned to next Wednesday.

8th May, 1822.

At Dr. Douglass's,

Present,

Dr. Douglass,

Major Goulburn.

Adjourned Meeting.

15th May, 1822

At Mr. Field's,

Present,

Mr. Berry,

Mr. Field,

Major Goulburn,
Capt. King,
Mr. Oxley,
Mr. Wollstonecraft.

The Secretary not having sent the Book from Parramatta, the Minutes of past Meetings could not be read.

The Letter from the Revd. Mr. Youl of Port Dalrymple was read, accompanying a case of contributions to the Museum.

Resolved, That the Secretary be directed to write to Mr. Youl a Letter of thanks for his present.

Ordered, That the Treasurer be authorized to pay five guineas to Stewart, the Engraver of the Inscription-plate.

Resolved, That it be referred to Capt. King and Mr. Wollstonecraft, to enquire into the state of the Inscription-plate and to consider whether, with the assistance of public subscription, a pillar might not be erected for the reception of it, out of the reach of the sea-spray.

Major Goulburn was fined for late-attendance.

22d. May, 1822.

At Major Goulburn's,
Present,
Mr. Berry,
Dr. Douglass,
Mr. Field
Major Goulburn,
Capt. King,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed,

Resolved, That the Secretary be directed to write Letters of thanks to Major Morissett and Capt. Allman, respectively, the Commandants of Ports Hunter and Macquarie, for their various contributions to the Society's Museum.

Messrs. Berry and Wollstonecraft and Major Goulburn were fined for late attendance.

29th May, 1822.

At Mr. Berry's,

Present,

Mr. Berry,
Mr. Field,
Capt. King,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

5th June, 1822.

At Dr. Douglass's

Present,

Sir Thomas Brisbane, P.
Dr. Douglass,
Mr. Field,
Major Goulburn,
Mr. Hill,
Mr. Howe,
Capt. King,
Mr. Mçleod.

Resolved, That the Society's Rule making it compulsary upon each Member in his turn to write a monthly paper, be suspended for the next six months; and that it be left to the interest and zeal which (it is hoped) each Member has in the objects of the Society, to lay before them a paper at such time as he may think proper, without any penalty for default.

Resolved, That the Society's Meeting on the first Wednesday in every month be held at the Secretary's House at

Paramatta, till further notice, as centrical both to town and country members; and that henceforth all Members absent from such meetings be fined ten shillings.

His Excellency the President requested the favour of the Society's company at a dinner at Government House, Paramatta, on the first Wednesday in next month, being the anniversary of the institution of the Society.

12th June, 1822.

At Mr. Field's,
Present,
Mr. Berry,
Mr. Field,
Major Goulburn,
Capt. King,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

19th June, 1822.

At Mr. Wollstonecraft's,
Present,
Mr. Berry,
Mr. Wollstonecraft.

26th June, 1822.

No Meeting appointed.

3d July, 1822.

At Government House,
Paramatta,
Present,
Sir Thomas Brisbane, P.
Dr. Douglass,
Major Goulburn,
Mr. Hill,
Capt. King,

Mr. Mcleod,
Mr. Oxley,
Mr. Rumker,
Mr. Wollstonecraft.

Anniversary Dinner.

10th July, 1822.

At Mr. Field's,
Present,
Mr. Field,
Major Goulburn,
Capt. King,
Mr. Oxley.

Major Goulburn was fined for late attendance.

17th July, 1822.

At Major Goulburn's,
Present,
Mr. Field,
Major Goulburn.

24th July, 1822.

At Mr. Oxley's,
Present,
Mr. Berry,
Mr. Field,
Major Goulburn,
Mr. Oxley,
Mr. Wollstonecraft.

Mr. Field laid before the Society a Catalogue of the respective Libraries of Mr. Berry, Dr. Douglass, Major Goulburn, Mr. Hill, Capt. Irvine, Mr. Oxley, Mr. Wollstonecraft and himself, which he had, in pursuance of a Resolution of the Society, digested into one volume.

Resolved, That the same be deposited in the Museum for reference.

Major Goulburn was fined for late attendance.

31st July, 1822.

At Mr. Berry's,
Present,
Mr. Berry,
Dr. Douglass,
Mr. Field,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Mr. Wollstonecraft was fined for late attendance.

7th August, 1822.

At Mr. Wollstonecraft's,
Present,
Sir Thomas Brisbane, P.
Dr. Douglass,
Mr. Field,
Major Goulburn,
Captn. Irvine,
Capt. King,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

Mr. Hill was excused from attendance, on account of indisposition.

Dr. Douglass & Major Goulburn were fined for late attendance.

Mr. Wollstonecraft proposed, and Mr. Field seconded, the name of Robert Townson, LL.D. as a Member of the Society.

14th August, 1822.

At Mr. Field's,
Present,
Mr. Field,
Major Goulburn,
Mr. Wollstonecraft.

The Minutes of the last Meeting were read and confirmed.

F. W. WHITE, PRINTER, 344 KENT STREET.

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Sydney:
F. W. White, Printer, 344 Kent Street.
1922.