ROYAL SOCIETY OF N.S.W.

OF

NSW

DONATIONS TO THE BUILDING FUND

OF THE

ROYAL SOCIETY OF NEW SOUTH WALES.

From 11th September, 1877, to September, 1884.

	£	s.	d.
Abbott, Hon. J. P., M.L.A.	1	1	0
Abbott, Thos. K., S.M.	3	0	0
Abbott, W. E.	1	1	0
Bartels, W. C. W.	5	0	0
Bassett, W. F., M.R.C.S.E.	1	1	0
Belfield, A. H.	3	3	0
Bennett, G. F., C.M.Z.S.	1	0	0
Bensusan, S. L.	2	2	0
Berney, Augustus	1	18	0
Blackmann, C. H. E.	3	3	0
Bladen, Thomas	2	2	0
Bolding, H. J. (£5, £2 2s.)	7	2	0
Bowen, G. M. C.	2	2	0
Bradridge, T. H.	2	2	0
Brazier, John, C.M.Z.S. (£3 3s., £2 2s.)	5	5	0
Brindley, Thomas	1	1	0
Brodribb, Hon. W. A., M.L.C., F.R.G.S., (£10 10s., £2)	12	10	0
Brooks, Joseph, F.R.G.S.	2	2	0
Brown, H. J. (£1 1s., £1 1s.)	2	2	0
Brown, Thomas	5	0	0
Burnell, A. J.	2	2	0
Cadell, Thomas, The Hon., M.L.C.	1	1	0
Cameron, John	2	2	0
Campbell, Hon. Alex., M.L.C.	20	0	0
Campbell, Allan, L.R.C.P., (£5 5s., £5, £2 2s.)	12	7	0
Campbell, Rev. Joseph, M.A.	1	1	0
Chard, J. S. (£2 2s., £1 1s.)	3	3	0
Christie, W.	5	5	0
Clarke, Rev. W. B., M.A., F.R.S.	5	5	0
Codrington, J. F., M.R.C.S., L.R.C.P., Lon.	1	1	0
Collie, Rev. Robert, F.L.S.	2	2	0
Colyer, J. U. C.	2	2	0
Conder, W. J.	5	5	0
Conlan, G. N., R.N.R.	2	2	0
Cox, Hon. G. H., M.L.C.	5	5	0
Croudace, Thomas	3	0	0
Daintrey, E.	5	5	0
Dangar, F. H.	50	0	0
Darley, C. W.	3	3	0
Dean, Alex., J.P.	1	1	0
Delarue, L. H.	2	2	0
De Salis, Hon. L. F., M.L.C. (£10, £3 19s.)	13	19	0
De Salis, L. W., junr. (£10, £1 1s.)	11	1	0
Dight, Arthur	5	5	0
Dixon, W. A., F.C.S. (£3 3s., 21s., 21s., 21s., 21s., 21s.)	8	8	0
Dixson, Craig, M.D., Syd.	1	1	0
Dixson, Thos., M.B., C.M., Ed.	1	1	0
Docker, E. B.	3	3	0
Du Faur, E., F.R.G.S.	1	1	0
Evans, George	3	3	0
Ewan, J. Frazer, M.B., Mast. Surg., Edin.	5	5	0
Fairfax, E. R.	10	10	0
Fairfax, James R.	20	0	0
Flavelle, Bros., and Roberts (£5, £2 2s.)	7	2	0
Flavelle, John	5	0	0

	£	s.	d.
Fraser, Robert	2	2	0
Frazer, Hon. John, M.L.C.	20	0	0
Gilliat, H. A.	1	1	0
Grahame, Hon. W., M.L.C.	5	0	0
Griffiths, F. C. (£10 10s., £5 5s., £5)	20	15	0
Gurney, Professor, M.A.	10	0	0
Haege, Hermann	5	5	0
Hall, R. T. (21s., 21s., 21s.)	3	3	0
Harrison, L. M. (£10 10s., £10)	20	10	0
Hay, Hon. Sir John, K.C.M.G. (£20, £1)	21	0	0
Henry, James	3	3	0
Heron, Henry (£10 10s., £5, £2 2s.)	17	12	0
Hirst, G. D. (21s., 21s., 21s., 21s.)	4	4	0
Holt, Hon. Thomas, M.L.C.	10	0	0
Horton, Rev. Thomas	2	0	0
Hume, F. R.	5	5	0
Hume, J. K. (£3 3s., £2 2s.)	5	5	0
Hunt, Robert, F.G.S. (£5 5s., £2 2s., 21s., 21s.)	9	9	0
Inglis, James (21s., 21s.)	2	2	0
Johnson, J. W.	2	2	0
Jones, James	2	2	0
Jones, J. A., L.R.C.P., Edin.	1	1	0
Jones, P. Sydney, M.D.	10	10	0
Josephson, J. F., F.G.S.	20	0	0
Josephson, J. P., A.M.I.C.E. (£3 3s., £2 2s., £1 1s.)	6	6	0
Keele, T. W.	3	3	0
Keep, J.	5	5	0
Kinloch, J., M.A.	2	2	0
Knox, Hon. Edward, M.L.C. (£20, £10)	30	0	0
Knox, E. W.	2	2	0
Latta, G. J.	1	1	0
Leibus, A., Ph.D., M.A. (£5 5s., £2 2s., £1 1s.)	8	8	0
Lenehan, H. A.	2	2	0
Liversidge, Professor, F.R.S. (£10, 21s., 21s., £3 3s.)	15	5	0
Lowe, Edwin	3	3	0
MacDonald, E.	2	2	0
MacDonnell, S.	1	1	0
MacDonnell, W. (£5, £2 2s.)	7	2	0
Mackenzie, John, F.G.S.	5	0	0
MacPherson, Rev. P., M.A. (£2 2s., £2 2s.)	4	4	0
Makin, G. E.	1	1	0
Mann, J. F.	3	3	0
Manning, F. N., M.D., St. And. (£5 5s., £2 2s.)	7	7	0
Matthews, Robert C. (£1 1s., £1 1s.)	2	2	0
Markey, James, L.R.C.P., Edin.	1	1	0
Marsden, Right Rev. Dr.	1	1	0
Martin, Rev. G.	2	2	0
Merriman, J.	5	5	0
Moir, James	3	3	0
Moore, Charles, F.L.S. (£5, £2 2s.)	7	2	0
Morehead, R. A. A. (£10, £5)	15	0	0
Morley, F.	2	2	0
Mullens, Josiah, F.R.G.S.	10	0	0
Mullins, J. F. L., M.A.	3	3	0
Murray, W. G. (£5, £1 1s.)	6	1	0
Myles, C. H.	2	2	0
Norton, Hon. James, M.L.C.	5	0	0
O'Reilly, Rev. A. Innes, B.A.	1	1	0
O'Reilly, W. W. J., M.D., Queen's Univ., Irel.	1	1	0

	£	s.	d.
Palmer, E.	1	1	0
Parrot, T. S.	1	1	0
Paterson, H.	2	2	0
Pedley, P. R.	5	5	0
Pittman, E. F.	1	1	0
Poolman, F.	5	5	0
Porter, Donald	2	2	0
Quaife, F. H., M.D., Mast. Surg., Glas.	3	3	0
Quirk, Rev. D. Placid, M.A.	1	1	0
Quodling, W. H. (21s., 21s.)	2	2	0
Riddell, C. E.	1	1	0
Roberts, John	5	0	0
Robertson, Thomas	2	2	0
Rolleston, Christopher, C.M.G. (£10, £5)	15	0	0
Russell, H. C., B.A., F.R.A.S. (£10, £3 3s., 21s., 21s., 21s.)	16	6	0
Sandy, James	2	2	0
Scott, Rev. W., M.A.	5	0	0
Selfe, Norman, M.I.C.E.	10	10	0
Sharp, J. B., J.P.	5	5	0
Shepherd, T. W.	1	1	0
Sleep, John S.	1	1	0
Smith, Hon. Professor, C.M.G., M.L.C. (£5, £2 2s., £1 1s.)	8	3	0
Smith, Robert	10	10	0
Suttor, W. H.	7	10	0
Taylor, W.	1	0	0
Tebbutt, J., F.R.A.S.	10	0	0
Thomas, H. A. (£3, £2 2s.)	5	2	0
Toohey, J. T.	10	0	0
Trouton, F. H. (£3 3s., £1 1s.)	4	4	0
Tucker, G. A., PhD.	10	10	0
Voss, H. H., J.P.	10	10	0
Walker, Thomas	500	0	0
Waterhouse, J.	2	2	0
Watt, A. J. (£5 5s., £1 1s.)	6	6	0
Watt, Charles	2	2	0
Ward, J. W. (£2 10s., £2 10s., £2 2s., £2 2s., £2 2s.)	11	6	0
Ward, R. D., M.R.C.S.	5	5	0
Webster, A. S.	10	0	0
Welch, E. W.	1	1	0
Weston, W. J.	2	2	0
Wilkinson, C. S., F.G.S. (£5 5s., £2 2s.)	7	7	0
Wilshire, J. T.	1	1	0
Woolrych, F. B. W. (£3 3s., £2 2s., £1 1s.)	6	6	0
Wright, H. G. A., M.R.C.S.E. (£5 5s., 21s., 21s., 21s., 21s., 21s.)	10	10	0
Young, L. H. G.	1	1	0
	£1,407	13	0

Contributions conditionally promised to the Building Fund.

In response to Circular, dated August, 1882.

	£	s.	d.
Abbott, The Hon. J. P., M.L.A.	5	5	0
Abbott, T. K., S.M.	5	0	0
Abbott, W. E.	5	0	0
Amos, Robert	10	10	0
Benbow, C. A.	2	2	0
Brady, A. J., L.K.Q., Coll. Phy., Irel.	1	1	0
Brodribb, The Hon. W. A., M.L.C., F.R.G.S.	5	0	0
Burnell, Arthur	2	2	0
Caird, G. S.	5	0	0

	£	s.	d.
Chisholm, E., M.R.C.S.E.	5	0	0
Codrington, J. F., L.R.C.P.L.	2	2	0
Conder, W. J.	5	0	0
Cox, The Hon. G. H., M.L.C.	20	0	0
Daintrey, Edwin	5	5	0
Dean, Alexander, J.P.	10	0	0
Du Faur, E., F.R.G.S.	2	0	0
Evans, George	5	0	0
Fairfax, E. Ross	10	10	0
Frazer, Hon. John, M.L.C.	10	10	0
Gipps, F. B.	3	0	0
Goodlet, J. H.	10	0	0
Goode, George, M.A., M.D., Trin. Coll., Dub.	1	1	0
Haege, Hermann	3	3	0
Helms, Albert, Ph.D.	2	2	0
Hills, Robert	5	0	0
Hitchins, E. L.	3	3	0
Knibbs, G. H., Mem. Inst. Surv.	4	4	0
Knox, George, M.A. (Cantab.)	5	0	0
Knox, E. W. (£5 promised, less £2 2s. paid)	2	18	0
Latta, G. J.	3	3	0
Leibius, A., Ph.D., M.A., F.C.S.	5	0	0
Lenehan, H. A.	2	2	0
Liversidge, Professor, F.R.S., &c.	5	5	0
Lord, The Hon. Francis, M.L.C.	10	0	0
McCulloch, A. H., junr., M.L.A.	10	0	0
Manning, Sir W. M., LL.D.	10	0	0
Meslée, E. M. de la	1	0	0
Mullens, Josiah, F.R.G.S.	10	0	0
Murray, W. G.	10	0	0
Nowlan, John	5	0	0
Poolman, F.	3	3	0
Roberts, C. J., C.M.G.	2	2	0
Roth, Henry Ling, F.S.S., &c.	2	2	0
Sharp, J. B., J.P.	5	5	0
Sharp, Henry	3	3	0
Sharp, Rev. W. Hey, M.A. (Oxon.)	2	0	0
Starkey, J. T.	2	0	0
Thomson, Dugald	1	1	0
Voss, H. H., J.P.	10	10	0
Webster, A. S.	10	0	0
Weston, W. J.	5	0	0
	£273	14	0

The present debt on the Building amounts to £900.

Annual Subscriptions promised to the Building Fund.

	£	s.	d.
Dixon, W. A., F.C.S.	1	1	0
Hirst, G. D.	1	1	0
Hunt, Robert, F.G.S., &c.	1	1	0
Leibius, Dr., F.C.S., &c.	1	1	0
Liversidge, Professor, F.C.S., &c.	1	1	0
Makin, G. E.	1	1	0
Moore, Charles, F.L.S.	1	1	0
Russell, H. C., B.A., F.R.A.S., &c.	1	1	0
Smith, The Hon. J., C.M.G., &c.	1	1	0
Wilkinson, G. S., F.G.S.	1	1	0
Wright, H. G. A., M.R.C.S.E.	1	1	0

ROYAL SOCIETY OF NEW SOUTH WALES.

JOURNAL

AND

PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

NEW SOUTH WALES,

FOR

1884.

INCORPORATED 1881.

VOL. XVIII.

EDITED BY

A. LIVERSIDGE, F.R.S.,
Professor of Chemistry and Mineralogy in the University of Sydney.

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

AGENTS FOR THE SOCIETY:
Messrs. Trübner & Co., 57, Ludgate Hill, London, E.C.

SYDNEY: THOMAS RICHARDS, GOVERNMENT PRINTER.

1885.

[illegible]

[illegible]

NOTICE.

The Native [illegible] of New South Wales [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] New South Wales [illegible] [illegible] [illegible] [illegible] [illegible] by Act of the Parliament of New South [illegible]

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 the Queen, it assumed its present title, and was incorporated by Act of the Parliament of New South Wales in 1881.

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VOLUME XVIII.

The Royal Society of New South Wales.

OFFICERS FOR 1884-85.

HONORARY PRESIDENT:

HIS EXCELLENCY THE RT. HON. LORD AUGUSTUS LOFTUS, G.C.B., &c., &c., &c.

PRESIDENT:

H. C. RUSSELL, B.A., F.R.A.S., &c.

VICE-PRESIDENTS:

W. A. DIXON, F.C.S.
DR. W. MORRIS.

HONORARY TREASURER:

H. G. A. WRIGHT, M.R.C.S., *Eng.*, L.S.A., *Lond.*

HONORARY SECRETARIES:

PROFESSOR LIVERSIDGE, F.R.S., F.C.S., &c.
DR. ADOLPH LEIBIUS, M.A., F.C.S.

COUNCIL:

CONDER, W. J.
HUNT, ROBERT, F.G.S., &c.
MOORE, CHAS., F.L.S.
PEDLEY, P. R.
ROLLESTON, CHR., C.M.G.
SMITH, HON. PROF., C.M.G., M.D., LL.D., M.L.C.

ASSISTANT SECRETARY:

W. H. WEBB.

ROYAL SOCIETY OF NEW SOUTH WALES INCORPORATION.

An Act to incorporate a Society called "The Royal Society of New South Wales." [16 December, 1881.]

WHEREAS a Society called (with the sanction of Her Most Gracious Majesty the Queen) "The Royal Society of New South Wales" has under certain rules and by-laws been formed at Sydney in the Colony of New South Wales for the encouragement of studies and investigations in Science Art Literature and Philosophy And whereas the Council of the said Society is at the present time composed of the following office-bearers and members His Excellency the Right Honorable Lord Augustus Loftus P.C. G.C.B. Honorary President The Honorable John Smith C.M.G. M.D. LL.D. President and Charles Moore Esquire F.L.S. Director of the Botanic Gardens Sydney and Henry Chamberlaine Russell Esquire B.A. (Sydney) F.R.A.S. F.M.S. London Government Astronomer for New South Wales Vice-Presidents and H. G. A. Wright Esquire M.R.C.S. Honorary Treasurer Archibald Liversidge Esquire Associate of the Royal School of Mines London Fellow of the Institute of Chemistry of Great Britain and Ireland and Professor of Geology and Mineralogy in the University of Sydney and Carl Adolph Leibius Esquire Doctor of Philosophy of the University of Heidelberg Fellow of the Institute of Chemistry of Great Britain and Ireland Honorary Secretaries W. A. Dixon Fellow of the Institute of Chemistry of Great Britain and Ireland G. D. Hirst Esquire Robert Hunt Esquire Associate of the Royal School of Mines London Deputy Master Sydney Branch Royal Mint Eliezer L. Montefiore Esquire Christopher Rolleston Esquire C.M.G. Preamble.

Charles Smith Wilkinson Esquire Government Geologist Members of the Council And whereas it is expedient that the said Society should be incorporated and should be invested with the powers and authorities hereinafter contained Be it therefore enacted by the Queen's Most Excellent Majesty by and with the advice and consent of the Legislative Council and Legislative Assembly of New South Wales in Parliament assembled and by the authority of the same as follows :—

Interpretation clause.

1. For the purposes of this Act the following words in inverted commas shall unless the context otherwise indicate bear the meaning set against them respectively—

"Corporation" the Society hereby incorporated

"Council" the Members of the Council at any duly convened meeting thereof at which a quorum according to the by-laws at the time being shall be present

"Secretary" such person or either one of such persons who shall for the time being be the Secretary or Secretaries honorary or otherwise of the said Society (saving and excepting any Assistant Secretary of the said Society).

Incorporation clause.

2. The Honorary President the President Vice-Presidents Officers and Members of the said Society for the time being and all persons who shall in manner provided by the rules and by-laws for the time being of the said Society become members thereof shall be for the purposes hereinafter mentioned a body corporate by the name or style of "The Royal Society of New South Wales" and by that name shall and may have perpetual succession and a common seal and shall and may enter into contracts and sue and be sued plead and be impleaded answer and be answered unto defend and be defended in all Courts and places whatsoever and may prefer lay and prosecute any indictment information and prosecution against any person whomsoever and any summons or other writ and any notice or other proceeding which it may be requisite to serve upon the Corporation may be served upon the Secretary or one of the Secretaries as the case may be or if there be no Secretary or if the Secretaries or Secretary be absent from the Colony then upon the President or either of the Vice-Presidents.

Rules and by-laws.

3. The present rules and by-laws of the said Society shall be deemed and considered to be and shall be the rules and by-laws of the said Corporation save and except in so far as any of them are or shall or may be altered varied or repealed under the powers for that purpose therein contained or are

or may be inconsistent or incompatible with or repugnant to any of the provisions of this Act or any of the laws now or hereafter to be in force in the said Colony.

4. The Corporation shall have power to purchase acquire and hold lands and any interest therein and also to sell and dispose of the said lands or any interest therein and all lands tenements hereditaments and other property of whatever nature now belonging to the said Society under the said rules and by-laws or vested in Trustees for them shall on the passing of this Act be vested in and become the property of the said Corporation subject to all charges claims and demands in anywise affecting the same. **Power to acquire and hold and to sell lands &c.**

5. The ordinary business of the Corporation in reference to its property shall be managed by the Council and it shall not be lawful for individual members to interfere in any way in the management of the affairs of the Corporation except as by the rules and by-laws for the time being shall be specially provided. **Ordinary business to be managed by the Council.**

6. The Council shall have the general management and superintendence of the affairs of the Corporation and excepting the appointment of President and Vice-Presidents and other honorary officers who shall be appointed as the by-laws of the Society shall from time to time provide the Council shall have the appointment of all officers and servants required for carrying out the purposes of the Society and of preserving its property and it may also define the duties and fix the salaries of all officers Provided that if a vacancy shall occur in the Council during any current year of the Society's proceedings it shall be lawful for the Council to elect a member of the Society to fill such vacancy for the unexpired portion of the then current year The Council may also purchase or rent land houses or offices and erect buildings or other structures for any of the purposes for which the Society is hereby incorporated and may borrow money for the purposes of the Corporation on mortgages of the real and chattel property of the Corporation or any part thereof or may borrow money without security provided that the amount so borrowed without security shall never exceed in the aggregate the amount of the income of the Corporation for the last preceding year and the Council may also settle and agree to the covenants powers and authorities to be contained in the securities aforesaid. **Powers of Council.**

7. In the event of the funds and property of the Corporation being insufficient to meet its engagements each member thereof shall in addition to his subscription for the **Liability of members.**

then current year be liable to contribute a sum equal thereto towards the payment of such engagements but shall not be otherwise individually liable for the same and no member who shall have commuted his annual subscription shall be so liable for any amount beyond that of one year's subscription.

Custody of common seal.

8. The Council shall have the custody of the common seal of the Corporation and have power to use the same in the affairs and business of the Corporation and for the execution of any of the securities aforesaid and may under such seal authorize any person without such seal to execute any deed or deeds and do such other matter as may be required to be done on behalf of the Corporation but it shall not be necessary to use the said seal in respect of the ordinary business of the Corporation nor for the appointment of their Secretaries Solicitor or other officers.

Certified copy of rules and by-laws to be evidence.

9. The production of a printed or written copy of the rules and by-laws of the Corporation certified in writing by the Secretary or one of the Secretaries as the case may be to be a true copy and having the common seal of the Corporation affixed thereto shall be conclusive evidence in all Courts of such rules and by-laws and of the same having been made under the authority of this Act.

Elections not made in due time may be made subsequently.

10. In case any of the elections directed by the rules and by-laws for the time being of the Corporation to be made shall not be made at the times required it shall nevertheless be competent to the Council or to the members as the case may be to make such elections respectively at any ordinary meeting of the Council or at any annual or special general meeting held subsequently.

Secretary may represent Corporation for certain purposes.

11. The Secretary or either one of the Secretaries may represent the Corporation in all legal and equitable proceedings and may for and on behalf of the Corporation make such affidavits and do such acts and sign such documents as are or may be required to be done by the plaintiff or complainant or defendant respectively in any proceedings to which the Corporation may be parties.

INDEX TO RULES.

RULES.

(Revised October 1st, 1879.)

Additional Rules adopted November 5th, 1884, marked thus, XA, &c.

Object of the Society.

I. The object of the Society is to receive at its stated meetings original papers on Science, Art, Literature, and Philosophy, and especially on such subjects as tend to develop the resources of Australia, and to illustrate its Natural History and Productions.

Honorary President.

II. The Governor of New South Wales shall be *ex officio* Honorary President of the Society.

Other Officers.

III. The other Officers of the Society shall consist of a President, who shall hold office for one year only, but shall be eligible for re-election after the lapse of one year; two Vice-Presidents, a Treasurer, and one or more Secretaries, who, with six other members, shall constitute a Council for the management of the affairs of the Society.

Election of Officers and Council.

IV. The President, Vice-Presidents, Secretaries, Treasurer, and the six other members of Council, shall be elected annually by ballot at the General Meeting in the month of May.

V. It shall be the duty of the Council each year to prepare a list containing the names of members whom they recommend for election to the respective offices of President, Vice-Presidents, Hon. Secretaries and Hon. Treasurer, together with the names of six other members whom they recommend for election as ordinary members of Council.

The names thus recommended shall be proposed at one meeting of the Council, and agreed to at a subsequent meeting.

Such list shall be suspended in the Society's Rooms, and a copy shall be sent to each ordinary member not less than fourteen days before the day appointed for the Annual General Meeting.

VA. There shall be elected on to the Council for each ensuing year, at least two and not more than three members of the Society who were not members of the Council for the previous year.

VI. Each member present at the Annual General Meeting shall have the power to alter the list of names recommended by the Council, by adding to it the names of any eligible members not already included in it and removing from it an equivalent number of names, and he shall use this list with or without such alterations as a balloting list at the election of Officers and Council.

The name of each member voting shall be entered into a book, kept for that purpose, by two Scrutineers elected by the members present.

No ballot for the election of members of Council, or of new members, shall be valid unless twenty members at least shall record their votes.

Vacancies in the Council during the year.

VII. Any vacancies occurring in the Council of Management during the year may be filled up by the Council.

Candidates for admission.

VIII. Candidates must be at least twenty-one years of age.

Every candidate for admission as an ordinary member of the Society shall be recommended according to a prescribed form of certificate by not less than three members, to two of whom the candidate must be personally known.

Such certificate must set forth the names, place of residence, and qualifications of the candidate.

The certificate shall be read at the three Ordinary General Meetings of the Society next ensuing after its receipt, and during the intervals between those three meetings, it shall be suspended in a conspicuous place in one of the rooms of the Society.

The vote as to admission shall take place by ballot, at the Ordinary General Meeting at which the certificate is appointed to be read the third time, and immediately after such reading.

At the ballot the assent of at least four-fifths of the members voting shall be requisite for the admission of the candidate.

Entrance Fee and Subscriptions.

IX. The entrance money paid by members on their admission shall be Two Guineas; and the annual subscription shall be Two Guineas, payable in advance; but members elected prior to December, 1879, shall be required to pay an annual subscription of One Guinea only as heretofore.

The amount of ten annual payments may be paid at any time as a life composition for the ordinary annual payment.

IXA. The entrance fee and first annual subscription shall be paid within two months from the date of election; otherwise the election shall be void.

The Council may, however, in special cases, extend the period within which these payments must be made.

IXB. Composition fees shall be treated as capital, and shall be devoted to the Building Fund Account, or invested.

New Members to be informed of their election.

X. Every new member shall receive due notification of his election, and be supplied with a copy of the obligation (No. 3 in Appendix), together with a copy of the Rules of the Society, a list of members, and a card of the dates of meeting.

Members shall sign Rules—Formal admission.

XI. Every member who has complied with the preceding Rules shall at the first Ordinary General Meeting at which he shall be present sign a duplicate of the aforesaid obligation in a book to be kept for that purpose, after which he shall be presented by some member to the Chairman, who, addressing him by name, shall say:—"In the name of the Royal Society of New South Wales I admit you a member thereof."

Annual subscriptions, when due.

XII. Annual subscriptions shall become due on the 1st of May for the year then commencing. The entrance fee and first year's subscription of a new member shall become due on the day of his election.

XIIA. Persons elected on or after the first day of October in any year shall pay the annual contribution as in advance for the following year, but in every case within two months after notification of their election has been made to them by the Honorary Secretary.

Members whose subscriptions are unpaid not to enjoy privileges.

XIII. An elected member shall not be entitled to attend the meetings or to enjoy any privilege of the Society, nor shall his name be printed in the list of the Society, until he shall have paid his admission fee and first annual subscription, and have returned to the Secretaries the obligation signed by himself.

Subscriptions in arrears.

XIV. Members who have not paid their subscriptions for the current year, on or before the 31st of May, shall be informed of the fact by the Hon. Treasurer.

No member shall be entitled to vote or hold office while his subscription for the previous year remains unpaid.

The name of any member who shall be two years in arrears with his subscriptions shall be erased from the list of members, but such member may be re-admitted on giving a satisfactory explanation to the Council, and on payment of arrears.

At the meeting held in July, and at all subsequent meetings for the year, a list of the names of all those members who are in arrears with their annual subscriptions shall be suspended in the Rooms of the Society. Members shall in such cases be informed that their names have been thus posted.

XIVA. Any member in arrears shall cease to receive the Society's publications, and shall not be entitled to any of the privileges of the Society until such arrears are paid.

Resignation of Members.

XV. Members who wish to resign their membership of the Society are requested to give notice in writing to the Honorary Secretaries, and are required to return all books or other property belonging to the Society.

Expulsion of Members.

XVI. A majority of members present at any ordinary meeting shall have power to expel an obnoxious member from the Society, provided that a resolution to that effect has been moved and seconded at the previous ordinary meeting, and that due notice of the same has been sent in writing to the member in question, within a week after the meeting at which such resolution has been brought forward.

Honorary Members.

XVII. The Honorary Members of the Society shall be persons who have been eminent benefactors to this or some other of the Australian Colonies, and distinguished patrons and promoters of the objects of the Society. Every person proposed as an Honorary Member must be recommended by the Council and elected by the Society. Honorary Members shall be exempted from payment of fees and contributions: they may attend the meetings of the Society, and they shall be furnished with copies of the publications of the Society, but they shall have no right to hold office, to vote, or otherwise interfere in the business of the Society.

The number of Honorary Members shall not at any one time exceed twenty, and not more than two Honorary Members shall be elected in any one year.

Corresponding Members.

XVIII. Corresponding Members shall be persons, not resident in New South Wales, of eminent scientific attainments, who may have furnished papers or otherwise promoted the objects of the Society.

Corresponding Members shall be recommended by the Council, and be balloted for in the same manner as ordinary Members.

Corresponding Members shall possess the same privileges only as Honorary Members.

The number of Corresponding Members shall not exceed twenty-five, and not more than three shall be elected in any one year.

Ordinary General Meetings.

XIX. An Ordinary General Meeting of the Royal Society, to be convened by public advertisement, shall take place at 8 p.m., on the first Wednesday in every month, during the last eight months of the year; subject to alteration by the Council with due notice.

Order of Business.

XX. At the Ordinary General Meetings the business shall be transacted in the following order, unless the Chairman specially decide otherwise:—

1—Minutes of the preceding Meeting.
2—New Members to enrol their names and be introduced.
3—Ballot for the election of new Members.
4—Candidates for membership to be proposed.
5—Business arising out of Minutes.
6—Communications from the Council.
7—Communications from the Sections.
8—Donations to be laid on the Table and acknowledged.
9—Correspondence to be read.
10—Motions from last Meeting.
11—Notices of Motion for the next Meeting to be given in.
12—Papers to be read.
13—Discussion.
14—Notice of Papers for the next Meeting.

XXa. At the ordinary meetings of the Society nothing relating to its regulations or management, except as regards the election or ejection of members, shall be brought forward, unless the same shall have been announced in the notice calling the meeting, or be otherwise provided for in these Rules.

XXb. A special meeting of the Society may be called by the Council, provided that seven days notice be given by advertisement, or shall be so called on a requisition signed by at least twenty-five members of the Society, to consider any special business thus notified.

Annual General Meeting.—Annual Reports.

XXI. A General Meeting of the Society shall be held annually in May, to receive a Report from the Council on the state of the Society, and to elect Officers for the ensuing year. The Treasurer shall also at this meeting present the annual financial statement.

Admission of Visitors.

XXII. Every ordinary member shall have the privilege of introducing two friends as visitors to an Ordinary General Meeting of the Society or its Sections, on the following conditions :—

1. That the name and residence of the visitors, together with the name of the member introducing them, be entered in a book at the time.
2. That they shall not have attended two consecutive meetings of the Society or of any of its Sections in the current year.

The Council shall have power to introduce visitors irrespective of the above restrictions.

Council Meetings.

XXIII. Meetings of the Council of Management shall take place on the last Wednesday in every month, and on such other days as the Council may determine.

XXIIIA. The President or Hon. Secretaries, or any three Members of the Council, may call a meeting of the Council, provided that due notice of the same has been sent to each Member of the Council at least three days before such meeting.

Absence from Meetings of Council.—Quorum.

XXIV. Any member of the Council absenting himself from three consecutive meetings of the Council, without giving a satisfactory explanation in writing, shall be considered to have vacated his office. No business shall be transacted at any meeting of the Council unless three members at least are present.

Duties of Secretaries.

XXV. The Honorary Secretaries shall perform, or shall cause the Assistant Secretary to perform, the following duties:—

1. Conduct the correspondence of the Society and Council.
2. Attend the General Meetings of the Society and the meetings of the Council, to take minutes of the proceedings of such meetings, and at the commencement of such to read aloud the minutes of the preceding meeting.
3. At the Ordinary Meetings of the members, to announce the presents made to the Society since their last meeting; to read the certificates of candidates for admission to the Society, and such original papers communicated to the Society as are not read by their respective authors, and the letters addressed to it.
4. To make abstracts of the papers read at the Ordinary General Meetings, to be inserted in the Minutes and printed in the Proceedings.
5. To edit the Transactions of the Society, and to superintend the making of an Index for the same.
6. To be responsible for the arrangement and safe custody of the books, maps, plans, specimens, and other property of the Society.

7. To make an entry of all books, maps, plans, pamphlets, &c., in the Library Catalogue, and of all presentations to the Society in the Donation Book.

8. To keep an account of the issue and return of books, &c., borrowed by members of the Society, and to see that the borrower, in every case, signs for the same in the Library Book.

9. To address to every person elected into the Society a printed copy of the Forms Nos. 2 and 3 (in the Appendix), together with a list of the members, a copy of the Rules, and a card of the dates of meeting; and to acknowledge all donations made to the Society, by Form No. 6.

10. To cause due notice to be given of all Meetings of the Society and Council.

11. To be in attendance at 4 p.m. on the afternoon of Wednesday in each week during the session.

12. To keep a list of the attendances of the members of the Council at the Council Meetings and at the ordinary General Meetings, in order that the same may be laid before the Society at the Annual General Meeting held in the month of May.

The Honorary Secretaries shall, by mutual agreement, divide the performance of the duties above enumerated.

The Honorary Secretaries shall, by virtue of their office, be members of all Committees appointed by the Council.

Contributions to the Society.

XXVI. Contributions to the Society, of whatever character, must be sent to one of the Secretaries, to be laid before the Council of Management. It will be the duty of the Council to arrange for promulgation and discussion at an Ordinary Meeting such communications as are suitable for that purpose, as well as to dispose of the whole in the manner best adapted to promote the objects of the Society.

XXVIA. The original copy of every paper communicated to the Society, with the illustrative drawings, shall become the property of the Society unless stipulation be made to the contrary; and authors shall not be at liberty, save by permission of the Council, to publish the papers they have communicated, until such papers or abstracts of them, have appeared in the Journal or other publications of the Society.

XXVIB. If any paper of importance is communicated during the recess, the same may be ordered for publication by the Council, without being read to the Society.

Management of Funds.

XXVII. The funds of the Society shall be lodged at a Bank named by the Council of Management. Claims against the Society, when approved by the Council, shall be paid by the Treasurer.

All cheques shall be countersigned by a member of the Council.

*Money Grants.**

XXVIII. Grants of money in aid of scientific purposes from the funds of the Society—to Sections or to members—shall expire on the 1st of November in each year. Such grants, if not expended, may be re-voted.

XXIX. Such grants of money to Committees and individual members shall not be used to defray any personal expenses which a member may incur.

Audit of Accounts.

XXX. Two Auditors shall be appointed annually, at an Ordinary Meeting, to audit the Treasurer's Accounts. The accounts as audited to be laid before the Annual Meeting in May.

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* Applicants for money grants are required to supply the following information :—

1. The nature of the research and the scientific results expected to follow therefrom.
2. The amount asked for.
3. Whether any previous grant has been received from any source, and, if so, with what results.
4. Whether any portion of the grant is to be devoted to personal remuneration.
5. What apparatus (if any) of permanent value will be required.

Property of the Society to be vested in the President, &c.

XXXI. All property whatever belonging to the Society shall be vested in the President, Vice-Presidents, Hon. Treasurer, and Hon. Secretaries for the time being, in trust for the use of the Society; but the Council shall have control over the disbursements of the funds and the management of the property of the Society.

SECTIONS.

XXXII. To allow those members of the Society who devote attention to particular branches of science fuller opportunities and facilities of meeting and working together with fewer formal restrictions than are necessary at the general Monthly Meetings of the Society,—Sections or Committees may be established in the following branches of science:—

Section A.—Astronomy, Meteorology, Physics, Mathematics, and Mechanics.

Section B.—Chemistry and Mineralogy, and their application to the Arts and Agriculture.

Section C.—Geology and Palæontology.

Section D.—Biology, *i.e.*, Botany and Zoology, including Entomology.

Section E.—Microscopical Science.

Section F.—Geography and Ethnology.

Section G.—Literature and the Fine Arts, including Architecture.

Section H.—Medical.

Section I.—Sanitary and Social Science and Statistics.

Section Committees—Card of Meetings.

XXXIII. The first meeting of each Section shall be appointed by the Council. At that meeting the members shall elect their own Chairman, Secretary, and a Committee of four; and arrange the days and hours of their future meetings. A card showing the dates of each meeting for the current year shall be printed for distribution amongst the members of the Society.

Membership of Sections.

XXXIV. Only members of the Society shall have the privilege of joining any of the Sections.

Reports from Sections.

XXXV. There shall be for each Section a Chairman to preside at the meetings, and a Secretary to keep minutes of the proceedings, who shall jointly prepare and forward to the Hon. Secretaries of the Society, on or before the 7th of December in each year, a report of the proceedings of the Section during that year, in order that the same may be transmitted to the Council.

Reports.

XXXVI. It shall be the duty of the President, Vice-Presidents, and Honorary Secretaries to annually examine into and report to the Council upon the state of—

1. The Society's house and effects.
2. The keeping of the official books and correspondence.
3. The library, including maps and drawings.
4. The Society's cabinets and collections.

Cabinets and Collections.

XXXVII. The keepers of the Society's cabinets and collections shall give a list of the contents, and report upon the condition of the same to the Council annually.

Documents.

XXXVIII. The Honorary Secretaries and Honorary Treasurer shall see that all documents relating to the Society's property, the obligations given by members, the policies of insurance, and other securities shall be lodged in the Society's iron chest, the contents of which shall be inspected by the Council once in every year; a list of such contents shall be kept, and such list shall be signed by the President or one of the Vice-Presidents at the annual inspection.

Branch Societies.

XXXIX. The Society shall have power to form Branch Societies in other parts of the Colony.

Library.

XL. The members of the Society shall have access to, and shall be entitled to borrow books from the Library, under such regulations as the Council may think necessary.

Alteration of Rules.

XLI. No alteration of, or addition to, the Rules of the Society shall be made unless carried at two successive General Meetings, at each of which twenty-five members at least must be present.

THE LIBRARY.

1. The Library shall be open for consultation and for the issue and return of books daily (except Saturday), between 1·30 and 6 p.m., and on Saturdays from 9 a.m. to 1·30 p.m.; also, on the evenings of Monday, Wednesday, and Friday, from 7 to 10 p.m.

1A. The Library will not be open on public holidays.

2. No book shall be issued without being signed for in the Library Book.

3. Members are not allowed to have more than two volumes at a time from the Library, without special permission from one of the Honorary Secretaries, nor to retain a book for a longer period than fourteen days; but when a book is returned by a member it may be borrowed by him again, provided it has not been bespoken by any other member. Books which have been bespoken shall circulate in rotation, according to priority of application.

4. Scientific Periodicals and Journals will not be lent until the volumes are completed and bound.

4A. Dictionaries, Encyclopædias, and other works of reference and cost, Atlases, Books and Illustrations in loose sheets, Drawings, Prints and unbound numbers of Periodicals and Works, Journals, Transactions and Proceedings of Societies or Institutions, Works of a Series, Maps or Charts, are not to be removed from the Library without the written order of the President or one of the Hon. Secretaries.

5. Members retaining books longer than the time specified shall be subject to a fine of sixpence per week for each volume.

6. The books which have been issued shall be called in by the Secretaries twice a year; and in the event of any book not being returned on those occasions, the member to whom it was issued shall be answerable for it, and shall be required to defray the cost of replacing the same.

7. No stranger shall be admitted to the Library except by the introduction of a member, whose name, together with that of the visitor, shall be inserted in a book kept for that purpose.

8. Members shall not lay the paper upon which they are writing on any Book or Map.

No tracings shall be made without express permission from the Hon. Secretaries.

Form No. 1.

ROYAL SOCIETY OF NEW SOUTH WALES.

Certificate of a Candidate for Election.

Name

Qualification or occupation

Address

being desirous of admission into the Royal Society of New South Wales, we, the undersigned members of the Society, propose and recommend him as a proper person to become a member thereof.

Dated this day of 18 .

FROM PERSONAL KNOWLEDGE.	FROM GENERAL KNOWLEDGE.

Signature of candidate

Date received 18 .

N.B.—This certificate must be signed by three or more members, to two of whom the candidate must be personally known. The candidate must be at least twenty-one years of age. This certificate has to be read at three ordinary general meetings of the Society.

Form No. 2.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's House,

Sir, Sydney, 18 .

I have the honour to inform you that you have this day been elected a member of the Royal Society of New South Wales, and I beg to forward to you a copy of the Rules of the Society, a printed copy of an obligation, a list of members, and a card announcing the dates of meeting during the present session.

According to the Regulations of the Society (*vide* Rule No. 9), you are required to pay your admission fee of two guineas, and annual subscription of two guineas for the current year, before admission. You are also requested to sign and return the enclosed form of obligation at your earliest convenience.

I have, &c.,

To Hon. Secretary.

Form No. 3.

ROYAL SOCIETY OF NEW SOUTH WALES.

I, the undersigned, do hereby engage that I will endeavour to promote the interests and welfare of the Royal Society of New South Wales, and to observe its Rules and By-laws, as long as I shall remain a member thereof.

Signed,

Address

Date

Form No. 4.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's House,
Sydney, 18 .

Sir,

I have the honour to inform you that your annual subscription of for the current year became due to the Royal Society of New South Wales on the 1st of May last.

It is requested that payment may be made by cheque or Post Office order drawn in favour of the Hon. Treasurer.

I have, &c.,

To

Hon. Treasurer.

Form No. 5.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's House,
Sydney, 18 .

Sir,

I am desired by the Royal Society of New South Wales to forward to you a copy of its Journal for the year 18 , as a donation to the library of your Society.

I am further requested to mention that the Society will be thankful to receive such of the very valuable publications issued by your Society as it may feel disposed to send.

I have the honour to be,
Sir,
Your most obedient servant,

Hon. Secretary.

Form No. 6.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's House,
Sydney, 18 .

Sir,

On behalf of the Royal Society of New South Wales, I beg to acknowledge the receipt of and I am directed to convey to you the best thanks of the Society for your most valuable donation.

I have the honour to be,
Sir,
Your most obedient servant,

Hon. Secretary.

Form No. 7.

Balloting List for the Election of the Officers and Council.

ROYAL SOCIETY OF NEW SOUTH WALES.

Date........................

BALLOTING LIST for the election of the Officers and Council.

Present Council.	Names proposed as Members of the new Council.	
	President.	
	Vice-Presidents.	
	Hon. Treasurer.	
	Hon. Secretaries.	
	Members of Council.	

If you wish to substitute any other name in place of that proposed, erase the printed name in the second column, and write opposite to it, in the third, that which you wish to substitute.

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; papers published in the Transactions of the Philosophical Society are also included. The numerals indicate the number of such contributions.

† Members of the Council.

‡ Life Members.

Elected.		
1877		Abbott, Joseph Palmer, 6 Wentworth Court, Elizabeth-street.
1877	P 1	Abbott, Thomas Kingsmill, S.M., Central Police Office, Sydney.
1877	P 3	Abbott, W. E., Abbotsford, Wingen.
1877		Adams, Francis, A.J.S. Bank, Sydney.
1864		Adams, P. F., Surveyor General, Kirribilli Point, St. Leonards.
1878		Alexander, George M., 48, Margaret-street.
1874		Alger, John, Macquarie-street.
1870		Allen, Sir George Wigram, K.C.M.G., Phillip-street.
1868		Allerding, F., Hunter-street.
1873		Allerding, H. R., Hunter-street.
1856		Allwood, Rev. Canon, B.A. *Cantab.*, "Rorklands," Edgecliff Road, Woollahra.
1881		Amos, Robert, "Renneil," Elizabeth Bay Road.
1877		Anderson, H. C. L., M.A., "Aberfeldie," Summer Hill.
1876		Atchison, Cunningham Archibald, C.E., North Shore.
1873		Atherton, Ebenezer, M.R.C.S. *Eng.*, Macquarie-street.
1882		Atkinson, J. J. O., J. P., Oldbury, Moss Vale.
1878		Backhouse, Alfred P., M.A., District Court Judge, "Melita," Elizabeth Bay.
1877		Baker, E. A., Erith Colliery, Bundanoon.
1878		Balfour, James, The Oriental Bank, Pitt-street.
1881		Barff, H. E., M.A., Registrar, Sydney University.
1878		Barker, Francis Lindsay, Pitt-street.
1879		Barraclough, William, Donnelly-street, Balmain.
1884		Barry, The Most Rev. Dr. A., D.D., D.C.L., LL.D., Bishop's Court, Randwick.
1875		Bartels, W. C. W., Richmond Terrace.
1876		Bassett, W. F., M.R.C.S., *Eng.*, Bathurst.
1878		Bayley, George W. A., Railway Department, Phillip-street.
1884		Baynes, Richd. B., Victoria Barracks.

NOTICE.

Members are particularly requested to communicate any change of address to the Hon. Secretaries, for which purpose this slip is inserted.

Corrected Address.

Name ....

....

Titles, &c. ....

....

Address ....

....

....

Date..

To the

Hon. Secretaries,

The Royal Society of N.S.W.,

37, Elizabeth-st., Sydney.

Elected.		
1880		Beattie, Josh. A., Lic. K. & Q. Coll. Phys., *Irel.*, Lic. R. Coll. Sur., *Irel.*, Coast Hospital, Little Bay.
1875		Bedford, W. J. G., M.R.C.S. *Eng.*, "Waratah," Newtown, Hobart, Tasmania.
1868		Beilby, E. T., 91, Pitt-street.
1875		Belgrave, Thomas B., M.D. *Edin.*, M.R.C.S. *Eng.*, 60, Castlereagh-street.
1877		Belfield, Algernon H., "Eversleigh," Armidale.
1875		Belisario, John, M.D., Lyons' Terrace.
1876		Benbow, Clement A., 30, College-street.
1869	P 2	Bensusan, S. L., 44, Castlereagh-street.
1877		Bennett, George F., C.M.Z.S., Toowoomba, Queensland.
1878		Berney, Augustus, H. M. Customs, Sydney.
1878		Bestic, Edwin Henry, L.R.C.S., *Irel.*, L.R.C.P., *Edin.*, Phillip-street.
1884		Binstead, Wm. H. Glenthorne, Boulevard, Petersham.
1878		Black, Reginald James, Union Club.
1878		Black, Morrice A., F.I.A., Actuary, Australian Mutual Provident Society, Pitt-street.
1880		Blackmann, C. H. E., 375, George-street.
1877		Bladen, Thomas, 205½, Victoria-street.
1883		Blaxland, Herbert, M.R.C.S.E., L.R.C.P. *Lond.*, Hospital for the Insane, Callan Park.
1872		Bolding, H. J., P.M., Narrabri.
1879		‡Bond, Albert, Bell's Chambers, Pitt-street.
1874		Bowen, George M. C., "Keston," Kirribilli Point, North Shore.
1876		Brady, Andrew John, Lic. K. & Q. Coll. Phys. *Irel.*, Lic. R. Coll. Sur. *Irel.*, 3, Lyons' Terrace.
1871	P 1	Brazier, John, C.M.Z.S., Corr. M.R.S., Tas., 82, Windmill-street.
1868		Brereton, John Le Gay, M.D. *St. Andrew's*, L.R.C.S. *Edin.*, Domain Terrace.
1879		Brindley, Thomas, St. Stephen's House, Bligh-street, Newtown.
1876		Brodribb, W. A., The Hon., M.L.C, F.R.G.S., 133, Macquarie-street.
1878		‡Brooks, Joseph, F.R.G.S., "Hope Bank," Nelson-st., Woollahra.
1876		Brown, Henry Joseph, Newcastle.
1880		Brown, John Studd, Dubbo.
1876		Brown, Thomas, Eskbank, Bowenfels.
1882		Bullock, Chas. Cyrus, 2, Euroka Terrace, St. Leonards.
1877		Bundock, W. C., "Wyangarie," Casino.
1877		Burnell, Arthur, "Clapton," Forbes-street.
1875		Burton, Edmund, Land Titles Office, Elizabeth-street North.
1875		Busby, The Hon. William, M.L.C., "Redleaf," South Head Road, Woollahra.
1880		Bush, Thomas James, Engineer's Office, Gas Works, Sydney.
1876		Cadell, Alfred, Vegetable Creek, New England.
1876		Cadell, Hon. Thomas, M.L.C., Australian Club.
1880		Caird, George S., "Lillingstone," Ocean-street, Woollahra.
1876		Campbell, Allan, L.R.C.P., *Glasgow*, Yass.
1876		Campbell, The Hon. Alexander, M.L.C., Woollahra.
1868		Campbell, The Hon. Charles, M.L.C., "Clunes," South Kingston.

Elected.		
1879		Cameron, John, Geodetic Surveyor, Trig. Branch, Surveyor-General's Office.
1879		Campbell, Revd. Joseph, M.A., "The Parsonage," Glen Innes.
1870		Cane, Alfred, 110, Victoria-street.
1876		Cape, Alfred J., M.A., *Syd.*, "Karoola," Edgecliff Road.
1882		Carruthers, Chas. Ulic, L.K.Q.C.P., L.R.C.S., *Irel.*, Montague-street, Balmain.
1876		Chandler, Alfred, "Wambiana," Homebush.
1882		Chambers, Thos., F.R.C.P., F.R.C.S. *Edin.*, 1. Lyons' Terrace.
1879	P 1	‡Chard, J. S., District Surveyor, Armidale.
1878		Chatfield, Captn. William, Smith-street, Parramatta.
1884		Chesterman, Alfd. Hy., L.S., Surveyor General's Office.
1878		Chisholm, Edwin, M.R.C.S., E., L.S.A., &c., "Abergeldie," Ashfield.
1876		Codrington, John Fredk., M.R.C.S., E.; Lic. R.C. Phys., L.; Lic. R.C. Phys., *Edin.*, Orange.
1878		Collie, Revd. Robert, F.L.S., "The Manse," Wellington-street, Newtown.
1878		Colquhoun, George, "Rossdhu," Darlinghurst Road.
1880		Colyer, Henry Cox, M.A., "Clinton," Liverpool-street, Darlinghurst.
1876		Colyer, John Ussher Cox, A.S.N. Company, Sydney.
1856		Comrie, James, "Northfield," Kurrajong Heights.
1876		†Conder, Wm., Survey Office, Sydney.
1882		Conlan, George Nugent, R.N.R., care of Mr. C. E. Riddell, Union Club.
1882		Copeland, H. P. R., S.W.S. Camp, Narellan.
1882		Cornwell, Samuel, junr., Kent Brewery, Sydney.
1878		Cottee, Wm. Alfred, 2, Spring-street.
1880		Cox, The Hon. George Henry, M.L.C., "Winbourn," Penrith.
1859	P 1	Cox, James, M.D. *Edin.* C.M.Z.S., F.L.S., 73, Hunter-street.
1884		Cox, Saml. Herbert, F.C.S., F.G.S., 1 Victoria Terrace, Miller-street, North Shore.
1865	P 2	Cracknell, E. C., Superintendent of Telegraphs, Telegraph Office, George-street.
1869		Creed, J. Mildred, M.R.C.S. *Eng.*, L.R.C.P., *Edin.*, Woollahra.
1870		Croudace, Thomas, Lambton.
1881		Crummer, Henry, 47, Rialto Terrace, Darlinghurst.
1877		Cunningham, Andrew, "Lanyon," Queanbeyan.
1882		Curran, Rev. John Milne, Dubbo.
1873		Daintrey, Edwin, "Æolia," Randwick.
1876		Dansey, George Frederick, M.R.C.S. *London*, Cleveland-street, Redfern.
1875		Dangar, Frederick H., care of Dangar, Gedye, & Co., Macquarie Place.
1876		Darley, Cecil West, Mount-street, St. Leonards.
1877		Darley, Hon. F. M., M.L.C., B.A., Wentworth Court, Elizabeth-street.
1879		Davenport, Sir Samuel, K.C.M.G., "Beaumont," Adelaide, South Australia.
1878		Dean, Alexander, J.P., Elizabeth-street.
1877		Deck, John Field, M.D., Ashfield.

Elected.		
1856		Deffell, George H., Chief Commissioner, Insolvency Court, Phillip-street.
1881		Delarue, Leopold H., 378, George-street.
1875		De Salis, The Hon. Leopold Fane, M.L.C., "Tharwa," Queanbeyan.
1876		Dight, Arthur, Richmond.
1875	P 9	†Dixon, W. A., F.C.S., Fellow and Member Inst. of Chemistry of Gt. Britain and Irel., Lecturer on Chemistry, The Technical College, School of Arts, Pitt-street, Sydney, *Vice-President.*
1882		Dixon, Fletcher, English, Scottish, and Australian Chartered Bank, George-street.
1880		Dixson, Craig, M.B., C.M., *Edin.*, M.R.C.S., *Eng.*, M.D. *Syd.*, 2, Clarendon Terrace, Elizabeth-street.
1880		Dixson, Thomas, M.B., Mast. Surg., *Edin.*, "Ellalong," Ashfield.
1876		Docker, Ernest B., M.A. *Sydn.*, "Carhullen," Parramatta.
1879		Docker, Wilfred L., "Kirketon," Darlinghurst Road.
1882		Donkin, J. B., The Exchange, Sydney.
1876		Douglas, James, L.R.C.S. *Edin.*, 3, Hope Terrace, Glebe Road.
1879		Dowling, Neville, Wallis-street, Woollahra.
1884		Dowling, Edward, "Warung," Blue's Point, North Shore.
1876		Drake, William Hedley, Fellow of the Inst. of Bankers, Lond., Colonial Bank of New Zealand, Napier, N.Z.
1873		Du Faur, Eccleston, F.R.G.S., "Marfa," Croydon.
1876		Eales, John, Duckenfield Park, Morpeth.
1876		Egan, Myles, M.R.C.S. *Eng.*, 2, Hyde Park Terrace, Liverpool-street.
1874		Eichler, Charles F., M.D. *Heidelberg*, M.R.C.S. *Eng.*, Bridge-street.
1876		Eldred, W. H., 62, Margaret-street.
1881		Elliott, F. W., Elizabeth Bay.
1876		Evans, George, "Como," Darling Point.
1881		Evans, Thomas, M.R.C.S., *E.*, 211, Macquarie-street North.
1881		Ewan, John Frazer, M.B., Mast. Surg. Univ. *Edin.*, Carlton Terrace, Wynyard Square.
1877		Fairfax, Edward R., 145, Macquarie-street.
1868		Fairfax, James R., *Herald* Office, Hunter-street.
1880		Ferguson, J. W., 70, Darlinghurst Road.
1881		Fiaschi, Thos., M.D., M. Ch., Univ. Pisa, 39, Phillip-street, Sydney.
1880		Finlayson, David, Manager, Union Bank, Pitt-street.
1876		Firth, Rev. Frank, Wesleyan Parsonage, Waverley.
1874		Fischer, Carl F., M.D., M.R.C.S., *Eng.*; L.R.C.P., *Lond.*; F.G.S.; F.L.S.; F.R.M.S.; Member Imp. Botanical and Zoological Society, Vienna; Corr. Member Imp. Geographical Society, Vienna.

Elected.		
1876		Fitzgerald, R. D., F.L.S., Deputy-Surveyor-General, Sydney.
1856		Flavelle, John, 340, George-street.
1880		Forbes, Alexr. Leith, M.A., Dept. of Public Instruction.
1879		‡Foreman, Joseph, M.R.C.S., L.R.C.P., *Edin.*, 161, Macquarie-street.
1863		Fortescue, G., M.B. *Lond.*, F.R.C.S., F.L.S., Lyons' Terrace.
1881		Foster, W. J., Temple Court, King-street.
1878		Fraser, Robert, Vickery's Buildings, 80A, Pitt-street.
1882		Fraser, Rev. John G., M.A., Warden of Camden College, Glebe Point.
1883	P 1	Fraser, John, B.A., *Edin.*, Délégué Général (pour l'Océanie), de l'Institution Ethnographique de Paris, Associate of the Victoria (Philosophical) Institute of Great Britain, "Sauchie House," West Maitland.
1878		Fuller, Francis John, Harbours and Rivers Office, Fitzroy Dock.
1881		Furber, T. F., Surveyor-General's Office.
1879		Gabriel, C. Louis, Australasian Club, Edinburgh, Scotland.
1880		Gardiner, Rev. Andrew, M.A., Glebe Point.
1884		Gardiner, John, Chief Examiner, Department of Public Instruction, Harrow Road.
1877		Garnsey, Rev. C. F., Christ Church Parsonage, Sydney.
1868	P 1	Garran, Andrew, LL.D., *Sydney Morning Herald* Office, Hunter-street.
1883		Garrett, H. Edwd., M.R.C.S.E., 37, Wynard Square West.
1877		Garvan, J. P., East St. Leonards.
1878		Gedye, Charles Townsend, "Eastbourne," Darling Point.
1878		George, Hugh, *Sydney Morning Herald* Office.
1876		George, W. R., 346, George-street.
1879		Gerard, Francis, Occupation of Lands Office.
1884		Gibbs, J. Burton, 70, Pitt-street North.
1876		Gilchrist, W. O., "Greenknowes," Potts's Point.
1884		Gill, Rev. Wm. Wyatt, B.A., *Lond.*, "Persica," Illawarra Road, Marrickville.
1875		Gilliat, Henry Alfred, Australian Club.
1876	P 2	Gipps, F. B., C.E., "Maida," Chandos-street, Ashfield.
1878		Goddard, William C., The Exchange, New Pitt-street.
1881		Goergs, Karl W., Riviere College, Woollahra.
1876		Goode, George, M.A., M.D., M. Ch., Trin. Coll., *Dub.*, Enfield House, Camden.
1883		Goode, Wm. Hy., M.A., M.D., Ch.M., Diplomate in State Medicine, *Dub.*, Surgeon Royal Navy, Corres. Mem. Royal Dublin Society, Mem. Brit. Med. Assoc., Lecturer on Medical Jurisprudence, University of Sydney, 159, Macquarie-street North.
1859		Goodlet, John H., George-street.
1876		Grahame, Hon. Wm., M.L.C., Strathearn House, Waverley.
1873		Greaves, W. A. B., "Braylesford," Bondi.
1881		Griffin, T. H. F., Commercial Bank, Richmond.
1878		Griffiths, Frederick C., Spring-street.
1877		Griffiths, G. Neville, The Domain, Sydney.

Elected.

1877 | | Gurney, T. T., M.A. *Cantab.*, late Fellow of St. John's College, Cambridge, Professor of Mathematics and Natural Philosophy, University of Sydney.
1880 | | Haege, Hermann, 93, Pitt-street.
1878 | | Hall, Richard T., "Thornton," Upper William-street.
1880 | | Halligan, Gerald H., C.E., "Eugowra," Hunter's Hill.
1882 | | Hammond, Mark J., M.L.A., Ashfield.
1882 | | Hankins, Geo. Thos., M.R.C.S.E., Liverpool-street, Hyde Park.
1881 | | Harcus, Lorimer E., Allt-street, Ashfield.
1877 | P 1 | Hargrave, Lawrence, 1, Macleay Villas, Rushcutter's Bay Road.
1881 | | ‡Harris, John, "Bulwarra," Jones-street, Ultimo.
1877 | | ‡Harrison, L. M., Macquarie Place.
1878 | P 2 | Hart, Ludovico, Kilcatten Lodge, Millswyn-street, South Yarra, Melbourne.
1884 | | Haswell, William Aitcheson, M.A., B.Sc., Demonstrator of Comparative Anatomy and Physiology, University of Sydney Australian Club.
1877 | P 1 | Hawkins, H. S., M.A., Balmain.
1874 | | Hay, The Hon. Sir John, K.C.M.G., M.L.C., A.M. *Aberdeen*. President of the Legislative Council, Rose Bay, Woollahra.
1876 | | Heaton, J. H., St. Stephens Club, Westminster, London.
1881 | | Helms, Albert, Ph. D., *Berlin*, Sydney University.
1875 | | Helsham, Douglass, "Eurimbulah," Port Curtis, Queensland.
1877 | | Henry, James, 750, George-street.
1884 | | Henson, Joshua B., C.E., Assistant City Engineer, Town Hall, Sydney.
1878 | | Herborn, E. W. L., "Flinton," Burwood.
1878 | | Herborn, Eugene, Licensed Surveyor, Bathurst.
1880 | | Hern, Charles E., 14, Cambridge Terrace, Hyde Park, London, W.
1876 | | Heron, Henry, solicitor, 53, Hunter-street.
1878 | | Hewett, Thomas Edward, Technical College, Sydney.
1879 | | Higgins, R. G., "Clifford," Potts's Point.
1879 | | Hills, Robert, Elizabeth Bay.
1879 | | Hitchins, Edwd. Lytton, "Florence," Victoria-street North, Darlinghurst.
1876 | P 2 | Hirst, Geo. D., 377, George-street.
1878 | | Hodgson, Rev. E. G., M.A. *Oxon.*, S.C.L., Vice-Warden of St. Paul's College, University.
1882 | | Hoff, August (changed name from Duckershoff) M.D. Univ. *Leipzig*, 197, Liverpool-street.
1876 | | Holroyd, Arthur Todd, M.B. *Cantab.*, M.D. *Edin.*, F.L.S., F.Z.S., F.R.G.S., Sherwood Scrubs, Parramatta.
1870 | | Horton, Rev. Thomas, Ina Terrace, Woollahra.
1879 | | Houison, Andrew, B.A., M.B.C.M., *Edin.*, 128, Phillip-street.
1877 | | Hume, J. K., "Beulah," Campbelltown.
1878 | | †Hunt, Robert, F.G.S., Associate of the Royal School of Mines, London, Deputy Master of the Royal Mint, Sydney.
1882 | | Hurst, George, M.B., Univ. *Lond.*, Mast. Surg. Univ. *Edin.*, 28, College-street, Hyde Park.

1879 | | Inglis, James, 28, Charlotte Place.
1880 | | Iredale, Lancelot, A.F., Goolhi, Gunnedah.

Elected.		
1878		Jackson, Arthur Levett, Government Printing Office.
1876		Jackson, Henry Willan, M.R.C.S. *Eng.*, Lic. R. C. Phys., *Edin.* 146, Phillip-street.
1879		Jarvie, Rev. A. Milne, Univ. Council, *Edin.*, "Manse," Jamison-street.
1879		Jefferis, Rev. James, LL.B., "The Retreat," Newtown.
1884		Jenkins, Edward Johnstone, M.A., M.B., *Oxon*, M.R.C.P., M.R.C.S., L.S.A., *Lond.*, Prince Alfred Hospital.
1879		Johnson, James W., "Brooksby," Double Bay.
1876		Jones, James Aberdeen, Lic. R.C. Phys. *Edin.*, Booth-street Balmain.
1876		Jones, Richard Theophilus, M.D. *Sydn.*, L.R.C.P. *Edin.*, Ashfield.
1867		Jones, P. Sydney, M.D. *Lond.*, F.R.C.S. *Eng.*, College-street.
1877		Jones, Edward Lloyd, 349, George-street, Sydney.
1874		Jones, James, Bathurst-street.
1879		Jones, John Trevor, C.E., North Shore.
1884		Jones, Llewellyn Chas. Russell, 33, Castlereagh-street.
1863		Josephson, Joshua Frey, F.G.S., Bellevue Hill, Double Bay.
1876	P 1	Josephson, J. P., Assoc. Mem. Inst. C.E., 235, Macquarie-street North.
1878		Joubert, Numa, Hunter's Hill.
1883		Kater, H. E., "Mount Broughton," Moss Vale.
1873		Keele, Thos. Wm., Harbours and Rivers Department, Phillip-street.
1877		Keep, John, "Broughton," Leichhardt.
1884		Kendall, Theodore M., B.A., L.R.C.P., L.R.C.S., *Lond.*, 50, Macleay-street.
1874		King, Philip G., "Banksia," William-street, Double Bay.
1878		Knaggs, Saml. J., M.D., 16, College-street.
1881		Knibbs, G. H., Mem. Inst. of Surveyors, Trig. Branch, Surveyor-General's Office.
1874		Knox, George, M.A., *Cantab.*, Phillip-street.
1875		Knox, Edward, The Hon., M.L.C., O'Connell-street.
1877		Knox, Edward W., "Lansdowne," Darling Point.
1877		Kopsch, G., 8, Boulevard, Petersham.
1878		Kyngdon, F. B., 221, Darlinghurst Road.
1878		Kyngdon, Fred. H., M.D. *Aberdeen*; L.S.A., *L.*; M.R.C.S., *E.*; C.M., *Aberdeen*, "Altona," North Shore.
1884		Kyngdon, Boughton, 69, Darlinghurst Road.
1884		Lackey, John, M.L.A., Union Club.
1883		Lane, Willm. H. H., 6, Bligh-street.
1874	P 1	Latta, G. J., "Hawthorne," Crystal-street, Petersham.
1876		Laure, Louis Thos., M.D. Surg. Univ. *Paris*, 138, Castlereagh-street.
1859	P 6	†Leibius, Adolph, Ph.D., Heidelberg, M.A., F.C.S.; Fel. Inst. Chemistry of Gt. Brit. and Irl.; Senior Assayer to the Sydney Branch of the Royal Mint, *Hon. Secretary*.

Elected.		
1874		Lenehan, Henry Alfred, Sydney Observatory.
1883		Lingen, J. T., M.A. *Cantab.*, 101, Elizabeth-street.
1883		Little, Wm., L.R.C.P., L.R.C.S. *Edin.*, Burwood.
1872	P 23	†Liversidge, Archibald, F.R.S.; Assoc. Roy. Sch. Mines, *Lond.*; F.C.S.; Fel. Inst. Chemistry of Gt. Brit. and Irl.; F.G.S.; F.L.S.; F.R.G.S.; Mem. Phy. Soc. London; Mem. Mineralogical Soc. Gt. Brit. and Irel.; Cor. Mem. Roy. Soc. Tas.; Cor. Mem. Senckenberg Institute, Frankfurt; Cor. Mem. Soc. d'Acclimat. Mauritius; Hon. Fel. Roy. Hist. Soc. Lond.; Mem. Min. Soc. of France; Professor of Chemistry and Mineralogy in the University of Sydney, *Hon. Secretary.* The University, Glebe.
1874		Lloyd, George Alfred, F.R.G.S., "Scottforth," Elizabeth Bay.
1881		Lloyd, Lancelot T., "Eurotah," William-street East.
1879		Loftus, His Excellency The Right Hon. Lord Augustus, G.C.B. &c., &c., &c., *Hon. President.*
1876		Lord, The Hon. Francis, M.L.C., North Shore.
1882		Lovell, R. Haynes, M.R.C.S., L.R.C.P., *Lond.* 26, Wynward Sq.
1878		Low, Hamilton, H.M. Customs.
1880		Low, Andrew S., "Merrylands," Granville.
1881		Lowe, Edwin, Wilgar Downs Station, *via* Girilambone.
1884		MacCormick Alexr., M.B., Ch.M., M.R.C.S.E, Demonstrator of Anatomy, University of Sydney.
1876		M'Culloch, A. H., jun., M.L.A., 121, Pitt-street.
1874		M'Cutcheon, John Warner, Assayer to the Sydney Branch of the Royal Mint.
1878		MacDonald, Ebenezer, "Woerden," Cambridge-street, Stanmore.
1868		MacDonnell, William J., F.R.A.S., Bank of New South Wales, Port Macquarie.
1877		MacDonnell, Samuel, 312, George-street, Sydney.
1882		MacGillivray, P. H., M.A., M.R.C.S., F.L.S., Sandhurst, Victoria.
1876		M'Kay, Dr., Church Hill.
1880	P 1	M'Kinney, Hugh G., Assoc. Mem. Inst. C.E., "Seaton," Point Piper Road, Paddington.
1876		MacLaurin, Henry Norman, M.A., M.D. Univ. *Edin.*, Lic. R. Coll. Sur. *Edin.*, No. 155, Macquarie-street.
1878	P 2	‡MacPherson, Rev. Peter, M.A., 187, Albion-street, Sydney.
1872		Mackenzie, John, F.G.S., Examiner of Coal Fields, Newcastle.
1874		Mackenzie, W. F., M.R.C.S., L.R.C.P. *Edin.*, *Eng.*, Lyons' Terrace.
1876		Mackenzie, Rev. P. F., 4, Jamieson-street.
1880		Mackenzie, R. M., Bond-street.
1884		Mackenzie, John Bower, M.I.C.E., Engineer's Office, Government Dockyard, Biloela, Sydney.
1876		Mackellar, Chas. Kinnard, M.B., C.M., *Glas.*, Macquarie-street.
1882		Madsen, Hans. F., "Hesselmed" House, Queen-street, Newtown.
1883		Maiden, Josh. Hy., Technological Museum, Sydney.
1878		Maitland, Duncan Mearns, "Afreba," Stanmore Road.
1873		Makin, G. E., Berrima.
1880		Manfred, Edmund C., Montague-street, Goulburn.

Elected.		
1877		Mann, John, F.L.S., 19, Hunter-street.
1881		Mann, Herbert W., care of Liverpool & London & Globe Insurance Co., Pitt-street.
1881		Manning, Sir W. M., LL.D., Primary Judge, "Walleroy," Edgecliff Road, Woollahra.
1873	P 6	Manning, James, Milson's Point, North Shore.
1876		Manning, Frederic Norton, M.D. Univ. *St. And.*, M.R.C.S. *Eng.*, Lic. Soc. Apoth. *Lond.*, Gladesville.
1869		Mansfield, G.A., 121, Pitt-street.
1878		Markey, James, L.R.C.S., *Irel.*, L.R.C. Phys., *Edin.*, Regent-street.
1880		Marano, G. V., M.D. Univ. *Naples*, Clarendon Terrace, Elizabeth-street.
1872		Marsden, The Right Rev. Dr., Bishop of Bathurst, Bathurst.
1876		Marshall, George, M.D. Univ. *Glas.*, Lic. R. Coll. S. *Edin.*, Lyons' Terrace.
1879		Masters, Edward, "Lurlei," Marrickville.
1875		Mathews, R. H., L.S., J.P., Singleton.
1879		Matthews, Robert, Tumut-street, Adelong.
1879		Meslée, E. Marin de la, Surveyor-General's Office.
1873		Milford, F., M.D. *Heidelberg*, M.R.C.S. *Eng.*, 3, Clarendon Terrace, Hyde Park.
1876		Millard, Rev. Henry Shaw, Newcastle Grammar School.
1884		Mills, Walter Wallace, 38, Sir John Young's Crescent, Domain.
1882		Milson, Alfred G., East St. Leonards.
1882		Milson, James, "Elamang," North Shore.
1875		Moir, James, 58, Margaret-street.
1875		Montefiore, E. L., Darlinghurst.
1850	P 5	†Moore, Charles, F.L.S., Director of the Botanic Gardens, Botanic Gardens.
1879		Moore, Fred. H., Exchange Buildings.
1850		Morehead, R. A. A., 30, O'Connell-street.
1876		Morgan, T. C., L.R.C.S. *Edin.*, M.K. & Q. Coll. Phys. *Ireland*, Australian Club.
1883		Morley, Frederick, 47, Surry-street.
1865	P 1	Morrell, G. A., C.E., Pitt-street.
1877		†Morris, William, Fel. Fac. Phys. and Surg. *Glas.*, F.R.M.S. Lond., 53, Castlereagh-street, *Vice-President*.
1880		Moses, David, J.P., Tenterfield.
1882		Moss, Sydney, 5, Hunter-street.
1879		Mountain, Adrian C., City Surveyor, Town Hall.
1877		‡Mullens, Josiah, F.R.G.S., Eldon Chambers, Pitt-street.
1879		Mullins, John, F.L., M.A., 209, Macquarie-street N.
1865		Murnin, M. E., "Eisenfels," Nattai.
1876		‡Murray, W. G., 93, Pitt-street.
1876		Myles, Chas. Henry, "Dingadee," Burwood.

Elected.		
1873		Neill, William, City Bank, Pitt-street.
1874		Neill, A. L. P., City Bank, Pitt-street.
1881		Newton, Dr. J. L., Mudgee.
1882		Norrie, Andrew, M.D., Mast. Surg., *Aberdeen* Univ., 177, Liverpool-street, Hyde Park.
1873		Norton, James, Hon., M.L.C., solicitor, O'Connell-street.
1875		Nott, Thomas, M.D. *Aberdeen*, M.R.C.S. *Eng.*, Ocean-street, Woollahra.
1878		Nowlan, John, "Eelah," West Maitland.
1879		O'Connor, Dr. Maurice, 26, College-street, Hyde Park.
1881		O'Connor, Richd. Edwd., M.A., Wentworth Court, Elizabeth-street.
1878		Ogilvy, James L., Commercial Bank of Australia, Pitt-street, Sydney.
1877		Olley, Rev. Jacob, Manse, Manly.
1883		Oram, Arthur Murray, M.D., Univ. *Edin.*, Liverpool-street, Hyde Park.
1875		O'Reilly, W. W. J., M.D., M.C., Q. Univ. *Irel.*, M.R.C.S., *Eng.*, Liverpool-street.
1882		O'Reilly, Rev. Alexr. Innes, B.A., *Cantab.*, Hayfield, Parramatta.
1883		Osborne, Benjn. M., J.P., Berrima.
1880		Paling, W. H., "Wonden," Cambridge-street, Petersham.
1875		Palmer, J. H., "Cairngorm," Balmain.
1880		Palmer, Joseph, 133, Pitt-street.
1882	P 1	Palmer, Edward, "Linden," Parramatta.
1876		Parrott, Thomas S., C.E., Ashfield.
1878		Paterson, Hugh, 229, Macquarie-street.
1877		Paterson, James A., Union Bank, Pitt-street.
1878		Paterson, Alexander, M.D., M.A., "Hillcrest," Stanmore Road.
1877		†Pedley, Perceval R., Carlton Terrace, Wynyard Square.
1884		Perdriau, Stephen E., "Claremont," Balmain.
1877		Perkins, Henry A., Burwood.
1881		Philip, Alexr., L.K. and Q.C.P., *Irel.*, L.R.C.S., *Irel.*, 540, Park View Terrace, Crown-street, Surry Hills.
1876		Pickburn, Thomas, M.D. *Aberdeen*, Ch. M., M.R.C.S. *Eng.*, 40, College-street.
1879		Pittman, Edwd. Fisher, L.S., Department of Mines, Sydney.
1881		Poate, Frederic, Government Surveyor, Summer Hill.
1879		Pockley, Thos. F. G., Commercial Bank, Singleton.
1878		†Poolman, F., care of Commercial Bank of Sydney, Lombard-street, London.
1882	P 1	Porter, Donald, Tamworth.
1878		Potts, F. H., Want-street, Burwood.

Elected.		
1876		Quaife, Fredk. Harrison, M.D., Mast. Surg. Univ. *Glas.*, "Hughenden," Queen-street, Woollahra.
1876		Quodling, W. H., "Couranga," Redmyre Road, Burwood.
1865	P 1	‡Ramsay, Edward, F.L.S., Curator of the Australian Museum, College-street.
1876		‡Ratte, A. F., F.L.S., The Museum, Sydney.
1874		Read, Reginald Bligh, M.R.C.S., *Eng.*, Coogee.
1868		Reading, E., Mem. Odont. Soc. *Lond.*, 33, Castlereagh-street.
1881		Reid, William, Australian Joint Stock Bank, Sydney.
1881	P 2	Rennie, Edwd, H., M.A. *Syd.*, D.Sc. *Lond.*, Professor of Chemistry, University, *Adelaide.*
1870		Renwick, Arthur, *Sydn.*, D.Sc., *Lond.*, M.D. *Edin.*, B.A. *Sydn.*, F.R.C.S. *Edin.*, M.L.A., 295, Elizabeth-street.
1882		Renwick, Geo. Jas., B.A., M.B., C.M., *Edin.*, 257, Elizabeth-street, Hyde Park.
1880		Riddell, C. E., Union Club.
1856		Roberts, J., 340, George-street.
1868	P 3	Roberts, Sir Alfred, M.R.C.S. *Eng.*, Hon. Mem. Zool. and Bot. Soc. *Vienna*, Bridge-street.
1881		Roberts, C. J., C.M.G., "Chatsworth," Potts's Point.
1871		Robertson, Thomas, solicitor, 85, Pitt-street.
1882		Robertson, Rev. James Thomas, M.A., "The Manse," Tumut.
1856	P 8	†Rolleston, Christopher, C.M.G., Palmer-street, St. Leonards East.
1865		Ross, J. Grafton, O'Connell-street.
1884		Ross, Chisholm, M.B., C.M., Hospital for the Insane, Gladesville.
1881	P 2	Roth, Henry Ling, Fellow of the Statistical Society, *Lond.*, Fellow of the Royal Meteorological Society, *Lond.*, Fellow of the Anthropological Institute of Great Britain and Ireland, 48, Wimpole-street, Cavendish Square, London, W.
1882		Rothe, W. H., Union Club.
1876		Rowling, Dr., Chas., Parramatta.
1864	P 30	†Russell, Henry C., B.A. *Syd.*, F.R.A.S., F.M.S., Hon. Mem. S. Aust. Inst., Government Astronomer, *President*, Sydney Observatory,
1882		Russell, H. E., Tattersall's Chambers, Hunter-street.
1875		Sahl, Charles L., German Consul, Consulate of the German Empire, Wynyard Square.
1876		Saliniere, Rev. E. M., Glebe.
1884		Sands, Robert, 374, George-street.
1876		Schuette, Rudolf, M.D., Univ. *Göttingen*, Lic. Soc. Apoth. *Lond.*, 10, College-street.
1883		Schulze, Oscar, 331, George-street.
1856	P 1	‡Scott, Rev. William, M.A. *Cantab.*, Hon. Mem. Roy. Soc. Vic., Kurrajong Heights.
1880		Scrivener, Charles Robert, Camp, Ryde.
1876		Sedgwick, Wm. Gillett, M.R.C.S., *Eng.*, Newtown.
1877		Selfe, Norman, C.E., M.I.C.E., "Rockleigh," Balmain.

Elected.		
1876		Sharp, James Burleigh, J.P., Clifton Wood, Yass.
1876		Sharp, Henry, Green Hills, Adelong.
1878	P 1	Sharp, Revd. W. Hey, M.A. *Oxon.*, Warden of St. Paul's College, University.
1883	P 1	Shellshear, Walter, Assoc. M. Inst. C.E., "Lauraville," Cambridge-street, Stanmore.
1879		Shepard, A. D., Box 728, G.P.O., Sydney.
1875		Sheppard, Rev. G., B.A., Berrima.
1882		Shewen, Alfred, M.B., M.D., Univ. *London*, M.R.C.S.E, Liverpool-street, Hyde Park.
1882		Sinclair, Eric, M.B., C.M., Univ. *Glasgow*, Lunacy Dept., Gladesville Hospital for the Insane.
1883		Sinclair, Sutherland, Secretary, Australian Museum.
1884		Skirving, Robt. Scot, M.B.C.M., Prince Alfred Hospital.
1877		Slattery, Thomas, Premier Terrace, 169, William-street, Woolloomooloo.
1877		Sloper, Fredk. Evans, 360, Liverpool-street.
1881		Smedley, John, 92, Eldon Chambers, Pitt-street.
1882		Smith, Bruce, Messrs. Howard Smith & Sons, *Melbourne*.
1852	P 7	†Smith, John, The Hon., C.M.G., M.D., LL.D., *Aberdeen*, M.L.C., F.C.S., Hon. Mem. Roy. Soc. Vic., Professor of Physics in the University of Sydney, 137, Macquarie-street.
1875		Smith, Robt., M.A. *Syd.*, solicitor, O'Connell-street.
1874		‡Smith, John M'Garvie.
1878		Smith, E. E., "Clytie," 70, Darlinghurst Road.
1883		Smith, Robt. Burdett, M.L.A., 203, Macquarie-street North.
1884		Smith, Fredc. Moore, M.D., M.R.C.S., 163, Macquarie-street.
1881		Smyth, F. L. S., M.A., F.R.G.S., "Woodlands," Edgecliff Road.
1879		Spry, James Monsell, Union Club.
1881		‡Starkey, John Thos., 61½, Castlereagh-street.
1882		Steel, John, L.R.C.P., L.R.C.S., *Edin.*, 205, Macquarie-street.
1872	P 1	Stephen, George Milner, B.A., F.G.S., Mem. Geol. Soc. of Germany; Cor. Mem. Nat. Hist. Soc., *Dresden*; F.R.G.S. of *Cornwall*; "Almaville," Pyrmont Bridge Road.
1879		‡Stephen, Septimus A., South Kingston.
1879		Stephen, Alfred F. H., Glebe Point Road.
1857		Stephens, William John, M.A. *Oxon.*, Professor of Natural History in the University of Sydney, 71, Darlinghurst Road.
1883		Stephen, Cecil B., M.A., 101, Elizabeth-street.
1884		Strange, Fredk. R., 8, Milton Terrace, Dawes' Point.
1878		Street, John Rendell, "Birtley," Elizabeth Bay Road.
1882		Strickland, Sir Edwd., K.C.B., F.R.G.S., "Cardowan," Manly Beach.
1876		Strong, Wm. Edmund, M.D., *Aberdeen*, M.R.C.S., *Eng.*, Liverpool.
1874		Stuart, Alexander, The Hon. M.L.A., Sydney.
1876		Stuart, Clarendon, Cross-street, Double Bay.
1883		Stuart, T. P. Anderson, M.D., Univ. *Edin.*, Professor of Anatomy and Physiology in the University of Sydney.
1883		Styles, G. Mildinhall, Commercial Bank, George-street.
1884		Sunderland, Rev. J. P., 19, Wentworth Court, Elizabeth-street.
1876		Suttor, Wm. Henry, M.L.A., "Cangoura," Bathurst.
1884		Syer, Frank Weston, 89, Pitt-street.

Elected.		
1879		Tarrant, Harman, M.R.C.S., M.L.A., Macquarie-street.
1862	P 10	Tebbutt, John, F.R.A.S., Observatory, Windsor.
1879		Thomson, Dugald, care of R. Harper & Co., 409, George-street.
1870	P 1	Thompson, H. A., Launceston, Tasmania.
1875		Thompson, Joseph, Bellevue Hill, Double Bay.
1877		Thompson, Thos. James, 139, Pitt-street, Sydney.
1878		Thomas, F. J., Hunter River N.S.N. Co., Market-street.
1882		Thornton, Hon. George, M.L.C., 377, George-street.
1876		Tibbits, Walter Hugh, M.R.C.S. *Eng.*, Manly.
1876		Toohey, J. T., "Moira," Burwood.
1884		Townsend, G. W., C.E., Rooty Hill.
1882		Traill, Mark W., L.R.C.P. *Lond.*, M.R.C.S.E., 211, Macquarie-street.
1873	P 1	Trebeck, Prosper N., Hunter-street.
1879		Trebeck, P. C., Hunter-street.
1883		Trebeck, Tom B., M.A., *Syd.*, Univ., "Leyton" 72, Elizabeth Bay.
1876		Trouton, F. H., A.S.N. Company's Offices, Sydney.
1877		‡Tucker, G. A., Ph. D., Superintendent, Bay View Asylum, Cook's River.
1868		Tucker, William, "Clifton," North Shore.
1875		Tulloh, W. H., "Airlee," Greenwich Point Road, North Shore.
1883		Tuxen, Peter Wilhelm, L.S., Survey Office, Sydney.
1882		Twynam, George Edwd., L.R.C.P. *Lond.*, M.R.C.S.E., "Cleone," West-street, Petersham.
1883		Vause, Arthur J., M.B., C.M., *Edin.*, Bay View House, Tempe.
1884		Verde, Felice, 16, Prione Spezia, Italy.
1876		Voss, Houlton H., J.P., Goulburn.
1879		Walker, H. O., Australian General Assurance Co., 129, Pitt-street.
1867		Walker, Philip B., Telegraph Office, George-street.
1870		Wallis, William, Moncur Lodge, Potts's Point.
1882		Want, Sydney A., "Carabena," Milson's Point, North Shore.
1867		Ward, R. D., M.R.C.S. *Eng.*, North Shore.
1883		Wardell, W. W., Fellow Royal Institute of British Architects, Lond., Member Institute Civil Engineers, Lond., "Upton Grange," St. Leonards.
1877		Warren, William Edward, M.D. and M.Ch., Queen's Univ. *Irel.*, 243, Elizabeth street, Sydney.
1883		Warren, W. H., C.E., Professor of Engineering, University of Sydney, "Madeley," London-street, Enmore.
1876		Watkins, John Leo, B.A. *Cantab.*, M.A. *Syd.*, 121, Elizabeth-street.
1876		Waterhouse, J., M.A., *Syd.*, High School, West Maitland.
1876		Watson, C. Russell, M.R.C.S., *Eng.*, "Morevale," Newtown.
1877		Watt, Alfred Joseph, 528, George-street.
1859		Watt, Charles, Government Analyst, Treasury Buildings.
1876		Waugh, Isaac, M.B., M.C., *T.C.D.*, Parramatta.
1876		Webster, A. S., Gresham Chambers.

Elected.		
1882		Webster, Rev. William, "Manse," Inglewood, Victoria.
1867		Weigall, Albert Bythesea, B.A. *Oxon.*, M.A. *Syd.*, Head Master of the Sydney Grammar School, College-street.
1881		‡Wesley, W. H., Stella House, Penzance, Cornwall.
1881		West, Arthur Annesley, M.D., M. Ch. Trin. Col. Dub., L.R.C.S., F.R.C.S. *Irel.*, Derby House, Glebe.
1878		Westgarth, G. C., solicitor, "Tresco," Elizabeth Bay.
1877		Weston, W. J., 5, Spring-street.
1879		‡Whitfeld, Lewis, B.A. *Sydney*, The Grammar School, Sydney.
1874		White, Rev. James S., M.A., LL.D., *Syd.*, "Gowrie," Singleton.
1875		White, Hon. James, M.L.C., "Cranbrook," Double Bay.
1877		‡White, Rev. W. Moore, A.M., LL.D., T.C.D.
1883		Whitelegge, Thomas, Orient Brewery, Bourke-street.
1884		Wiesener, T. F., 334, George-street.
1874	P 1	Wilkinson, C. S., F.G.S., Government Geologist, Department of Mines.
1880		Wilkinson, Robt. Bliss, 12, Spring-street.
1878		Wilkinson, Rev. Samuel, Regent House, Regent-street, Petersham.
1876		Williams, Percy Edward, Treasury.
1884		Williamson, Willm. Collir, M.D., Hospital for the Insane, Parramatta.
1879		Wilshire, F. R., P.M., Berrima.
1878		Wilshire, James Thompson, "Havilah," Burwood.
1879		Wilson, F. A. A., Mercantile Bank, Sydney.
1876		Windeyer, W. C., His Honor Judge, M.A., *Syd.*, King-street.
1876		Wise, George Foster, Immigration Office, Hyde Park.
1878		Wise, Henry, Savings' Bank, Barrack-street.
1873		Wood, Harrie, Under Secretary for Mines, Department of Mines.
1881		Wood, W. H. O'M., Surveyor-General's Office.
1884		Wood, Arthur Pepys, C.E., Sydney Club.
1879		Woodhouse, E. B., "Mount Gilead," Campbelltown.
1877		Woods, T. A. Tenison-, 110, Fitzroy-street, Moore Park.
1876		Woolrych, F. B. W., Wilson-street, Newtown.
1881		Wright, Frederic, M.P.S., Harnett-street
1872		†Wright, Horatio G. A., M.R.C.S., *Eng.*, Wynyard Square, *Hon. Treasurer*.
1878		Wright, Rev. Edwin H., St. Stephen's, Bourke.
1884		Yeomans, Allan, Gilgoin.
1879		Young, John, Young's Buildings, corner of Pitt & Park Streets.

Honorary Members.

Limited to Twenty.

M. recipients of the Clarke Medal.

1875		Agnew, Dr., Hon. Secretary, Royal Society of Tasmania, Hobart.
1884		Airy, Sir George Biddell, K.C.B., M.A., D.C.L., *Oxon.*, LL.D., *Cantab. et Edin.*, F.R.S., &c., The White House, Croom's Hill, Greenwich Park, S.E.

Elected		
1875		Bernays, Lewis A., F.L.S., F.R.G.S., Brisbane.
1876	P 1	Cockle, His Honor Sir James, late Chief Justice of Queensland, M.A., F.R.S., Ealing, London.
1876		De Köninck, Prof., M.D., Liège, Belgium.
1875		Ellery, Robert F., F.R.S., F.R.A.S., Government Astronomer of Victoria, Melbourne.
1875		Gregory, Augustus Charles, C.M.G., F.R.G.S., Geological Surveyor, Brisbane.
1875		Haast, Dr. Julius von, C.M.G., Ph. D., F.R.S., F.G.S., Professor of Geology, Canterbury College, and Director of the Canterbury Museum, Christchurch, New Zealand.
1875	P 1	Hector, James, C.M.G., M.D., F.R.S., Director of the Colonial Museum and Geological Survey of New Zealand, Wellington.
1880		Hooker, Sir Joseph Dalton, K.C.S.I., M.D., C.B., F.R.S., &c., Director of the Royal Gardens, Kew.
1879	M	Huxley, Professor, F.R.S., LL.D., F.G.S., F.Z.S., F.L.S., &c., &c., Professor of Natural History in the Royal School of Mines, South Kensington, London.
1875	M	M'Coy, Frederick, F.R.S., F.G.S., Hon. F.C.P.S., C.M.Z.S., Professor of Natural Science in the Melbourne University, Government Palæontologist, and Director of the National Museum, Melbourne.
1875	P 3 M	Mueller, Baron Ferdinand von, K.C.M.G., M.D., Ph.D., F.R.S., F.L.S., Government Botanist, Melbourne.
1879	M	Owen, Professor Sir R., K.C.B., M.D., D.C.S., LL.D., F.L.S., F.G.S., V.P.Z.S., &c., &c., The British Museum, London, W.C.
1883		Pasteur, Louis, M.D., Paris.
1875		Schomburgh, Dr., Director of the Botanic Gardens, Adelaide, South Australia.
1884		Tyndall, John, D.C.L., *Oxon.*, LL.D., *Cantab.*, F.G.S., &c., Professor of Natural Philosophy in the Royal Institution, Albemarle-street, London.
1878		Walker, Thomas, Yaralla, Concord.
1875		Waterhouse, F. G., F.G.S., C.M.Z.S., Curator of the Museum, Adelaide, South Australia.
1875	P 14	Woods, Rev. Julian E. Tenison-, F.G.S., F.L.S., Hon. Mem. Roy. Soc., Victoria, Hon. Mem. Roy. Soc., Tasmania, Hon. Mem. Adelaide Phil. Soc., Hon. Mem. New Zealand Institute, Hon. Mem. Linnean Soc., N.S.W., &c., Union Club, Sydney.

Corresponding Members.

Limited to Twenty-five.

1810	P 1	Clarke, Hyde, V.P. Anthropological Institute, 32, St. George's Square, London, S.W.
1879	P 3	Etheridge, Robert, junr., F.G.S., &c., The British Museum.
1883	P 1	Feistmantel, Ottokar, M.D., Geological Survey, Calcutta.
1880		Miller, F. B., F.C.S., Melbourne Mint.
1880		Ward, Sir Edward, K.C.M.G., Major-General, R.E., Cannes, France.

Obituary, 1884.

Ordinary Members.

Elected.	
1875	Frazer, Hon. John, M.L.C.
1878	Giblin, Vincent W.
1881	Maclean, L. H. J., M.D., M.R.C.P., *Lond.*, M.R.C.S.
1856	Phillips, H.
1881	Shepherd, T. W.
1876	Thomas, H. Arding.

Honorary Members.

1875	Barlee, His Excellency Sir F. P., K.C.M.G., late Governor of Honduras.
1879	Bentham, George, F.R.S., V.P.L.S., C.M.G.

AWARDS of the CLARKE MEDAL.

Established in memory of

The late Revd. W. B. CLARKE, M.A., F.R.S., F.G.S., &c.,

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, to men of science, whether resident in Australia or elsewhere.

1878. Professor Sir Richard Owen, K.C.B., F.R.S., Hampton Court.

1879. Mr. George Bentham, C.M.G., F.R.S., The Royal Gardens, Kew.

1880. Professor Huxley, F.R.S., The Royal School of Mines, London.

1881. Professor F. M'Coy, F.R.S., F.G.S., The University of Melbourne.

1882. Professor James Dwight Dana, LL.D., Yale College, New Haven, Conn., United States of America.

1883. Baron Ferdinand von Mueller, K.C.M.G., M.D., Ph.D., F.R.S., F.L.S., Government Botanist, Melbourne.

1884. Dr. Alfred R. C. Selwyn, LL.D., F.R.S., F.G.S., Director of the Geological Survey of Canada, Ottawa.

1885. Sir Joseph Dalton Hooker, K.C.S.I., F.R.S., Director of the Royal Gardens, Kew.

ANNIVERSARY ADDRESS.

By the Hon. Professor SMITH, C.M.G., M.L.C., &c., President.

[*Delivered to the Royal Society of N.S.W., 7 May, 1884.*]

GENTLEMEN,

In taking up once more the meetings of the Society, we have the satisfaction of looking back upon a fair amount of work and progress during the past year. Nine meetings were held in 1883, with an average attendance of about forty members. Thirteen papers were read, their titles and authors being as follows:—May 2, 1883, "President's Address," by Chr. Rolleston, C.M.G. June 6, "On the Aborigines inhabiting the great Lacustrine and Riverine Depression of the Lower Murray, Lower Murrumbidgee, Lower Lachlan, and Lower Darling," by Peter Beveridge. July 4, "On the Wianamatta Shales," by the Rev. J. E. Tenison-Woods, F.G.S., F.L.S.: "Further Remarks on Australian Strophalosiæ, and Description of a New Species of Aucella from the Cretaceous Rocks of North-east Australia," by Robert Etheridge, junr., F.G.S., &c. August 1, "On Plants used by the Natives of North Queensland, Flinders and Mitchell Rivers, for Food, Medicine, &c.," by Edward Palmer, M.L.A., Queensland. September 5, "Notes on the Genus Macrozamia, with Descriptions of some New Species," by Chas. Moore, F.L.S., V.P.: "A List of Double Stars," by H. C. Russell, B.A., F.R.A.S.: "Some Facts connected with Irrigation," by H. C. Russell, B.A., F.R.A.S.: "On the Discolouration of White Bricks made from certain Clays in the Neighbourhood of Sydney," by E. H. Rennie, M.A., D.Sc. October 3, "On the Roots of the Sugar-cane," by Henry Ling Roth. November 7, "On Irrigation in Upper India," by H. G. M'Kinney, M.E.: "On Tanks and Wells of New South Wales Water-supply and Irrigation," by A. Pepys Wood. December 5, "Additions to the Census of the Genera of Plants hitherto known as Indigenous to Australia," by Baron Ferd. von Müeller, K.C.M.G., M.D., Ph.D., F.R.S., &c.

Besides these formal papers, there have been short discussions on other subjects, and interesting specimens and apparatus have been from time to time exhibited. Two of the Sections—the Medical and the Microscopical—have kept up their meetings regularly, and have gone through a considerable amount of useful work. From the report of the Council just read you have learned that the Society has very nearly reached the maximum number of members allowed by the resolution passed about three years ago. The accessions last year more than balanced the defections by fourteen. The annual income keeps well up, being over £1,000, while the expenditure has been kept within the income by about £50. The debt on the building has been reduced by £400, and towards this Mr. Frederick Dangar gave the handsome donation of £50. The debt now stands at £1,100, and, although the interest upon this is by no means a heavy burden, yet it is desirable that it should be got rid of. The Society could make a better use of the money. For example, if we could afford to pay for the bringing out of the annual volume of "Proceedings," it could be placed much more promptly in the hands of the members. Our best thanks are due to the Government for their liberality in printing our volume, and the Government Printer turns it out in admirable style, but the exigencies of the Public Service stand in the way of a speedy execution of the work.

We have also to tender our thanks to the Government for the continuance of their annual contribution to our funds, in the proportion of one-half our subscriptions. It would be well, however, if we could do without this, and if the proper resources of the Society could be made sufficient for the whole of its expenditure.

Three years ago the Society began to offer money-prizes for the best essays on prescribed subjects. These prizes are still offered, but they fail to bring the response that was expected. Only two have as yet been awarded. Last year nine essays were sent in, but, after careful scrutiny by all the members of the Council, none were considered to have sufficiently met the conditions. In 1882 twenty-one essays were received. This year we add the temptation (such as it is) of a bronze medal to accompany the money-prize and it is hoped that the results may be more encouraging.

The Clarke medal for this year has been awarded to Mr. Selwyn, Director of the Geological Survey of Canada, and who formerly held a similar position in Victoria. This is now the seventh medal that has been awarded since its institution.

The vacancy in our limited list of honorary members caused by the death of Charles Darwin has been filled by the election of M. Pasteur, the well-known French chemist. Pasteur, in the course of a long life, has made many valuable contributions to chemical science, but he is best known to us by his successful researches into the nature of fermentation and the propagation of zymotic diseases. It was he that proved that the only effective agency in fermentation is a living organism, and that if this is hindered from access to a fermentable liquid, or destroyed in the liquid, the fermenting process cannot go on. His valuable discoveries have brought him many honours in his own country. For example, in 1878 he was made Grand Officer of the Legion of Honour, and in 1882 he was appointed a member of the French Academy. He is also one of the fifty foreign members of the Royal Society of London. Towards the end of last year a Bill was introduced into the Chamber of Deputies to increase the pension allowed him by the Government. On that occasion M. Paul Bert gave a brief sketch of the great chemist's labours, from which I extract the following, as published in an American paper :—

"He was the first to prove that fermentation is simply the result of the development and nutrition of an infinite number of infinitely small organisms. He studied successively alcoholic, acetic, lactic fermentations, and the putrefaction of azotised matter, and arrived at the result that each is produced by a special organism. The question then arose as to the source of the germs producing fermentation, and among other theories was that of spontaneous generation. But this theory Pasteur disproved by showing that liquids most subject to change, like blood and milk, can be kept in their natural state, exposed to the air, without previous preparation of any kind, by simply preventing the germs of fermentation floating in the atmosphere from coming in contact with them.

"But M. Pasteur's labours have had practical results of the greatest importance to the world. The first practical applications of the truths discovered were made in the case of beer and wine, which were often subject to destructive secondary fermentations. The discovery of the cause and nature of fermentation enabled him to destroy by a determinate degree of heat the organized germs that produce these effects. Fermentation can be regulated by the rules laid down by him; and now the manufacture of wine, beer, vinegar, &c., which was formerly carried on by empirical processes, is governed by science.

"The next great work of M. Pasteur was undertaken at the request of the French Government, which requested him to study the '*pébrine*,' a disease which threatened to exterminate the silkworms of France and Italy. He discovered the cause of the malady to be a microscopic organism developed in the silkworm. Then he showed that the eggs of the silkworm moths not containing "corpuscles" always produce healthy worms. This discovery solved the problem, and saved the important industry from destruction. In speaking of these discoveries Professor Huxley says that they are sufficient of themselves to offset the war indemnity of five milliards paid by France to Germany after the war."

Now, to fill up the remainder of the time usually occupied by a presidential address, I have, in default of anything better, strung together some gossip connected with scientific matters gathered during my recent visit to Europe. As it is now nearly a year since my return to Sydney, there must be to some extent a lack of novelty in what I have to bring forward, but I have had no sufficient leisure to provide anything more deserving of your notice.

On the way homewards I made a break of the voyage at Bombay, and took a hasty run by rail to certain historic places in India.

Some notes of this Indian tour were published in the *Sydney Morning Herald*. Before reaching Bombay, two points of minor scientific interest came under my notice. In passing up the Arabian Gulf in January we had an excellent example of sea and land breezes—the latter beginning about midnight and freshening till about 9 a.m., bringing faint aromatic odours from the shore, then dying away with rapid rise of temperature to 83° or 84°, and being succeeded by the sea breeze about midday. The other item was the change of magnetic polarity in the stanchions and other upright pieces of wrought iron about the decks. South of Ceylon the lower ends of these had south polarity, but on passing up the Gulf they changed decidedly to north. Of course, in each case the upper ends presented opposite polarity. It is this changing of polarity in different hemispheres through the magnetic induction of the earth that makes the permanent correction of binnacle compasses impossible. It is fortunate, however, that certain parts of the ship are about neutral to the compass.

At Bombay I visited the handsome new buildings of the University, two large halls, a little distance apart. One for library and offices, with a tower 250 feet high, commanding the best views of the city, was built by a native gentleman; the other, for convocation, was built by joint contributions from a Parsee gentleman and Government. The latter is a beautiful structure, with arched stone roof, floor of marble and encaustic tiles, and painted windows. The University examines and confers degrees, but does not teach. I visited the Grant Medical College affiliated to it, with its contiguous hospital containing 600 beds, clean, cool, and airy. I was told that there were about 600 students going through the medical curriculum. Connected with the University I may mention an incident related to me by a fellow-traveller. While rambling in a town in Southern India he came upon a blacksmith's shop, where two young natives were resting awhile from their labours, and improving the time by reading Balfour Stewart's "Elementary Physics" and Roscoe's "Elementary Chemistry," with the view of matriculating in the University.

In travelling northward through Jeypore to Delhi, then southward by way of Agra, Cawnpore, and Lucknow, to Benares, and finally westward to Bombay, I was frequently struck with the amount of uncultivated land, and with the absence of forests. India is so densely peopled, and so much of the population is engaged in agriculture, that one would naturally expect the whole country to be subjected to husbandry; but, as a matter of fact, large tracts lie waste, probably for want of water; and at the time of my journey, which was the dry season, active cultivation seemed restricted within the limits of irrigation. I was interested in observing that the methods of raising water from wells for irrigation were mostly the same as in Egypt; but one process was new to me. It consisted of a huge water-bag, made out of a bullock's hide, lowered down by ropes and pulleys to the bottom of the well, then drawn up by two or four bullocks, and, by a simple arrangement of the pulleys, when the mouth of the bag comes to the surface, the bottom is pulled higher, so that the contents are emptied into the channels which convey the water to the desired points.

In regard to forests, I rarely in my journey of 2,400 miles saw anything that we in Australia would call "bush." There were some patches about Delhi, and also near the Nerbudda, between Jubbulpore and Bombay, where, however, the trees were very young; and, lastly, on the picturesque ranges which are crossed before reaching Bombay. Solitary trees, often of great size and beauty, were not uncommon, and many villages were embowered in leafy groves.

In regard to temperature, although it was the coolest time of the year (January), the thermometer sometimes got as high as 95° in the shade. The nights were generally cold, and the daily range occasionally as much as 50°. We seldom had any wind, or not more than light airs; and as the sky was usually cloudless, the sun poured down its heat upon us without mitigation.

This is not the place to enlarge upon the wonderful architecture of India, especially the old mosques and tombs of the Mogul dynasty, exhibiting most graceful forms, executed in beautiful materials, and enriched with an exuberance and delicacy of ornamentation which words fail to depict. To specify only one example of ornamental work—the perforated marble screens round certain tombs, and separating apartments or filling window spaces, are unique in their character, and so exquisite in design as to resemble the finest lacework. The lower part of such a screen, where not perforated, is often covered with a mosaic of flowers, birds, &c., in coloured stones.

The tomb buildings are not only superb examples of decorated architecture, but usually they are surrounded by gardens full of bright flowers and fountains and noble trees. The gem of these Mogul tombs is admitted to be the Taj Mahal at Agra, of which the well-known writer on architecture, Fergusson, says: "There is not perhaps in the whole world a scene where nature and art so successfully combine to produce a perfect work of art as within the precincts of this far-famed mausoleum." But I must return to more prosaic matters.

We passed through the Suez Canal in the middle of February, and at that time the traffic was enormous. No fewer than twenty-two steamers going southward met us on the day before we reached Suez. At that port we were detained a day waiting for a chance of entering the canal, and while lying at anchor I counted forty steamers, mostly of large size, in the bay around us. It took us three days to get through to Port Said, and over three dozen steamers passed us in that time. At Port Said I counted twenty-six steamers, most of them waiting for permission to enter the canal. It was no wonder that an outcry arose for increase of canal accommodation, but the diplomatic difficulties seem greater than the physical, and nothing appears yet to be definitely settled. It is proposed by Baron Lesseps to cut a second canal; but to an unprofessional mind it would seem more advantageous to double the width of the existing one, for then vessels could maintain a higher speed in the transit, and could pass each other at any point while underway; whereas at present they can pass only at appointed stations, which occur every 5 or 6 miles, and those going one way must make fast to the bank. The speed also has to be restricted to about 5 miles an hour. Now in a second canal of the same size the speed would still have to be kept low, and the grounding of a large vessel would block up the channel, as at present.

On returning through the canal in April last year the appearance of traffic had greatly diminished. There were only two or three steamers at Port Said, and as many at Suez; and during our passage of forty-eight hours from one place to the other we met about two dozen going northwards. The charges on steamers are very heavy, amounting in our case to about £1,200, and the profits are said to be enormous.

To resume the homeward journey. We were not allowed to land in Egypt, through fear of having cholera brought from India, and such of us as wished to proceed to Italy had to go on to Malta. From Malta I crossed to Sicily, and spent a few days on the east and north coasts of that picturesque island. A curious optical appearance on Mount Etna may be worth mentioning. We watched the sunset one evening from the ruins of a Greek theatre at Taormina, a village romantically perched on a steep and rocky mountain side, about 600 feet above the sea, and looking down upon the site of Naxos, the earliest Greek colony in Sicily. After the sun had disappeared behind the snowy crest of Etna, a speck of bright silvery light, like a large star, remained for a few minutes at the point where the sun had vanished. The guardian of the ruins explained to us that this was not an unusual appearance. It was probably connected with reflections from fields of ice on the distant side of Etna; but, whatever the cause, it was certainly a striking and beautiful phenomenon.

From Palermo we crossed to Naples. There I visited the Zoological Station, superintended by Dr. Dohrn. It is admirably got up, and puts through a large amount of biological work. At the time of my visit there were seven naturalists and thirty-five servants on the paid staff. A steam launch and boats were kept for dredging, and the equipment included diving apparatus, arrayed in which Dr. Dohrn sometimes takes a walk at the bottom of the sea for the mere pleasure of it. There are forty tables available for work, but only fifteen were at that time occupied. Each table is charged £80 per annum. The German Government pays for ten, Cambridge one, and the British Association one. Each table has glass tanks with streams of sea-water running through them, besides other appliances. Three publications are carried on to report the work of the station, all published at Leipsic. One of them is beautifully illustrated.

The aquarium on the ground floor is admirably contrived, and is filled with most interesting and beautiful objects. A living torpedo is usually kept in a convenient place for giving shocks to visitors. I was told that the annual expense of the whole establishment amounts to about £5,000.

Dr. Dohrn has attained to great success in preserving specimens of the most delicate forms of animal life without change of colour. Different species require different treatment. Some are killed by immersion in strong corrosive sublimate before transference to alcohol; and it was discovered accidentally that the use of tobacco smoke in stupefying some jelly-fish was successful in preserving delicate colours that had always hitherto proved evanescent. Dr. Dohrn sent a large collection to the late Fisheries Exhibition, and the specimens (nearly 400 in number) were much admired for the extraordinary success attending their preservation.

You may remember that in my address to the Society three years ago I called your attention to this Zoological Station at Naples, and to the efforts then being made by Baron Maclay to establish such a station here, and I asked you for contributions to assist in this enterprise. The Council, on behalf of the Society, made such a donation to the funds as to entitle it to nominate a worker in the laboratory, but no one applied for this privilege. I call your attention to the matter again, in the hope that some member of the Society may be disposed to take up biological investigations, and make use of the convenient laboratory now available.

At the University of Naples Professor Palmieri showed me his ingenious apparatus for recording any movements of the nature of earthquakes, but I took no notes of the instruments at the time, and cannot now recall the details. The University contains some very fine mineral specimens, and among these is the largest mass of rock crystal probably in the world. One prism must be 7 or 8 feet in girth.

I ascended Vesuvius, and had the benefit of the funicular railway for the last and most difficult part of the way. The volcano being tolerably quiescent, we were able to stand on the outer rim of the crater and watch the explosions of steam and showers of scoria from the inner cone. So long as we kept on the windward side the position was safe and comfortable enough, except that the ground was very hot under foot; but now and again the atmospheric eddies enveloped us in choking clouds of hot sulphurous steam, which could scarcely be breathed. The lava and ashes about the old crater were tinged with many and beautiful colours, chiefly by sulphur and its compounds; and at some distance down the east side we came upon a stream of fluid lava about 2 feet wide, flowing sluggishly at a white heat down to a hollow far below us. On returning hot and weary to the upper station of the railway, we received the depressing news that the engine had stopped for want of water, and there was no help for it but to walk or slide down the cone of loose cinders and ashes for 1,000 yards to the lower station where carriages were waiting. The water for the engine had to be brought in carts from the foot of the mountain, but tanks were then being constructed for conserving rain-water at the station.

In passing northwards through Italy I embraced every opportunity of visiting collections of philosophical apparatus in the various Universities and Scientific Institutions, in order that I might expend to the best advantage the money entrusted to me for the purchase of apparatus for the University here. At Rome, in the commodious new buildings erected for physical science, I saw some excellent electrical apparatus and air-pumps, made, however, not in Italy, but in Paris. At Florence there were huge electrical machines and batteries, and an electrical pendulum, which had been oscillating between two dry piles for twelve years. Here also I noticed a simple method of purifying mercury by distillation at a low heat *in vacuo*. The Museum of Natural History in another part of the city is a noble collection, and the wax models, illustrating human and comparative anatomy, are probably unequalled in the world.

The University of Padua I found rich in electrical machines and electro-magnetic engines. There is a pair of dry piles, with a light pendulum oscillating between them, as at Florence; but this one was made in 1830 by Zamboni, and has been going almost continuously ever since. It was explained to me that when the atmosphere is very dry the motion sometimes stops, but a piece of moist paper placed under the glass shade will start it again. I saw afterwards, at Verona, the house where Zamboni lived, and on a marble tablet attached to the wall he is styled the inventor of electric perpetual motion. Later in the year I saw at Oxford another of these electric pendulums, that had been going forty-two years.

The University of Padua has now about 900 students and fifty professors, far outstripping its more ancient and celebrated neighbour at Bologna, which has now about 500 students. In its best days it is said to have numbered 10,000, though that probably is an exaggeration.

At Pavia, Turin, and Paris, and afterwards in various parts of England, I inspected collections of philosophical apparatus, and visited workshops where such apparatus is made. These factories, especially where electrical appliances were turned out, had increased considerably in numbers, and the old ones had materially expanded since my previous visit to England twelve years ago. I need not, however, enter into further details on this subject, beyond stating that everywhere I found great activity prevailing in such factories, so much so that I had some difficulty in getting my comparatively small orders attended to.

The electric-lighting fever was raging when I reached England, and new patents were taken out and new Companies formed about every week. I took every opportunity of observing the electric light in actual use, and was fortunate in seeing the last of the Electrical Exhibition at the Crystal Palace. At the preceding Exhibition in Paris the arc light was the leading feature, but at the Crystal Palace the chief novelty was the incandescent light, which in the short interval between the two Exhibitions had come to the front. The incandescent light is far the pleasanter of the two, and is much steadier, but unfortunately it is much more expensive. In this important matter of expense it never seemed possible to get trustworthy returns, so that to the present day it is still a matter of debate whether gas or electricity affords the cheaper light. It is, however, generally understood that the arc light for large spaces and outdoor work is less expensive than gas, but that the incandescent light for house illumination is usually more expensive. The arc light, from its troublesome and unsteady character and unpleasant glare, has rather lost ground of late. It is probably less used publicly at the present time in Paris, London, and other cities than it was two years ago, while the incandescent light, though far from perfect, seems steadily rising in favour. It would no doubt spread more rapidly if a durable, trustworthy, and not too expensive secondary battery could be supplied to regulate the light and diminish the risk of accidents; but such a battery has still to be invented.

Electric lighting has had the effect of stimulating and improving gas lighting. Many new forms of burner and lamp have been brought out, and gas has obviously a long career of usefulness before it. I had several good opportunities of comparing the two modes of street lighting in London and Paris, and there could be no doubt that the best examples of gas lighting were more successful than the electric lighting. It was softer, better diffused, steadier, and more agreeable to the eye. In the South Kensington Museum I saw some halls lighted with gas, and others with arc lights, and no one could hesitate in giving the preference to gas;

but, had the electricity been used through the medium of incandescent lamps, the verdict might have been different. The finest examples of the latter kind of lighting which I came across were at the Savoy Theatre, in London, and the Alhambra Court in the Crystal Palace. In both these cases the lighting was very effective and agreeable.

The dynamo-electric machines for generating the necessary currents were continually being improved; at all events, new patents were following in quick succession; and I could not learn that any one form of dynamo was considered clearly superior to others. The number of fatal accidents that had occurred in the use of machines giving electricity of high tension was leading to the invention of machines of a different type, worked at lower speed, and producing currents of less intensity. I had an opportunity of inspecting the largest dynamo-electric machine yet constructed, the invention of Mr. Gordon, Engineer of the Telegraph Construction and Maintenance Company, at Greenwich. This machine weighed about 18 tons; the wheel carrying the revolving electro-magnets was 9 feet in diameter, and weighed 7 tons. When I saw it in action it was keeping up 1,300 Swan lights of sixteen or twenty candles each, but it was said to be capable of running 5,000 such lights.

I visited the works of the Electric Power and Storage Company at Millwall, where about 400 men were employed in the manufacture of secondary batteries. The Faure-Sellon-Volckmar battery there made was the favourite one at that time, and great expectations were cherished of its value in promoting the application of electricity to lighting, and as a source of mechanical power. To exemplify the latter application, the Company had fitted up a boat with electric propeller; it made frequent trips on the Thames, and attained a good speed. At the time of my visit there was also a street tramcar being fitted up with electric motive power; it was afterwards put in operation, but with doubtful success. By recent accounts I learn that secondary batteries have developed weaknesses which, if not overcome, will stand materially in the way of their general adoption.

In connection with electrical appliances, I may mention the friendly rivalry that was going on at the time of my stay in England between the President of the Royal Society (Mr. Spottiswoode) and Mr. Warren De La Rue—a rivalry unfortunately brought to a close soon afterwards by the lamented death of the former. These gentlemen were studying (among other electrical phenomena) the discharge through vacuous tubes, and for this purpose electricity of pretty high tension is required. Mr. Spottiswoode used induced electricity, and he had made for him the largest induction coil ever constructed. It had a primary coil of 660 yards, enclosing a core of iron wire weighing 67 lbs., and the secondary wire measured 280 miles. With thirty Grove cells this coil gave a spark 42 inches long. This powerful machine was ruined (as I understood) at the Paris Exhibition. He afterwards got an induction machine of the Topler variety, consisting of 85 pairs of ebonite plates, about 2 feet in diameter. I saw this in action, and it gave a splendid rush of sparks. Mr. Spottiswoode showed me also a large magneto-electric machine that he was getting made for the same experiments.

Mr. De La Rue, on the other hand, sought to compass the same ends by battery electricity, and to obtain the necessary tension he had to multiply cells to a great extent. He invented the chloride of silver battery, in which the elements are chloride of silver and zinc, immersed in solution of sal ammoniac enclosed in a small test tube. Each cell has an E. M. F. of 1 volt. He continued to add cells to this battery until at the time I saw it there were no fewer than 15,000. This number gave a spark three-quarters of an inch long.

One of the pieces of apparatus that I was commissioned to get for the University was a polariscope of large size. My instructions were to get the largest Nicol prisms procurable, and my hunt after these was troublesome but at the same time interesting. I applied to all the principal dealers in these articles, and could find no prisms with so much as 2 inches aperture. I consulted with Professor Adams, of King's College, and with Mr. Spottiswoode, both of whom had very fine instruments. That belonging to Mr. Spottiswoode was, I understood, the largest in the world, the diameter of the prisms being about 4 inches. He informed me that the supply of Iceland spar fit for making prisms had entirely stopped, the quarry being exhausted. He had tried to induce people to search for other deposits in Iceland, but without effect, and he advised me to secure the best prisms available without delay, as the market would soon be cleared. He said he believed there was only one large crystal in London remaining to be worked up; that there was a larger one at Copenhagen, but the quality was not so good; and that if I did not secure the English one it would likely soon go to America. It was some time before I could learn where this big crystal was to be found. There seemed a degree of mystery about it. At length I came upon the coveted prize in an obscure and dingy workshop, and speedily agreed upon terms for its purchase. It made a polariser of $2\frac{3}{4}$ inches aperture, but it was impossible to get an analyser of the same size, and I had to be content with one less than 2 inches. Now, however, the University is in possession of a fine instrument, there being only (as I was assured) three or four polarisers in existence of larger aperture.

Another instrument of far less pretension, in which I felt considerable interest, was the "Rainband Spectroscope." It is simply a direct-vision pocket spectroscope, carefully made, so as to give fine definition of the absorption lines. It was brought into prominence chiefly through the writings of Professor Piazzi Smyth, Astronomer Royal for Scotland, who extolled its value in prognosticating rain. One of these instruments, made by A. Hilger, I now exhibit. I have made frequent use of it for more than a year, and only on one occasion has it afforded me a distinct indication of rain prior to the usual atmospheric signs. This was at Melbourne, at the close of a day of hot wind, when the air seemed excessively dry, and no appearance of a change. Indeed, ordinary observers were prognosticating a hotter wind for next day; but this little instrument showed the vapour bands with marked distinctness. The upshot was that the weather changed completely about midnight; rain set in, and continued for several days.

With this spectroscope I have frequently examined the red glows which at intervals for nearly eight months have afforded such grand and puzzling displays of nocturnal splendour. Even yet they occasionally irradiate the evening and morning skies, though shorn of their earlier glory.

The spectrum of the red light appears to be almost identical with that of the ordinary red clouds which often attend the setting sun. I exhibit two diagrams, in which I have attempted to represent what I have seen with this spectroscope—first, when directed to a glowing sunset in the tropics, and, second, when directed to the red after-glow here. The two are substantially the same, the chief difference being on the red side of D, where in the case of the tropical sunset there is a distinct line, which I understand to be the special "rain-band," and in the after-glow this line disappears in the general shading that stretches from D half-way to "*a*." The line *a* between D and C is broader and denser in the after-glow than in the sunset. So far the evidence might be taken as showing that both phenomena arise from the same cause, namely, water in some form in the atmosphere; but the spectroscope is by no means able to settle this difficult question; it analyses the light that comes to us, but does not identify the agency that decomposes and reflects the light. It is possible that the polarisation of the reflected rays might throw some light on the nature of the reflecting substance, but probably the light is too faint for such an observation; at all events I have not seen any record of observations of this kind. You must all have watched and admired these strange and beautiful evening and morning displays, for which, by the way, we are in want of a good distinctive appellation, and no doubt you are all aware of the various explanations that have been put forth; but let me remind you of the leading features of the phenomenon. I have not myself been favourably situated for good observations, and I therefore copy the following from an anonymous writer in the *Herald*:—"I have observed the sun to set in a cloudless sky, coloured orange yellow; the daylight seems to decrease for fifteen or twenty minutes after sunset, when I observe a whitish oval patch of light, at an altitude of 20° to 30°; this rapidly changes in colour, becoming yellowish purple, pink, brick red, and crimson; the coloured patch of light at the same time elongates and settles rapidly down on to the horizon, this phase ending about forty-five minutes after sunset. A second purplish patch now appears, at about 30° altitude, the horizon turning to a brown colour: this second patch is more widely diffused and its boundaries are more ill-defined than the first one; it changes to yellowish purple, yellowish red, brick red, and crimson, spreading in azimuth, and settles down on the horizon in about 100 minutes after sunset, when the last tinge of colour disappears." My friend Mr. Comrie has supplied me (under date March 10) with some observations made by him at Northfield, Kurrajong Heights, about 1,870 feet above the sea:—"We first noticed them here the first week in September. They were not always red, but sometimes pink, deeper or lighter crimson, golden yellow, peculiarly bright, having the power of lighting up everything brilliantly, and often a deep rich orange. I have been watching them for months, and, although they have lost something in brilliancy, they are still (March 10) to be seen. We have also seen the bright red glow that precedes the sunrise, and have heard from others who have watched the morning glows more than I have been able to do, that they were at first finer, richer, and more extensive than the evening ones. A special feature of the evening glow is its not appearing till after the sunset glow has passed away and the evening shadows begin to fall. Then the objects on the lawn begin to lose their indistinctness, a sudden brightness envelopes them, and they stand out clear and distinct, clothed with a golden radiance which seems reflected everywhere, and for five or ten minutes the whole lawn is lighted up and glows like a fairy bower, when as suddenly as it came up in the heavens the glow passes away, and everything is speedily shrouded in darkness."

My friend Mr. Wright, of Drummoyne, on the Parramatta River, informs me that the morning glow has frequently been more intense and rich than the evening, and that the river eastward from Drummoyne has sometimes been, as it were, turned into blood. The grandest of these weird and flaming heralds of the morning occurred in the early part of last month, and previous to that there was a gorgeous display on the morning of March 1.

One of the finest of the later exhibitions of evening glow at Sydney was on February 26, when the rosy light extended all round the horizon. Venus, in the west, shone with a beautiful green colour, complementary to the surrounding brilliant red. On March 13 there was also a fine display, with Venus showing distinctly green. Since then the evening glow has become rarer and more faint. Mr. Russell tells me that at Cobar, about 350 miles inland, the most brilliant display of evening glow was on February 24.

I adduce also a description by Mr. Todd, C.M.G., Government Astronomer at Adelaide, because it brings out some further details, and to show that the phenomenon has the same characteristics there as here :—"On every clear evening during this month (October) and the last fortnight of September a peculiar phenomenon has been apparent in the western sky. Shortly after sunset a red glow will make its appearance at an altitude of about 50°, being very faint at first ; but, as the brightness of the sky near the horizon dies away with the receding sun, the red glow will expand downwards, becoming at the same time more brilliant, until at last the whole western sky will be lit up with a beautiful light, varying in colour from a delicate pink to a most intense scarlet, and the spectacle presents a most brilliant appearance. The upper part will then gradually fade away, until the colour is noticeable only at 7° or 8° above the horizon, at which time the light is about its brightest. Afterwards a secondary glow will sometimes make its appearance at an altitude of about 50°, and gradually spread downwards until the sky is again lit up. In the secondary phenomenon the colours are generally more delicate. The whole thing will fade away about 8 p.m."

No doubt you are aware that three explanations have been put forward to account for these remarkable appearances. The first is that they are due simply to water vapour at an unusual altitude. This, I think, must be set aside, for it is scarcely conceivable that the phenomena should be so rare were this the cause. The present generation has hitherto seen nothing similar, and there seems to be no distinct record of like appearances in former times, unless indeed the atmospheric phenomena of 1831 were of the same kind. It is true that Professor Piazzi Smyth and others aver that they observed like appearances some thirty years ago, but it appears to be generally admitted that the atmospheric phenomena referred to were connected with ordinary red sunsets, where the rich colouring is evidently produced by the action of the sun's rays on water or ice in fine particles, and that the late appearances are of a different character; and even if it were conceded that in some one part of the earth water vapour might occupy an unusual position and produce unusual displays, is it at all probable that within a limited period a like condition of water-vapour should prevail over the whole earth, and continue for months?

The second, and apparently the most popular, explanation is that the wonderful decomposition and reflection of light has been caused by fine dust, emitted during the great eruption of Krakatoa in the end of August last year; and the third hypothesis is the same in so far as dust is concerned, but differs in regard to the origin of the dust, accounting it to be of meteoric or cosmical origin, instead of an emission from a terrestrial centre.

Now in favour of the volcanic origin we are informed that dust as actually collected from new-fallen snow at Madrid on December 7, very similar in composition to dust that had fallen near Krakatoa. Volcanic dust (of a different character however) was also found in new-fallen snow at Philadelphia on January 22; and at Constantinople on December 2 there was a shower of a white substance like snow, of saltish taste and soluble in water. On the previous night there had been a gorgeous display of colour, the crimson glow being visible an hour and a half after sunset, and on the morning of December 2 the same magnificent colour flooded the eastern sky long before the dawn. I understand that at other places also, dust from the atmosphere has been collected, more or less resembling a volcanic product.

But the argument chiefly relied on is the fact that the splendid colouring on the twilight skies began to be observed immediately after the great eruption, and that the phenomena seemed to spread from Krakatoa as a centre. A careful examination, however, of recorded dates makes this last fact very doubtful; and in regard to the former, I have been assured by Mr. Baracchi of the Melbourne Observatory that exactly the same atmospheric appearances were frequently seen by him at Port Darwin as early as February of last year. Of course Krakatoa had nothing to do with these. The evidence obtained from a comparison of dates is open to a good deal of uncertainty, inasmuch as in many cases the first appearance of the colours was not noted or has not been definitely published. Even here in Sydney I am unable to fix the date of first appearance, nor have I been able to obtain definite first dates for Melbourne or Adelaide; but if we can determine within even a few days the time of first appearance at a considerable number of places, we may be able to judge how far the eruption of Krakatoa might account for the necessary distribution of dust.

The earliest date of the abnormal appearances that I can find (leaving out of view for the present the case of Port Darwin) is August 28, at the Seychelles, and on the same date at Karachi, the former place being 3,000 miles west of Krakatoa, and the latter about as far to the north-west, the two places being about 2,000 miles asunder. The great eruption occurred on the afternoon of August 26, through the following night, and during the forenoon of the 27th, and we are at once met with the difficulty of conceiving how dust could travel so rapidly. We have certainly no reason to suppose that the higher aerial currents ever move so fast. If it should be supposed that the earth's rotation had anything to do with it, then we are confronted with a record at Yokohama, on the 29th, 3,200 miles to the north-east; and at New

Ireland on September 1, 2,700 miles to the east. Again, we have a record at Maranham, in the north of Brazil, on August 31, 9,000 miles to the west, so that the dust must have travelled 2,000 miles per day westward from Seychelles. An inconsistent observation comes from the Gold Coast, September 1, 6,300 miles to the west—inconsistent I mean with the supposition that the dust came from Krakatoa; but it is not fatal to that supposition, as a cloudy sky may have hidden the first red glow on the Gold Coast. On September 2 we have the phenomenon recorded at Trinidad, 10,000 miles west, and at Panama, about 1,000 miles further west. The latter case gives a movement of 1,000 miles per day westward from Brazil. On September 2 it appeared also in Peru. On September 3 we have a record from a ship 4,000 miles west of Panama; but this can scarcely be connected with the westerly movement, and we must turn again to the easterly. On September 1 we had the phenomenon at New Ireland. From that to the place of the ship above indicated is an eastward course of 3,600 miles, giving 1,800 miles per day. Honolulu lies about 900 miles north-west from the position indicated, or 6,000 E.N.E. from Krakatoa, and there the phenomenon occurred first on September 5, quite inconsistent with the previous case. But, waiving this anomaly for the present, it seems to me quite impossible that upper currents of the atmosphere could carry dust from Krakatoa eastward and westward simultaneously at such a prodigious rate. If the dust came from Krakatoa, then the only agency that seems capable of dispersing it is electrical repulsion, and to that view there are serious objections.

On September 8th we have the first record at Ceylon, 1,600 miles to the north-west, although at Karachi, 1,400 miles further in the same direction, the record is August 28. Ongole, September 9th, 500 miles northwards from Ceylon, and Madras, not so far north, both agree well with the Ceylon observation. At these places, as at some others, the first appearance noted was the green colour of the sun; but as this seems undoubtedly to be caused by the same agency that produces the red glow, it is not necessary to distinguish the two phenomena in giving dates.

Early in September, probably about the end of the first week, we began to have the magnificent red skies at Sydney, 3,000 miles south-easterly from Krakatoa; and the same approximate date will answer for Melbourne and Adelaide. About the same date we have a record from Virginia, and a little later from the west coast of South America, both of which agree tolerably well with the record at Panama and Trinidad on September 2. At the Cape, 5,200 miles south-westerly, the first appearance was on September 20. Comparing Sydney and the Cape, we find the dispersion occurring simultaneously at about the same rate to the S.E. and S.W., but this rate is very much slower than the E. and W. dispersion.

The next place in order of time for which I have a date is Sapporo, in the north of Japan, 3,800 miles N.E., where there was a red sun and fall of ashes on October 13. Santa Barbara, 8,000 miles E.N.E., October 14, although San Francisco, not far away, seems to have had nothing till November 23. On November 9 the red skies were first seen in England, about 6,300 miles north-westerly, giving 85 miles per day of dispersion, although places much nearer Krakatoa on the same bearing were later. For instance, Constantinople, 1,300 miles nearer, gives November 20; Italy, November 25; Berlin, November 28; and Madrid (a little further away than England), about the same date. These cases do not at all correspond with the supposition of a dispersion from Krakatoa. November 23 is the date given at Iceland. On November 27 we have the first record from New York and the north-eastern States of America, 10,200 miles E.N.E. On that date we are told that the fire-engines were tuurned out at Poughkeepsie, on the Hudson, under the impression that a great conflagration was going on. This date is inconsistent with that from Virginia early in September.

If we suppose that the dust travelled westward from England to New York, it would give us a rate of about 167 miles per day. If we try the eastward movement, we get a much slower rate from Honolulu (48 miles per day), although up to that point it must have travelled 667 miles per day. On the same day that the red skies appeared at New York, they appeared also at Victoria, British Columbia, about 2,200 miles westward.

It seems needless to pursue the matter further. If these dates are at all trustworthy, we cannot account for them by dust from Krakatoa, for neither winds nor electrical repulsion would explain such erratic movements. Another difficulty in the way of admitting that Krakatoa is the source of the dust, is the persistency of the phenomena. Here at Sydney we have enjoyed frequent displays of the rich celestial colourings for nearly eight months, and, although they have become fainter in the evenings, I am assured that some of the morning glows, within the last few weeks, have been as grand as ever. We are driven, therefore, to conclude that the dust, if dust is really the agent in question, must have been meteoric, and had its origin outside our earth. The dates however require fresh examination; and this will, no doubt, be done effectually by the Committee lately appointed by the Royal Society of England to investigate the whole matter.

It now only remains for me to induct my successor, Mr. Russell your newly elected President, and to take my leave.

On the Removal of Bars from the Entrances to our Rivers.

By WALTER SHELLSHEAR, Assoc. M. Inst. C.E.

[*Read before the Royal Society of N.S.W., 4 June, 1884.*]

THE removal of bars from the entrances to our rivers is a work of national importance, directly affecting as it does the progress and trade of the whole group of Australian Colonies, and in New South Wales especially it is the great step necessary in the development of the abundant resources of our fertile coast districts. A paper on this subject may not, therefore, be without interest to the members of this Society.

The coast of New South Wales might not inaptly be described as ironbound, the cliffs in most cases rising perpendicularly from the water, the sea being of great depth right up to the shore. It is broken by a few bays and sandy beaches, some of the latter being of considerable length; but deep water is invariably found at a moderate distance from the shore. The rivers fall into the sea mostly through sandy estuaries obstructed by extensive sand-bars, but in some few instances they pass into rock-bound inlets of considerable depth, notably in the case of the Hawkesbury River. The formation of bars at the entrances to our rivers is mainly due to the action of the waves in lifting large quantities of sand as they pass into shallow water, the sand being carried up the estuary by the incoming tide, and is deposited as soon as it is beyond the influence of the waves; the ebb tide, being unassisted by the waves, is unable to cope with the incoming sand, and thus we see, when the tide and waves are left to themselves, the tendency is to close the entrance altogether. To this is to be attributed the deplorable state of our river mouths in time of prolonged drought. This point is very forcibly brought out in the notes on the Admiralty charts, where it is stated that certain entrances are only open after a heavy fresh.

The opinion that bars are mainly formed by the action of the waves is held by many leading authorities on the subject. Mr.

David Stevenson, F.R.S.E., member of Council Inst. C.E., said :—[1] "It was now thirty years since he propounded the theory—and at that time he believed he stood alone in holding it—that the bars of the rivers of the United Kingdom were due entirely to the action of the sea constantly heaping up sand and detritus, and that but for some counteracting influence the effect of that action would be to form a continuous line of beach across the mouths of navigable rivers and estuaries. The counteracting influence to which he referred was that of the tidal and river scour. He might say that that theory, now thirty years old, had been fully confirmed by his subsequent experience. * * * * It was further known that those bars were always worst after a prevalence of on-shore wind and heavy sea, and were best when the river was in flood. * * * * The waves were the true 'depositors' of the bar, the river was only an 'excavator,' and there would still be all the phenomena of a bar at the mouths of estuaries, although the river water did not bring down a single particle of suspended matter. * * * * If his bar theory, as applicable to tidal rivers, was right, it clearly followed that, if the pier heads were carried into water of sufficient depth to prevent the waves from acting upon the bottom with such force as would throw up sandbanks, it would be possible to secure permanently the depth obtained by extending the piers, because there would be no submerged beach thrown up by the sea, and the alluvial matter in suspension would be carried out with the current." Mr. I. J. Mann, C.E., in his valuable paper on the removal of river bars by induced tidal scour, remarks :—[2] "With reference to the bar at the mouth of the Liffey, the author has no hesitation in attributing its formation to the combined action of waves and current of the flood tide, the former stirring up and keeping in agitation the fine sand of which the bottom of the bay is composed; the lower stratum of the water becomes therefore surcharged with sand, which is carried along by the tidal current."

Sir John Coode, remarking on the formation of bars, says :—[3] "They were formed almost entirely by the sea, some rivers illustrating this in Australia. At the Swan River, on the coast of Western Australia, facing the Southern Ocean, with very little tide, there was a bar of the worst possible description; while the Yarra, at Melbourne, which discharged into a sheltered embayment at the head of Port Phillip, though it had a rise of tide precisely the same as the Swan River (about 2 feet), had no bar, simply because it was in a sheltered position, and there was no

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[1] Minutes, Inst. C.E., vol. xxxvi, p. 236.
[2] "Engineering," vol. 27, p. 108.
[3] Minutes, Inst. C.E., vol. lviii, p. 130.

heavy wave action to throw up the material to form a bar." The same remarks are equally true in the case of the Hawkesbury River, the entrance of which is sheltered, and there is therefore no bar. The contrary effect is seen in the case of the Richmond River, where the entrance is exposed to the wave action; consequently a bar obstructs the entrance.

We may safely deduce from this that, in order to cope permanently and successfully with the sand, it is necessary to extend artifically the entrance to a point where the depth of the water is such that the waves are unable to heap up the sand, to make the entrance of such form that the force of the waves will be expended before they advance into shallow water, and at the same time directing and concentrating the action of the ebb tide and upland waters, so that their force may be used to the best advantage in combating the mischievous action of the waves. Sir John Coode's observations show that the movement of the sand from the beach seaward always terminates in about $3\frac{1}{2}$ fathoms, and in his works he goes upon the broad principle of passing beyond the line of disturbance.[1] This demonstrates the advisability, where practicable, of carrying the works out to at least that depth. On dealing with the action of waves he says that "the effect of wave action is at least a hundredfold greater than that of the tidal action." And if this be so, it clearly proves the necessity of breaking the force of the waves before they have an opportunity of throwing up sand.

Mr. Walter Raleigh Brown, M.A., M. Inst. C. E., speaking upon the subject, says:—[2] "In all cases of sand pushing across the mouth of a harbour, the principle to be kept in mind, in his opinion, was to concentrate all efforts upon one point, in order to keep a clear and deep channel at that place." Mr. Vernon Harcourt, M. Inst. C.E., in reply to the discussion on his paper on "Harbours and Estuaries,"[3] considered that "a harbour should be formed with solid piers, starting from the shore at some distance apart, and converging at their extremities, which should be carried into as deep water as practicable."

It may be well at this point to examine what has been done in dealing with bar harbours situated in similar positions to those on our coast, in other parts of the world—that is, bar harbours situated on rapidly shelving coasts.

The entrance to the Tyne (plate No. 1) has many points of resemblance to our rivers. Upon an examination of the chart of the Tyne in 1813, it will be seen that at that date it was in almost exactly the

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[1] Minutes, Inst. C.E., vol. lxx, p. 45.
[2] Minutes, Inst. C.E., vol. lxx, p. 35.
[3] Minutes, Inst. C.E., vol. lxx, p. 53.

same state as our principal rivers are at present, namely, nearly blocked by a shifting sand-bar, with deep water on either side. A reference to a recent chart of the same river shows what a great transformation has been made in this entrance by the carrying out of judiciously planned works. By the construction of the two breakwaters, starting from the shore at a considerable distance apart, approaching each other as they extend seaward into deep water, the sand-bar has ceased to exist, having been removed by the combined action of the induced scour and dredging; the breakwaters extending into deep water thus prevent the waves from lifting fresh sand, the waves losing their force after they enter, on account of the widening out of the works, and at the same time the tidal scour has been greatly improved by reason of the large area enclosed by the breakwaters. The foreshore has only slightly advanced, and from the rapidly increasing depth seaward there is little danger of any serious trouble from this cause.

The entrance to the Tees (plate No. 2) has undergone a somewhat different treatment, the river having been taken through the estuary between half tidal groining walls; but these not having proved as successful as the Tyne works, it was decided to construct two breakwaters in some respects similar to those on the Tyne, one of which has been constructed and the other is in progress, the result so far being most satisfactory, for since the completion of the south breakwater, a considerable improvement has already taken place, the bar having been lowered several feet.

The entrance to the Liffey, near Dublin (plate No. 3), is one of the most interesting and instructive examples of the successful treatment of a difficult bar. The improvement works were commenced in the last century, by the construction of the great south wall, extending seaward in almost a straight line with the river, crossing the low foreshore known as the South Bull Sand. The effect of this wall was to fix the direction of the channel. Several plans were suggested early in the present century for further improving the entrance, and if possible for the removal of the bar. Eventually it was decided to construct the great north wall, starting some distance up the coast and converging towards the end of the great south wall, thus enclosing a great tidal area for scouring purposes, at the same time forming, with the south wall, a sort of nozzle, directing and concentrating the action of the tide on the bar, and likewise protecting the inside harbour from the waves.

Although these works are placed at great disadvantage on account of the shallowness of the sea for some distance from the entrance, they have been designed so as to make the best possible use of the available scouring power, and their success is established by the fact that the bar has been lowered to the extent of 10 feet. The following table gives a progressive account of the effect of these works since their completion :—

Date.	Minimum depth on Bar at low-water.	Interval.	Increase of minimum depth	Rate of increase of minimum depth per year.	Depth on Bar at standard high-water.
	ft. in.	years.	ft. in.	in.	ft. in.
1822	6 3	......	....	....	19 3
1828	9 6	6	3 3	6·50	22 6
1833	10 6	5	1 0	2·40	23 6
1856	13 0	23	3 6	1·82	26 0
1873	16 0	17	3 0	2·11	29 0

An interesting history of the Dublin works will be found in Mr. I. J. Mann's paper on "The Removal of River Bars by Induced Tidal Scour," published in *Engineering*, vol. 26, from which paper the above table has been taken. Another history will be found in the "Minutes of the Institution of Civil Engineers," vol. lviii, in a paper by Mr. J. P. Griffith, M. Inst. C.E.

From these cases it will be noticed that there are certain fixed principles involved in each and all of them. The first is that the entrance is fixed at a point in a direct line with the direction of the river, and in as deep water as circumstances will allow. The second is that the works are so constructed that the force of the waves is dispersed as soon as they pass the entrance, on account of the widening out of the works. The third is that, whilst the flood-tide approaches from all directions, and any material it may bring in is deposited near the entrance, as soon as it arrives in comparatively still water the ebb-tide and the upland waters having their forces directed and concentrated in a certain fixed direction, are therefore able to remove, and carry well out to sea, any deposit that may have been left by the flood-tide, and at the same time maintaining a straight channel out to sea.

Having so far endeavoured to bring forward general principles, it is now proposed to see how they can be applied in dealing with our rivers; and in doing so, it must be remembered (to quote the words of Sir John Hawkshaw) "that there is nothing more certain than that each one must be dealt with according to its own special *régime.*"

At the entrance to the Hunter River, Newcastle, there is a remarkable instance of a natural breakwater, illustrating the advantage of protection works (natural or artificial) extending into deep water. By referring to the plan of the river taken in 1816, we see a channel of 3 fathoms marked under the lee of a reef extending from the mainland to Nobby's Head. But as this reef only afforded partial shelter, we find the waves struggling with the tidal current, and reducing the width of the channel to very narrow limits, by the formation of the dangerous "oyster-bank." The improvement of the reef by the construction of the southern breakwater somewhat reduced the "oyster-bank," and now the breakwater has been extended beyond Nobby's Head. The entrance being thus more perfectly protected from the waves, we see a most satisfactory improvement by the widening of the channel and the almost entire removal of the "oyster-bank," brought about by the comparatively undisturbed action of the tidal and upland water scour. At the present time, the entrance is so far protected by the breakwater on the south, and the bay-like line of the coast on the north, that the tidal and upland waters have decidedly the best of the situation, and thus we see a progressive state of improvement.

Although this harbour possesses great natural advantages, by the position of the reef upon which the south breakwater has been built, and by the deep water and absence of sand to the south of the entrance, it labours under a serious disadvantage on account of the great curvature of the river at the harbour, the effect of which, as is well-known, is to cause the currents to scour out deep holes at certain points, and to throw up banks and others, and there is no doubt that this action will necessitate a large amount of dredging to keep the harbour of uniform depth.

In investigating how far the general principles set forth above, and illustrated by the works at the Tyne, Tees, and Liffey, may be applied in dealing with our rivers, it may be well to take the Richmond and Clarence Rivers as examples; and, in dealing with these cases, to show how, with modifications to suit local circumstances, they may be generally applied to the other rivers along our coast.

The Richmond River (plate No. 4) flows through one of the most fertile districts of the Colony, and is navigable for vessels of moderate size for some distance from the entrance; but, as is unfortunately the case with most of our rivers, it is blocked by a very dangerous shifting bar. The width across the entrance is about 6,000 feet. The North Creek joins the main river at nearly right angles, opposite the centre of the entrance, thus forming a somewhat complicated combination. The general tendency of the waves is to heap up the sand-bar across the entire distance between the heads, with the exception of a narrow channel under the North Head, and occasionally there is a second channel at the South Head, but this is not permanently navigable.

In attempting to improve this entrance, the first thing to be considered is at what point should the entrance channel be fixed; and in fixing this point, it is necessary to study the effect of the tidal waters from the North Creek upon the tidal waters of the river, and, if possible, to combine them into one concentrated stream, to act jointly upon our fixed point on the bar. Looking at the case with the above considerations before us, it appears that the best point on which to focus our large available scouring power, would be in the neighbourhood of A on the plan, as near as possible in a direct line with the centre of the last reach of the river, and somewhat to the north line of the North Creek.

Having determined this point, we have to consider what works would be necessary in order that the tidal and upland water scour might be concentrated at that point. Firstly: By the construction of a breakwater starting from the South Head, extending seaward for about 2,000 feet in an easterly direction; the entrance would then be protected from the south and south-easterly weather; at the same time the tidal waters would be directed so as to improve the South Channel. Secondly: By the construction of a wall from the pilot station in a south-easterly direction, crossing the sandbank, and terminating by a breakwater of about the same length as the proposed south breakwater, leaving an entrance of about 1,500 feet between the extremities of the works. The northern works would protect the entrance from the north-easterly and easterly weather, which, as is well-known, are the principal agents in heaping up bars; they would, in conjunction with the southern breakwater, direct and concentrate the tidal action on the bar, thus enabling the ebb-tide and upland water to carry the sand well out to sea. Considering the large amount of tidal water available, and the great depth of the sea a short distance from the entrance, there can be no doubt that, in a short time after the completion of these works, there would be a sufficient depth at the entrance to enable the largest steamer afloat to enter; moreover, the lower reach of the river being protected from the prejudicial action of the waves, and having its direction fixed by the position of the entrance, would soon make for itself a permanent deep channel.

Judging from the effect of the works at Dublin, where an insignificant river has been made available for a first-class shipping trade, by the correct application of sound principles, the author has every confidence in predicting that, if works were carried out on the lines proposed, this great natural highway, which is now closed to all except small steamers and coasting craft, would be available for our first-class intercolonial steamers, the effect of which, as far as enhancing the value of property and increasing the prosperity of this district, cannot well be gauged, or, in these times of advancement, even imagined. After the maturest consideration of this case, the author feels convinced that, by the application of the most modern and improved construction, these works could be carried out for a sum not exceeding £200,000 or £220,000.

The Clarence (plate No. 5) is undoubtedly the most important of all the rivers of this Colony running into the Pacific. It flows through one of the most productive districts of New South Wales; and from the wonderful richness of the soil, there can be little doubt that this district is destined to play an important part in the development of the great agricultural resources of this Colony. But for the existence of the bar at the entrance of this great natural means of internal communication, Grafton and the Clarence district would, there is little reason to doubt, be next in importance to Sydney herself, for with the entrance once secured the port would be the natural outlet for the trade, not only from the immediate district itself, but from the whole of the country stretching away to the table-lands of New England and beyond. The pressing necessity, therefore, of removing this obstruction to the progress of this important part of the Colony cannot be overestimated.

In examining this case the same contending forces are seen at work—namely, the struggle between waves and tide, the result being that the entrance has been driven into a most awkward corner by the action of the north-east winds, the river being diverted from its straight course into one of the most ugly bends imaginable, with the result that, instead of a good channel, we see a succession of deep holes and sandbanks, and to make matters worse there are several dangerous sunken rocks in this already uninviting entrance. Nature has done much towards the removal of this most unsatisfactory state of things, the entrance being well protected on the south by the South Head; moreover an enormous volume of tidal water is available, only wanting skilful directing in order that it may become a most powerful agent, and one that would be more than equal to the task of removing all obstructions. Wanting such directing, this great natural power is expended in dredging deep holes in places where they are not required, and heaping up sand-banks on the site of the much desired entrance; at the same time, on account of the frequent changes of direction, troublesome eddies are formed to further increase the difficulties of navigation.

There should be no great difficulty in fixing the entrance and removing the bar, considering that Nature has provided perfect protection on the south side; all that appears necessary is the construction of a breakwater to protect the entrance from the north and north-easterly weather. At the same time, the channel should be straightened by cutting through the spit, and deflecting the stream from the south side of the river by the construction of a dyke from the south bank to Rabbit Island, extending a short distance into the main channel. The breakwater, once constructed, the removal of the spit would be an easy matter; for by cutting a narrow canal parallel with Queen-street, Iluka, the tide would soon complete the work of cutting a good channel. The new channel being straight, the banks would moreover require but little protection, as they would not be subjected to the excavating action inseparable from curved channels.

The advantages of this plan of treatment must be commendable to the most casual observer. Firstly—The entrance being protected on the south by the South Head, and on the north by the breakwater, extending into deep water, the protection from the waves is complete. Moreover, the channel being straightened, the tidal and upland waters, unimpaired by any abrupt changes of direction, would do the work of maintaining and improving the channel, and at the same time keeping the entrance clear of all obstructions. Secondly—The entrance being well protected and in deep water, and the channel being straightened and removed from the neighbourhood of the sunken rocks, the port would be made available for the passage of large vessels, and could be entered without danger in all weathers. The benefit that would follow the opening up of this seaport, and the increased wealth and prosperity it would confer upon this valuable portion of our territory, does not require to be enlarged upon in this paper. The straightening of the entrance channel would be by no means as formidable an undertaking as it at first appears, for with the proposed breakwater once constructed, this would be the natural course of the river.

A remarkable instance of the ease with which the channel of a river may be diverted from one bank to the other is given in the case of the Missouri River, where by the construction of a comparatively inexpensive dyke, the centre of the channel of this great river was shifted from the west to the east bank, a distance of nearly 2,000 feet; and in a few months the river cut for itself a new channel many feet in depth.[1] This case clearly demonstrates the practicability of the works proposed for the Clarence. The entrance to the Clarence has been compared to that of the Hunter, and it has been argued that works carried out on similar lines in the two cases should have like results. Careful consideration will show that there is but little grounds for such conclusions. The two entrances are alike in this respect—that they are both protected on the south by a natural breakwater; but in the most important particular, as far as the treatment of the bars is concerned, the cases are widely different; for whilst the entrance to the Hunter is in a great measure protected from the N.E. wind by the easterly direction of the coast-line between Newcastle and Port Stephens, the Clarence is exposed to its full force, and, as is well known, the long prevalence of N.E. winds has a very prejudicial effect on the river entrances exposed to them, as is evidenced by the heaping up of the sand at all such rivers; thus clearly showing the

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[1] See *Railroad Gazette* of New York, for November 30, 1883.

necessity of treating each case according to its own special requirements. To carry out the works proposed by the author at the entrance to the Clarence would probably cost about £150,000 to £160,000.

In coming to the above conclusion as to the best method of treating the Clarence River, the author has been guided by the experience gained in the successful treatment of the Tyne, Tees, Liffey, Danube, the Kurrachee mouth of the Indus, and the recent great works at the mouth of the Mississippi, in all of which cases the object kept in view has been the protection of the entrance from the wave action, and improving the scour by making the entrance channel as straight as possible; whereas the existing works on the Clarence, in his opinion, merely deal with the "result" brought about by the disturbing action of the waves and tide, instead of treating with the "cause" by protecting the tidal action from the disturbing action of the waves, which would be the case if the works proposed by the author were carried out.

The entrance to the Bellinger River is rather a complicated case, judging from the country map and the Admiralty chart, and in the absence of a detailed chart of the river it would be unwise to speculate on the best method of improving it. The Nambuccra and Manning Rivers have more direct entrances than any of the rivers above mentioned, and could probably be dealt with by the construction of much less stupendous works, at a moderate cost.

The entrance to the Macleay River is one that would require careful study; but as it is well protected on the south by Trial Bay, and having a large volume of tidal water available for maintaining the entrance, there should be no great difficulty in acquiring a satisfactory channel across the bar.

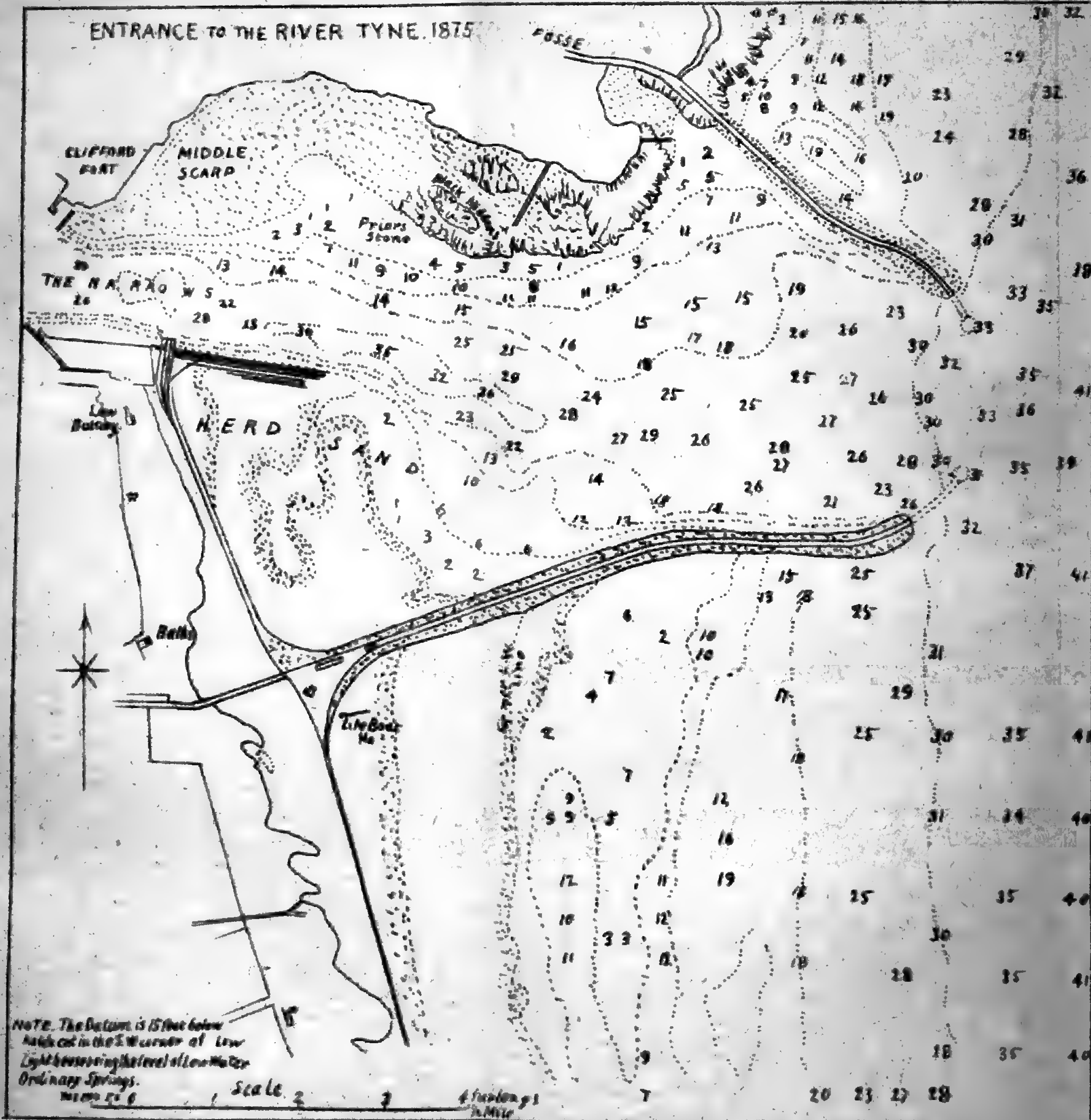
The entrance to the Hastings River at Port Macquarie (plate No. 6) could be much improved, and at the same time a valuable harbour formed, by taking advantage of the sand-bank opposite the town, and constructing a breakwater on the north in the direction shown on the map. This breakwater would protect the entrance from the north-easterly weather, and at the same time steady the tidal current along the south side, thus forming a deep channel near the town, and by the increasing width of the harbour, the force of the waves in time of easterly gales would be broken; the current at the same time would be focused at the entrance, and be enabled to keep down the bar.

With skilful handling, many of the inlets that are now practically closed for navigation might be made available, and those that at present can only be frequented by the smallest craft might be used by a much larger class of vessels; but in all cases the first principle to be kept in mind is that the battle has to be fought with the waves.

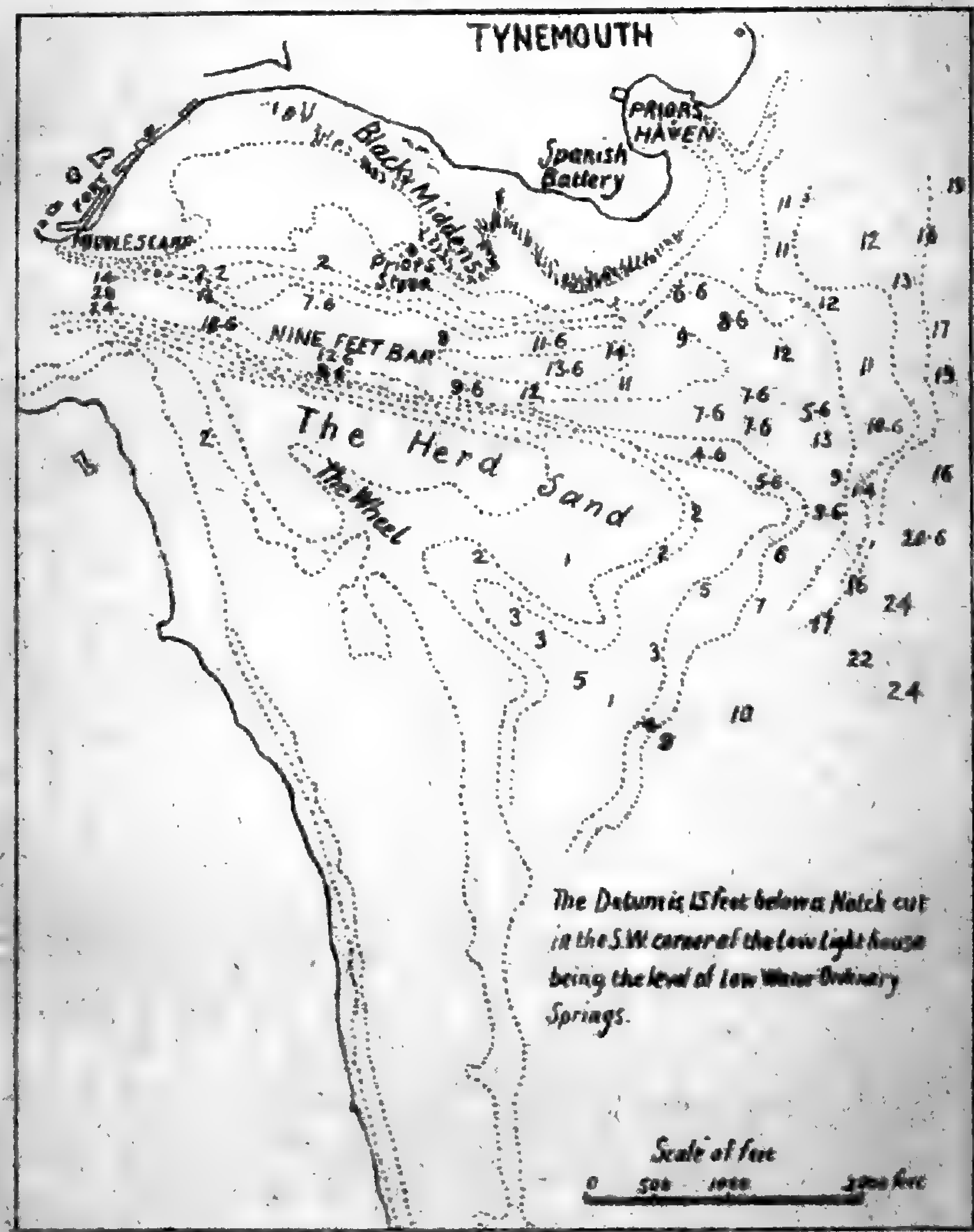
As to the best system of carrying out such works as are proposed in this paper, great strides have of late years been made in this branch of civil engineering, by the use of large concrete blocks, breakwaters having been constructed at a speed altogether unknown a few years since. Thus, 710 feet were added to the Manora Breakwater, Kurrachee, in less than four months, by the use of concrete blocks of 27 tons each, placed in position by suitable machinery; at the same time this work was carried out at a very moderate cost compared with similar work under the old system. Many other instances might be quoted where, by the use of concrete in its different forms, works have been rapidly constructed at a moderate cost that would have been well nigh impossible to carry out except at an enormous outlay, but for the aid of this most valuable material. Another great advance has been made in the direction of cheapening such works, by the use of large mattresses made of fascine, which, when sunk in position, prevent the sand from being washed out. Layers of stones are placed on these mattresses, which in their turn are covered with other mattresses, the work being thus well bound together. This system has been used with great advantage in America, and has recently been adopted in Holland, where the extensive works at the mouth of the river Maas have been carried out on this system at a very moderate cost, and at the same time giving great satisfaction.

In conclusion, the author's apology for bringing this subject under the notice of the Royal Society of New South Wales is its vital importance to the best interests of the coast districts of the Colony; the improvement of the river entrances being the principal work necessary to develop the resources of these rich agricultural lands. From valuable instruction in the principles that govern the movements of solid matter held in suspension by tidal and wave-disturbed water, imparted by Dr. James Thomson, during an engineering course at the Glasgow University, and from careful study of the subject extending over several years, and from personal inspection of many important harbours, the author is convinced that all that is necessary to ensure success in the treatment of our different rivers is: "The close observation of physical features and effects, and the adoption of means to assist the operations of Nature instead of opposing them"—that is (as expressed in the charter of the Institution of Civil Engineers), "directing the great sources of power in Nature for the use and convenience of man."

The paper was illustrated by numerous charts and maps, from which plates 1, 2, 3, 4, 5, and 6 have been prepared.



ENTRANCE TO THE TYNE 1813



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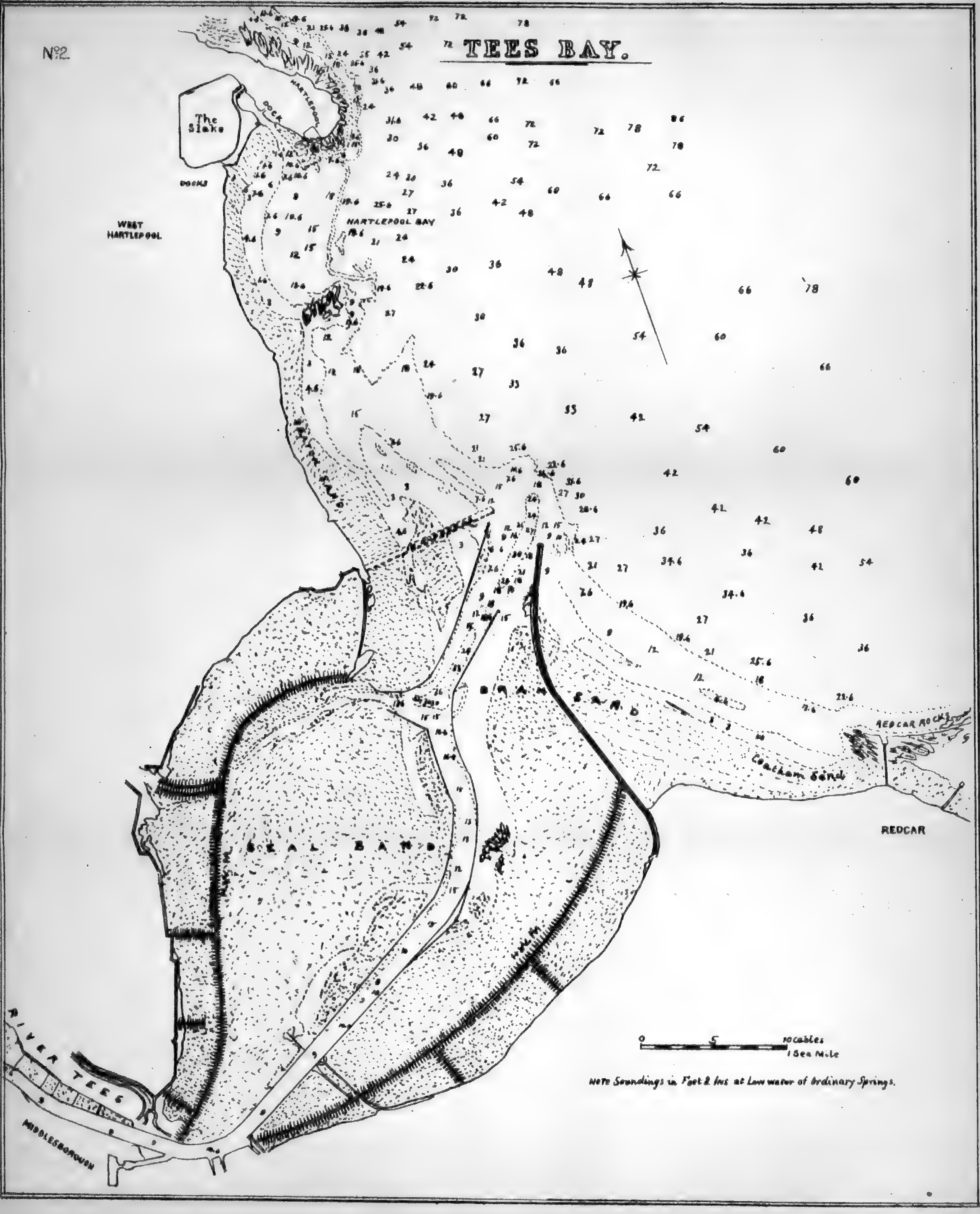
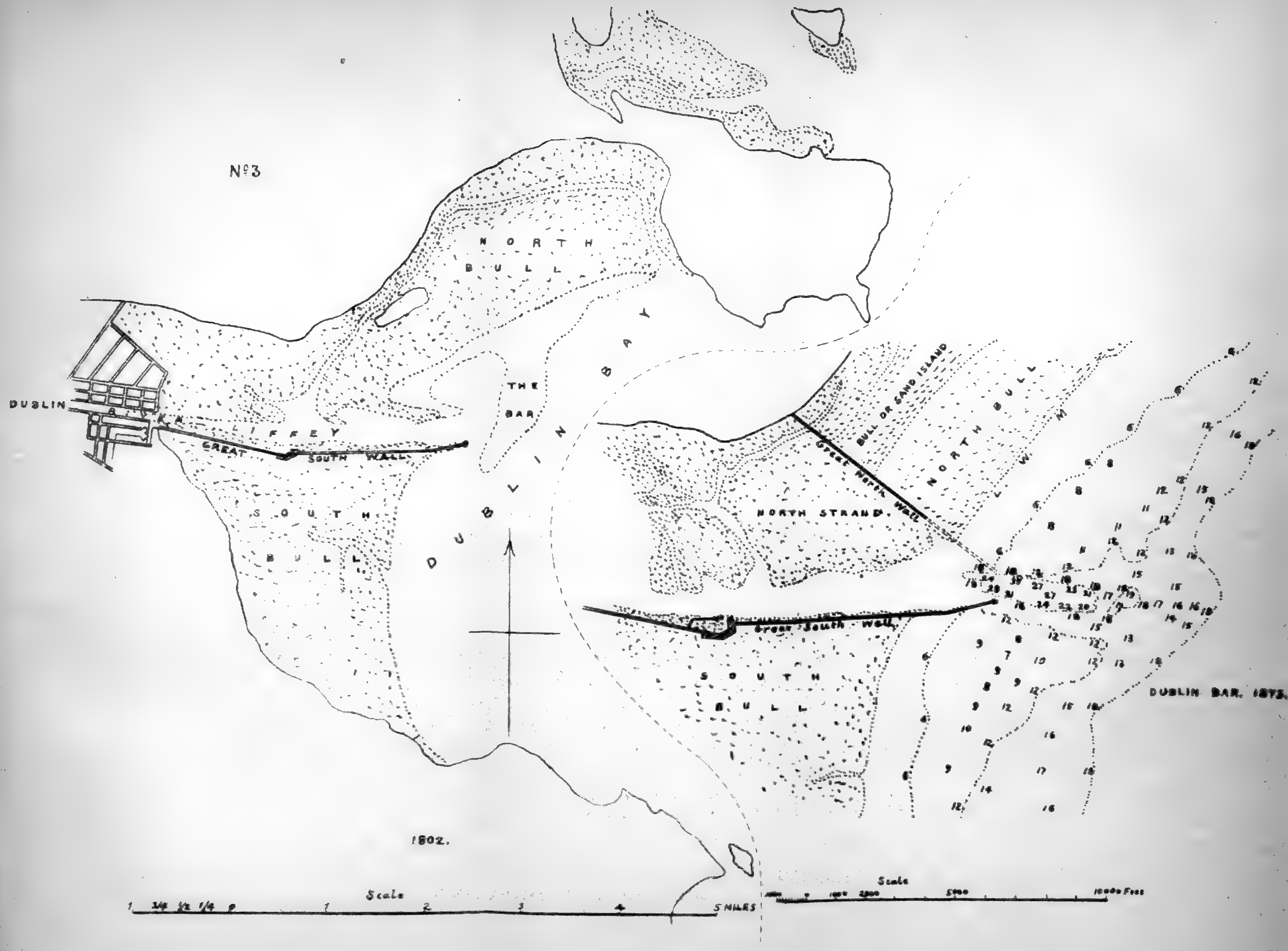

No. 2
TEES BAY.
The Slake
DOCKS
WEST HARTLEPOOL
HARTLEPOOL BAY
REDCAR ROCKS
Coatham Sand
REDCAR
SEAL SAND
BRAN SAND
RIVER TEES
MIDDLESBOROUGH
0 5 10 cables
1 Sea Mile
NOTE Soundings in Feet & Ins at Low water of Ordinary Springs.

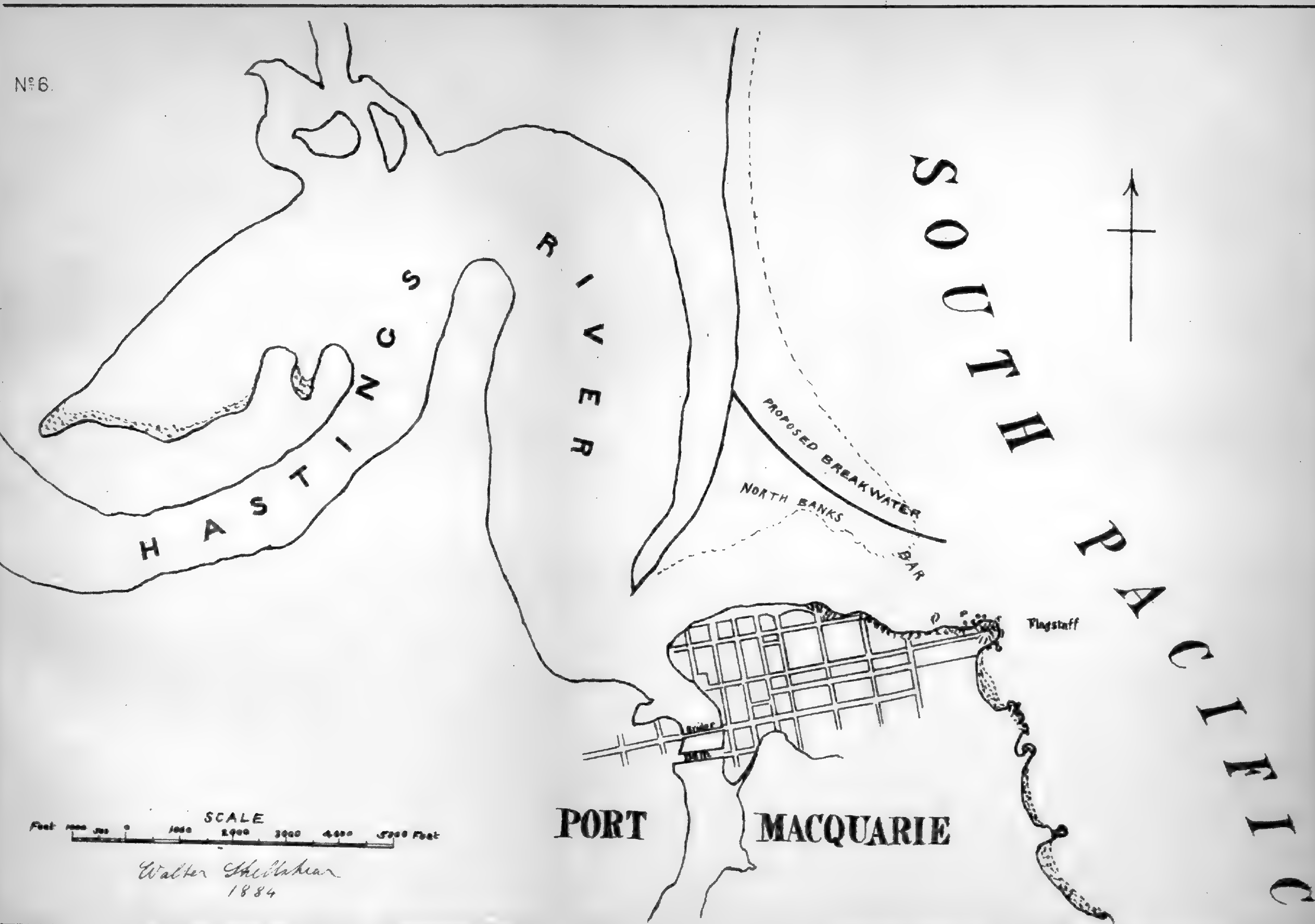


No 3
NORTH BULL
THE BAR
DUBLIN BAY
DUBLIN
LIFFEY
GREAT SOUTH WALL
SOUTH BULL
1802.
Scale
1 3/4 1/2 1/4 0 1 2 3 4 5 MILES
BULL OR SAND ISLAND
NORTH BULL
Great North Wall
NORTH STRAND
Great South Wall
SOUTH BULL
DUBLIN BAR, 1873.
Scale
5000 10000 Feet

No. 4.
RICHMOND RIVER
SOUNDINGS - IN - FEET.
SCALE
6000 FEET
1884
PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE
SYDNEY, NEW SOUTH WALES
WEST BALLINA
EAST BALLINA
THE NORTH CREEK
PILOT STATION
THE NORTH CHANNEL
BLACK HEAD
NORTH HEAD
THE SOUTH CHANNEL
SOUTH HEAD
PROPOSED BREAKWATER
SAND HILLOCKS
SOUTH PACIFIC OCEAN

Nº5
CLARENCE RIVER
Soundings in feet.
Township of
ILUKA
PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE, SYDNEY, NEW SOUTH WALES.
FREEBURN
ISLAND
Mud flat at low water
NORTH ARM
SHOAL PASSAGE
MAIN CHANNEL
PROPOSED DYKE
RABBIT IS
QUEEN ST
PROPOSED BREAKWATER
SOUTH HEAD
OUTER Sth HEAD
YAMBA
SOUTH PACIFIC OCEAN

No. 6.



HASTINGS RIVER
SOUTH PACIFIC
PROPOSED BREAKWATER
NORTH BANKS
BAR
Flagstaff
PORT MACQUARIE
SCALE
Feet 1000 500 0 1000 2000 3000 4000 5000 Feet
Walter Shellshear
1884

Notes on Gold.

By A. Leibius, Ph.D., M.A., F.C.S.

[*Read before the Royal Society of N.S.W., 2 July, 1884.*]

1. *On a remarkable occurrence of gold in Queensland.*—Towards the end of 1882 three brothers, named Morgan, discovered about 25 miles from Rockhampton, near the Dee River, auriferous deposits, which, not only on account of their richness, but especially from a scientific point of view, bid fair to be classed among the most remarkable examples of auriferous deposits yet known. The lucky prospectors have for some time kept their discovery rather quiet. Last year they had been for several months retarded in their work of developing their mine by want of water, and it is only comparatively lately that its extent and richness have been ascertained. The *Capricornian*, a Rockhampton newspaper, in its issue of 22nd March last, gives an interesting account of this mine, under the heading "The Dee Gold-mine," from which, and also from information and specimen kindly supplied to me by Mr. Walter Hall, of Sydney, one of the present owners of the mine, I have obtained much valuable information regarding the same.

The Mount Morgan Mine, so called after the name of its discoverers, is a mountain ridge, rising about 400 feet, and consists of ferruginous quartz in which the gold is disseminated in a very finely divided state. This mountain ridge appears to be the result of a thermo-spring which in past ages held quartz, iron, and gold in solution, and from which the gold has been precipitated in a finely divided state, more or less coated with hydrated oxide of iron. As the mine is being developed caves are opened out, from the roof of which this oxide of iron and silica hangs like stalactites the size of a finger, and in which the gold is readily seen finely disseminated, as shown by samples brought here to-night.

As the *Capricornian*, before referred to, says, "the formation operated on cannot be called a reef. The whole hill-top seems to be of richly auriferous stone. It is merely cut away to suit the convenience of the miners, so that a quarry or broad terrace has been formed. The cutting is 20 feet high and about 100 feet long, and the stone is of the same character the whole distance, and extends to the summit of the mountain, several chains higher."

"The facility with which the gold-bearing quartz may be obtained, may be judged from the fact that a charge of blasting powder only needs to be put in anywhere along the workings, and tons of it can be displaced. The expense of securing it is therefore comparatively small. It is carted about a quarter of a mile along a good metalled road down the mountain side, and is then thrown into a wooden shoot, wide and deep, and about 200 feet long. At the bottom a cutting has been made for the reception of the stone, and barriers raised to prevent its progress down the hill. It is then carted about half a mile to No. 1 battery." There are two batteries, one of ten the other of fifteen stampers, where about 230 tons are passed through per week.

The before-mentioned paper says:—"The owners here possess an apparently inexhaustible deposit of auriferous quartz, and are able to mine it for almost a quarter of the usual cost. They are very reticent as to the amount of stone they are putting through and the yield obtained; but we understand about 100 tons are being crushed at No. 1 battery, and 130 at No. 2, weekly. The return is said to be not less than 5 ozs. to the ton."

While, however, especially from a geological point of view, the occurrence of this gold is highly interesting, the character of the gold obtained is not less so. Lock, in his work on gold, published 1882, says:—"No gold has yet been found in nature unalloyed with silver," yet this gold from the Mount Morgan Mine, of which since February last already over 10,000 ozs. have been received as retorted gold at the Sydney Mint, is found to be free from silver—a minute trace excepted. I have brought some of this retorted gold rolled out very thin to show its toughness. It assays 99 and 7-10ths per cent. of gold; the rest is copper, with a trace of iron. Gold assaying 99 and 7-10ths per cent. is worth £4 4s. 8d. per oz. Gold from the same mine received at the Mint assayed as high as 99 and 8-10ths. per cent. It is, as far as I know, the richest native gold hitherto found. The richest gold next to this comes, I believe, from Maryborough, Victoria, which assays 99 and 3-10ths per cent.; while that from its namesake in Queensland contains only 85 per cent. gold.

F. B. Miller, in his paper on "Gold-refining by Chlorine Gas," read before this Society in 1869, alludes to the curious fact that as a rule the gold contains more silver as we go northwards, giving the average fineness of Victoria gold as 96 per cent., New South Wales, 93 per cent., and Queensland, 87 per cent. He says, however, "these are averages only. It is not to be supposed that there is a regular and consecutive diminution in fineness with every degree of latitude we go north. There are exceptional localities in the north of this Colony, as at Rocky River, where the gold is over 96 per cent." To these exceptions we must now add the gold from Mount Morgan.

Having now shortly described the remarkable occurrence and purity of this Mount Morgan gold, a not less interesting, though less satisfactory fact, is this—that only about half the gold is extracted by the ordinary quartz-crushing and amalgamating machinery. The *Capricornian* says :—"The tailings which are being stored are said to contain as much gold as is saved, and as they will be subjected to treatment at a future date, the result will be highly advantageous to the owners." Having the small quartz-crushing machinery erected at the Sydney Mint under my charge, I have had an opportunity of testing this fact. In November last we received, through Mr. Hall of Sydney, 458 lbs. of this ferruginous quartz, part of it consisting of picked stone. It was carefully crushed and amalgamated in the Chilian mill, with 240 lbs. of mercury. Thus 7·44-100 ozs. of gold, assaying 991·5, were extracted. Another lot, weighing 174 lbs. was similarly treated, and 12·12–100 ozs. of gold extracted, assaying 998·2. Thus lot 1 gave gold at the rate of 39·32–100 ozs. standard per ton of quartz; while lot 2 gave gold at the rate of 169·86–100 ozs. standard per ton of quartz. In lot 1 gold at the rate of 46 ozs. 2 dwts. 12 grs. per ton was left in the tailings; while in lot 2 the tailings assayed 64 ozs. 5 dwts. 18 grs. of gold per ton. Both lots of tailings were now mixed and passed for two hours in the Chilian mill with 240 lbs. clean retorted mercury—only 1·66–100 ozs. of gold, assaying ·981, were, however, obtained by this treatment. The tailings were dried, and found to weigh 476 lbs., containing gold at the rate of 41 ozs. 13 dwts. 16 grs. per ton; or in above 476 lbs. tailings no less than 8 ozs. 17 dwts. 3 grs. gold. I have brought some of these tailings here. Under the microscope there is no gold visible. I thought that if the oxide of iron were removed, by boiling the tailings in hydrochloric acid, and the solution filtered off, the gold might more readily be discernible in the boiled-out residue. I found, however, that this was not the case, and that 1,000 grs. of tailings thus boiled in strong hydrochloric acid, by which about 20 per cent. were dissolved, gave me only 0·730 grs. of pure gold; while 1,000 grs. of the original tailings, not boiled out, gave 1·306 grs. of gold, the same as when boiled out within nitric acid. The loss of gold by boiling in hydrochloric acid was no doubt due to the action of this acid upon manganese in the ore, whereby chlorine gas was formed, a ready solvent for gold.

That the ordinary amalgamating Chilian mill did not extract all the gold in this stone I can only attribute to the supposition that the oxide of iron has literally coated some of the fine gold, thus preventing it from coming in contact with the mercury. For such ore Plattner's chlorination process, if worked on a large scale, ought to be highly successful. I am glad to hear that arrangements have been made by which the tailings will presently be treated at the mine by the chlorination process, whereby the gold is dissolved by an aqueous solution of chlorine gas, and precipitated by hydro-sulphuric acid. It would, however be interesting to see whether some or any of the numerous patent gold-extracting machinery or appliances would be able to overcome the difficulty, and to treat economically and successfully these tailings or the original ore. That it would be of great advantage both to a patentee and the owners of this mine is evident.

While on this subject I may be permitted to allude to the want in this Colony of a mining laboratory, supplied with all the appliances, not only for examining ores, but for extracting by the most approved methods their metalliferous treasures on a large scale. Of course such an establishment would be both extensive and expensive, but while giving valuable aid to mining enterprise, it could be made not only self-supporting but remunerative. All depends on its organization and suitability to our wants.

I have brought here one of the printed circulars issued by the celebrated Government Smelting Works of Clausthal, Freiberg, and Eisleben, in Germany. This circular gives the price-list for extracting different metals, such as gold, silver, copper, lead, bismuth, cobalt, nickel, arsenic, and zinc from their ores, as well as for treating Mint and jeweller's sweep. From this it will be seen that the German Government not only makes use of these establishments for home purpose, but actually courts for customers all over the world. Such an establishment, with a staff of highly experienced officers, would soon become a school wherefrom our future mining managers and metallurgists might issue, and our mining industry would thus receive the much-wanted scientific basis to work upon in developing the great wealth hidden in the bowels of this great continent.

2. *Preparation of fine gold.*—The preparation of absolutely pure gold, such as is required by assayers, &c., is tedious. The gold is dissolved in nitro-muriatic acid, evaporated, largely diluted with water to precipitate all silver it may contain, when the gold is precipitated in the filtrate by oxalic or sulphurous acid. By Miller's refining process with chlorine gas, by which since 1869 to present date, over 720,000 ozs. of silver—more than 20 tons—have been extracted in this Mint out of the gold imported, the present quantity of silver thus obtained being between 40 and 50 thousand ounces per year, the gold is obtained of an average fineness of 99·6-10ths per cent., some being as high as 99·8-10ths per cent. The occurrence of this almost pure gold at Mount Morgan suggested the experiment of submitting the same to a short chlorination process whereby the small quantity of copper, &c., would be readily eliminated. The result of such chlorination carried out in an unglazed clay crucible was highly satisfactory. I have here some of the gold which has been subjected to a series of most carefully conducted assays, and compared with fine gold received from the chemist of the London

Mint, Professor Chandler Roberts, F.R.S., with the result that it was found to be absolutely fine, and since the process by which it became so is a very short and simple one, I was very glad of seeing it so successful.

3. *Volatilization of Gold.*—On this subject a vast amount of notices have from time to time appeared in print, and the slight volatility of gold under certain conditions is therefore nothing new. The erection of a scaffolding round the Mint chimney, preparatory to its being repaired, enabled me to get some of the stuff which was found outside the chimney on the very top coping-stone. This stuff, of which, however, there was but little, was found to contain in 235 grains of sweep, 3·424 grains of gold and 14·242 grains of silver, or about 1·46 per cent. gold and 6·06 per cent. silver. The gold could be seen under the microscope. The horizontal flues in front of the melting furnaces, as well as the base of the chimney to the height of about 20 feet, are periodically swept, and gold and silver extracted therefrom. Since the Mint chimney is about 70 feet high, it shows how under certain conditions and strong draught some gold is carried to the top, and probably beyond.

In conclusion I would draw your attention to several interesting specimens of auriferous ores, and also a beautiful specimen of native silver from the Boorook mine, which I have brought here or your inspection.

On some New South Wales Minerals.

By A. LIVERSIDGE, F.R.S., Professor of Chemistry and Mineralogy in the University of Sydney.

[*Read before the Royal Society of N.S. W., 2 July, 1884.*]

THE specimens forming the subject of the following notes were exhibited and described at the July meeting of the Society, 1884.

NATIVE GOLD

Is found in association with antimonite at Sandgate, county of Sandon, New England. In some cases the antimonite serves as the matrix of the gold, but in most of the specimens which have come under my notice the gold is held by quartz, intimately mixed with the antimonite. This association of gold and antimonite is extremely rare, not only in New South Wales but elsewhere. At the new Reform Gold Mining Company, Lucknow, native gold occurs with native arsenic in calcite.

CRYSTALLIZED GOLD.

A beautiful group of gold crystals is to be seen in the Museum of Science and Art at Edinburgh—perhaps one of the finest in existence. The model of this rare and very valuable nugget, now on the table, has been kindly made for me by Professor Archer, the Director of the Museum.

As will be seen from the photographs (plates 1 and 2), the crystals are for the most part imperfect octohedra and elongated cubes; some have imperfectly developed faces of the rhombic dodecahedron, joined end to end in an arborescent form.

Professor Archer was under the impression that the specimen came from New South Wales, but the exact locality is no longer known. This notice may, perhaps, draw attention to the specimen, and be the means of eliciting some information as to its history.

It is much to be regretted that more of such specimens have not been preserved. At the present day they are extremely scarce, and even in the early days of the gold discoveries they were never

FIG. 1.

Group of Gold Crystals in Edinburgh Museum.

abundant. Unfortunately most of them very quickly find their way into the melting-pot, and of the few which have been preserved, probably even fewer are to be found in Australia than elsewhere.

TOURMALINE.

Amongst the specimens placed before you are some very fine examples of tourmaline crystals, collected by Mr. Cleghorne of Uralla, which I obtained from him in June, 1883. In form, size, and appearance they closely resemble the large and well-developed black rhombohedral crystals, for which the locality of Bovey Tracy, in Devonshire, used to be so famous.

Great credit is due to Mr. Cleghorne for the good service he has done to the knowledge of the mineralogy of New South Wales, by collecting and preserving these and many other minerals hitherto unknown in the Colony.

SCHEELITE.

Scheelite or tungstate of lime occurs in massive lumps in association with molybdenite and molybdenum ochre at Hillgrove, county Sandon.

Axinite.

This mineral has been found near Nundle, by Mr. D. A. Porter of Tamworth, a diligent and painstaking collector of minerals, to whom we are also indebted for bringing to light several minerals new to the Colony.

The crystals are large, fairly well formed, and of a clove brown colour.

Idocrase.

Mr. Porter has also found idocrase in the same district, of a green colour, associated with small colourless garnets, crystallized in rhombic dodecahedra, apparently of the variety known as grossularite, consisting of silicate of lime and alumina.

Ironstone Concretions.

The hollow nodules of ironstone were found by Mr. Murdoch, of the Railway Department, in the bed of the Macquarie River, near Dubbo, where they apparently are not uncommon.

The outer shell consists for the most part of brown hydrated oxide of iron, and when first found they are quite soft and can be cut with a knife. I am informed that the interior is usually filled with sand, which can be shaken out, leaving a hollow cavity. Although hard and compact, they are evidently of quite recent origin.

Lithomarge.

A variety of lithomarge, a hydrated silicate of alumina, of a pale bluish colour, more or less translucent, occurs as the matrix of native copper at the Great Blayney Mine, near Blayney. The metallic copper is scattered through it in small granular crystalline masses.

Breaks in places with a somewhat conchoidal fracture, but earthy in others. Soft and greasy feel.

Chrome Iron Ore.

A very rich chrome iron ore deposit occurs near Nundle. The outcrop which I saw was about 700 feet above Bowling Alley Point, and the apparent thickness of the vein is in one part some 40 odd feet; one huge block of the mineral lying loose on the surface, measures about 12 feet long by 6 feet high and 5 feet wide.

The chrome iron vein is in association with serpentine, diallage rock, and black slates. This deposit ought to be easily and cheaply worked.

Chrome iron of good quality also occurs with serpentine beyond Young in the Bland district.

Iron Pyrites Concretions.

Some very interesting concretions of iron pyrites occur at the Sunny Corner Silver and Gold Mine, which is situated on Mitchell's Creek, some 16 miles from Rydal, on the Western line.

The rocks in which the Sunny Corner deposits occur are altered Devonian or Silurian shales and sandstones, penetrated by a porphyry dyke. The portion of the lode worked for silver, which bears nearly north and south with westerly dip, is mainly composed of a loose earthy ferruginous material, and is rather cavernous in places. The vuggs or cavities vary much in size, but are usually small, and are lined with stalactites of brown hæmatite, externally of a deep brown or black colour.

The vein stuff is very variously coloured, yellow, brown, green, red, black, &c., and contains but little mineral matter of a definite and readily recognizable character except galena and pyrites; occasionally small crystals of barytes are found and some black oxide of copper. In places it is as much as 50 feet across, but usually much less.

Formerly this mine, when owned by Messrs. Winter & Morgan, the first of whom used to bring me specimens from it for identification, was worked for gold only, and yielded some very rich returns.

In some respects these concretions of pyrites resemble the calcareous concretions of the London clay, known as septaria, and used for the preparation of hydraulic cement; *i.e.*, as far as general form and structure, both are more or less rounded and both are fissured, but the fissures or cracks in those from Sunny Corner are filled in either with pyrites or with quartz. I am indebted to Mr. J. M. Smith, of Sydney, the superintendent of the mine, for the various specimens placed before you, as well as for the many others which he has been good enough to obtain for me from time to time.

The concretions occur in a pale-coloured shale of a greyish tint, abutting against the vein, full of cavities, which can be seen to have formerly contained crystals of iron pyrites. This gradually passes into a slaty shale of a dark bluish-grey colour, studded with cubical crystals of pyrites, most of which are twinned.

As will be seen from the figure No. 2, the concretions of pyrites have a somewhat concentric structure, and are fissured in a more or less regular radiate manner.

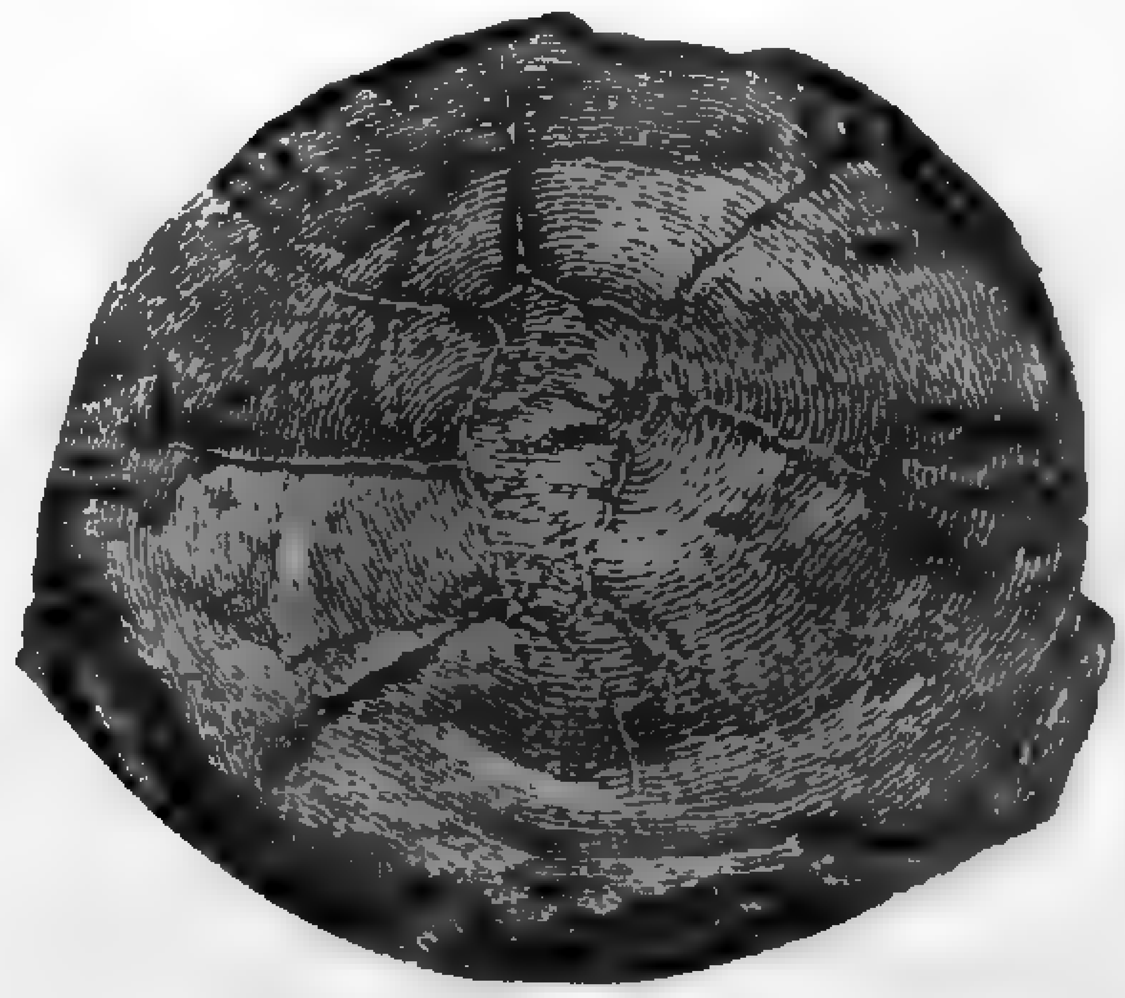


FIG. 2.

Concretion of Iron Pyrites, showing the radial lines.

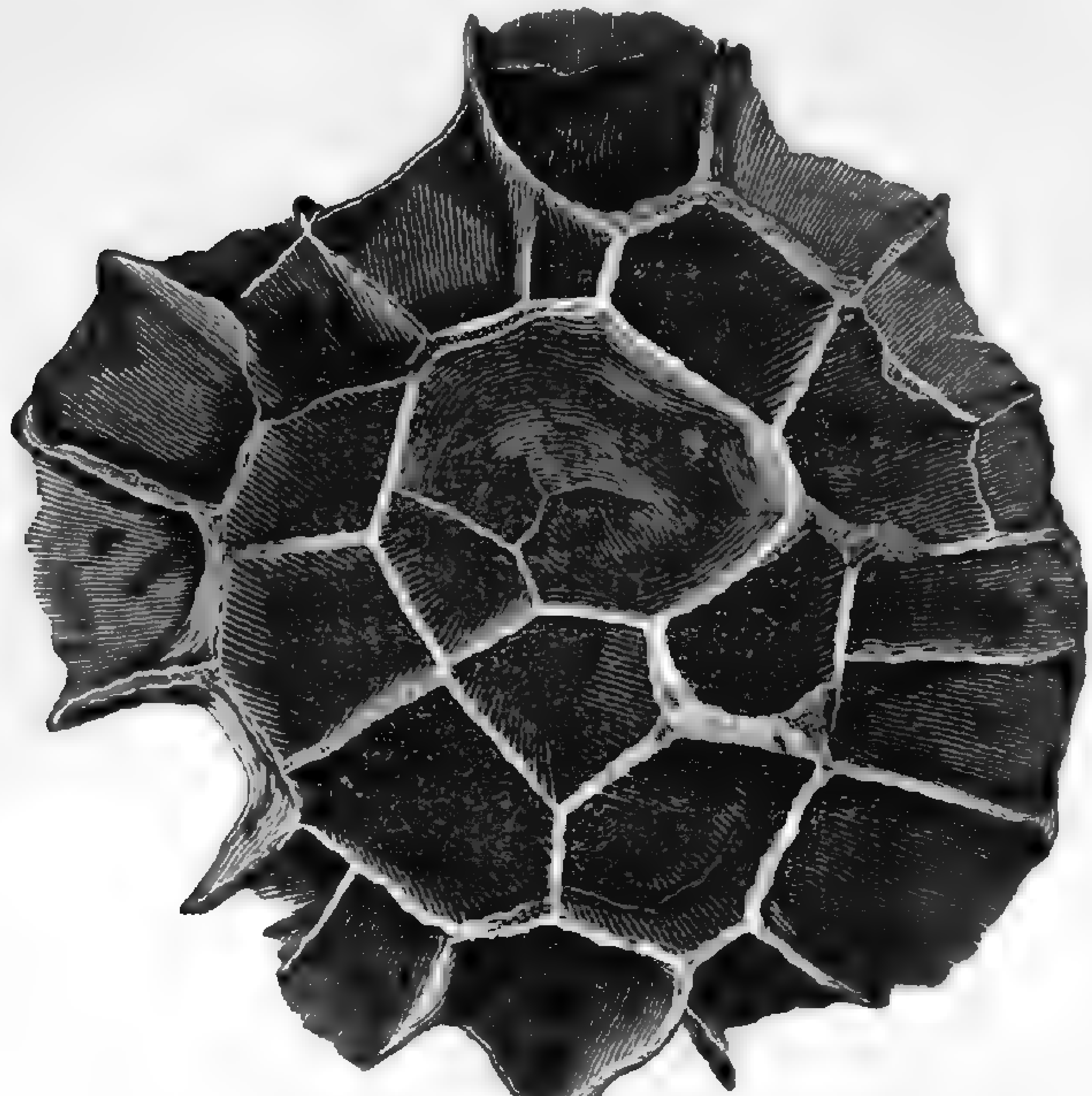


FIG. 3.
Siliceous septa set free from concretions of Iron Pyrites.

They vary in size; some are an inch or less in diameter, and others are several inches through.

Some of the concretions (fig. 2) consist wholly of iron pyrites, with the fissures or cracks also filled in with the same material, but of a more compact character. Others consist of soft friable pyrites with the fissures filled in with hard white quartz, thus forming septa. As the rock weathers and exposes the concretions, the granular pyrites falls out and the septa are left in the form of irregular, exaggerated honey-comb structures (fig. 3).

The changes which appear to have gone on are as follows:—

1. The iron pyrites, crystallized in more or less well-developed cubes, were formed in the slaty shale, probably while it was in a soft and clay-like condition.
2. The pyrites crystals gradually passed into solution.
3. The pyrites was gradually re-deposited from solution, not in the form of cubical crystals, but in the form of nodules of marcassite, *i.e.*, the rhombic and less durable form of iron pyrites.
4. The pyrites nodules (marcassite) cracked or fissured, probably from unequal contraction. Probably due to the outer portions of such nodules having become hardened first, then as the inner portions hardened and contracted, fissures would necessarily form within, since the hard outer portions would not give way so readily as the softer and weaker inner portions.

5. The fissures in the pyrites nodules were next filled in, in some cases with pyrites in others with quartz; it may have been that the latter were also filled in first with pyrites which was afterwards dissolved out and replaced by quartz.
6. Finally the marcassite has been removed and the silicious septa set free (fig. 3).

The pyrites of the nodules oxidizes with great rapidity: specimens kept for only a few months rapidly fall to powder, and become incrusted with crystals of iron sulphate.

[Two photo-lithographs.]

PLATE I.

CRYSTALLIZED GOLD.
(Slightly reduced.)

PLATE II.

CRYSTALLIZED GOLD.
(Slightly reduced.)

The Oven-mounds of the Aborigines in Victoria.

By the Rev. Peter MacPherson, M.A.

[*Read before the Royal Society of N.S.W., 2 July, 1884.*]

In the district of Meredith, midway between Geelong and Ballarat, there is a considerable number of mounds, locally known as *Blackfellows' ovens*. In the landscape they appear as ordinary irregularities on the surface of the ground, and in many cases would be passed by without arresting the least attention. At times, however, the grass growing upon them presents a freshness of luxuriance which shows that the soil in which that grass is growing is richer than the soil around. In a field near Meredith two ovens were ploughed up, and the ground was planted with potatoes. The luxuriance of the growth which took place clearly marked out the position of the ovens. The growth, however, was too rank, and the luxuriant bunches gradually faded, leaving the crop of potatoes at the roots far inferior to what prevailed generally in the field. In another case, at Cargerie, a piece of land, on which was an oven-mound, was ploughed up and sown with oats. There was a vigorous growth of stalk, but the grain came to nothing. On the uncultivated country the oven-mounds, in ordinary seasons, are not easily distinguished from irregularities of the surface of the earth. After severe droughts, however, they are much more easily discerned. This was exemplified during the very dry season in the early part of 1869. Owing to the drought which then prevailed, the green mantle of grass had disappeared, leaving the black patches of the oven-mounds very easily distinguishable from the bare surface of the soil generally. Numbers of the mounds could be distinguished from the carriage windows of the Geelong and Ballarat Railway, at Bruce's Creek, near Lethbridge, and also on the slopes of the heights at the upper part of Cowie's Creek. The powdery black ashes of the primitive hearths and cooking-ovens of the aborigines are distinguishable from the blackest soil, and can be traced on the ploughed fields long after the subverting agency of the ploughshare has been at work. Still it is obviously only a question of time when the last traces of such hearths will disappear for ever.

Sites of Oven-mounds.

As cooking was concerned, the necessity for ready access to water explains at once why so many ovens are to be found along the banks of creeks and rivers, as well as by the margin of lagoons and lakes. In a hollow of the Woodbourne Creek, near Meredith, there is an oven so near the channel of the creek that the ashes fall over the bank into the water. Rising out of the ashes is the stump of a tree four feet in diameter. About a quarter of a mile from this oven, in the direction of Cargerie, there is another oven perched on the very apex of a large mound of ironstone nodules, and occupying the highest ground in the neighbourhood. Taking one locality with another, ovens are to be found in all positions between these two extremes—the lowest and highest points. They are found, as just shown, on the very brink of a creek, or a few yards from it, or in an angle, or on a gently rising slope, or on a steep brow with volcanic rocks cropping out close by, and on the flat ground or heights beyond. A point to be noted is that they are to be found on the eastern bank of a creek as well as on the western, exposed apparently to the full strength of the westerly and north-westerly gales. The explanation why sites appear to have been chosen exposed to so much inconvenience is probably to be found in this,—that as the ovens are very numerous, suitable ones could be used according to the season of the year when they were required. A similar explanation applies to cases in which ovens are found at considerable distances from permanent water. They were used during the wet season, when water could be got readily in what are locally called *crab-holes* and in small depressions on the surface of the ground. Moreover, it is to be remembered that ovens which appear now to be quite shelterless, were probably not so when used by the aborigines. The destruction of trees by the white settlers affects the question. Restore the hundreds or thousands of trees which have been destroyed, and the oven, which appears now to occupy a bleak and exposed position, will be well sheltered behind a vast expanse of branches. There is an oven on the outer slope leading to the lagoon near Woodbourne, well sheltered at present owing to the thick growth of trees. Now this oven would be in a very exposed position were the trees to be cut down. Some of the trees, also, in this locality, are peculiarly well adapted for camping purposes. They spread out their branches to a great distance, forming a covering only 3 or 4 feet overhead. Doubtless the dusky limbs of the poor wandering aborigines have often reposed during hot winds under the branches of these very trees which are so near the cooking-ovens. From beneath the agreeable shade of the spreading *eucalyptus*, no doubt, the aboriginal cooks watched the progress of the steaming process by which large quantities of game were cooked at once. The native bread or potato (*Mylitta australis*) also prevailed in this locality;

it is occasionally turned up yet in the district by the plough. Altogether, the numerous ovens on the Woodbourne Creek and in the neighbourhood, also the numerous traces of bark-stripping to supply material for pegging boards for stretching out opossum skins, also for erecting their temporary shelters, afford clear evidence that the locality now in question was a favourite haunt of the aborigines in former times. It remains only to be stated, in regard to the sites of the oven-mounds, that they are to be seen indiscriminately on the east and west side of a creek, hence there could not have been in this locality any prevailing superstition leading the aborigines to prefer either east side or west side for their cooking-ovens.

Structure of Oven-mounds—External.

Let us now come to a closer scrutiny of the mound and its oven. The collection of ashes, charcoal, and stones may be 20 or 30 feet in diameter, and 1 or 2 feet thick at the centre. But the real oven, formed of stones, is much smaller than what the foregoing figures indicate. The stone oven itself varies in size from 4 to 9 feet in diameter; 6 feet, however, may be taken as a common size in the whole of the Meredith District. This stone oven is usually slightly concave, or crater-like, with a central stone larger than those otherwise employed in the oven. Such a central stone, or occasionally two, may be commonly seen in those ovens which have been formed with some regularity. Such central stone was obviously convenient for the process of cooking by steam. Kangaroo and other game were placed on the oven of heated stones, grass and bark were placed over the game, and earth scraped up from alongside the oven was placed on the grass and bark. An opening was left or made for pouring water down upon the heated central stone, and the operation of the steam was rendered all the more effectual by the arrangement of grass, bark, and loose earth. The places from which the earth was scooped up are quite distinguishable many years after the aborigines have ceased to use the ovens. In an oven at Cargerie the dimensions are 9 feet by 5, but here the space of 9 feet is broken by the occurrence of two stones at intervals, both of which would seem to have been used for the purpose of producing steam. Moreover this oven is a considerable distance from the Cargerie Creek, but there are flats and depressions, within a hundred yards, where pools of water collect in wet weather, as the writer has oftened witnessed.

Besides the ovens which gave evidence of some regularity of formation, with central stone or stones, there are also those which present the appearance of a mere promiscuous collection of stones. These little heaps have sometimes been made so near each other that, in course of time, the ashes of the different heaps have co-mingled and formed one irregular oven-mound with some approximation to the circular shape. The interior ovens vary in size from three or four stones to a cart-load.

In dealing with the external shape of the oven-mounds we have to consider the action of gravity, when the ovens are made on slopes; and also the action of the winds in drifting the loose ashes of the mound. The stone oven, of course, will remain till disturbed by the white man, but it is otherwise with the loose ashes and charcoal. While the ovens were in use the constant trampling of feet kept the ashes loose and all the more exposed to the transporting agency of the winds; moreover, when the ovens were built on inclinations more or less steep, the action of trampling would urge the ashes downwards in the direction of gravity. Thus the oven-mounds as well as the trees become records of the prevailing direction of the winds. The inclination of the trees is from north-west to south-east, and the drift of the ashes of the oven-mounds is the same, modified, however, by the action of gravity. When wind and gravity both acted in the same direction, the stones of the oven formed a sort of nucleus from which a fan or comet-shaped tail spread downwards.

Structure of Oven-mounds—Internal.

Having surveyed the oven-mound externally, we have to take pick and shovel to examine its internal structure. We select one for our operations on the Woodbourne Station, near the dam on the Meredith and Cargerie Road. The stones are larger than usual, being, in some cases, larger than a man's head. Patches of variously coloured ashes are turned up, sometimes red, sometimes bluish-grey, but mostly black—sooty black. The colours seem to indicate different kinds of wood used for fuel. The stones also present the plainest evidences of having been subjected to the action of fire. In many cases they exhibit a greasy appearance, strongly reminding us that, no doubt, the fat of emu and kangaroo, as well as of opossums and other creatures, had often oozed out upon these stones. Moreover the cooking by steam included putting hot stones in the inside of the larger animals, in which cases pieces of porous bluestone, volcanic lava, would become saturated with animal fat. Some of the stones also presented the ghastly white appearance of having been subjected to great heat. But continuing to use the pick, we remove all the stones connected with the oven and come to a layer of ashes in which are no stones. This would seem to indicate that quantities of ashes, in some cases at least, were allowed to accumulate before the stone oven was made. It is this layer of ashes which has become such a convenience for the rabbits. They burrow into it very easily, and the covering of stones becomes a protecting barricade to them.

Moreover, some mounds contain ashes and charcoal without any stones. This is sometimes accounted for by the fact that there are no stones in the neighbourhood. But the anomaly also occurs of two mounds being situated near each other, the one having quantities of stones in it while the other has none. This the writer noticed in regard to the mounds in the Meredith district, as well as about Mortlake, localities which are 80 miles apart. Along the Coolebarghurk and Cargerie Creeks, honeycomb, the volcanic lava commonly called bluestone, is invariably found in the ovens, because the country through which these creeks flow is covered with lava. On the Moorabool, however, the Silurian slaty shale, producing the picturesque scenery of the river just named, naturally supplies the small fragments of stone used in the ovens. In a locality between Meredith and the Moorabool a coarse red conglomerate makes its appearance, and fragments of this are accordingly found in the ovens. In parts of the Colony where there is no stone available it is said that the aborigines were in the habit of baking clay into a coarse kind of brick or pottery, and of using it as a substitute for heating purposes in their ovens. Baked clay of this description is said to have been used by the Murray blacks.

Circles of Stones about Oven-mounds.

Besides the stones which are used for making the cooking oven, there are sometimes others which present all the appearance of having been designedly placed as circles about the mound. The writer took note of two such specimens of oven-mound in which the circles were in one case quite complete, and in the other case very nearly so. These two may be described. One was situated on the Native Hut Creek, near Meredith, on the east bank, and about 40 yards distant from the creek. Its longer diameter was $19\frac{1}{4}$ feet by $18\frac{1}{4}$ feet shorter diameter, while the ashes and stones at the centre were about $1\frac{1}{2}$ foot thick. The stone oven was about $6\frac{1}{2}$ feet in diameter, and was embedded in a layer of ashes which extended quite distinctly below the stone oven; moreover there were several of those shallow excavations around, from which no doubt the earth had been scooped out to cover over the bark and grass, as already described in regard to the cooking operations.

It may be noticed also that the basaltic rock cropped up close by; and although the aborigines squat down in oriental fashion, yet it is no unreasonable stretch of imagination to suppose that the patriarchs of the tribe sat on these blocks, forming natural seats, and held converse with one another, while the kangaroo and other game were steaming in the oven close by. But it is the circle of stones, extending very nearly round the whole oven-mound, which here specially attracts our attention. The stones are there in large numbers, and the question arises for what purpose were they placed there? Now and again sharpening-stones are found about the mounds, but these were not sharpening-stones, and the number of them puts the supposition of sharpening-stones aside. The same applies to the suggestion as to the stones having been used for cracking the marrow-bones of the larger animals. The number of stones is altogether too great, and above all there was no necessity to arrange them so methodically in a circle around the oven. It must not be omitted to take proper notice of the fact that the stones of the circle have been somewhat disturbed. The treading of sheep and cattle will easily account for that. The fact remains that, notwithstanding some disturbance, the evidence of the circular arrangement cannot be doubted.

Moreover these stones, seldom as large as a man's head, are in no way to be confounded with those built up into shelters or break-winds in bleak localities on the great plains in the west of Victoria.

But the second case to be described presents us with an oven-mound surrounded with a circle which may be regarded as complete, although a few stones have been displaced. The object of our attention in this case is situated on the Cargerie Creek, and about 150 yards from the east bank. It is about 14 feet by 13 feet in longer and shorter diameter, the stone oven in the centre being 5½ feet, and the thickness of ashes, charcoal, and stones, being about 1 foot. The oven bedded in the ashes contains about sixty stones, mostly small, not much larger than a man's double fist. The ring of stones is 18 feet in diameter, thus leaving a space of about 2 feet between the outer edge of the mound and the circle of stones. About 150 stones formed the circle, mostly small in size, very few of them being as large as a man's head. Although a few have got displaced, yet the circle extends right round the oven-mound. Here obviously the question of sharpening-stones and crackers for breaking the marrow-bones of the larger animals used for game is quite insufficient to explain the facts. The same applies to the breakwinds already noticed. As a circumstantial point, it should be mentioned that the oven-mound with this ring of stones is situated in an angle, and not far from it the ends of basaltic rocks crop out, as in the case already described.

While thus illustrating the fact of stone rings extending round the oven-mounds of the aborigines, it may be noticed that the circular arrangement is also carried out in the case in which a whole mound consists of about half a dozen stone ovens, formed in a circle around a central oven.

Of course it is not our purpose here to enter upon the subject of the mystic stone circles in Britain, India, and other countries, yet in passing we may note the fact that there are such materials, which, along with others, will one day help to throw light on the origin and migration of the Australian race. Perhaps it should be mentioned here, that the magnificent stonehenges, consisting of monolithic blocks, 8 or 9 feet high, represented in the illustrated papers of Melbourne and Sydney a few years ago, as existing in the west of Victoria, were works of imagination, except in so far as they seemed to have been modelled on the plan of the Druidical circles which are found in various places in Britain.

Contents of Oven-mounds.

The mass of the mound, in accordance with what has been already said, obviously consists of ashes, charcoal, stones, and earth. The stones, as already pointed out, vary according to the district. But besides the materials which, one way or another, have come before our notice, we may expect to find remains of the reptiles, fishes, birds, and quadrupeds, as well as shells which were used as food by the aborigines. No doubt the large number of miserable dogs, which constantly kept about the encampments of the blacks, would destroy a large quantity of the smaller bones of birds and various animals ; still, an examination of the ashes brings to light traces of the game used by the aborigines. In some mounds about half a mile from the bay at Geelong there are fragments of shells which no doubt were brought from the neighbouring sea-shore. In the largest of the mounds examined, near Lake Webster, at Mortlake, in the west of Victoria, the writer found a considerable quantity of animal remains in the ashes. These consisted of fresh-water shells, fragments of emu egg-shells, jaw-bones and teeth of opossums, as well as bones of kangaroo. This mound was 79 feet in diameter, with 5 feet of ashes at the centre.

Human Remains in Oven-mounds.

In the neighbourhood of Mortlake, in the west of Victoria, an oven-mound was pointed out to the writer as one in which it was said that the remains of an aboriginal had been placed. It was said, moreover, that these remains had been removed from another still larger mound. It is possible this removal of the remains might be owing to the fact that a European dwelling was built near the large mound, and the ashes of the mound were used to improve the soil in a garden. Proceeding with a spade to make excavation, the first important point was to decide where to begin, as the quantity of ashes in a mound 60 feet in longer diameter, and 4 feet thick in the centre, was very large. Scanning the mass carefully with the eye to detect if there were inequalities, the outline presented a beautiful curve. After continued examination, one spot was chosen for the purpose of making a beginning in the operations, as it seemed to present a very slight flaw in the regularity and symmetry of the curve representing the surface. The first 6 or 8 inches were nearly as hard as brick, but under this hard dome the ashes were quite loose and easily tossed about. After prolonged work there was no sign of human remains. Another portion of the mound was pierced and searched, but still without success. Returning to the portion first tried, the spade was driven into the open side, when several bones fell down along with the loose dry ashes. In succession the leg and thigh bones made their appearance, as also the arms and vertebræ, ribs and skull, as well as a number of small bones, all being evidently the remains of a human being. The skull was nearly erect, and not many inches beneath the surface. The leg and thigh bones were huddled together, and stuck out at right angles to the vertebræ. The arm bones were found at the sides, the hands having been doubled up so that the bones of the fingers were near the neck and cheeks.

On surveying another of the large oven-mounds which are numerous about Mortlake, the writer's attention was arrested by the presence of three rather large stones, so placed together upon an oven-mound as to indicate that they must have been designedly placed where they were. On removing these three stones another was found under them and well bedded in the ashes. Upon digging under these stones in the loose ashes a second entire human skeleton was discovered. From the charred wood which was found lying across the skeleton, as well as from the appearance of some of the bones, it seemed that an attempt had been made to consume the body with fire. In both cases the leading idea seemed to be to huddle the remains into the smallest space; hence the limbs were all doubled up at the knee and elbow joints. In the first case the body was laid on the back, with the arms at the sides and the legs pressed over to the right side; in the second case the body was laid on the left side, so that the arm bones were found like a bundle of sticks together.

Distribution of Oven-mounds.

The necessity for water accounts at once for so many oven-mounds being situated near creeks, rivers, lagoons, and lakes. Sometimes they occur at considerable distances from permanent water, but, as already stated, in the winter time crab-holes and small depressions on the surface of the ground would be supplied with water for weeks together, or even longer. Where game and water both were abundant, there would be the more numerous encampments, and these would be continued the longer in use. The forests afforded not only food and shelter, but also the important element of fuel for the ordinary fires and the cooking ovens. It is a curious fact, however, that large oven-mounds are in existence on extensive plains where there is no forest wood within many miles. Such oven-mounds are to be seen near the lakes on the great bare expanse to the west of the Leigh River. The suggestion might occur that forests once existing have disappeared, but when the ashes are examined there is no appearance of charcoal

Upon making specific inquiry into the matter the writer ascertained that the material used for fuel was the coarse kind of peat or turf forming at the edge of lakes which are situated at some places in the region called The Plains. Quantities of long grass are also available. In the circumstances it is interesting to find that to make the most of the materials to hand, the aborigines on the western plains of Victoria hit upon the very same device which was adopted by the inhabitants of the Faroe Islands in the northern seas of Europe. The stormy petrel was used as fuel (as well as a candle to give light) by the inhabitants of the north, and so the fat of the game used by the aborigines of the west of Victoria was used to feed the flame which cooked the animals themselves intended for food.

In connection with the distribution of oven-mounds may be taken the question of size, as distinguishing those in the Meredith district from those in the neighbourhood of Mortlake. The mounds in the latter district are often of great size; some of them are described as upwards of 100 feet in diameter, with ashes about 10 feet thick at the centre. The writer paced one which was 79 feet in diameter. The largest which he saw in the Meredith district was only about 33 feet in diameter. Points which supply at least some elements of explanation of this difference in size are such as these:—Many of the Meredith ovens are on small creeks, whereas the large accumulations of ashes in the Mortlake district are alongside lakes which abound with water-fowl, fish, and eels. With plenty of forest to supply fuel, the aborigines could thus remain at the same camping places all the year round; whereas in the less favoured places about Meredith they would have to wander about much more extensively. Another point is that the number of aborigines in the Portland district, as the region including Mortlake was called in the early times, was very much greater than in the Meredith district.

But the most important point in connection with the distribution of the oven-mounds is the limited area in which they are found in Australia. They extend from the Murray to the sea, through central Victoria; they are numerous and large on the Murray, and extend for some distance into New South Wales on the banks of the Lachlan, where Sir Thomas Mitchell's attention was first arrested by them. He had not seen such collections of ashes in other parts of this Colony, although heaps of shells, the refuse of aboriginal feasts, have been observed on the shores of Port Jackson, and in other localities, as on one of the little islands in Lake Macquarie. Other observers have noticed the absence of the oven-mounds in Central Australia, and also in Western Australia.

These facts raise broadly the question, how are the mounds restricted to so small an area? The suggestion has been made that the accumulation of ashes supplied a space elevated above the cold wet soil, and more agreeable for the feet of the aborigines in rainy weather. Allowing something for this suggestion, there still remains the outstanding question, how were the stone ovens not used in other parts of Australia? The point is every way worthy of notice, as it may help to give a clue to the course of migration in the original occupation of the country by the blacks.

Antiquity of Oven-mounds.

It has been noticed that trees are to be seen growing out of the oven-mounds. None, however, have been seen by the writer which would indicate an antiquity of more than half a century. As to the materials, which may yet be carefully examined, in the large accumulations in the Mortlake district, it remains to be seen what evidence may come to light bearing on the question whether aboriginal man in Australia was contemporaneous with any species of our extinct fauna. We have also the evidence which may be deduced from the size of the oven-mounds. But here there are some elements calculated to perplex the problem. We may indeed measure the existing accumulations, but the question arises, how much larger would they have been but for the quantity of ashes dissipated by the prevailing winds? As to the space occupied by the stones of the ovens, where such exist, measurement can approximately determine how much deduction is to be made on this score. There is, however, the more difficult point to determine, namely, how much earth was pulverized to be mixed up with the ashes, on account of the cooking arrangements before noticed. While considering this question the writer observed the common ash-heap which had been formed in a country locality connected with a European dwelling. It was about the size of one of the smaller oven-mounds to be seen in the Meredith district. It had been formed in about ten years by a family of about ten persons. There is this very important point, that the operation of the prevailing winds, in causing the ashes to be drifted away and dissipated, would be nearly equal in both cases, the aboriginal and the European. Proceeding tentatively, are there any even general conclusions to which we can come? Let us put together such materials as there are to bear upon the point. The oven-mounds in the Meredith district may be regarded as varying in contents between 100 cubic feet and 500. In a space of about 14 miles by 10 the writer counted forty oven-mounds. Then let us suppose that an average mound of ashes and charcoal would be produced in ten years by a family of ten aborigines. Then 200 would leave behind them twenty such mounds in ten years. Now 200 is the actual number of aborigines who inhabited the district in 1845, according to a census taken by the New South Wales Government at the time. But the same 200 roamed over the whole of what is now the county of Grant in Victoria, an area about twenty times as large as that for which we have been attempting to account. At the same rate the whole area would include 800 oven-mounds, a number probably much greater than the reality, as the area of special observation presented the mounds in much greater numbers than were noticed elsewhere. Still, taking the foregoing figures, the 200 of an aboriginal population would cover the area in question with the 800 mounds in the space of 400 years. But again, while working out these figures, let it be clearly understood there is no pretence of attempting to fix a real approximation. On the other hand, it would seem that on data of no extravagant or improbable character, we reach a general conclusion that the materials under review do not compel us helplessly to admit some great antiquity, such as 3,000 or 4,000 years, much less fabulous ages of hundreds of thousands of years, to the time when palæolithic or neolithic man first began to build oven-mounds in the county of Grant in the colony of Victoria.

It is true that the enormous mounds in the Mortlake district would seem to drive us back into a much greater antiquity than 400 years, but several material points have to be kept in view. If the mounds are so much larger, they seem to be proportionably fewer. Moreover, according to the census already referred to, the aboriginal population in the Mortlake district appears to have been far more dense than in the Meredith district. Thus the process of accumulation of ashes and charcoal would be all the more rapid. But, again, if the unity of the Australian race, and various considerations on the strength of which a great antiquity is claimed for that race, are to be taken as resting on substantial grounds, we shall have to regard the building of ovens and the accumulation of the mounds of ashes as comparatively modern innovations. In this aspect of the matter the inquiry arises, what reasons can be discovered to explain why the innovation sprang up in that part of all Australia in which it is found to prevail? And the stone circles, too, are they to be regarded with the interest which attaches to mystic ideas early implanted in the mind of the human family, and carried perhaps by one division of mankind to Britain, and by another or others to India and Australia, or are they the mere spontaneous illustrations of aboriginal fancy and playfulness, dating back but a few generations or centuries at the most?

The Trochoided Plane.

By Lawrence Hargrave.

[*Read before the Royal Society of N. S. W., 6 August, 1884.*]

I HAVE been told that the subject of this paper is one that would interest the members of this Society, and therefore I have strung together my thoughts, experiments, and deductions, that refer in any way to the trochoided plane, pointing out where I see Nature working with it, and how it can be used by man for the transmission of force; and I trust that if other members have heard of, or made similar observations, they will bring them forward so that my mistakes may be corrected by comparison with the ideas of others, and also that the truth may be elicited about a matter that does not seem to get its fair share of investigation.

I will first endeavour to make clear what I mean by the several terms I use, or have had to invent, in describing the action of the trochoided plane.

The "*trochoided plane*" is a flat surface, the centre of which moves at a uniform speed in a circle, the plane being kept normal to the surface of a trochoidal wave, having a period equal to the time occupied by the centre of the plane in completing one revolution.

By "*Normal*" is meant tangential to an undulating surface.

"*Orbit*" is the path of any particle of a substance through which undulations are being passed.

"*Crank*" is the radius or radius-vector of the orbit.

"*Connecting-rod*" is the line at right angles to the trochoided plane; the length of the connecting-rod is equal to the crank multiplied by the secant of the pitch-angle. I used to call this the normal to the trochoid, but to avoid confusion I shall in future call it the connecting-rod, unless some one points out its true mathematical designation; radius-vector of the trochoid seems a good name also, but not so descriptive as connecting-rod; every one knows what a connecting-rod of a reciprocating engine is, and its familiar motion.

"*Pitch*," or length of wave, is the distance of waves from crest to crest, measured in the line of propagation; the length of a trochoidal wave is equal to the length of the orbit of a particle divided by the co-tangent of the pitch-angle.

"*Pitch-angle*" is the angle contained between the crank and connecting-rod, when the trochoided plane is at half the height of the wave; it is also the angle contained between the trochoided plane and the guides when in the before-mentioned position.

By "*the guides*," I mean that straight line drawn by the end of the connecting-rod farthest from the trochoided plane during the passage of half a wave.

The "*trochoidal wave*" may be defined as the projection of a right helix on to a plane parallel to its axis, and is resolvable into an infinite number of trochoided planes.

The "*prolate-cycloidal*," "*cycloidal*," and "*curtate-cycloidal*" waves are the projections of the helix on to a plane that is at various angles with the axis of the helix. If we take a right cylinder, and cut it diagonally, and open the two cylindrical parts out flat, we get two trochoidal waves or curves of sines.

If one circle touch another internally, and we cut through the circles at the point of contact, and open out the figure till the circumference of the small circle becomes a straight line, the resulting figure will be bounded on the other side by a curve of the same class.

The line drawn on a uniformly moving sheet of paper, by a pendulum swinging at right angles to the line of motion of the paper, is also the trochoidal wave.

If the waves are prolate-cycloidal, the orbits of the particles are elliptic, and the crank or radius-vector follows Kepler's second law, describing equal areas in equal times, the focal distance being measured from the crest of the wave; the connecting-rod varying in length from the focal distance to infinity, and it is obvious that when the distance of the foci becomes O, the waves are trochoidal, and the orbit is a circle.

It is evident that if the weight of the moving parts be neglected, it is immaterial at which end of the connecting-rod the trochoided plane is placed, and that waves may be thrown or generated by a plane, or infinite series of planes, that are trochoided in unison; and that each plane may be trochoided by moving the ends of the connecting-rod or its continuations in the various combinations of the straight line, circle, and ellipse, and doubtless other figures; but each combination is reducible to the simple principle of the plane at right angles to the connecting-rod, moving in a circle, and guided by a straight line.

The area of the triangle, that is bounded on two sides by the crank and connecting-rod, is directly proportional to the thrust at right angles to the guides: and the thrust is greatest at the centre, and decreases gradually to the sides of the column of matter acted on by the trochoided plane, so that there is no violent disruption of any two parallel streams.

If I have succeeded in communicating my views with regard to the motion of a plane surface when acted on by an undulating one, and the converse, it will be obvious that if the undulating surface is rolled up into a cylinder, with the axis parallel to the direction of propagation of the waves, the same reasoning will hold good, and reduce the examples of cylindrical waves to plane waves; but when we consider the action of the particles composing the axis of the cylinder, it becomes necessary to explain the spherical wave.

Let us suppose a spherical shell to be composed of any elastic medium, also, the polar axis to be similarly constituted; let the point of bisection of the polar axis come exactly between two of the particles composing it, which two particles we will set approaching and receding from one another; this will send an equal series of waves of extension and compression through the two halves of the polar axis, culminating in the pushing out and pulling in of the poles synchronously, and the generation of a series of ring waves passing over each hemisphere, meeting at the equator, and crossing each other to the opposite poles. The orbits of the particles composing the sphere will at first be long ellipses; as the waves recede further from the poles the orbits become circular; one wave length from the equator they become elliptic again; at the equatorial plane they move radially to the sphere, and after one wave has reached the opposite pole, every particle of the spherical shell will be moving radially and harmonically with the two central vibrating particles. Any number of atoms may be conceived as being at the centre, and completely filling the sphere, vibrating in every direction, causing any number of spherical waves on the spherical shell, crossing in every direction.

If we take the converse of this, and suppose the equatorial particles, or those in any parallel of latitude, to be set vibrating in unison, radially, the resultant will be an intensified vibration of the polar axis longitudinally; this is closely analogous to a sea wave meeting a vertical obstruction, and causing that horizontal downward-moving vortex that is so destructive to the foundations of steep smooth marine structures *in shallow water*. Where this occurs, the practice is to tumble in loose blocks of stone or concrete, the effect of which is to break up the vortex, and rob it of its power.

Our Sydney summer thunder-storms often show this atmospherically; the sun's heat over the land causes the sea-breeze to come in from the N.E. with increasing force as the day advances, and the heated air returns to the sea by an upper current from the S.W. There is an upward current at the Blue Mountains, or where the sea-breeze takes off in force, and heavy cumulus clouds gather, their tops being drawn out by the return current in long streaks pointing seaward; towards evening, if more air comes in than can readily be restored by the upper current, a plenum is formed, resulting in an uprush, sudden cooling, and downfall of air at the centre of the disturbed area, that produces a horizontal vortex, which pushes itself under the sea-breeze, and shows its presence by a long roll-shaped cloud, rotating on its axis, the upper surface moving from N.E. to S.W., the under surface almost touching the tree tops, moving from S.W. to N.E. Sometimes the thunderstorm comes without this characteristic cloud, sometimes there are two of them; there is a similar roll-cloud often seen on the pampas of South America, described, I think, by Dr. Gould; I believe I am correct in saying he does not account for its formation in this manner. If we substitute the trade winds, equatorial calms, and return trade winds for the sea-breeze, plenum, and return S.W. upper current, the result is one or more hurricanes or cyclones, instead of the roll-cloud.

Allied phenomena are those witnessed when a drop of water falls into water; if the drop falls from a short distance, only ring waves are formed; if from a height, the drop seems to make a hole in the water, as well as the ring waves, and the closing up of this hole sends up a peak with sufficient force to detach another drop from its point.

Also, if a large drop be allowed to fall from a height, it will be seen that after it has attained a certain speed it will leave its spherical shape and spread out into an irregular ring; the movements of the particles of the ring being similar to those composing a smoke ring.

But to return to the spherical wave; if one of the central particles bears an infinite proportion to the other particle, the vibration of the smaller one will send waves through a sphere surrounding both, resulting in an equal vibration of the antipodes of the smaller particle.

When this action of spherical waves is applied to the supposed string of spherical particles composing the axis of a cylindrical wave, it is obvious that we may conceive the great circles passing through the spheres and the longitudinal axis of the string of spherical particles, as being shoved out of shape or made elliptical, first transversely, and then longitudinally: stated otherwise, the pulsation of the spherical particles is their vibration or change of form from the ellipsoid to the oblate-spheroid; here, I take it, we are brought face to face with one form of infinity.

From this it is evident that if the ultimate composition of a cylinder be elastic spherical atoms, the organised pulsation of these atoms in unison will produce waves on the surface of the cylinder, and the converse proposition will also be true, that is, that if the pulsations be produced in a pipe covering the cylinder, the waves will be communicated from the inside of the pipe to the contained matter.

I will now state my views as to the formation of vortices, by an imperfect plane passing end on through a viscous medium.

If the plane is perfect and of no thickness, and the medium homogeneous, no vortex can be formed; but if the plane has imperfections, at approximately equal distances, zones of compression and tenuity will be formed at and between the imperfections, and their amplitude will constantly increase as they recede from the leading end of the plane, the stratification of the medium parallel to the plane becoming prolate-cycloidal. When the proportion between the amplitude of the disturbances, and the wave length or distance apart of two zones of compression, exceeds that of one to Π, or the prolate-cycloid passes into a curtate-cycloid, vortices will be formed in the loops, and go on increasing in diameter till they nearly equal the wave length, when anti-vortices will be formed between them, that either break up the system of waves, or begin a fresh series farther out from the plane. If the force acts at right angles to the plane, a vortex is generated behind the plane.

A breaker shows the vortex initiated vertically, but gravity prevents its complete formation.

A common instance of this action is seen in the skin of eddying water that adheres to the side of a vessel in motion, and, it is my opinion that vortices formed in this way eat away the tips of screw-propeller blades in the unaccountable manner we so often see them. I may also add that the pitting of the interior of steam-boilers at and near the water-line is to my mind clearly the mechanical action of vortices formed by the rapid circulation of the water.

This brings us to a considerable distance from where I started with the plane wave, but I thought it best to indicate the natural sequence and deductions that follow from the trochoided plane to the vortex, and will now try to show some natural movements of matter and mechanisms that I associate with the different sorts of waves.

First, about ocean waves, we find much has been written by the late Mr. Scott Russell and others, dealing with their form, and the motion of the particles composing them, about the forced wave and the free wave; but no one, as far as I have read, seems to note when dealing with the trochoidal form, the motion of the imaginary line that I call the connecting-rod, and which appears to me to be as important in describing that wave as the radius is to the circle (this is probably due to the form of long free ocean waves being *approximately* trochoidal); and I do not hesitate in saying that the connection of the trochoidal wave and trochoided plane with our simplest mechanical movement, the crank and connecting-rod, opens up a field for the development of engineering talent as extensive as the discovery of the screw did when our mechanisms were limited to the use of the lever and wedge.

The power may be abstracted from the swell of the ocean by means of the trochoided plane, thus :—Take a flat float, and rigidly connect a plane at some distance below parallel to the float, and it will be found that the plane and float alternately pull each other in the direction of propagation of the waves, the result being that the apparatus progresses through the water faster than a float without the plane attached.

If the plane is fixed vertically, or at right angles with the float, the resultant is in a direction contrary to that in which the waves are moving.

Again, if two floats are connected by linkwork end to end, and separated by a distance equal to half a wave, the trochoidal movement of each float may be used to propel the whole concern.

From this it follows that when a vessel has another in tow in a seaway, the length of the hawser should be such that both vessels are as near as possible to the crests of waves at the same time ; if there is a cross sea, this is impossible ; if the sea is at all regular, attention to this, whether by accident or design, saves many a savage jerk to the tow-line ; the distances, $\frac{1}{2}$ wave, $1\frac{1}{2}$ waves, $2\frac{1}{2}$ waves, are obviously those to be most avoided.

I will now draw your attention to the motion of living organisms, and how their movements seem to me to have a common origin, and that the trochoided plane is the mechanical power almost universally used by Nature for the transmission of force.

The backfin of a fish is a good example to begin with ; observation will show that the ends of the spines that keep the membrane extended, are points in the curve of sines, or trochoidal wave, and that if they are rotated on their axes in unison, or oscillated from side to side harmonically, a series of complementary waves will be thrown by the membrane towards the tail ; the cross-section in the first case is an isosceles triangle, and in the second a sector of a circle ; the membrane of the tail is trochoided similarly, so as to raise or depress the head ; the prolate-cycloidal wave is also used in fin swimming. This action of fins is best seen when fishes are confined in a bowl, and appears to me to be only used when the speed required does not necessitate the use of the large muscles of the body ; the converse of this proposition is seen when the wind makes trochoidal waves on a fluttering flag.

The geometry of body swimming may be seen in its simplest form in a slow-moving organism like the leech. You will observe that the head is raised and thrust forward, depressed, and drawn backwards, describing a circle for each undulation that is passed through its frame ; as the motion increases in rapidity, the circle becomes an ellipse, and then a straight line. Then we want to know how the undulations are produced in its frame ; here, the cylindrical wave comes to our aid, and it becomes evident that if two cylindrical muscles be enclosed in a skin (take the swimming of the eel as the type), and a series of waves be passed through each muscle, such that the thick part of one wave is abreast the thin part of the wave on the other side of the eel, the backbone and skin will necessarily take a trochoidal form, and as long as the waves are generated the eel must go ahead.

It will be observed that if the fish or eel is swimming with its body, and the fins on the back and belly are kept rigidly extended, they serve to increase the trochoided surface. The body swimming of fishes reaches its extreme form in the sunfish, whose powerful body cuts trochoids of extreme length in proportion to their amplitude.

Porpoises, when rolling, seem to cut vertical prolate-cycloidal waves, and they blow when passing the crests; the horizontal position of the tail is well adapted for this mode of progression.

If the top edge of the tail of a schnapper, or other deep fish, be twisted to one side, and the lower edge to the other side, and the trochoidal action of the body continued, the fish at once turns on its side, and will thus be able to dive suddenly.

The effect on the water of this action of fishes that are long enough to contain a number of waves in their length is a tendency to produce right-handed vortices on one side, and left-handed ones on the other, so that after the fish has passed the two series gear together, as it were, like a train of equal sized cog-wheels.

If we conceive the action of the back fin, as thus described, to be communicated to a series of legs on each side, as in the centipede, the effect will obviously be progression along a surface; and if we cut off all the legs but two pairs, separated by a distance equal to one wave length, we have the quadrupedal action popularly assigned to the giraffe; if the two pairs are only half a wave length apart, we have the trotting pace of a horse, and the various other paces become clearly dependent on the length of the wave used by the animal. The legs and body of an alligator or lizard show the connection between many-legged and four-legged progression, as well as any one instance I can point to; but it is impossible to define any hard and fast line between any two classes, as the more instances of progression we notice, the more it is forced upon us that they are but links in a chain, the two end links of which are unknown, whilst any two adjoining links are hardly distinguishable. The swinging of the hands and arms, in walking or running, is evidence that bipedal is evolved from quadrupedal progression, which to me seems to have developed from the trochoidal action of a fin.

When the amplitude of the waves is in a vertical plane, each pair of legs is moved together, and the form of the wave is plainly seen in the back of a dog when going full split; this method of progression reaches its extreme form in the hopping birds.

Slugs, and other so-called one-footed organisms, move by a beautiful application of the trochoided plane; their mode of progression will perhaps be best understood by examining the converse movement, as exemplified in the fluttering of a flag, in which case, as I pointed out before, the passing wind communicates ripples to a stationary flexible plane; in the slug the ripples on its base are applied to the surface, across which it wishes to move; the crests of the ripples are transversal to the longitudinal axis, and move towards the tail; the slime is a great aid in passing over a smooth surface, as a partial vacuum can be formed in the hollow of each wave; if the surface of the slug's foot is covered with cilia, the undulatory motion of these may be conversely seen on a field of waving corn as the breeze passes over it; the mode of progression of some caterpillars is parallel with that of the slugs.

In order to make this more than mere theory, it became necessary to pursue one of two courses; either to go in for an elaborate system of instantaneous photography in connection with a chronograph, or to make some models, the geometrical construction of which would show the trochoided plane, and the outward appearance and movement of the apparatus would appeal direct to the eye. I have adopted the latter course, for several reasons, the principal one being that the first method, besides being very expensive to me, would only be accessible, if understood at all, by the few; whilst the second course is now within the reach of any boy who can handle a few tools. As these are experiments that I venture to call capital, it will be excusable if the details seem rather trivial.

The simplest trochoided plane may be constructed by attaching a flat surface at right angles to the connecting-rod of the ordinary crank and connecting-rod motion of the reciprocating engine; and if two of these be coupled with the cranks at right angles (Fig. I), the sum of the sectional areas of the columns of wind or water, acted on by the two planes, will be the same at every point in one revolution, and if the apparatus be placed so that wind or water act on the planes at right angles to the guides, a uniform rotary motion will be communicated to the crank-shaft; if we rotate the machine by steam or hand, motion is communicated to the air or water by the two planes.

If two oar-like planes (Fig. VI) be protruded vertically under the counter of a vessel, and trochoided through ball and socket joints or cross-journals, the connecting-rods and guides being inboard (as was shown in the largest model), it will be found to possess several advantages as a propeller that are not to be despised; it seems impossible to foul it, as no amount of floating canvas, nets, or ropes, could be twisted round the blades; the blades would be no impediment to sailing, and a rudder would be superfluous, as the steering is effected by rotating the guides; the engine would not need reversing gear, and the pitch could be made easily adjustable by altering the length of the connecting-rods of the propellers.

Again, if we take two floats that offer equal lateral resistance (Fig. II), and fix a bar in the centre of each float at right angles to the vertical longitudinal section; then put a rotating crank with the shaft vertical in the centre of one of the floats, and a guide of some description on the bar of the other float; unite the end of the bar from the crank-float to the guide, and the end of the bar of the float that carries the guide to the crank-pin, and it will be seen that the whole apparatus will be propelled through the water by rotating the crank; this is like a common feat with skates on ice. Two wheels may be substituted for each plane in this model for motion on a surface, but the results are unsatisfactory.

If a pair of equal floats be made with a total displacement exceeding that of a man, it will be found that crank, guides, and connecting-rod can be dispensed with, and that the floats can be trochoided by the feet. The steering is effected by bearing a little heavier on the float towards which it is wished to turn; the increased skin resistance will do the rest. The total absence of mechanism will commend this form of exercise, and I hope to see it become a feature in our regattas.

But these experiments are not calculated to convey to every eye the identity of the trochoided plane with the mechanical power used by a fish in swimming, so it was thought necessary to make something with a general likeness to a fish, and cut it up into a number of sections, and unite the sections again so that they were free to move from side to side on vertical hinges (Fig. IV). Each section was provided underneath with a keel, and every alternate section had a vertical guide stuck in its centre; the section corresponding to the head of the fish was enlarged so that it was able to float a coiled spring driving a wheel and pinion; on the end of the pinion shaft was soldered a right helical wire; the diameter of the helix was made equal to the amplitude of the trochoidal waves it was intended the model should use, and the pitch was made equal to the wave length. The forward end of the helix was brought into the centre, as if it had been twisted round a spindle instead of a cylinder; this helical shaft was rove through the guides on the alternate sections of the model, and as you saw trochoided all the planes together, and made the model swim in a strikingly natural manner; by drawing the model tail first through the water, the operation is reversed, and the trochoided planes wind up the spring. This model is remarkable for the diminutive nature of the motive power, the easy trochoiding of the planes, and the small percentage of slip.

Here, I would remark, that a running stream offers a good field for investigation on this subject; however straight its channel is cut, it will, if left to itself, meander, and the bends work down stream. This may be best seen when the stream runs through an alluvial flat; it will be observed that the down stream sides of the bends are continually being washed away, and that deposits are made on the down stream sides of the points.

If the upper ends of the guides in the last-described model be connected to a rigid bar, the motion of the helical wire will make the guides, or an elastic web covering them, take the form of a fin, showing the action I have previously described.

Again, if a number of pieces of wood be rove loosely across a rotating helical wire, the ends of the pieces will be trochoided like the legs of a centipede; owing to difficulties about making the clawing apparatus, this was made to float in water, and you had an opportunity of judging for yourselves whether or not it proved the truth of my deductions.*

I will now direct your attention to the swimming of that common jelly-fish (*medusa*), as being a slow and easily observed case of cylindrical waves; watch closely the movement of the equatorial ring of its hemispherical head, and the path described will be seen to be similar to that of a zone of particles in a smoke ring; the equatorial ring moving forward when most contracted, and backwards when most expanded; the superficial resultant being annular or cylindrical trochoidal waves thrown backwards, and motion of the jelly-fish forward.

The progress of an earth-worm through a cylindrical hole is another obvious case of cylindrical waves, and from the worm's movement on a flat surface it appears capable of throwing more than one wave towards its tail at the same time, or, in other words, that its body is longer than a wave length; in this case the motion of the rings is evidently not circular, as in a smoke ring, but very elliptical, with the major axis parallel to the direction of propagation of the waves.

If you note the mechanical action of swallowing, it will be evident that it is the converse of the motion of the worm; observe the jaws or mouth opened and thrust forward, closed and drawn back for a fresh bite, the prey being forced to the stomach by a similar movement of the rings of the gullet.

The trochoidal action of fins, muscles, and legs, seemed so plain that I could not help being led to theorize on the action of wings in flight; I say theorize simply because I have not a flying-machine to show you, but the chain of evidence seems so complete, that I have no doubt it will soon be accomplished without the aid of the screw or gas bag.

The wings of flying-fish are, in my opinion, only used for flight, or when the fish is swimming very slowly with its fins alone, without trochoiding its body.

* A six-legged model was afterwards made and exhibited that worked satisfactorily.

There is a distinction between the vertical lift we see when a bird hovers or rises straight up from the ground, as exemplified by skylarks, hawks, partridges, and the horizontal flight of ducks, pelicans, and albatrosses; in the first case, the wing which is in effect a plane, is rotated in a cone, and kept normal to a trochoid during each revolution; the connecting-rod is moved in a plane at right angles to the axis of the cone, and the guides are horizontal; the plane of the wing being in the line of the connecting-rod, and not at right angles to it; the path cut in the air by this motion is a zigzag, one of the pieces between two angles being half a trochoid, the two half trochoids making up each revolution of the axis of the wing.

In horizontal flight the conical movement is the same, but the connecting-rod is at right angles to the plane of the wings, and flight is the resultant of gravity, and the waves of air being thrust downwards and backwards by the wings. The part played by the plane of the body and tail in flight is the same as that of the second plane in Fig. II. I have not put the second plane in all the models of wings, as I think it useless before the power of the machine is sufficient to overcome its specific gravity. (Fig. V and all subsequent models have the second plane.) Peacocks' tails, and the plumes of birds of paradise, are a hindrance to flight, and the effects of sexual selection.

The same action takes place in the wing that I mentioned about the leech's head, and is equivalent to sliding the plane along the connecting-rod towards the guide-pin, so that the centre of effort moves first in a circle, then in an ellipse, and finally in a straight line. I have shown the first and last movements in Fig. VII and Fig. III.

These are the motions we often see when the passing breeze sets a blade of grass rotating; it is common with flat leaves having thin stalks, and must have been observed by every one present. Fig. VII will show the geometry.

These remarks refer to all wings, but, in addition, it is observable that jointed wings can be trochoided by opening and shutting the wing, the connecting-rod working in a vertical plane transversal to the line of flight.

A little consideration will show that turning, rising, and descending, are merely resultants dependent on the position of the centre of gravity, and the direction the waves are thrown in; by depressing one side of the tail, and raising the other, a portion of the thrust is directed to one side; and in the construction of a flying-machine, it is an unnecessary waste of power to try to lift the enormous rudders that are given such prominence to in many of the schemes we see depicted.

As to the soaring of birds, that branch of flight has been well argued lately in "*Nature,*" and it is quite clear to me that the birds work the upward and downward currents of the air, the existence of which is plainly shown by the form of clouds and smoke.

Natural selection and the survival of the fittest account for the development of the wing membrane on the afterside, and its curtailment on the leading edge of wings, and not as I have made it in the models equal on each side of the quill; it is so constructed because I recognize the course the evolution of artificial flight will take, and that in its first stages the motion will be slow; and, as we gain confidence in the construction of the machine, we shall notice that by leaning our body in the direction we wish to go, that is, altering the position of the centre of gravity, and reducing the speed of the planes, our object will be attained; and then we shall find the leading edge of the planes will be liable to double up and get damaged, making it necessary to follow in the footsteps of Nature.

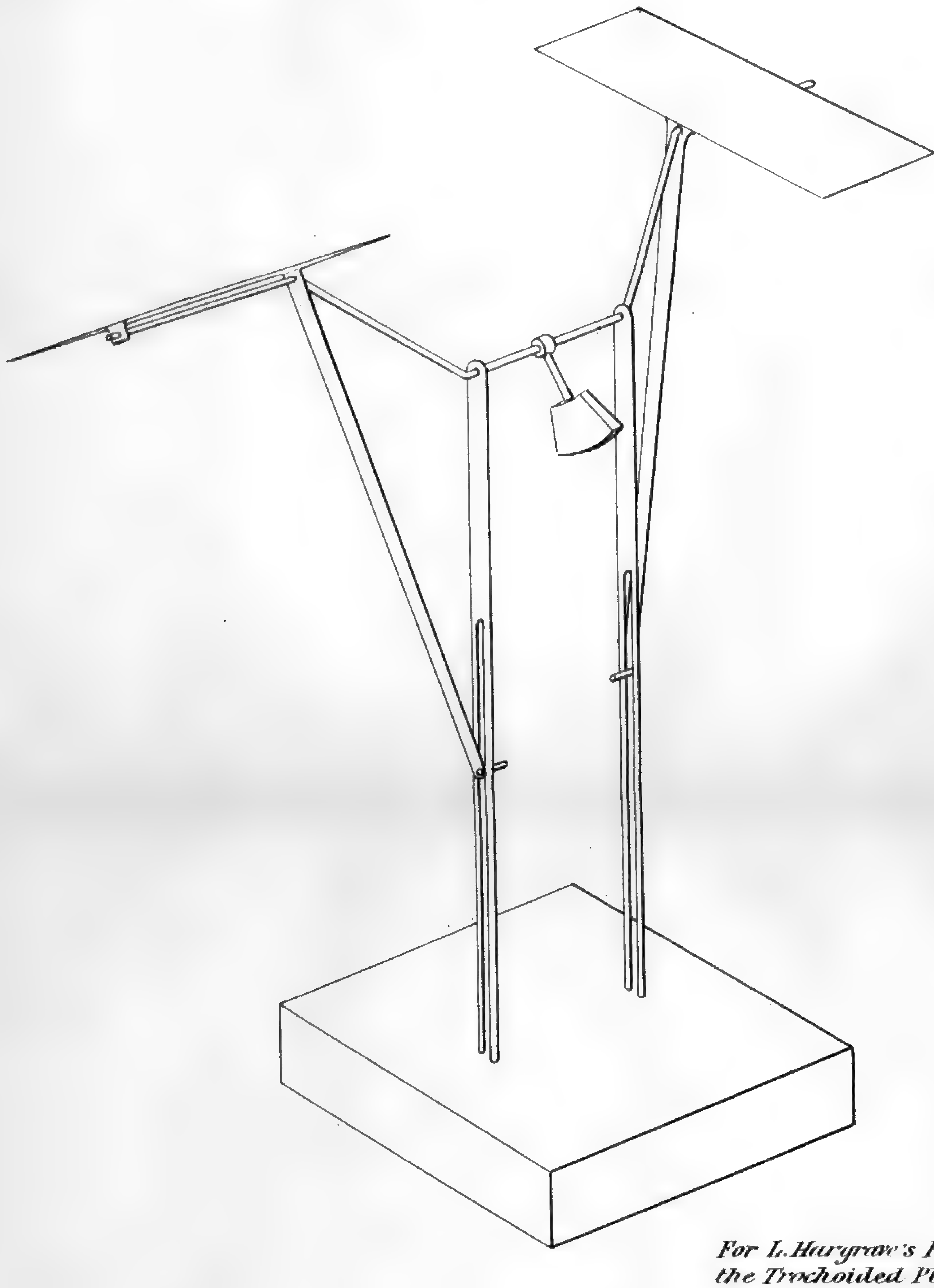
These are my views, stated as concisely as I can; and if you think there is any novel truth embodied in them, this Society is welcome to any of the laboratory models that aided me in finding it out.

In conclusion, gentlemen, I should like your opinion as to *whether or not* there is evidence to show that there is a power almost universally used by Nature for the transmission of force, that can claim to be regarded as distinct from those previously used in our mechanisms; and if not, under what head do you class the trochoided plane?

Regarding these models,* they are exhibited here as the result of about a dozen efforts in the direction of artificial flight, and they are, to the best of my knowledge, quite original; and let me point out the certainty that if only twenty more are made several marked improvements must be evolved; and if there are any mechanical members of this Society who see that the successful construction of such a machine would be advantageous, they could, at the cost of a few shillings, copy these models, making such alterations as their imperfections suggest, and a comparison of the improved models would show what progress had been made; this would hasten a process that is, to say the least of it, laborious and tedious.

* These models were somewhat similar to Figs. III, V, and VII, and were not shown at the previous conversazione.

[Seven diagrams.]



For L. Hargrave's Paper on the Trochoided Plane.

FIG. I.

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.

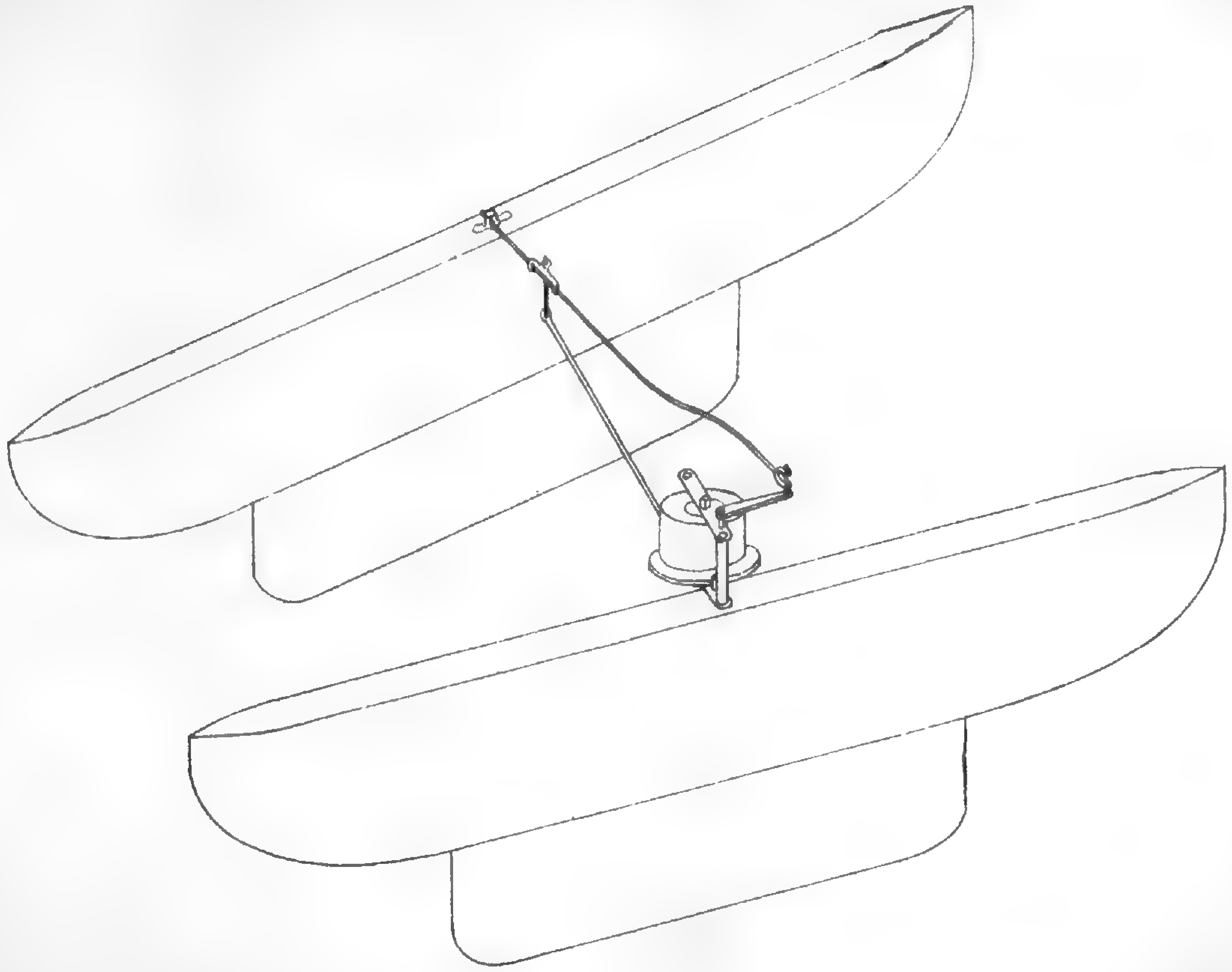


FIG. II.

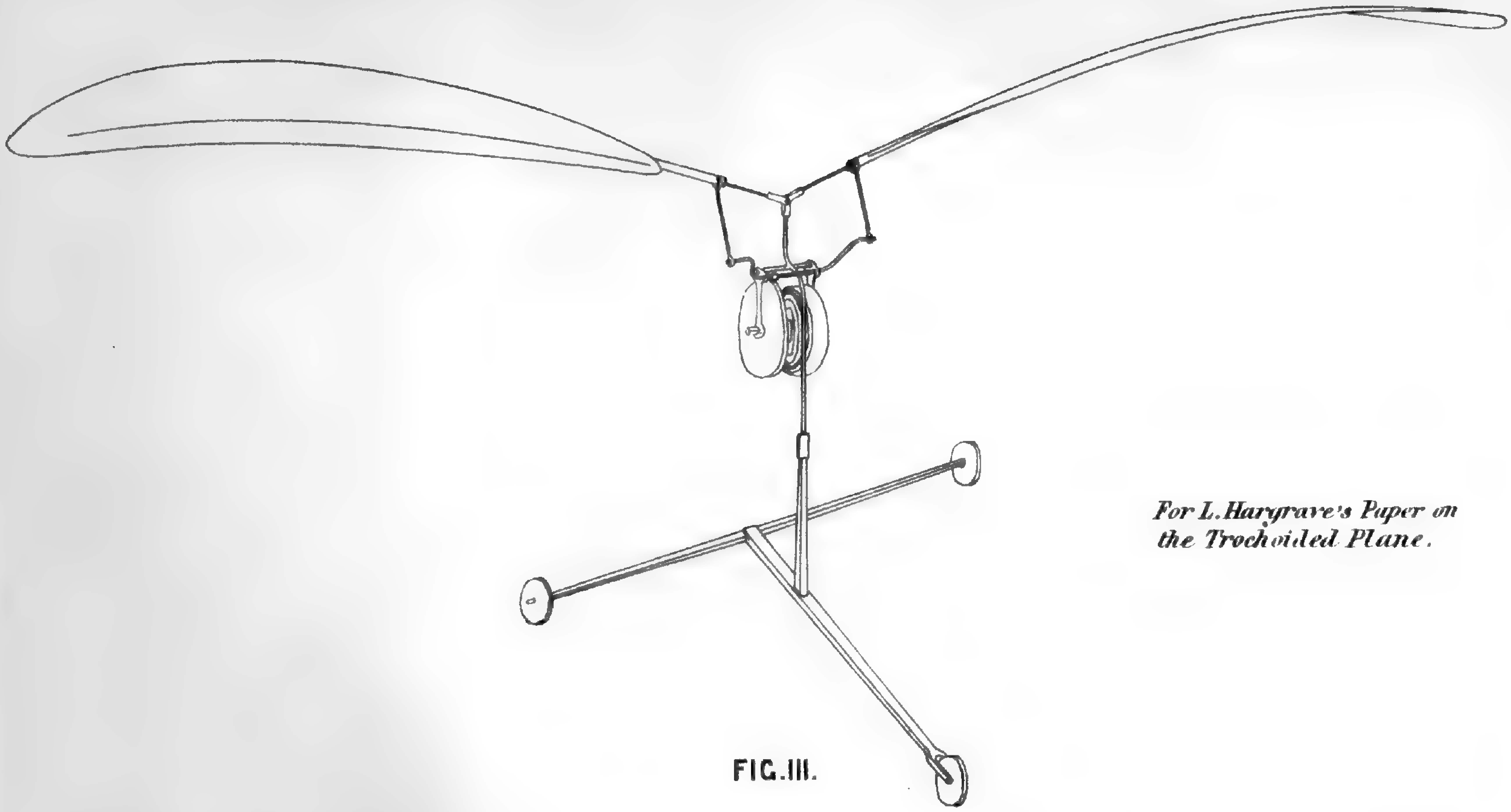


FIG. III.

For L. Hargrave's Paper on the Trochoided Plane.

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.

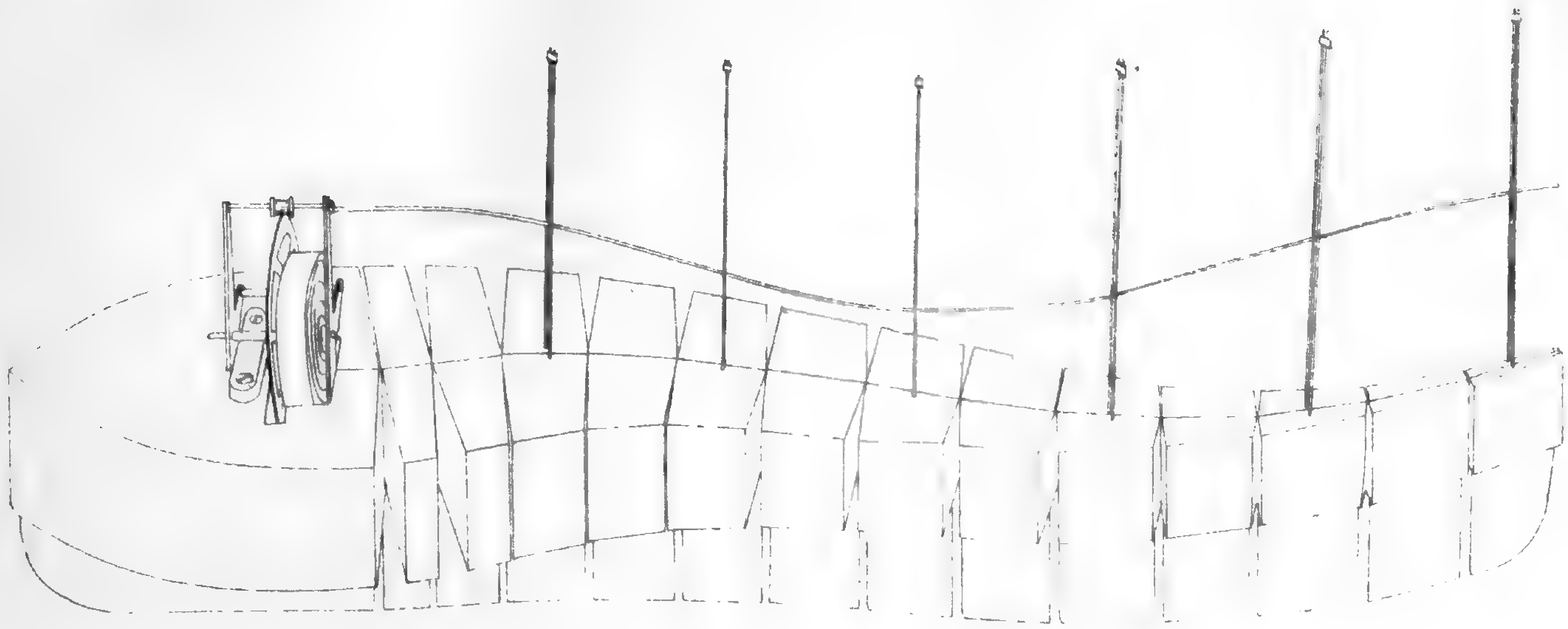


FIG. IV.

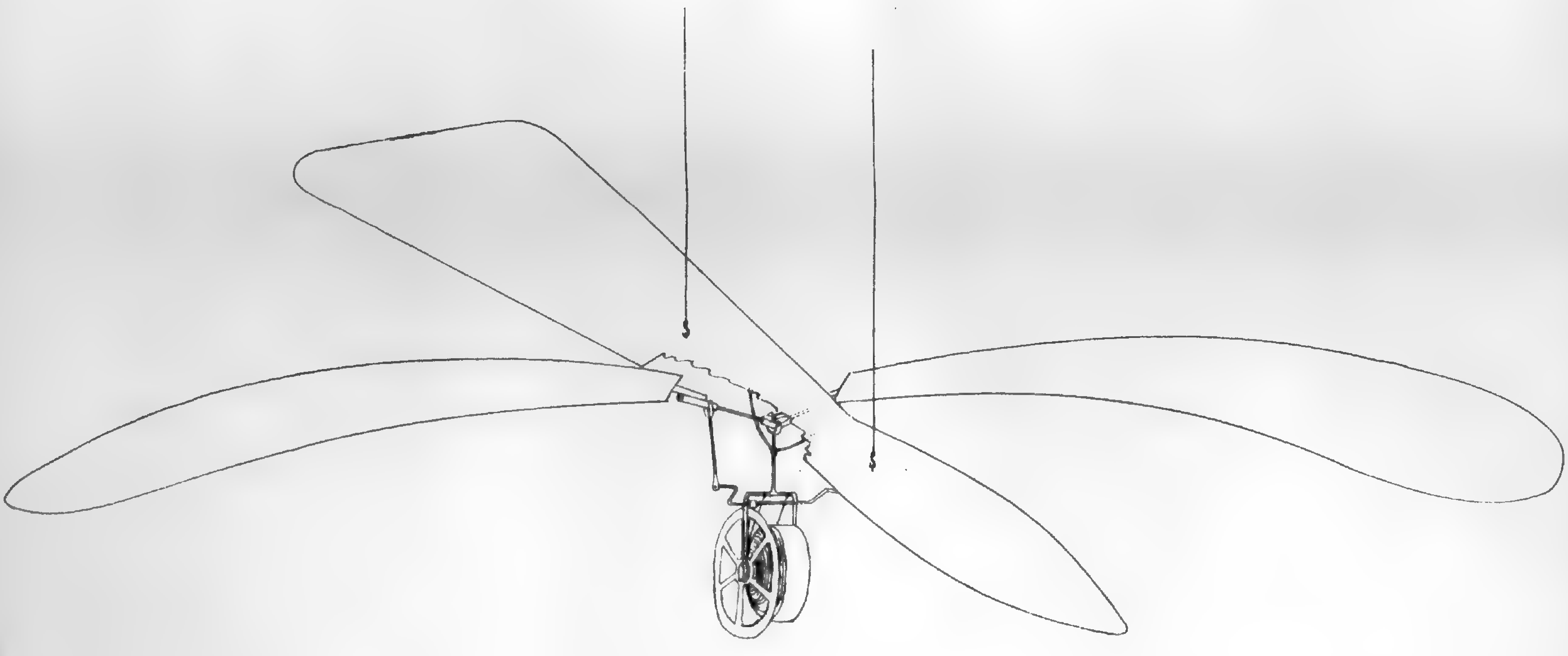


FIG. V.

For L. Hargrave's Paper on the Trochoided Plane.

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE, SYDNEY, NEW SOUTH WALES.

For L. Hargrave's Paper on the Trochoided Plane.

Fig. VI.

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE.
SYDNEY, NEW SOUTH WALES.

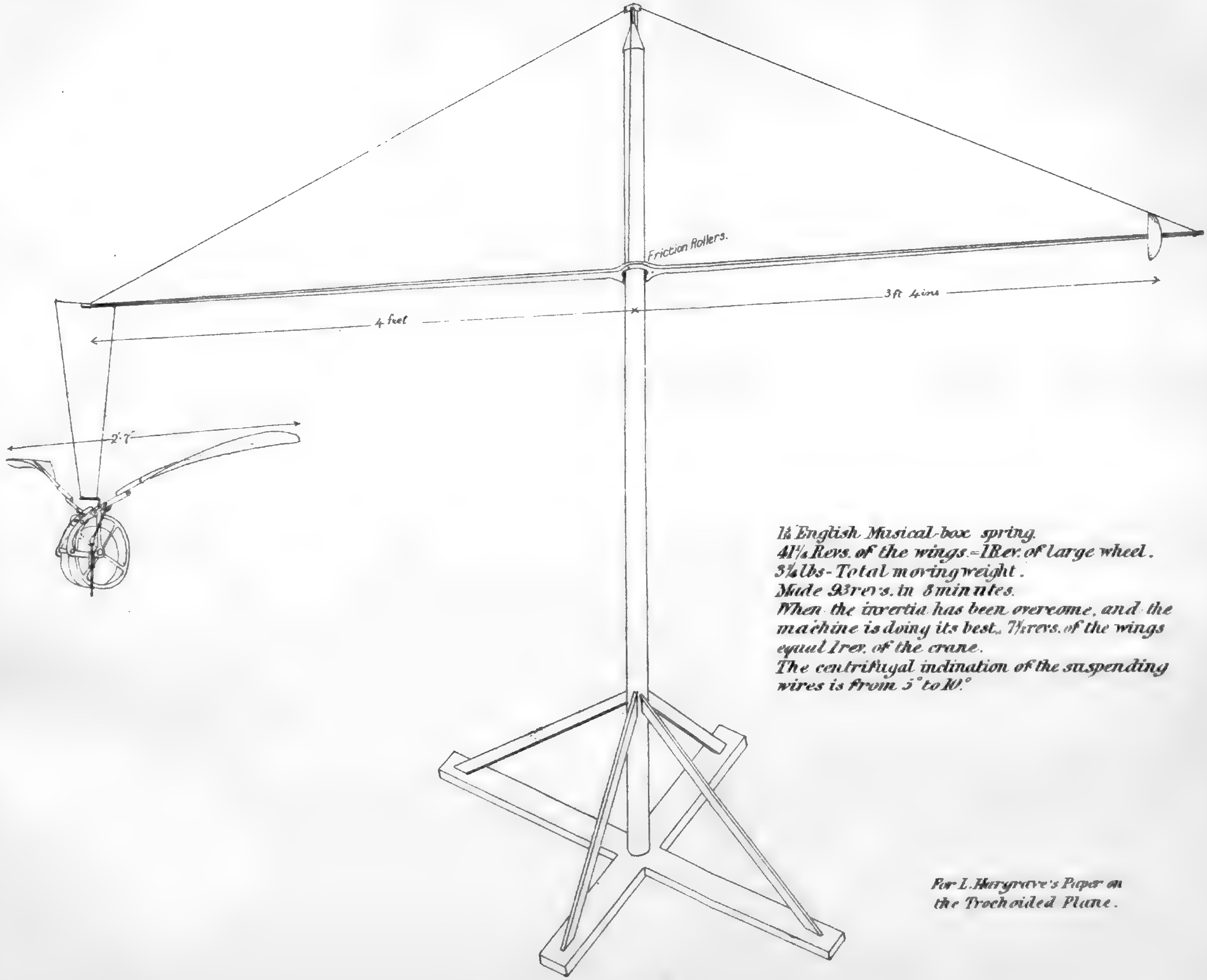


FIG. VII.

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.

On a New Form of Actinometer.

By H. C. Russell, B.A., F.R.A.S.

[Read before the Royal Society of N.S.W., 5 November, 1884.]

Amongst the instruments designed to record the sunshine, I have not seen one which satisfied the conditions required, viz., an instrument that would not only record the hours of sunshine, but measure and record the heat received on a given surface in a given time. I have tried to fulfil these conditions in the instrument before you. You will see that it is similar to an equatorial stand for a telescope, in so far that it has a polar axis and clock-work, and also a means of setting the lens to the declination of the sun. For the recording part it was considered best to put a half cylinder over the polar axis, and attached to the stand, so that two arms attached to the cross-head of the polar axis and parallel to it would move above this half-cylinder and at the same distance from it throughout the day. The use of these arms is to carry a light pen-carriage and pen resting on the paper which is attached to the half cylinder. Attached to the upper end of the polar axis is a frame supporting a short-focus 12-inch lens, so arranged that its axis for adjustment in declination would, if continuous, pass through the continuation of the centre of the polar axis. Now, the intersection of these two axes is obviously a point the locus of which will not be changed by the rotation of the polar axis. At this point I put a miniature water-boiler and supply it with water from a fixed reservoir attached to the stand, the supply going in at the bottom and the steam out of the top ; the water in the boiler will therefore be at a practically constant height and supplied at a temperature known by a thermometer placed in the reservoir, which is protected from the direct rays of the sun. When the instrument is to be used, the lens is turned to the sun and adjusted until its focus is on the boiler ; the clock-work is then started and keeps the lens pointed to the sun, and therefore its focus on the boiler, which goes on boiling in proportion to the intensity of the sun's heat ; the steam thus generated turns a small turbine, and its motion by means of light wheels is made slower, and then given to the pen-carriage, causing it to move down its guide-bars 1 inch for a given amount of water evaporated, and may in a very hot day make it move the whole length of the slide, 9 inches.

Now, while this steam-engine is giving one motion to the pen, the clock-work is giving it another motion over the paper with its guide-arms at the rate of 1 inch per hour. Should the sun be hidden, the boiling would cease and the pen would be carried in a straight line by the clock; and should the sun come out and start the engine, and thence the pen, the mark would be an oblique one or compound of the two motions.

You will see, then, how this machine will show not only the hours when the sun shines, but also the intensity of that heat. In such an arrangement some of the water evaporated must be lost in the machine, and I propose to measure the water into the reservoir in the morning and measure it out at night, so determining *exactly the quantity* of water boiled away during the day, and by means of the pen record the relative rate of evaporation during each moment of sunshine. Experience will no doubt suggest precautions and modifications of this proposal which will make it a complete machine.

Notes on some Mineral Localities in the Northern Districts of New South Wales.

By D. A. PORTER, Tamworth.

[*Read before the Royal Society of N.S.W., 5 November*, 1884.]

QUARTZ—Crystallized varieties.—At *Oban* (N.E.),* in alluvial, auriferous, and stanniferous drifts; colours, black, brown, yellowish, colourless; rarely purple. Crystals having only one pyramidal termination. Faces of pyramids sometimes appear as if etched; crystals often much rubbed, but good specimens with clean faces and sharp angles are easily obtained. Crystals occasionally exhibit imperfect cleavage, and often penetrated by prisms of orthoclase. The associated minerals are topaz, tourmaline, corundum, gold, and cassiterite. The quartz crystals of this locality have probably been derived, as also the tourmaline, topaz, and orthoclase, from drusy cavities in the granites of the surrounding mountains; this granite is highly feldspathic in character.

In *Cope's Creek* (N.E.), and in tributaries of the same; colours, brown, black, colourless; associated with corundum and tin ore. Often penetrated by rutile.

At *Glen Elgin* (N.E.), in crystals in alluvial drifts; colours, brown, rarely black, colourless. The purple variety (amethyst) not uncommon. Associated minerals, gold, cassiterite, and blue and green corundum.

At *Bowling Alley Point*, near Nundle, in bunches or nests in drusy cavities in veins of amorphous quartz, colourless—sides of prisms often have a frosted appearance from partial formation of minute crystals; also in separate crystals, or crystals which are attached by side of prism, and which have double pyramidal terminations.

At *Hanging Rock*, near Nundle, about half a mile north from Mr. P. Prisk's hotel; in loose crystals in surface clay; derived from cavities in the auriferous quartz veins of the neighbourhood. Semi-transparent to opaque, greenish. Similar crystals occur in Balala Creek, near Stony Batter.

At *Garrawilla*, Liverpool Plains, radiated, with stilbite and calcite, often in flat even plates, alternating with similar plates of stilbite. Derived from the amygdaloidal cavities in the basalt of this locality.

* N.E. is a contraction for the New England District.

At *Puddledock*, near Armidale, in radiated masses with stilbite.

At *Hanging Rock*, Nundle, half a mile south from Mr. Prisk's hotel, near Public School; in pyramids massed together and covering chalcedony.

In *Cope's Creek* (N.E.), at lower crossing, in rounded polished fragments, with stream tin ore.

At *Stannifer* (N.E.), in drifts with tin ore, rounded portions of prisms common. Sometimes 5 inches in diameter, exterior rough; colours, black, brown, colourless. Crystals coloured in part, brown or black, common.

At the *Gulf*, near Emmaville (N.E.), in the "Dutchman's" claim, from drusy cavities in quartz, and felspathic granite veins. Crystals large, transparent; often tapering from base to summit of prism. Splendid specimens for cabinet purposes are to be obtained at this locality.

There are a great number of New England localities, not herein mentioned, in which good specimens are occasionally obtained; I have however only enumerated those places in which good specimens occur plentifully, or in which peculiar varieties are found.

Tourmaline.

At *Oban*, in alluvial drifts, with gold and crystals of topaz, feldspar, and tin ore; colour, black, opaque; often attached by side of prism to crystals of orthoclase. A specimen from this locality (a part of a prism) measured $6\frac{3}{4}$ inches in circumference by 2 inches in length, and weighed $9\frac{1}{4}$ oz. Some of the specimens from this locality are hexagonal, but mostly hemihedral. Both forms of prism are found terminating in three-faced pyramids. The prisms are often penetrated by crystals of quartz.

Near *Bendemeer*, 7 miles down the M'Donald River, with muscovite in milky quartz, prisms $\frac{1}{8}$ to $\frac{1}{4}$ inch thick, hemihedral, black opaque.

At *Black Jack Mountain* (Mt. Gulligal), near Bendemeer, in quartz vein with orthoclase, in hemihedral prisms; colour, black, opaque. A specimen from this locality measured 2 inches in length (broken prism), $8\frac{1}{2}$ inches in circumference, and weighed $14\frac{1}{4}$ ozs.; another from the same locality, 4 inches long and 6 inches in circumference, weighed $14\frac{3}{4}$ ozs. The last-mentioned specimen was penetrated by two smaller prisms of the same mineral.

Near *Bingera*, in disintegrated conglomerate drift, with diamond, corundum, and gold, much worn, highly polished; in shape something resembling date-stones; black, opaque, form of prism hemihedral.

At *Balala*, near Uralla (N.E.), in long slender prisms on white quartz; colour, black, opaque.

At *Never Never*, 15 miles north from Tamworth, in large masses of broken crystals agglutinated together, forming schorl breccia, black, opaque.

Near *Kentucky* (Uralla, N.E.) in amorphous masses, often exceeding 20 lbs. in weight, black, opaque.

Topaz.

At *Oban* (N.E.) in stanniferous drifts, with gold, quartz, feldspar, and tourmaline; colour, greenish, yellowish, bluish, pale, also colourless; generally in irregularly broken fragments, but good crystals are not uncommon. Prisms generally with one perfect termination. A prism with perfect termination from this locality was $1\frac{5}{8}$ inches in length, $4\frac{1}{2}$ inches in circumference, and weighed 3·87 ozs. troy. Its sp. g. was 3·57. Another specimen from the same locality weighed 3·90 oz. troy, and had a sp. g. of 3·53.

At *Scrubby Gully* (Emmaville, N.E.), with cassiterite, in rolled fragments much rounded and smoothed, $\frac{1}{8}$ to 1 inch in diameter; colour, pale, greenish, yellowish, colourless.

At *Rocky River* (Uralla, N.E.), with gold, spinels and titanic iron sand.

At the *Gulf*, near Emmaville (N.E.), crystals of topaz $\frac{1}{4}$ inch in length have been observed *in situ* in cavities in cassiterite.

Termination of prism. Side of prism.

Prism of topaz (No. 1), from *Oban* (N.E.)

Corundum.

In *Furracabad Creek* (Glen Innes, N.E.), rough pieces up to 60 grs. in weight, common; colours, blue, brown, mostly opaque.

In the *Severn River* heads and in most of the watercourses which rise from the same ranges, with tin ore, gold, topaz, and garnet; colours mostly blue, green, or grey. Good stones as regards size, tint and freedom from flaws; very rare. Red varieties are often met with, but are invariably small, flawed, or of bad colour.

At *Glen Elgin*, 30 miles east from Glen Innes, with amethyst, gold, and tin ore; colours principally green or yellowish green, transparent, semi-transparent. Prisms, with one perfect termination, are sometimes found, and do not appear to have travelled far, as the angles and edges are in most instances clean and sharp.

In *Cope's Creek* (N.E.), with tin ore, titanic iron, and waterworn quartz crystals; colours, blue, green, brown; opaque, semi-transparent, common; good-coloured transparent stones, rare.

At *Rocky River* (N.E.), in alluvial drifts, with gold, titanic iron, and spinel, small, much worn; colours, blue or brown.

Near *Bingera,* in Eaglehawk and Doctor's Creek, with diamond, spinel, gold, magnetic iron sand, and waterworn tourmalines, semi-transparent, opaque, sometimes transparent; colours, blue, red, brown, green, yellow; generally small in size.

At *Oban* (N.E.), rare, but occasionally found in comparatively large pieces, always much rubbed.

Parti-coloured stones are often met with in the before-mentioned localities; some specimens are from blue to green, others from blue or green, in part, to colourless. Some varieties exhibit rays from centre to circumference.

Following are the weights in grains troy and the sp. g. of four stones from New England:—

	Locality.	Weight in air in grains	Sp.G.
No. 1.	Severn River........................... ..	68½	4·151
No. 2.	,, ...	103	4·120
No. 3.	,, ...	194	3·959
No. 4.	Oban	257	4·015

No. 1. Colour, blue, semi-transparent.
No. 2. Green, pale, transparent; much flawed, worn on edges.
No. 3. Blue, opaque; slightly worn on edges.
No. 4. Blue, opaque; very much rubbed and rounded.

All the above specimens, except No. 4, have been broken in such a manner as to prevent the original crystalline form from being recognized. No. 4 is apparently a portion of a prism in which cleavage has taken place at right angles to the longer axis.

Beryl.

Near *Emmaville* (N.E.), in Carr's claim. Gulf tin-mines, *in situ* in feldspathic rock; prisms small, rarely more than $\frac{3}{16}$ inches thick.

In *Vegetable Creek* (Emmaville, N.E.), rare, in worn prisms and fragments with tin ore, small; colour, pale green.

At *Kangaroo Flat,* 12 miles N.W. from Emmaville, in stanniferous drifts under basalt, in prisms and fragments generally much worn, associated in the drift with quartz and topaz; both of which occur in rounded polished pieces; blue and brown corundum is also found in these drifts with the beryls.

Following is a description of four of the largest stones observed from this locality :—

No. 1. Colour, pale green ; exterior, rough; edges, rounded weight in air, 755 grs. ; sp. g. 2·673.

No. 2. Portion of prism not much worn ; colour, green, rather pale; weight in air, 341 grs. ; sp. g. 2·664.

No. 3. Irregular fragment ; colour, green, pale ; weight in air, 319 grs. ; sp. g. 2·703.

No. 4. Green prism, much worn, $\frac{3}{4}$-in. in diameter, 1 in. long, transparent ; weight in air, 269 grs. ; sp. g. 2·690.

Diamond.

In *Eaglehawk* and *Doctor's Creek*, near Bingera, in drift formed by the decomposition of quartz conglomerates, associated with blue, green, red, and colourless corundum ; also, topaz, garnet, tourmaline, and quartz. All the associated minerals are more or less rubbed and worn.

At and in the neighbourhood of *Tingha* (N.E.), small diamonds are occasionally obtained whilst washing for tin ore. A large but misshapen octohedral stone was found, or said to have been found, in Cope's Creek, at Tingha, some time in the year 1882. This stone, which is now in the possession of Mr. S. W. Moore, of Tingha, is nearly amber yellow in colour. The solid edges formed by the meeting of the faces are smoothed off, and thus give the stone the appearance of being worn, but I suspect that this is the natural form.

The conglomerate rocks from which some persons—especially the miners—are of opinion the diamonds in the Bingera Mines have been derived, are found outcropping on some of the low ridges about the locality. Much of this rock, which might be more accurately described as a brecciated, ferruginous, quartz conglomerate, has become disintegrated, and has spread out and enveloped the sides of the hillocks ; other portions, having been carried further downwards, have filled up some of the small valleys adjacent. It is from this disintegrated conglomerate drift that the diamonds found in this locality are in nearly every instance obtained, though there appears to be as yet no certainty as to whether they have been really derived from these conglomerate rocks, or have only become associated with the disintegrated materials after the decomposition of the original rock. The conglomerates in question are found to be resting unconformably upon argillaceous slates of upper devonian or lower carboniferous formation. I have obtained fossils of *Lepidodendron nothum*, some specimens of *sigillaria*, and the impression of the fruit of a cone-bearing tree, from exposed portions of the slates adjacent to and underlaying the diamondiferous drift ; but have never had an opportunity to make a proper search in this locality for fossils.

VESUVIANITE (*Idocrase*).

At *Bowling Alley Point*, near Nundle, in cavities in vein of finely granular garnet, penetrating serpentine rock; in tetragonal prisms, with pyramidal terminations; colour, dark green, transparent, glassy lustre; hardness between 6 and 7. Specimen too small to admit of specific gravity being taken; white streak. Before blowpipe fuses easily to a greenish glassy globule; associated with small crystals of pale yellow garnet. Good specimens would probably be met with if proper search were made.

AXINITE.

About 5 miles south-east from *Moonbi Railway Station*, in tabular acute-edged crystals, grouped together, glassy lustre; hardness between 6 and 7. Scratches glass, is scratched by quartz; colour, brown; when newly broken has a decided violet tinge; specific gravity, 3·11; streak pale, nearly colourless; not observed *in situ*. The specimen examined was found detached, on side of steep mountain. Before blowpipe fuses readily to black opaque bead; gives the reactions for manganese.

WOLFRAM.

(*Tungstate of Iron and Manganese.*)

In tributary of *Hogue's Creek*, near the road from Glen Innes to Dundee, about 14 miles from Glen Innes, in large lumps in amorphous quartz, associated with molybdenite and tin ore, both of which occur sparingly.

At *Wilson's Downfall*, 30 miles north of Tenterfield, in white quartz, with tin ore.

At *Kingsgate*, about 20 miles from Glen Innes, in milky quartz, associated with bismuth, molybdenite, and mispickel. A specimen from this locality had a specific gravity of 7·196, and possessed the usual characteristics of wolfram.

Notes on the Genus Doryanthes, with a notice and description of a new species.

By Charles Moore, F.L.S.

[*Read before the Royal Society of N.S.W., 3 December, 1884.*]

The Genus Doryanthes—the Gigantic Lily of colonists, or the Goumea of the aborigines—was founded in 1800, on a single species discovered by the earlier settlers in this country, growing in great numbers on the western extremity of Botany Bay, near George's River. Not one of the many remarkable new forms of plants found by the first scientific explorers in this country appears to have attracted more attention than this so-called Gigantic Lily, with its singularly large compact heads of reddish flowers borne on long stalks from 10 to 20 feet high. Although first found near George's River, it is by no means a local plant, as it has a range extending in more or less abundance as far south as Jervis Bay, and northwards to the Manning River; it may, however, extend still further in both directions, as Mr. Hill, of Brisbane, is said to have found a white variety growing on Mount Lindsay, north of the Tweed River. I suspect, however, that this white flowering plant, of which no description has been given, may be a form of a different species, *Doryanthes Palmeri*, subsequently gathered near Toowoomba, Queensland. Be that as it may, the country to the west of Botany Bay may be regarded as the central locality of this type of the genus.

It was not only that this plant was remarkable for the beauty of its flowers, but it was also found that the leaves produced a valuable fibre, which furnished the natives with a material for fishing lines and nets. The late Sir Thomas Mitchell—who long held the office of Surveyor-General of this Colony, and perhaps on the whole the most distinguished colonist Australia can yet boast of—one of the founders of this Society, read a paper at one of its first meetings, entitled the "Resources of the County of Cumberland," in which he drew marked attention to the beauty, tenacity, and probable ultimate value of its fibre, of which, prepared for the occasion, a splendid sample was produced, nearly 3 feet in length, and of quite a silky appearance; but notwithstanding the valuable qualities of this fibre, and that it could be obtained in any quantity over the whole country lying between South Botany and Illawarra, it has not as yet been, so far as I am aware, turned to any commercial advantage. In a botanical sense Doryanthes does not belong to the lily tribe, but is one of the family of Amaryllideæ, a class of plants principally distinguished from the lilies by having the fruit inferior, *i.e.*, under or outside the floral leaves, instead of within the floral envelope, as characteristic of the Lily family. For more than seventy years this singular plant stood alone in our text-books of Botany as the only one of its kind, and often referred to by botanists as an extraordinary feature in our vegetation, standing alone without any very close congener. It was therefore most interesting to learn that in the year 1870, another and very distinct species of the genus had been discovered growing in many places in high and rocky situations not far from Cunningham's Gap, near the Darling Downs, Queensland, and first accurately described in the "Botanical Magazine," tab. 6,665, by Sir Joseph Hooker, under the name of *Doryanthes Palmeri*, in honor of Mr. Palmer, the then Premier of Queensland. Curiously enough a plant of this new species had been in cultivation in one of the conservatories of Kew Botanic Gardens for upwards of sixteen years previously, having been sent to that establishment as *Doryanthes excelsa*; its true character not having been discovered until it flowered.

I shall now refer to the object of this short paper, which is to record a third species of this remarkable genus sent to me by Mr. George Larkin, Lismore. The locality from which this novelty was obtained lies about 25 miles north-west of Lismore, *i.e.*, between the Richmond and Tweed Rivers, where it was found growing on basaltic ranges. The only material from which to describe this plant yet placed in my possession is a scape or stalk with flowers and some leaves; but these are, I consider, sufficient to identify it as being a new plant, and enable me to draw out and submit a description of it. I cannot, however, disguise from myself that it is very closely allied to the Queensland *B. Palmeri*; but when I become better acquainted with its appearance and habit I shall then be able to judge of its distinctive character and, as a means to do this, Mr. Larkin has most kindly promised to send me plants and seeds, as well as photos of the plant in its natural habitat. At some future time I may therefore have to bring this subject before our Society; in the meantime I accept the plant as a new species, which I have much pleasure in naming, after its discoverer, as *Doryanthes Larkini*.

Description.

Radical leaves spreading broadly ensiform, 4 to 5 feet long, and about 4 inches broad, much ribbed, terminating in a sharp brown tubular tip tapering to within 9 inches of the base, and then of equal breadth to the point of connection.

Scape rarely erect, from 6 to 8 feet high, clothed with acute lanceolate leafy bracts becoming broader towards the apex.

Inflorescence about 4 feet long, thyrsoid, loose of many long few-flowered spikes, the primary rachis being about 14 inches, long, with short reddish brown bracts very broad at the base and graduating into an acute point, and terminating in short trichotomous spikelets, and each bearing from two to three flowers.

Flowers red, tube of the ovary about 1 inch long, segment of the flower erect, the outer row slightly longer than the inner, narrowly oblong, paler in colour on the inside, and rather longer than the tube of the perianth.

Stamens shorter than the segments of the flower, gradually narrowed upwards.

Fruit unknown.

Although this new species is very closely allied to *D. Palmeri*, it may readily be distinguished from that plant by the erect stem, loose branching rachis—the branches being some distance apart, and from 12 to 14 inches long, and by its shorter leaves and smaller flowers. The stem or scape of *D. Palmeri* is never erect; the spikelets of flowers adhere close to the stem, which are in consequence somewhat secund, or all bearing towards the upper side. From both of the preceding *D. excelsa* can at sight be recognized by its large compact head of flowers on a perfectly straight erect stem, and by its narrower slightly-ribbed leaves and recurved segments of the perianth.

Water Supply in the Interior of New South Wales.

By W. E. Abbott, Abbotsford, Wingen.

[*Read before the Royal Society of N.S.W., 3 December, 1884.*]

In dealing with the question of water supply in the interior of New South Wales, it will be most convenient to divide the subject, and deal first with "wells ordinary or artesian," and next with the "conservation of surface water." In practice, of course there is no such division, as both methods of obtaining a supply of fresh water will be found in operation to a greater or less extent on almost every station in the interior of the Colony. The interior of New South Wales is almost wholly occupied by the watershed of the Darling River, which forms the main line of drainage of the Australian Continent. The tributaries of this river flow away from the great dividing range to the north-west and west through a great alluvial plain, sloping imperceptibly from the spurs of the range for a distance to the Darling River of from 200 to 300 miles. The section map appended, taken from Mr. Russell's "Physical Geography and Climate of New South Wales," gives an excellent idea of the general slope of the country. This great plain is not timberless, though nearly all the timber which grows on it is stunted, and different in every way from the forests which clothe the eastern slopes of the great dividing range. As it has been suggested that the water supply of the great western plains might be increased by planting forests, I have endeavoured to form an estimate of how much of it is timbered at present, and what would be the chances of success in the attempt to plant forests. From my own observations, made in many parts of the Darling watershed, I do not think more than 20 per cent. of the country is timberless, and on that part which is timbered there is a rather larger number of trees to the acre than on our eastern slopes of forest country. The real difference is in the size of the trees. Except along the courses of the rivers and in a few isolated spots, trees of a foot in diameter are extremely rare, scarcely one to 100 miles of country in some places. I think this is owing to the extremely salt nature of the soil, and only to a small extent to climatic conditions. The proof of this is in the fact that where we may reasonably suppose the soluble salts to have been to a large extent washed out of the soil, large trees do grow; but deep-rooting trees of the larger kinds are unable to exist in the salt-bush plains. In 1880 I examined an orchard on the Lower Macquarie which had been planted about five years on a piece of salt-bush country. The trees grew with great luxuriance for some time, and then died. It seemed to me they died as soon as their roots reached the salt subsoil after passing through the surface-soil, out of which the salts had in a great measure been washed by rain. In other places I have seen orchards successfully planted, but always on the banks of rivers where the country had been liable to flood for ages, and where large gum-trees grew, as they do along the banks of rivers, but scarcely anywhere else. For these reasons, I do not think it would be possible to cover the western plains with forests, even if it were certain (which it is not) that the result would be to increase the rainfall or the flow of water in the watercourses. In endeavouring to arrive at some conclusion as to the possibility of watering our inland plains by wells, ordinary or artesian, it will be necessary to deal at some length with the geological formation of that part of New South Wales. The whole of the interior of the Colony may be described as a single plain, sloping away imperceptibly to the west from the spurs of the great dividing range.

This range is on an average less than 3,000 feet high, though many of the peaks rise considerably above that altitude. No-where does it reach the line of perpetual snow; and the rivers which flow away to the west, to feed the Darling River, are only maintained by the annual rainfall which, along the summit of the range, is about 30 inches, becoming less gradually as we go west, until near the western boundary of the Colony it falls below 10 inches; the average for the five years from 1879 to 1883 inclusive being a little more than 22 inches on the Darling watershed above Bourke. (Russell, Rain and River Obs., 1883.) That this plain is of aqueous origin, I think, will scarcely be denied by any-one who carefully considers the numberless facts which support such a conclusion.

I know that it has been maintained by Mr. Tenison-Woods that the interior of New South Wales is wholly a formation of wind-blown sand, but I trust that gentleman will yet see reasons for changing his opinion.

The conclusion at which I had arrived some years ago, when I first went through the Darling country, was that the whole of that part of Australia which forms the Darling watershed had been covered, within comparatively recent geological time, by a sea, partly or perhaps wholly landlocked.

Apart from the scientific interest centred in this question of the geological formation of the Darling country, it has a very direct bearing on the probability of obtaining, by boring or sinking, an adequate supply of artesian or other well water, and for this reason I shall endeavour to state, as shortly as possible, a few of the facts on which the opinions which I hold are grounded.

From the western spurs of the dividing range we find the land sloping away to the west as far as the Darling River. West of the Darling, as far as the South Australian boundary, the country, except for a few low ranges, seems to be almost level, as shown by the uncertain course which the water takes. In that part of the Colony there have not yet been any railway surveys made, so that we have no accurate records of the levels in any direction.

Bourke, on the Darling, as shown by the railway survey, is only 349 feet above sea-level, and Dubbo, on the same line of railway, is 865 feet above sea-level. Dubbo is situated just near the edge of the great western plain; and here we have an average slope of about 2 feet per mile, but the slope is much greater in the first 100 miles than after, as Nyngan, about 100 miles from Dubbo, is only 567* feet above sea-level. Taking the north-western line of railway, I find that Gunnedah, in the northern part of the Colony, situated near the edge of the great western plain, close to the spurs of the dividing range, is 874 feet above sea-level. In 1880, by barometer measurement, I made Walgett (which is situated on the Darling River, a little north of west from Gunnedah, about 180 miles and about the same distance up the river from Bourke), 468 feet above sea-level, so that here we have also a fall of something more than 2 feet per mile. In addition to the slope away from the great dividing range, the plain which forms the interior of New South Wales has a very even slope to the south-west, along the course of the Darling River, of something less than 1 foot per mile. The fall along the course of the Darling River, following the bends, is only a few inches per mile; but I think, from a series of observations made by myself a few years ago, that the general slope of the country from the Queensland boundary to Bourke is about 8 inches per mile. Below Bourke the fall becomes less. Between the courses of the Bogan River and the Lachlan there is a slight rise in the country, which has turned the Bogan to the north and the Lachlan to the south-west. This rise seems to be continued right across the Colony to the western boundary, and all along the higher ground the older silurian and devonian rocks come to the surface with granite in many places, quartzite, and conglomerates of undetermined geological position.

* In a time-table issued 10 September, 1884, from the Railway Department, the height above sea-level of Nyngan is given as 637 feet, but as my information is derived also from the survey of the line, and direct from the Railway Department, it is impossible to say which is correct. The difference does not affect the argument.

The slope from the rivers Lachlan and Bogan to the centre of this dividing rise is so gradual as to be quite imperceptible in riding over the country, and no well-defined watercourses are formed in the whole of that piece of country, triangular in shape, about 300 by 250 miles, which is almost enclosed by the three rivers—Bogan, Darling, and Lachlan. In speaking of this rising ground being of silurian, devonian, or granite formation, it must not be understood that any large proportion of the country belongs to these formations. In this part of the Colony, as well as in all the rest of our western plains, the country on the surface consists for at least 90 per cent. of evenly deposited clay beds, thinly interspersed with stretches of sandy country, which are probably all of tertiary or recent geological age. And here I may note that in a country like the interior of New South Wales, where we have a vast area of nearly level country covered by clay beds and sands, probably of recent formation, with the harder underlying rocks coming to the surface in isolated spots, we are apt to take the fossils of these older rocks as indicating the age of a large part of the formation, which they do not, as these more prominent parts pierce through stratified beds of much more recent date.

The peculiarities of the great western plain which forms about three-fourths of the Colony of New South Wales are, first, that it runs up among the spurs of the dividing range exactly in the same way that water penetrates a broken coast-line, forming deep bays and inlets with ranges and peaks of hard crystalline or conglomerate rock, rising through the evenly stratified clay-beds like capes, peninsulas, and islands, along a broken coast-line, the island-like peaks becoming fewer and fewer as we go west until we reach the Darling River; and here we may travel hundreds of miles without coming across a rise in the country of even a few feet. The whole country slopes away from the lower spurs of the range with a wonderfully even slope, first of about 2 feet to the mile, becoming gradually less until the Darling is reached, where the western slope ceases, and the only fall of the country is to the south or south-west. Numerous creeks come down from the range along well-defined valleys, which are evidently valleys of erosion, and on reaching the heads of the inlets of plain spread out and are lost, only the larger watercourses forcing a way through the plains and ultimately reaching some tributary of the Darling. This is the case more particularly in the Liverpool Plains district. That these creeks could never have had a defined course through the plain during all the ages in which they have been cutting down the gorges in the mountains through which they flow, but must at the point where they now spread out on the plain have always either flowed into water where there was no current, or into a plain as they now do, which had by some agency been rendered so level as to prevent the concentration of their waters in any particular channel, is proved, I think, by the following table, which gives the excavating power of currents of different velocities:—

Inches per second.	Miles per hour.	
3	0·170	will begin to work on fine clay.
6	0·340	will lift fine sand.
8	0·4,545	will lift sand as coarse as linseed.
12	0·6,819	will sweep along fine gravel.
24	1·3,683	will roll along pebbles an inch in diameter.
36	2·045	will sweep along angular stones the size of an egg.

(D. Stephenson, Canal and River Engineering, p. 315.)

The current of the Darling River with a fall of only a few inches per mile is from half a mile to more than a mile per hour. The fall from the western spurs of the range towards the Darling is at least 2 feet per mile, and probably for the first 100 miles more than 3 feet, so that with such a fall these creeks would, as the above table shows, have been able to maintain and deepen their channels, if they ever had had any. The larger creeks or rivers which have, by reason of the great quantity of water carried down from the mountains, succeeded in cutting defined channels through the plain, and reached the lowest level to form the Darling, have one peculiarity which, without exception, is found in them all. From the point at which they leave the mountains they have no defined valleys, although above that point the valleys are well defined, and must have taken ages to cut out. All the tributaries of the Darling from the Gwydir in the north to the Bogan in the south have the appearance of canals rather than rivers, and yet with a fall of from 2 to 3 feet per mile, and a current of 3 or 4 miles per hour, as some of them have, we should find many signs of long continued erosion unless, as I suppose, the country had by some agency been rendered so flat in the cross section of the river courses that the most of the water always spread out over the country. The older and harder strata on which the clay beds rest are not level, as is shown by the various depths at which they are reached in sinking wells, therefore it seems clear that if the present rivers, with the current which they would have had with a fall of 2 or 3 feet per mile, had ever flowed along this uneven bottom formation, they never could have built up an even plain with a general level extending over hundreds of miles. Besides the fact that these clay-beds and sand drifts with nearly horizontal stratification are found in places hundreds of feet below sea-level, and there contain fossil trees and other signs of the proximity of land, seems to me an unanswerable argument against any theory of their formation, except that of an inland sea or vast salt lake. From the Gwydir to the Bogan, travelling across the courses of the Namoi, Castlereagh, Macquarie, and Bogan, it is impossible to say where the watershed of one river ends and that of the next begins. There is a remarkable sameness about the whole of the interior of New South Wales. The plains consist almost wholly of two sorts of soil, which in the most widely separated places are found to possess the same distinctive characteristics. One which constitutes about three-fourths of the whole watershed of the Darling in New South Wales is a red clay with a very slight admixture of extremely find sand, commonly called the red-soil country. All the salt-bush plains are of this formation. The other is a greyish black soil, commonly called black-soil country. This lies chiefly along the courses of the rivers, and is generally liable to be flooded in wet seasons, the red soil being rarely, if ever, covered to any depth or extent by the overflow from the rivers. This black or greyish black soil, when found along the Darling or the lower courses of its tributaries, is extremely fine-grained, and when rubbed between the fingers in water leaves no grit, the whole mass dissolving in the water. Near the spurs of the dividing range, along the edge of the great western plain, it is much darker in colour, and contains a larger proportion of grit or sand than further west. In addition to these two kinds of country, there are stretches of sandy country having the same general level as the rest of the plains. The black soil is the newest of the three kinds of country described, always overlying both the red soil and the sands. Wherever wells have been sunk in the black soil country, either the red soil or the sand has been reached at a small depth. It generally follows depressions in the country, and is found all along the courses of the rivers, seldom if ever beyond the line of flooded country, and almost all flooded country is black soil, and it is never of any great thickness. This black soil has evidently been formed by the finer particles of soil carried down and deposited in shallow depressions of the older formations of red soil and sand. With regard to the red soil and the sand, I have been unable to satisfy myself that there is any regularity in the way in which they lie with reference to each other. I believe they are contemporaneous, and may be found passing under or over each other indiscriminately.

Owing to the kindness of Mr. James Doyle, of Invermein, Scone, I have been able to obtain samples of both the red and black soils for analysis. I had some hope that the analysis, or a microscopical examination of the samples kindly made by Mr. C. S. Wilkinson, would have thrown some light on the origin of both these formations; but all that has been shown is that both soils, though very different in appearance, are similar in constitution, and the black soil is probably derived from the red, having been deposited from water having little or no current, as is shown by the extreme fineness of the particles. The fact that the particles of silica are not rounded but angular, will also have some bearing on the question of the eolian origin of these formations. Mr. Wilkinson, who examined these soils microscopically, "found no trace of any organism," and describes them as "chiefly silica in angular grains, such as would be derived from rocks of a very silicious nature, such as the silurian, devonian, or tertiary sandstones, or some kinds of granite."

They are probably derived from the same strata as the quartzite conglomarates called murillo ridges, or from these conglomerates.

The following analyses are by Mr. Chas. Watt, Government Analyst:—

Analyses of red soil from the Darling watershed.

Fixed Substances.

	In 100 parts.
Soluble in cold hydrochloric acid—	
Peroxide of iron	2·76
Alumina	2·51
Lime	·82
Magnesia	·86
Potash (K_2O)	·37
Soda (Na_2O)	·10
Phosphoric acid	·07
Sulphuric acid	trace
Carbonic acid	trace
Soluble silica	·05
Copper	trace
Decomposable by sulphuric acid—	
Peroxide of iron	2·31
Alumina	8·73
Potash (K_2O)	1·06
Soda, (Na_2O)	·88
Silica and silicates, undecomposable by sulphuric acid	69·84
Combustible and volatile substances—	
Moisture at 125° C.	7·50
Loss on ignition	2·24
Total ammonia	·07
Nitrates	trace
	100·17

Analyses of black soil from the Darling watershed.

Fixed Substances.

Soluble in cold hydrochloric acid—	
Peroxide of iron	1·78
Alumina	2·71
Lime	1·27
Magnesia	·68
Potash (K_2O)	·45
Soda (Na_2O)	trace

Phosphoric acid (P_2O_5)	·07
Sulphuric acid	trace
Carbonic acid	·30
Copper	trace
Decomposable by sulphuric acid—	
Peroxide of iron	3·23
Alumina	10·68
Potash (K_2O)	1·08
Soda (Na_2O)	·84
Silica and silicates, undecomposable by sulphuric acid	67·56
Combustible and volatile substances—	
Moisture at 125° C.	7·78
Loss on ignition	1·55
Total ammonia	·03
Nitrates	traces
	100·01

Neither of the above samples of soil show any trace of chloride of sodium, which I suppose arises from the fact that being taken from near the surface all the most soluble salts had been washed out by rain-water. Throughout the whole of the western plains the soil must contain a large quantity of common salt or chloride of sodium, for on an average in five wells out of six sunk salt water is found, and the whole country gets its name of the salt-bush country from the fact that nearly all the fodder plants which grow in that part of New South Wales contain a very large proportion of common salt and soda. In a paper published in the "Journal of the Transactions of the Royal Society of New South Wales, 1880, by W. A. Dixon, F.C.S., on Salt-bush and Native Fodder Plants," it is shown that in the ash of the salt-bushes soda and chloride of sodium range as high as 42·82 and 35·36 per cent. respectively; while in English fodder plants, the percentages of which are given for comparison in the same paper, there is no soda, and only in one instance does the chloride of sodium go as high as 11·04 per cent., the next highest sample to this having only 3·84 per cent. About Brewarrina, and in other places on the Darling, along both banks of the river, at from 20 to 30 feet below the general level of the country, there are strong springs of intensely salt water flowing into the river; and so large is the quantity of salt brought in by these springs that in dry seasons the river water becomes too salt for use, and sometimes the fish die in large numbers. That the salts contained in these springs and in wells where salt water is found all through the interior of New South Wales are identical with the salts contained in the sea or in many of the great salt lakes now in existence is shown, I think, by the following series of analyses :—

Analyses of water from Spring Ridge, Liverpool Plains, from well 22 feet deep, in centre of black soil; plain about 1,100 feet above sea-level.

	Grains per gallon.	Proportion of solid constituents in 1,000 parts of water.
Chloride of sodium	864·83	12·146
,, magnesium	170·25	2·389
Sulphate of sodium	54·80	0·769
Carbonate of soda	60·57	0·850
,, lime	18·15	0·255
,, magnesia	33·25	0·467
Silica, iron, and alumina	2·10	0·029
Organic matter	12·90	0·182
	1,216·85	17·087

Total chlorine......................669·65 grains per gallon.
,, sulphuric acid.................. 30·88 ,, ,,

Colour yellow, with a strong odour of sulphureted hydrogen.

The proportion of organic constituents in the water is so excessive as to render it totally unsuitable for domestic uses, or even for cattle; it should only be used when other is unobtainable.

Analyses of water from Diamond-drill, Girilambone.

Colour bright.

Total fixed matter ....812·48 grains per gallon.
,, chlorine ....365·63 ,, ,,

Fixed matter consisting of chlorides of magnesium and sodium, carbonate of lime, sulphate of zinc, &c.

Analyses of water from Diamond-drill, Girilambone.

Total fixed matter ....775·04 grains per gallon.
,, chlorine ....343·28 ,, ,,

Fixed matter consisting of chlorides of magnesium and sodium, carbonat of lime, sulphate of lime, oxide of iron, &c.

Analyses of water from Diamond-drill, Girilambone.

Total fixed matter ....777·92 grains per gallon.
,, chlorine ....346·12 ,, ,,

Fixed matters consisting of chlorides of magnesium and sodium, carbonat of lime, sulphate of lime, oxide of iron, &c.

Analyses of water from Caspian Sea, near mouth of River Ural. Göbel.

Constituent (except where otherwise stated).

Chloride of sodium	0·3673
,, magnesium	0·0632
,, calcium	0·0013 ($MgCO_3$)
,, potassium	0·0076

Bromide of magnesium	trace	
Sulphate of calcium	0·0490	
„ potassium	0·0171	($CaCO_3$)
„ magnesium	0·1237	
Water	99·3086	
	100·0000	

Analyses of water from Caspian Sea at Baku. Abich.

Constituent (except where otherwise stated).

Chloride of sodium	8·5267	
„ magnesium	0·3039	
„ calcium	....	
„ potassium	trace	
Bromide of magnesium	....	
Sulphate of calcium	1·0742	
„ potassium	0·0554	($CaCO_3$)
„ magnesium	3·2493	
Water	86·7905	
	100·0000	

Analyses of water from Indertsch Lake. Göbel.

Constituent (except where otherwise stated).

Chloride of sodium	23·928
„ magnesium	1·736
„ calcium	......
„ potassium	0·101
Bromide of magnesium	0·005
Sulphate of calcium	0·042
„ potassium	......
„ magnesium	0·346
Water	73·842
	100·000

Analyses of water from Great Salt Lake, Utah. O. D. Allen.

Constituent (except where otherwise stated).

Chloride of sodium	11·8628	
„ magnesium	1·4908	
„ calcium	....	
„ potassium	0·0862 excess chlorine	
Bromide of magnesium	....	
Sulphate of calcium	0·0858	
„ potassium	0·5363	
„ magnesium	0·9321	($NaSo_4$)
Water	85·0060	
	100·0000	

Analyses of water from Elton Lake, Kirghis Steppe. H. Rose.

Constituent (except where otherwise stated).	
Chloride of sodium	3·83
,, magnesium	19·75
,, calcium	......
,, potassium	0·23
Bromide of magnesium	......
Sulphate of calcium	......
,, potassium	......
,, magnesium	5·32
Water	70·87
	100·000

Analyses of water from the Dead Sea. A. Geikie.

Constituent (except where otherwise stated).	
Chloride of sodium	3·6372
,, magnesium	15·9774
,, calcium	4·7197
,, potassium	0·8379
Bromide of magnesium	0·8157
Sulphate of calcium	0·0889
,, potassium	....
,, magnesium	....
Water	73·9232
	100·0000

The mineral constituents of ocean water occur in the following average ratios :—

Sodium chloride (common salt)	75·786
Magnesium chloride	9·159
Potassium chloride	3·657
Calcium sulphate (gypsum)	4·617
Magnesium sulphate (Epsom salts)	5·597
Sodium bromide	1·184
	100·000
Total percentage of salts in sea-water ...	3·527

A. Geikie

On comparing these tables of analysis, it will be seen that salt lakes vary greatly in the proportion of the mineral constituents contained in their waters, but in nearly every case sodium chloride (common salt) as in the sea, is the chief constituent, and where sodium chloride does not stand first in quantity, magnesium chloride does ; and this is found to be the same in the Darling salt water. These variations are caused perhaps to a small extent by the local geological conditions prevailing in the watershed of each particular lake, but chiefly, as I will show further on, by the stage of concentration which has been reached by the waters. A noticeable feature in the formation of the western plains is the wide distribution of gypsum in nodules and beds interstratified with the clay beds. In every part of the Darling country which I have examined, I have noticed gypsum in the excavated material from tanks and wells, and also on the surface in places; and on questioning well-sinkers, I was much struck by the generally expressed opinion that wherever you find gypsum you will find salt water not far off. The manner of formation of gypsum will show that the generalization reached by the practical experience of the well-sinkers is probably not far from the truth.

Professor A. Geikie, LL.D., F.R.S., Director-General of the Geological Survey of Great Britain and Ireland, says—(Text-book of Geology, p. 398):—"The study of the precipitations which take place on the floors of modern salt lakes is important, as throwing light on the history of a number of chemically-formed rocks. The salts in these waters accumulate until their point of saturation is reached, or until by chemical re-action they are thrown down. The least soluble are naturally the first to appear, the water becoming progressively more and more saline till it reaches a condition like that of the mother liquor in a salt work. Gypsum begins to be thrown down from sea-water when 37 per cent. of water has been evaporated, but 93 per cent. of water must be drawn off before chloride of sodium can begin to be deposited. Hence the concentration and evaporation of the water of a salt lake having a composition like that of sea-water would give rise first to a layer or sole of gypsum, followed by one of rock-salt. This has been found to be the normal order among the various saliferous formations in the earth's crust. But gypsum may be precipitated without rock-salt, either because the water was diluted before the point of saturation for rock-salt was reached, or because the salt, if deposited, was subsequently dissolved and removed." Sir A. C. Ramsay, LL.D., F.R.S., P.G.S., President of the British Association for the Advancement of Science, has connected the occurrence of certain red formations with the existence of salt lakes, from the bitter waters of which not only iron of oxide, but often rock-salt, magnesian limestone, and gypsum, were thrown down. He points to the presence of land plants, footprints of amphibia, and other indications of terrestrial surfaces, while truly marine organisms are either found in stunted condition, or absent altogether. (Geikie, Text-book of Geology, p. 711); also (Inaugural Address to British Association for the Advancement of Science, 1880, by A. C. Ramsay, President). The absence or scarcity of marine or lacustrine fossils (for we cannot say they are absent) in the Darling formations of recent deposit is not without a parallel in formations of a similar character now being deposited in other parts of the world. Professor Geikie says:—"As the level of the Dead

Sea is liable to variations, parts of the bottom are from time to time exposed, and show a surface of bluish clay or marl, full of crystals of common salt and gypsum. Beds of similar saliferous and gypsiferous clays with bands of gypsum rise along the slopes for some height above the present surface af the water, and mark the deposits left when the Dead Sea covered a larger area than it now does. Save occasional impressions of drifted terrestrial plants, these strata contains no organic remains." (Geikie, Text-book of Geology, p. 401). But the part of the world which most resembles what the Darling watershed must have been, is the great depression now occupied by the Caspian Sea. This inland sea or lake covers 180,000 square miles of territory, contains numerous shoals or sand banks, is from 2,000 to 3,000 feet deep in places, has no outlet, and is below sea-level. It is being gradually silted up; and if sufficient time were to elapse, and no subsidence to take place, must ultimately become a great plain, with a slope away from the rivers by which the silt is being carried in. Saliferous clays are being deposited, interstratified with gypsum, in some places with a very even slope, while in other places sand-banks and shoals come to the surfaces of the water. Where the drainage of the large rivers reaches the Caspian, the waters of that lake or sea are not so salt as those of the Mediterranean, or even as those of the ocean; but in the parts most remote from the mouth of the great rivers crystals of salt and gypsum are being deposited with the mud, and sometimes covered up by sand. (A. Geikie, F.R.S.) If we endeavour to picture to ourselves this great depression filled up, and it must be remembered that such a filling up is inevitable, unless changes of level are produced by subterranean causes, would we not have something so closely resembling the western plains of New South Wales that it would be impossible to come to any other conclusion than that both formations had been produced under like conditions.

In many places the slope of the land round the borders of the Caspian to and under the water is so gradual that the water is often driven by the wind blowing from the sea far inland, and it is impossible for even the smallest boat to approach the shore. Having all these things in view, I cannot come to any other conclusion than that the great western plains of New South Wales are of salt or bitter-lake formation. Possibly there may be a considerable variation in the beds as we pass downwards, but I think there can be no doubt that the saliferous clays and sands with which they are interstratified, as well as the beds and nodules of gypsum, are of salt-lake formation, and that they are now, and have been for a long period, undergoing a process of washing out, by which the salts deposited from the bitter waters are being gradually dissolved out of the soil and carried away to sea, partly through the rivers and partly by underground drainage. Of course in such a process of washing out the order in which the salts were deposited would be reversed, the more soluble such as chloride or common salt being dissolved out first, and the least soluble such as gypsum remaining.

I know of no agency, except water in such a land-locked sea as the Caspian, capable of producing all the conditions found in the Darling watershed.

A theory has been put forward by Mr. Tenison-Woods, which attributes these formations to wind-blown sand, and he has compared them to the wind-blown sand formations of China, described by Richtofen; but the formation described by Richtofen is a yellow calcareous clay, *wholly unstratified,* with a thickness in places of from 1,500 to 2,000 feet, and of course does not in any way resemble the Darling formations, which consist of saliferous clays, interstratified with gypsum and uncompacted sand or sand-drifts, and some cemented sands covered in places by the black soil, which in some respects resembles the Tundras, north of the Caspian, the stratification being always, as far as I can judge, nearly horizontal. Quite recently it has been suggested to me by a gentleman whose opinion should have very great weight, that the plains might be a river formation, and I have given the idea careful consideration; and though I cannot deal with the question now, I may say that on comparing the suggestion with my own observations, I find the difficulties in the way of accepting it insuperable.

Taking the facts as above stated, and apart from any theory or conclusion as to how the country assumed its present form, I will endeavour to show what are the probabilities of and the difficulties in the way of obtaining a supply of underground water, either artesian or by ordinary wells, from which the water would require to be lifted. I need not do more than allude to the well-known work which has been done by Mr. Russell, the Government Astronomer, in the last ten years, in connection with water supply in the interior of New South Wales. The conclusions reached, though at first disputed, are now, I think, generally accepted. They are, shortly, that the rainfall of the Darling watershed is not adequately accounted for by evaporation, and the outflow of the river, and consequently there must be some other means of escape for the missing water. Mr. Russell has shown (Rain and River Observations, 1883) that in dry years, such as 1883, only $\frac{1}{120}$ of the rainfall of the Darling watershed which falls above Bourke passes that town, and in good years about $\frac{1}{50}$. The difference between the Darling and the other rivers, even in New South Wales, in this respect, is very marked, as in most parts of the world the outflow of the rivers ranges from one-quarter to one-third of the total rainfall of the area drained. This applies to rivers having a comparatively level course like the Darling. Rivers with steep and hard watersheds sometimes carry off as much as 90 per cent. of the amount of rain which falls within their drainage area.

The following tables of outflow of various rivers in different parts of the world by different observers will perhaps give a tolerably fair average or normal ratio of outflow to rainfall :—

Ratio of drainage or outflow to rainfall.

Ohio River	0·24	Messrs. Humphreys and Abbott, Engineers to the United States Government, America.
Missouri	0·15	
Upper Mississippi	0·24	
Small tributaries	0·90	
Arkansas and White Rivers	0·15	
Red River	0·20	
Zazoo River	0·90	
St. Francis' River	0·90	
Entire Mississippi, exclusive of Red River	0·25	

The Thames, in England, carries off a little less than one-third of the rainfall (Beardmore's Hydrology, p. 201). The Elbe carries off one-quarter of the rainfall (Verhandl Geol. Reichsanstalt, p. 173). The Seine, at Paris, carries off a third of the rainfall (A. Geikie). The Upper Nepean and Cataract Rivers, on the eastern slopes of the dividing range in New South Wales, carry off about 39 per cent. of the rainfall, as shown by the Commissioner appointed for the investigation of the Sydney water supply. The Murray, which most nearly in climatic conditions and character of watershed approaches the Darling, discharges at Euston nearly one-fourth of the rainfall, or about the same as rivers of similar character in other parts of the world (H. C. Russell: Journal of the Royal Society of New South Wales, 1883). The Murray is a western river, and in area of drainage is only second to the Darling of all our Australian rivers.

Mr. Russell's calculations as to average evaporation in the interior of New South Wales may, I think, be accepted as nearest to the truth of any which have yet been made, as there are numerous instances in the recent drought of tanks only 10 or 12 feet deep watering large numbers of sheep for more than twelve months without any water running into them. And I may mention one case on Gurley Station, in the Gwydir district (my informant is Mr. Keene, the Manager of Gurley), where 2,000 sheep were watered for considerably more than a year from a tank 10 feet deep, and there was still water in the tank, though none had run into it during the whole time.

This is only one case out of hundreds. But I do not see the use of multiplying instances, as a hundred cases only prove what one proves—that in a dry year in the interior of New South Wales, from a water surface the evaporation cannot be more than 5, or at most, 6 feet per year, and is probably less than either of these estimates. Supposing Mr. Russell's conclusions as to the missing water to be true, the question arises how does it find its way to the sea,—through what strata or channels. The greater part of the interior of New South Wales consists of saliferous clays, interstratified with fine sand beds or drifts, permeable by water, hard cemented sand, impermeable, and gypsum, the stratification being generally horizontal or nearly so. In some places the harder underlying formations of more ancient geological date come to the surface, as at Cobar, and along the rising ground between the Lachlan and the Bogan, and in some places we find isolated peaks of crystalline rock rising through the clay beds, and also quartzite conglomerates. The fact of these older and harder formations coming to the surface in places all through the Darling watershed, while in the other places, as shown by wells that have been sunk, the stratified clays and sands have a thickness of several hundred feet, and pass down far below sea-level, proves that the present remarkably level surface of the country has been attained by filling up the hollows of the older and harder formation to the level of the higher country. How this filling up has been done is of course open to question, but that it has been done is beyond dispute.

The only attempt which has yet been made to collect and tabulate information concerning the wells that have been sunk in the interior was made by Mr. T. K. Abbott, P.M., and the results published in the Journal of the Royal Society, New South Wales, 1880. The wells there described are all situated in the Liverpool Plains district, a small district just on the edge of the great western plain and partly among the spurs of the great dividing range. If such work had been done for the whole of the western country it would be of immense value now. Mr. Abbott says :—“ From the sameness of the western country, it may possibly happen that what is true of Liverpool Plains may be true of the rest of the Colony; and this supposition, I find, after making due allowance for the proximity of the great dividing range, is supported by the information which I have been able to collect in the last few years in reference to wells bored or sunk on the Darling and its tributaries. Of eighty-nine wells described by Mr. Abbott in the watershed of Cox's Creek and the Mooki River, seventy-three bottomed in sand or gravel with abundance of fresh water, six in clay with salt water, eight in rock with water hard to brackish, one in sand with water bitter, and one in rock with water good. It must not be supposed that this number (eighty-nine) represents all the wells sunk in a given area of country, as there would be no record of many of the failures, while the successes would be always there to be seen ; but I think the main facts brought out will be found to be generally true of all the western country, though further west and away from the main range the proportion of successes to failures becomes gradually less. The most important fact brought out by Mr. Abbott's paper is that, on Liverpool Plains, the sand beds are the water-bearing strata. The great well at Booroora, between the Narran and Mooni Rivers, which gives an inexhaustible supply of perfectly fresh water (described by W. E. Abbott, Journal of the Royal Society, N.S.W., 1880), and all the other good wells in the most widely separated parts of our western plains, have their source of supply in the sand drifts. The Government borings, as far as I have seen accounts of them, seem to support the inference that these sand drifts are the only sources of fresh water in the west. In many cases the water-bearing sand beds are so fine-grained as to make it difficult, if not impossible, to keep wells or tubes from filling up—generally finer far away from the main range than close to it. These sands are interstratified with the saliferous clays at all depths, are not always quite horizontal, though never, as far as I have seen, very much inclined, and come to the surface in many places. That the fresh water passes from the surface through these sands, and has by reason of their permeability dissolved out of them the greater part of the soluble salts which they in common with the clays may have originally contained is, I think, tolerably certain. Probably these sand beds are not continuous over any large area of country included in the western plains, nor are they likely to be all connected with each other; but in those that contain fresh water there must necessarily be some connection with the surface from which they obtain fresh water, and with some outlet, either through the rivers or underground to the sea, by which the soluble salts are carried off, or have been carried off in the past. If this were not so, the water contained in the sands as it is in the clay beds, where it has been imprisoned by the impermeability of the strata, would be salt.

There must have been for a long time a tolerably free circulation of water through the strata where fresh water is now found. It is shown in Mr. Abbott's wells of Liverpool Plains, that in every one of them where water was found in the clay it was salt, and I think at least five out of six wells sunk further west on the Darling to a depth of 100 feet or under reach salt water. In one case, I knew of nineteen wells sunk on one station, and only one reached fresh water. Of course if we go deeper the chances of striking fresh water are increased, as the sand-beds are numerous, and when we reach one through which there is a free circulation of water it will be found to be fresh. It has been held by some that the missing portion of the rainfall passes down through openings in the ground or permeable strata to an underground lake or series of lakes, and there remains without any outlet; but a little consideration will show that such a lake, if it were possible, would have the same character as if situated on the surface without any outlet. It would be salt or bitter, as the soluble salts would be dissolved out of the saliferous clays and carried into it. Looking at the quantity of salt water found in every part of the interior of New South Wales, the saline nature of the vegetation, and the numerous salt springs which break out along the banks of the Darling River, it seems to me that the only possible explanation of the fact that fresh water is found anywhere underground is that, in the strata in which it is now found, there has been for ages past a current flowing through, with some means of escape, whereby the soluble salts have nearly all been dissolved out along the line of drainage and carried away. Where the water is found, as it is so often in enormous quantities, heavily charged with soluble salts, we may fairly conclude either that it has no such outlet, or the flow in past ages has not been sufficient to dissolve out and carry away all the saline constituents of the soil. Supposing the above deductions to be true, it will be seen that the chances of obtaining a supply of underground fresh water are great, and the numerous mud springs found in so many places all through the Darling country should strengthen our expectations. These mud springs are evidently caused by the water under great pressure, and would be strong springs of fresh water if it were not for the nature of the overlying clay, which, instead of allowing the water to force a way through, dissolves into thick mud and rises with it. I have before suggested that pipes might be sunk through these mud springs to the bottom, and water obtained in this way. The fact of the water coming to the surface at all through the clay shows that the water-bearing strata at that particular point cannot be situated very deep.

The pipes would, I think, sink by their own weight, and if, as we may reasonably suppose, the source of supply is a sand bed, when this was reached the water would rise through the pipes above the surface. Of course it would be necessary to clear the mud out of the pipe, or prevent it from entering until the water-bearing strata had been pierced. By filling the pipes with water as they were pressed down the hydraulic pressure of the water would, perhaps, keep the mud out, more particularly if the pipes were filled to some distance above the surface so as to obtain a good head of pressure against the mud. For the purpose of watering stock, or supplying towns, there can be no doubt that artesian or ordinary well water will be of great value, being so much more permanent than any surface supply; but for the purpose of irrigating and cultivating the western plains of New South Wales, I do not think in the present state of the Colony, or until our population has reached at least 20,000,000, the question is worth discussing. The cultivation of the soil is only carried on to a very limited extent in what in our new Land Bill are called the Eastern and Central Divisions of the Colony, and it is certainly unreasonable to suppose that in the far west any set of men will be found foolish enough to engage in a kind of cultivation in which the expenses would be tenfold greater, and the cost of getting produce to market increased in the same ratio. Wells of some kind are almost a necessity on any large station situated on the western plains, because though water can be conserved in tanks or dams to last for a very considerable time, perhaps even as long as three years, yet we cannot be sure that over small areas droughts during which no water will run into the tanks may not last even longer than this, and in that case the only chance of keeping any portion of the stock on the station would be in the possession of some good wells. I would certainly advise every station-owner to sink or bore some wells if there be any reasonable prospect of success; but I am quite sure that if any squatters or intending squatters were to attempt to water the dry back blocks by wells only, they would in nine cases out of ten be ruined before they got any returns. In every part of the world the search for artesian water has been a costly and uncertain process; and though I think the chances of obtaining it are as good in the interior of New South Wales as anywhere, still I am of opinion that the main supply for ordinary watering purposes must be by the conservation of surface water. As time goes on the experience gained in particular localities will make well-boring less a matter of uncertainty, and wells will become more and more numerous, each successful artesian well bored giving adjoining holders a better chance to estimate the probabilities of success and cost in that particular locality; but it must by no means be forgotten that nothing is more common than for bores to be put down within a few hundred feet of each other (as has been the case in the town of San Francisco), and some will give powerful streams of artesian water, while others, though sunk far below the level of the source of general supply, will be perfectly dry.

If, as I suppose, the underground fresh water of the interior of New South Wales is contained in the sand-beds of a lacustrine or inland sea formation, out of which the soluble salts have been dissolved, the chances of obtaining artesian water, or water that will rise within easy reach from the surface, are unusually good; but yet I would say to those who are engaged in the enterprise of stocking the dry country, in the words of the wise councillor of Queen Elizabeth, "above all things it is necessary that ye hasten slowly."

Conservation of Surface Water.

There are two ways by which surface water in the interior of New South Wales may be stored: either in the natural watercourses by means of dams and weirs, or, where there are no suitable watercourses, by leading the water which falls on a hard surface through drains into tanks excavated below the surface level. The first method has not been very generally applied, as small watercourses suitable for such a purpose are very scarce in the western plains. As I have before remarked, the tributaries of the Darling resemble canals rather than rivers. We may follow their courses for hundreds of miles without finding any creeks flowing into them; and though few, if any, can be said to be permanently running streams, yet immense bodies of water pass down them in flood-time from the mountains. What are called temporary dams are sometimes made in some of them when a fresh has nearly run past, and in this way considerable quantities of water are stored until the next fresh carries away the embankment. Overshot dams of timber have also been tried, but have, so far as I know, been always failures, and the reason is not far to seek. Such a thing as a solid rock foundation is unknown, and the fine clay through which all these rivers flow is so easily and rapidly excavated by running water that the existence of an overshot dam is short and precarious. It might be possible for a skilful engineer to construct an overshot dam of timber with a clay foundation in such a way that it would be permanent, but the expense and risk would be too great for any lessee to incur. Quite recently it has been suggested that weirs and locks should be placed in the Darling at such distances apart as would render the river permanently navigable, as well as throwing the water back a considerable distance in all the main tributaries. For such a national work as this both the necessary money and engineering skill might be found, but I cannot help thinking the difficulties have been very much underrated by the engineers who have discussed the question. First, the foundations of the weirs in almost all cases would be in clay, which is very easily washed out by flowing water, and the ends at both sides of the river would have to abut against banks of similar clay. Next, for scores of miles along the banks of all these inland rivers there is no stone of any kind, and timber suitable for piles is very scarce. But the greatest difficulty which I see would be to prevent the rivers from completely changing their courses and leaving the weirs high and dry. All along the course of the Darling at some distance back from the river, sometimes as much as 20 or 30 miles, there are shallow watercourses called warrambools, along which the flood-waters pass in wet seasons. One of these warrambools, north-west of the Darling above Brewarrina, runs parallel to the river for more than 100 miles before returning into the main channel. It seems probable to me that if any serious obstruction were placed in the Darling River, it would totally change its course, or change it in many places, returning to and leaving the main channel, as these warrambools offered a freer course. Three or four years ago, I saw an earthen dam which had been placed in the course of the Narran, and raised above the level of the banks, in the expectation that the river would flow out on the plain and return to its course below the dam. Instead of doing this, the river took a new course; and though when I saw it the dam had only been made about seven years, the new channel was quite as deep as the old one, and looked as if it had been occupied by the river for ages. Knowing that in many places large areas of very valuable country are situated more than 100 miles from any watercourse, it will be seen that the western plains cannot generally be watered by dams or weirs in the natural watercourses. There can be no doubt, I think, that a material alteration in the average flow of the western rivers will be caused by stocking the whole country, more particularly with sheep. The difference between stocked country and that which has never been stocked is apparent even after a few years. The surface becomes firmer, and water runs where it never ran before. The habit which sheep have of travelling in single file soon cuts out a track a few inches deep, and wherever these tracks happen to have the same direction as the fall of the country, the water is concentrated when it rains, and a small channel cut out. The accumulated effects of this process over an immense area of country must in time cause an appreciable increase in the quantity of water carried off by the main drainage channels; and squatters have informed me that in the Bokhira and other channels, in the delta of the Ballonne, it does not now take half the amount of rain to put water in the rivers that it did thirty years ago, just after it was first settled.

Next, we come to the method of watering dry country which is most common,—I mean by means of excavated tanks and drains. This plan has come into very general use in the last ten or twelve years all through the western interior, and there is much to be said in its favour. These tanks are made of various slopes, sizes, and depths, and there can be no doubt there is much yet to be learned as to the principles which are most conducive to success. Excavated tanks have many advantages over dams and wells, and squatters have been quick to see those advantages. No doubt wells would be far superior; and artesian wells are above everything else if they could only be bored with a reasonable certainty of success, and at an expense on an average, taking successes with failures, of not more than double the cost of a tank to water the same area of country. But this measure of success has not by any means been yet attained in any part of the interior of New South Wales; nor do I think it will be attained for many years, or until a long series of experiments have been made. Dams must be made where the natural features of the country are suitable, and the choice in this respect is so limited that they can never become a main source of supply in the west. The idea of storing the water in the ranges and carrying it out for hundreds of miles across the plains is far too expensive, unless we had a vast, half-starved population like that of India, or China, with only the bare means of subsistence, living from day to day in the imminent fear of starvation if the rains failed,—and this state of things, I trust, is far from us. If it should ever come in Australia, with our very uncertain climate, and the absence of any snow-fed rivers, wholesale death from famine in some part of the continent would be a thing of almost annual occurrence. With excavated tanks the advantages are, first,—the choice of position is much more extensive than with any other method of obtaining water in the western country, and the position of a watering-place with reference to the surrounding country may make it of double or treble the value which it would otherwise have. Second, there is no danger from floods of the watering-place being destroyed at a time when plenty of water is available for conservation, as with dams. Third, and perhaps most important of all, it is possible to calculate beforehand the cost of watering a given area of country, and the amount of water that will be stored for a given sum. Knowing the average rainfall of any district, and how the rain generally falls, the number of acres required per sheep, the position of available sites for tanks, and the tenure and rent of a given area of country, it is possible to say, with a reasonable amount of certainty, whether it will pay to water and stock it or not; and this is an immense advantage in the investment of capital—it makes all the difference between legitimate speculation and gambling. In looking through the salt-bush country, it seems the greatest mistake that has been made by the average squatter is that of compelling sheep to travel over too great a distance for water. I have seen runs on the Darling where some parts of the paddocks were more than 10 miles from water, necessitating a journey of 20 miles if sheep went to the back for food. Of course in such a case the outside country is only available in wet weather or during the winter when sheep do not require much water. It may, I think, be laid down as a principle that in no case should sheep, if we expect to make the best of our country and our sheep, be asked to travel more than 6 miles in search of food—that is 3 miles out from water and 3 miles back. From my own experience, I feel confident that if the western plains were by any means watered so as to place sheep in this position of not having to travel more than 3 miles back with only the same amount of food available, 50 per cent. more sheep could be depastured in the interior of New South Wales. A little consideration will show with mathematical certainty that this must be so.

There is only a certain fixed quantity of force or life-sustaining power in the food available, and if in addition to sustaining the vital functions the sheep has to find sufficient energy to carry him daily over 15 or 20 miles of country, he must either consume more food or die. If we avoid the necessity for travelling more than is sufficient to maintain health, all the available food may be devoted to sustaining the vital functions. I believe the mistake of making the paddocks too large and the watering-places too far apart arises from the attempt to spread a small capital over a large extent of country, when it would really pay to concentrate it. The capital sufficient to make the necessary water so as to give the sheep on our inland pastures a fair chance would no doubt be very large, but still I think, after looking into it carefully, it would pay if squatters could venture to make the expenditure. The best kind of tank which has yet been made is that in which all the material excavated is used in the shape of an embankment for the storage of water above the surface. A subsidiary tank is made close to the main tank, and connected with it by means of a pipe, which can be closed when the main tank is full to surface level, and the water must then be pumped from the tank over the embankment, to be stored above the surface in the main tank, run out again from above the surface by means of a syphon and pumped from below for the use of stock. A puddle-gutter, which is simply a trench 6 or 8 feet wide and carried down to the firm impermeable subsoil, to be afterwards filled up with clay from the excavation, should always be made along the line where the embankment is to stand. All the drains from the catchment area or watershed are led into the subsidiary or silt tank; and one advantage of this is that the silt carried down will to a large extent be deposited in the outside tank. But the clays of the western plains are so finely divided that, in spite of all that can be done, a considerable quantity will pass into the main tank. So fine are these clays that clear or colourless water, except what is caught off the roofs of buildings, is unknown in the back country. From the extremely slight fall in the country, it is often almost impossible to say which way water will run; and I have frequently seen tanks so placed that the water ran away from instead of into them. I believe that if accurate levels were taken with proper instruments, before deciding on the position in which tanks are to be placed, it would be found that available sites are much more numerous on any given area of country than is generally supposed, and of course the mistake above mentioned would be avoided. The curvature of the earth being about 8 inches to the mile, and the slope of the country in many places out west about the same, it is of course necessary to take this into consideration in looking for a sufficient slope to cause water to run. The cost of excavation is, on an average, about 1s. per cubic yard; and such a tank as I have described, with an excavation in the main tank of 10,000 yards and in the silt tank of 1,000 yards, would cost, when finished, with drains and all complete, about £800. Excavations of less than 10,000 yards are only of use in good seasons, and are utterly valueless in times of drought: they are in fact mere traps, inducing men to stock up while the seasons are good, and leading them ultimately when drought comes to inevitable ruin. Such a tank as I have described may be made to hold in the excavation and above the surface within the embankment about 6,750,000 gallons of water, about three-fourths of this being above the surface. It would be available if situated about the middle of a paddock 6 miles square in first-class country, which would carry one sheep to 2 acres, for watering about 11,000 sheep without requiring them to travel more than 3 miles out from water. Evaporation at 5 feet per annum would remove something more than 2,800,000 gallons, leaving 3,900,000 gallons for the use of the sheep for one year. Eleven thousand sheep at one gallon each per day would use a little over 4,000,000 gallons.

It will be seen from this that a tank such as I have described, though of at least four times the capacity of most of the tanks in the western country, would not carry the number of sheep that could be watered at it if situated in first-class country through one year of drought; but as sheep drink little or no water in the winter, we may estimate such a tank as good for somewhat more than a year—possibly a year and a half. Droughts of one year are not at all uncommon, and droughts of three years have been known, if we are to believe old settlers. To carry 11,000 sheep through a drought of three years would require a tank of 20,000 cubic yards excavation, made in the same way as the one above described. These are my reasons for saying that some wells should be made if possible on every station as a last resource, and as the only means of keeping a remnant of the stock on the station if no rain sufficient to fill the tanks should fall for a longer period than three years. For my own part, in spite of all we hear from old settlers, I do not believe there ever has been a period of three years during which over any considerable extent of country there was no rain or storms sufficient to fill a tank with a good hard catchment area. In nearly every part of the western plains, when we get clear of the spurs of the dividing range, the soil is what tank-makers call good holding ground—that is, it is impermeable to water; and this arises, I think, from the extreme fineness of the particles and the homogeneous nature of the clay. There are no veins of gravel such as we find in the more broken country, and the whole appearance of the formations indicate a sameness continuing over long periods in the conditions under which they were deposited. If a tank is not quite watertight at first, the very fine sediment carried in with the water will generally make it so in time, more particularly if the slopes are not too steep. In watering dry country, it must not be forgotten that a tank will water a given area of country according to the capacity of the tank, but the number of stock capable of being watered at any tank will depend on the quality of the country. For instance, the tank which I have described would water on good country capable of carrying a sheep to 2 acres, 11,000 sheep, and they would not have to travel more than 3 miles back from water; but if the country will only carry a sheep to 4 acres, then, with like conditions, it will only water 5,500. Of course there will be more water available after deducting for evaporation, but even allowing for this, the expense of watering sheep on dry country becomes absolutely greater the poorer the country is. I have used Mr. Russell's estimate of the rate of evaporation in the interior, and placed it at about 5 feet, but I cannot help thinking that in a tank protected by the banks, and with a sufficiently large body of water to prevent the temperature from rising very much during the day, the evaporation is even less than this. I have no exact measurements to support this opinion, but it is supported by the numerous instances which have come under my notice of comparatively shallow tanks holding out through long periods of drought. Seeing that the chief industry of the Colony, and what must continue to be the chief industry of the interior for many years to come, is so vitally concerned to know how much water it is necessary to store to last through even an ordinary drought, and that opinions differ so widely on the question of evaporation, it would not be too much to ask the Government to settle the question. The usual plan of exposing a shallow vessel of water above the surface is of no value as a guide to settlers. If a 400-gallon tank were sunk a few feet below the surface, and the evaporation noted daily for one year, it might be of some value, but even then I think it would show more than the real evaporation from a tank with a large body of water in it. From the moment water runs into a tank a process of silting up begins, which must sooner or later fill the tank. No matter what care is taken, some silt will inevitably pass in with the water. It may take a long time, but still it is only a question of time how soon the tank will require re-excavating. If stock are allowed to walk into the tank for water, this process will be comparatively rapid, and a good tank may be destroyed in a very few years, so that there can be no doubt the water should in every case be drawn out for stock. Of course, in estimating the cost of watering dry country, the time for which a tank will last, or the rate per annum at which it is likely to silt up, would be an item of considerable importance, and I have endeavoured to come to some conclusions on the subject.

I find, however, that the amount of silt carried in varies so indefinitely with the nature of the watershed, the way in which stock are watered, and the amount of care exercised, that to lay down any rule would only be to mislead. To clean out an old tank which has been silted up is a work of very great difficulty, for long after the water has dried out the extremely fine mud remains in a semi-fluid state, incapable of being shovelled, and even after the surface has become dry the mud underneath is so soft that it is impossible to take horses or teams of bullocks with scoops into the tanks. For these reasons, it will be almost if not quite as cheap to excavate a new tank as to clean out an old one which has been silted up. Another source of difficulty would be the necessity for allowing the tank to dry out, which could not be done if the country were fully stocked, without first providing some other way of watering or removing the stock.

Thinking over this matter, and seeing its importance in the future as the country is becoming overspread with excavated tanks, which only in a few cases have yet had time to silt up, it has seemed to me that it might be possible to clear out the silt and even materially to deepen and enlarge the tanks while they were full of water; and if experience gained in other places is borne out in this instance, it might even be done more cheaply than excavating in the first place. In the hope that some one will test it practically, I will make the suggestion. The method I would suggest is to excavate the silt while the tank is full of water in a wet season. Silt is removed from a depth of 20 feet of water in harbours and carried out to sea at a cost, I believe, of less than 4d. per yard; and it was found in excavating the Suez Canal, that, after the water was let in, the bottom of the canal could be dredged out for about one-third the cost of removing the dry earth. On the Panama Canal dredging machines are now being used, by which the silt is raised in the usual way by means of buckets on an endless chain and then passed into pipes through which it is dumped at some distance from the bank.

Knowing these things, it seems that it should be possible to construct a small dredging machine, in parts, so as to be portable, put it together on the station or on the tank, and then dredge out the silt and as much of the clay as was soft enough, and convey it over the bank in a wet time when the tank was not immediately required. Of course only one machine would be necessary for hundreds of stations, as the work could be done by contract at so much per yard, and there would be no pressure to get the tanks all done within a limited time. No new invention is required, but only an adaptation of a known process, which is a much simpler matter. If we have to depend for many years to come, if not always, chiefly on excavated tanks—and I think this is pretty certain—these tanks must be made very much larger in the future than they have been in the past, and some means must be found to make them more permament. I offer this suggestion as a possible way of attaining these ends.

The conclusions which I would deduce from the foregoing facts and arguments are:—That the interior of New South Wales is of salt or bitter-lake formation—in fact the deposits from an inland sea, resembling in many ways the formations now being deposited in the Caspian depression. That there is probably in the sand drifts or beds of loose sand that are interstratified with the clays a large supply of fresh water which will rise above or near enough to the surface to be available. That in the interior of New South Wales fresh water is only found in any quantity in those strata through which for ages past there has been a sufficient flow of water to wash out and carry away the greater part of the soluble salts with which they were originally charged. That, owing to the natural conditions of the great western plains, and the scarcity or absence of water-courses of any kind in much of the country though the flow of water in these channels where any are found, may be materially increased by the stocking which is now going on, watering by dams or weirs can only be a method of minor importance as far as the greater part of the country is concerned. That though in the interior of New South Wales the probabilities of obtaining supplies of artesian water are as great as anywhere else in the world, still, as the search for such water has been at all times and in all places a costly and uncertain process, colonists in the interior will have to depend mainly for their water supply on excavated tanks, and it is highly important that these tanks should be made much larger than they have been, and kept clear of silt. In view of this, it seems a pity that our new land law directly discourages improvements of a permanent character in the Western Division of the Colony, for without such improvements these plains can never be fully utilized. The money which has been spent in water improvements is only a tithe of what must be spent before these plains can be fully stocked.

[Map.]

Diagram I.

SECTION FROM SYDNEY to WILCANNIA

A New Self-registering Anemometer and Pluviometer for Sydney Observatory.

By H. C. Russell, B.A., F.R.A.S.

[*Read before the Royal Society of N.S.W., 17 December, 1884.*]

The first Self-registering Anemometer and Pluviometer in Sydney Observatory was made and set to work in 1863, and, with slight repairs, this instrument has done its work ever since; but the wear and tear of twenty-one years has told so severely on some of the wheels, more particularly the one into which the screw-spindle of the cups works, that it became necessary either to make extensive repairs or a new instrument. As repairing the old one would have stopped the record, it was determined to have a new one made embodying some ideas which experience had suggested. As these may be useful to others, I have determined to explain to you the more important parts of the new instrument.

Owing to the fact that the Time-ball and shaft are on the only available tower, it was necessary from the first to elevate the vane and cups above them; otherwise the wind eddying round the shaft affected the cups and vitiated the record; but as this required the cups to be 17 feet above the leads, there was some difficulty in bringing the motion down to the registering part or cylinder. In the old one this was effected by reducing the rate of motion of the cups, by screw and wheels, until the last wheel which worked the chain turned once for 560 revolutions of the cup, or 4 miles of wind.

In the new anemometer, a brass box $6 \times 4 \times 3$ inches is placed on top of a tube 3 inches in diameter, and extending 17 feet above the leads of the tower. Into the top of this box a piece of inch brass tubing 12 inches long is fixed, and serves to support the upper bearing of the $\frac{5}{8}$-inch tube that carries the vane. The lower bearing of this is attached to the side of the box, and a bevel wheel is attached to the lower end, and gears into one of equal size on a horizontal axis. On this is a wheel with a V-shaped groove.

The cups are 4 inches in diameter, and set 4 feet from centre to centre; they work on a spindle inside the vane spindle, the top bearing being of bone and the lower one a hardened steel cup, larger than the end of the screw spindle that works in it, so that it serves as oil-cup and bearing. This screw spindle works a wheel of fifty teeth, the axis of which is a screw working into a wheel of fifty-six teeth. The axis of this wheel carries a wheel with a grooved rim and a light arm which is free to move round it; a spring keeps this pressed up to the wheel; the end of this arm projects beyond the edge of the groove, and to it the wire working the velocity-pen is attached in such a way that it hangs in front of the groove, and when the wheel is turned round by the motion of the cups, and the pin in the side of it catches the arm and carries it round, the wire falls into the groove and is wound up one turn on the wheel. As the wheel continues to revolve, it brings the arm against an unlocking part which throws it off the pin, and the weight of the wire at once pulls it round to the starting-point. For each 20 miles of wind, therefore, the wire is drawn up 4 inches and suddenly let go.

In placing the cylinder, a convenient position for reference at all times was considered of paramount importance. The old one being 50 feet above the ground, in the top room of the tower, was very inconvenient, and it was determined to put the new one on the ground floor, but as this was 58 feet below the leads and 75 feet from the vane and cups, it became necessary to devise some means of carrying the motion down which should give the least friction, and at the same time be rigid enough to convey every oscillation of the vane. A suitable material for this was found in steel wire, and it was applied in the following way :—

Holes having been cut in the four floors, a wire was taken up to the grooved wheel on the horizonal axis of the bevel-wheel; passed one and a half times round it and then down the tower again, where it was passed through the pulley on a weight of 5 lb., and then fastened to the other end, thus making a double length of wire from the vane to the floor, *i.e.*, 75 feet, arranged for endless motion, so that it does not matter how often the vane turns round, it will not come to the limit of motion allowed by the wire. This motion was made to record itself on the vertical cylinder by attaching the wire to a very light frame made of $\frac{1}{8}$-inch brass tubing, and carrying four pencils. The means of attaching this to the wire is a screw clip, and if the pen frame is carried over a space of 8 inches, that is two complete revolutions of the vane, it is necessary to disconnect it and make it fast again,—an operation taking only a few seconds. This arrangement is even more satisfactory than I anticipated, for I feared the elasticity of such a length of wire might allow the vane to move without moving the pencil, but it does not,—the strain of the weight is sufficient to keep the wire straight, and as it has no friction to overcome except that of the pencil and frame and the axis of the bevel-wheel, it moves with the greatest ease and responds to every motion of the vane.

The cylinder for receiving the record is on a vertical axis, and is 8 inches in diameter and 10 inches long, and is turned by the clock at the rate of 1 inch per hour; but the clock is provided with an additional wheel which can be thrown into gear in a moment, and which then causes the cylinder to revolve at the rate of 2 inches per hour. This is only used for heavy storms.

The top and bottom bearing of the cylinder project beyond it $1\frac{1}{2}$ in. and form the guides for the pencil carriage just described, as well as for that which carries the pen showing the velocity. I have already described the motion of the parts of the velocity gear for 20 miles of wind, and the wire there referred to passes right down the tower by the side of the direction wires and is attached to a light frame similar to that used for the direction, and the record is made by a glass pen. This frame and pen serve to pull the wire down when the click is unlocked at the top.

It will be seen from what has already been said that the motion of direction pencils and velocity pen are in straight lines; and it is only necessary to add that the points record in line so that both point to the same hour line at once. The direction pencil accords on the upper part of the paper using 4 inches and the velocity pen records on the lower 4 inches, and the spare pencils do not catch on the pen because, when passing it, they are riding on the guide which lifts them off the paper except when over that part on which they have to record.

The rain is collected on the tower 65 feet above the ground, and is carried by a pipe thence to the top of a vertical tube 2 inches in diameter and 45 feet long, and it drops from the pipe into the middle of the tube, and thence to the bottom without touching the sides, so that little or none is lost between the receiver and the recording parts. When the rain reaches the bottom of the tube it is caught in a small glass funnel fitting the tube, and thence led into the tip bucket which happens to be uppermost. These buckets each hold 0·20 in. of rain, and are fixed bottom to bottom on an axis in such a way that when standing upright they are not balanced but tend to fall over. This tendency is prevented by a catch which holds them upright until 0·20 in. rain has fallen in. As the rain accumulates, the bucket which is at the end of a lever and held up by a spiral spring, descends, pulling down with it the pen frame which records the rain, and is similar to the other two. By the time the bucket has received the 0·20 in. it has descended far enough to bring the catch on to a stud and unhook itself. Its want of balance instantly takes effect. It falls over and the momentum carries it 180°, or until the other bucket has taken its place to receive the rain and follow the same motions. When the water is thrown out, the spring lifts up the pen-frame ready to begin again; so that the rain record appears as a series of lines more or less like the teeth of a saw according to the rate of rainfall. The pen moves 2 inches for 0·20 in. rain. The rain so thrown out by the machine is received in a bucket and measured when the paper is changed, *i.e.* once a day. I have already spoken of the ease with which the direction-parts work, and may add that the cups which are, as just stated, 75 feet above the ground, will go on recording one or two miles per hour, when there is perfect calm on the ground and amongst the trees 20 or 30 feet high. This favourable result has been attained by making the cups as thin as possible and the arms supporting them of brass tubing,—the gross weight of cups, arms, and screw-spindle, being only 30 ounces. The old and new anemometers have some time been working side by side, and in very light winds the new one sometimes registers 10 per cent. more than the old one, but in a good breeze, 20 or 30 miles per hour, there is practically no difference in the number of miles recorded.

The design for this instrument includes a record of the pressure of the wind, and also an electric pen which, under a signal from the standard clock, will record on the paper each hour as a check upon the time of its own clock, but these parts are not yet made. One valuable property of this arrangement was not seen in the design, viz., that the position of the join in the wire showing the direction keeps a record of the number of whole revolutions the wind has made in one direction, and in four months it has not made one complete turn backwards, but several times the vane has "hacked" 90°, and once or twice 180°, but in 120 days it has turned in the normal direction $12\frac{1}{4}$ times, or once in ten days.

On the development of the Monotremes and Ceratodus.

By W. H. Caldwell, M.A., Balfour Student in the University, and Fellow of Gonville and Caius College, Cambridge.

[*The Royal Society of N.S.W., 17 December, 1884.*]

*** The following abstract is from notes of an extempore explanation by Mr. Caldwell of the specimens and embryological material recently obtained by him, and exhibited to the members of the Royal Society of N.S.W. on December 17, 1884.

Mr. Caldwell, in introducing his remarks, described the circumstances under which he had been led to the Colonies. It was three years since his master, the late Professor Balfour, F.R.S., suggested to him, when still his pupil, that it might be possible for him to leave his university for a period of two or three years to obtain the necessary material in connection with this matter. On Professor Balfour's death, the memorial which was subscribed for in England and all over the world made this possibility much easier to him (Mr. Caldwell), for whilst he had left his post in Cambridge he was still attached by holding the Balfour Studentship. When he came out, two years ago, he found very great difficulty in getting specimens of the platypus or echidna. Whilst every one told him it was to be obtained in this river or in that, he generally found that the skin-hunter had been before him. The first few months of the present year he spent in obtaining marsupials, such as kangaroos, opossums, and native bears. A knowledge of the early stages of the marsupials was considered in the Colonies to be universal property, and every one considered himself qualified to tell him how the kangaroos produced their young. As a matter of fact, the scientific world knew already that the kangaroo produced its young in the same way as the rest of the milk-giving animals. That had been proved by Sir Richard Owen nearly fifty years ago, whilst the early stages of the development which formed the basis of modern morphological work upon the subject had not been found. Although no naturalist expected to find the kangaroo growing on the teat, no one had found the stages from impregnation up to birth of the young. This material, however, he had obtained in the last months of 1883 and the first few of the present year. He had made a number of expeditions all over New South Wales in search of marsupials, and in April of this year he went to the Burnett River, in Queensland, where the ceratodus is found. He had remained there since that time, and whilst he obtained there the ceratodus, he also got in the same district the early stages of the ornithorhynchus and the echidna or porcupine.

He then said a few words about his camp. He found it was useless to live on the stations or far away from the river if he hoped to observe the ceratodi. It was four months before he found any trace of their mode of depositing their eggs in the river, till he found it by a chance which could only have occurred by his camping on the bank of the river. His material for observation was obtained by an aboriginal camp, he having at one time as many as fifty aborigines at work for him. They got the porcupines for him, and some he employed searching weeds for the ceratodus.

He proposed to describe the outlines of the embryology of the three main groups of animals which formed his scheme of work in Australia, and the embryology of which was, in the case of two, entirely unknown before, and in the case of marsupials unknown in the early stages. To make the matter clear to those present, he asked them to listen to a few elementary tenets he would state. Many present might think that only the hen and similar creatures laid eggs, but, as a matter of fact, all animals except the very simplest, reproduced sexually by ova. He then entered upon an explanation of the structure of the egg, illustrating his remarks by diagrams on a black-board. What he would state with regard to his investigations were not theories but were facts, and were consequently not open to argument. Within the last few weeks he had received several letters from people denying that the platypus laid eggs, and they wanted him to argue about it. That was impossible. He stated a fact; it was possible to disbelieve it; but, being a fact, it could not be argued. The interpretation of these facts he was not prepared to add, as he had come there with the simple intention of exhibiting a few specimens, and not with the intention of entering into any theoretical consideration derived from these facts.

Starting with the marsupial animals, he would go on to describe the ceratodus and then the monotremes. Marsupials were found all over Australia, and were in a way characteristic of it, as it was the only place where they had their habitat except in South America, and reaching to North America, as far as Florida and San Francisco; but they were essentially Australian. They were milk-giving animals, the same as the higher mammals such as dogs and cats; but the difference between the marsupials and the higher mammals of the old world was that the young were born at a very early stage, and this fact carried with it a series of differences in structure which were characteristic of marsupials. But on the whole the marsupials did not differ to any great extent from the ordinary mammals, such as the cat, dog, or sheep. The main difference between these latter and the marsupials was that the embryo in the uterus before birth had no vascular attachment to the walls. There was no blood nourishment passing from the parent to the young animal. The egg of the marsupial had, in common with that of the higher mammals, a very small amount of food yolk (holoblastic). He then, by the aid of diagrams, described the structure of the egg of the marsupial. But the marsupials had a peculiar arrangement of the membranes, though the development of the egg itself was not essentially different from the development of the higher mammals.

He then passed on to the development of the ceratodus. This animal was a representative of a series of animals which once were numerous in many parts of the world. At the present day there were three living representatives of this group of animals—the ceratodus, found in Queensland only, in the Mary and Burnett Rivers; the other, the lepidosiren, found in the Amazon; and the third, the protopterus, found in certain of the rivers of Africa. These three formed a class different from all other animals, inasmuch as they possessed gills, and had the form of a fish in an adult state, and at the same time they possessed lungs. The structure known in other fish as the air-bladder became in this fish highly vascular, and the aerated blood freshened by oxygen did not pass from the air-bladder through the system, but passed direct to the heart, and there they had the first indication of two chambers in the heart, and they had for the first time arterial blood in the heart of a fish. Blood was found in an arterial state in animals with lungs, but only in a venous state in animals without lungs. One of the chief objects in coming to Australia had been to study the development of the ceratodus. He went up to the Burnett River in April, and found that at that time the fish were ripe, the ovaries and testes being nearly developed; but it was not till the beginning of September that he found the first eggs of the ceratodus. He spent many weeks hunting, and, with the assistance of the blacks, turned up many hundred waterholes before he found the eggs. The eggs were laid upon the weeds. They were laid singly, resembling those of the common newt. The whole development of the ceratodus had a strong resemblance to that of the amphibians, and any one who had any acquaintance with the development of the newt would at once perceive the resemblance. These eggs were fertilized in the water in a similar way to some species of the newt. The eggs he found it very difficult to get. They were covered with an enormous quantity of gelatinous matter which required some special means to remove. He was eight days before he got a single egg out whole. When he succeeded in getting the early stages, it remained to rear them until they were practically identical with the adult fish. This was a very difficult task, as the enemies of the ceratodus were very numerous. There were two kinds of fungi which attacked the eggs. He put in crustacea to devour the fungus, but these in turn attacked the young fish when it emerged from the egg. He was three months, till near the end of November, developing the eggs. The living fish on the table had been hatched some weeks ago, but the hind legs were not yet developed. The development of the fins would probably yield important knowledge on embryology. The egg of the ceratodus underwent a complete segmentation similar to that of the kangaroo.

He then proceeded to describe the monotremata, namely—the ornithorhynchus and echidna. These, though differing from one another, were identical in structure, and were in every way similar animals. These two living representatives formed something quite as unique in its way as the ceratodus. They were both milk-giving, and both suckled their young. When he came out he had a strong belief that the ornithorhynchus and echidna produced their young in much the same way as the marsupials, and he thought last year he had confirmatory proof of this being so; but he found he was in error. He found in the uterus of the ornithorhynchus a cellular membrane, but it was probably only part of a ruptured egg. He then, with the aid of diagrams, described the stages in the development in the platypus, pointing out the large food yolk and *meroblastic* segmentation. He had found that invariably the female platypus had two eggs, and these left the parent at about the age of a chick thirty-six hours after the laying of the egg, while the echidna had usually only a single one. In both the egg, covered with its shell, was nearly the same size, viz., three-quarters of an inch in the long, and half an inch in the shorter axis. With regard to the echidna, he had not determined the exact age at which the young were born. That of the platypus he had discovered by a lucky chance. He happened to kill one which had laid one egg, and had the other on its way out through the passage, and the age of this egg enabled him to determine when the eggs of the platypus were laid. His series of monotremata would be made up in the early stages by the ornithorhynchus, and in the latter by the echidna.

These were the facts determined by his researches. But the research was still in its early stages. Years would elapse before the details of the development could be discovered and interpreted. So far the material had been only roughly examined, and it promised to produce, with the help of the instruments now at the command of the embryologist, great results. They might perhaps ask what, after all, these investigations were for. In the early days of Darwinism it was hoped to get a pedigree for every animal. This is still the object for which much excellent work is done. But now that all biologists are Darwinists, pedigree-hunting has gone out of fashion. The recognition that each living form has descended from some differently constructed ancestor is in itself a great step in advance. But there are further steps to be made, and it is by observing the minute differences between organic beings that the morphologist hopes to discover those laws which form the basis of his philosophy.

Mr. Caldwell, in answer to a question as to whether he had come to any conclusion with regard to what became of the embryo of the marsupial, and how it becomes attached to the mother's teat, said that the exact mode in which the kangaroo or other marsupial put the young to the teat was not of so much importance as the other facts. It had been observed by Professor Osborne, of America, who had seen the act, that the mother lifted it from the vulva to the teat. Marsupial embryos possess at birth a very large and sensitive tongue, which probably assists them in attaching themselves to the teat. At first the newly-born young were not attached to the teat at all. For a week or so after birth the shock of a fall is sufficient to detach the young one from the mammary gland. It was a few weeks after the first attachment that the lips grew over the extremity of the teat, but no connection actually took place between it and the mouth. By careful manipulation one could always extricate the lips of the young kangaroo from the teat. He had not personally observed how the embryo was actually moved into the pouch—he had not considered it of sufficient importance to waste any time about. He could conceive no difficulty in the lips or tongue of the mother kangaroo placing the young, which was at least an inch long when born, upon the teat. The question did not appear to him to be a matter of any importance—it did not form part of his researches.

The President conveyed the thanks of the Society to Mr. Caldwell for the interesting account of his researches and discoveries.

Mr. Caldwell states he is very anxious to find a large number of kangaroos, and would be obliged if any one knowing of a kangaroo drive in actual work, no matter in what part of the Colonies, would inform him of the locality.

List of Specimens placed on the table :—

Monotremata.

1. Series of early stages of Ornithorhynchus, from a few hours after fertilization to the newly laid egg, of about the stage of a 36-hour chick.
2. Series of early stages of Echidna, from just before laying to the newly hatched fœtus.
3. Various stages of young Echidna, from hatching up to 5 inches long.

Dipnoi.

1. Complete series of Ceratodus, from the unsegmented egg to hatching.
2. Stages of young Ceratodus after hatching.
3. Globe containing live Ceratodus, aged 1 month and 10 days from hatching.

Marsupialia.

1. Series of about thirty stages, from segmenting egg up to birth of *Phascolarctos cinereus.*
2. Ditto of *Halmaturus rufus.*
3. Specimens showing the arrangement of the embryonic membranes in *Macropus major.*

PROCEEDINGS.

PROCEEDINGS

OF THE

ROYAL SOCIETY OF NEW SOUTH WALES.

WEDNESDAY, 7 MAY, 1884.

ANNUAL GENERAL MEETING.

Hon. Prof. Smith, C.M.G., President, in the Chair.

The minutes of the meeting held on December 5th, 1883, were read and confirmed.

The Annual Report of the Council was then read, as follows :—

"In presenting its Annual Report, the Council has the pleasure to state that the Society's affairs continue to steadily prosper. The number of new members elected during the year was thirty, the Society lost by death six members, by resignation two, ten had to be struck off the roll for the non-payment of annual subscription, the election of three new members was cancelled on account of non-payment of the entrance fee and subscription, and two names were restored to the roll, making the total number of members on the 30th April, 1884, 494. The vacancy in the list of Honorary Members caused by the death of Dr. Charles Darwin was filled by the election of Mons. Louis Pasteur, M.D., of the French Academy of Sciences. Ottokar Feistmantel, Esq., M.D., Palæontologist to the Geological Survey of India, was elected a corresponding member.

"During the past year the Society has received 871 volumes and pamphlets as donations ; in return it has presented 309 volumes to various kindred Societies, as per accompanying list, to which the following names have been added during the year, viz :—The Royal Agricultural Society of England, the Institute of Chemistry, London ; the Bristol Naturalists' Society, and the Editor of 'Science,' Cambridge, Mass, U.S.A.

"The Council has subscribed to fifty scientific journals and publications, and has purchased 588 volumes, amongst the most important of which are the following complete series from the commencement :—The Philosophical Magazine of London ; Proceedings, Literary and Philosophical Society of Liverpool ; Old and New Sydenham Society's publications ; Monthly Microscopical Journal ; Royal Geographical Society, Journal ; Popular Science Review ; Quekett Microscopical Club, Journal ; Science Gossip ; Telegraphic Journal ; Photographic Society, Journal ; Geological Society of

Dublin, Journal; Journal of Telegraphic Engineers; Anthropological Society, Memoirs, Journal and Review; and the Ray Society's publications, at a cost of £342 3s. 3d.

"The following Societies and Institutes have been written to, soliciting such volumes and parts of their publications as are required to complete the sets now in the Society's library; and those names marked by an asterisk have either complied with the request of the Council or promised to do so as far as possible:—Baltimore, *Johns Hopkins University; Brussels, *Société Royale Malacologique de Belgique; Caen, *Académie Nationale des Sciences, Arts, et Belles Lettres; Calcutta, Geological Survey of India; Cambridge, *Philosophical Society; Dublin, Royal Dublin Society and Royal Irish Academy; Edinburgh, Botanical Society, *Geological Society, and *Royal Physical Society; Glasgow, Geological Society; Leeds, Conchological Society; Liège, *Société Géologique de Belgique; Liverpool, *Literary and Philosophical Society; London Physical Society, South Kensington Museum, and *Royal Astronomical Society; Madison, Superintendent of Public Property; Manchester, *Geological Society; Melbourne, *Government Botanist; Paris, *Société Zoologique de France; Penzance, Royal Geographical Society of Cornwall; Philadelphia, Academy of Natural Sciences and *Franklin Institute; Plymouth, *Plymouth Institution and Devon and Cornwall Natural History Society; Rome, R. Accademia dei Lincei; Salem, Mass., American Association for the Advancement of Science and Essex Institution; Washington, American Medical Association, Chief of Engineers (War Department), *Chief Signal Officer (War Department), Director of the Mint, *Hon. Secretary (Department of the Interior), *Smithsonian Institution, and *United States National Museum.

"During the past year six new Societies have entered into an exchange of publications, viz:—Royal Agricultural Society of England, Bristol Naturalists' Society, the Science Company, Cambridge, Mass., U.S.A.; the Botanic and Zoological Gardens, Singapore; Königlich Offentliche Bibliothek, Dresden; Verein für Erdkunde zu Dresden. And the following Societies, already on the list, have commenced sending their publications, viz.:—Académie des Sciences, Inscriptions et Belles Lettres de Toulouse, Société d'Anthropologie de Paris, Société d'Encouragement pour l'Industrie Nationale, Société de Géographie, Société Zoologique de France, Naturwissenschaftlicher Verein in Karlsruhe, Peabody Academy of Science, Salem, Mass.

"The Council reports that during the past year the mortgage upon the building has been reduced from £1,500 to £1,100; the amount subscribed to the Building Fund during the year was £100 16s., and the balance now standing to the credit of the fund in the Bank is £44 4s. 11d. The sum of £267 8s. has also been promised, on condition that the full amount of £1,000 be obtained necessary to secure the Parliamentary grant of £500.

"The Society's Journal, vol. xvi, for 1882, has been distributed to all members entitled to it; the issue was greatly delayed owing to the press of work in the Government Printing Office. Vol. xvii is already in type, and will be published very shortly.

"During the year the Society held nine meetings, including one adjourned meeting, at which thirteen papers were read. The Medical and Microscopical Sections have held regular monthly meetings. The Chairman of the Medical Section, at the preliminary meeting of the Section this year, announced 'that never during the history of the Section had its meetings been so numerously attended, and that the value of the papers read before it was attested by the fact that so many of them had been reprinted in the home journals.' At the Council meeting held on 13th December, 1883, it was unanimously resolved to award the Clarke medal for 1884 to Alfred R. C. Selwyn, LL.D., F.R.S., Director of the Geological Survey of Canada, and formerly Director of the Geological Survey of Victoria from 1853 to 1866.

"In response to the offer of prizes by the Society for communications containing the results of original research or observation upon given subjects, the following were received:—On the Chemistry of the Australian Gums and Resins, nil; on the Water Supply in the interior of New South Wales, six papers; on the embryology and development of the Marsupials, two papers; on the Infusoria peculiar to Australia, one paper. The Council, however, awarded no prize, as it was considered that none of the papers complied sufficiently with the published regulations. The good done must not, however, be measured simply by the essays sent in for competition. Attention has, by the Society's action, been drawn to the various subjects, as shown by the subsequent contribution of non-competitive papers to the Society, and by the fact that in certain cases it has caused the subjects to be discussed in the daily papers and elsewhere.

"The Council has since issued the following list of subjects, with the offer of the Society's bronze medal and a price of £25 for each of the best researches, if of sufficient merit. Series III.—To be sent in not later than September 30, 1884: No. 9. Origin and mode of occurrence of Gold-bearing Veins and of the associated minerals. No. 10. Influence of the Australian Climate in producing modifications of diseases. No. 11. On the Infusoria peculiar to Australia. No. 12. On Water Supply in the interior of New South Wales. Series IV.—To be sent in not later than May 1, 1885: No. 13. Anatomy and life history of the Echidna and Platypus. No. 14. Anatomy and life history of Mollusca peculiar to Australia. No. 15. The chemical composition of the products from the so-called Kerosene Shale of New South Wales. Series V.—To be sent in not later than May 1, 1886: No. 16. On the chemistry of the Australian Gums and Resins."

The following Financial Statement for the year ending 30 April, 1884, was presented by the Honorary Treasurer :—

GENERAL ACCOUNT.

Receipts.	£ s. d.	£ s. d.
To balance in Union Bank, 30th April, 1883		7 7 2
,, subscription from 1st May, 1883, to 30th April, 1884..	613 8 6	
,, entrance fees from 1st May, 1883, to 30th April, 1884	52 10 0	
		665 18 6
Parliamentary Grant on subscriptions and entrance fees, from 1st January to 31st December, 1883—£675 3s.—viz., half the amount		337 11 6
,, sale of Society's Journal		3 2 6
		£1,013 19 8

Expenditure.	£ s. d.	£ s. d.
By advertisements	22 3 6	
,, Assistant Secretary—12 months' salary to 30th April, 1884	200 0 0	
,, books and periodicals	342 3 3	
,, bookbinding	12 14 6	
,, corporate seal and press	14 18 6	
,, covering and packing exchanges and presentations to Foreign Societies	1 8 6	
,, delivering Society's Journal to members ...	4 17 3	
,, engraving illustrations for Society's Journal and Clarke Medals	16 5 6	
,, freight, cartage, Customs entries, &c. ...	14 14 0	
,, furniture and effects	10 10 0	
,, gas account	15 16 6	
,, housekeeper, to 30th April, 1884	10 0 0	
,, interest on mortgage £1,500	88 2 6	
,, insurance on building (for £4,000)	5 0 0	
,, insurance on books and furniture (for £2,500)	2 10 0	
,, Microscopical Section — Orthoscopic eyepieces for Microscope	6 6 0	
,, postage	33 18 0	
,, petty cash	15 2 0	
,, printing	28 2 0	
,, rates—City, water, and sewerage	34 8 0	
,, refreshments—general meetings	11 13 0	
,, repairs to premises	10 12 6	
,, stationery	61 18 9	
,, sundries	1 13 6	
		964 17 9
,, Balance in Union Bank, 30th April, 1884 ...		49 1 11
		£1,013 19 8

H. G. A. WRIGHT, Honorary Treasurer.
W. H. WEBB, Assistant Secretary.

Audited,—
W. G. Murray,
P. N. Trebeck.
Sydney, 2nd May, 1884.

BUILDING FUND ACCOUNT.

Receipts.

	£	s.	d.
To balance in the Union Bank, 30th April, 1883	189	13	11
,, subscriptions to Building Fund	100	16	0
,, Parliamentary Grant on subscriptions received from 1st January to 31st December, 1883, £153 19s.	76	19	6
,, rent of rooms from sundry Societies	76	15	6
	£444	4	11

Expenditure.

	£	s.	d.
By amount paid Savings Bank of New South Wales in reduction of mortgage	400	0	0
,, balance in Union Bank, 30th April, 1884	44	4	11
	£444	4	11

H. G. A. WRIGHT, Honorary Treasurer.
W. H. WEBB, Assistant Secretary.

Audited,—
W. G. Murray.
P. N. Trebeck.

Sydney, 2nd May, 1884.

STATEMENT OF ASSETS AND LIABILITIES ON THE 30th APRIL, 1884.

Assets.	£	s.	d.
To balance in Union Bank to credit of General Account ...	49	1	11
,, subscriptions due	99	15	0
,, rent of Hall, Senate of the University—two months due 30th April, 1884	6	13	4
,, books and furniture valued at	2,500	0	0
,, premises in Elizabeth Street—cost of purchase	3,525	0	0
,, balance in Union Bank to credit of Building Fund Account	44	4	11
	£6,224	15	2

Liabilities.	£	s.	d.
By Savings Bank of New South Wales—loan on mortgage ...	1,100	0	0
,, balance of assets over liabilities	5,124	15	2
	£6,224	15	2

H. G. A. WRIGHT, Honorary Treasurer.
W. H. WEBB, Assistant Secretary.

Audited,—
W. G. Murray,
P. N. Trebeck.

Sydney, 2nd May, 1884.

CLARKE MEMORIAL FUND ACCOUNT.

1884.		£	s.	d.
March 29	—To amount at fixed deposit in Oriental Bank Corporation (balance 29th March, 1883, £226 16s. 7d., interest twelve months at 6 per cent., £13 12s. 4d.)...	240	8	11

H. G. A. WRIGHT, Honorary Treasurer.
W. H. WEBB, Assistant Secretary.

Audited,—
W. G. Murray.
P. N. Trebeck.

Sydney, 2nd May, 1884.

The statement was adopted.

Messrs. E. L. Montefiore and P. N. Trebeck were elected Scrutineers for the election of officers and members of Council.

A ballot was then taken, and the following gentlemen were duly elected officers and members of Council for the current year:—

HONORARY PRESIDENT:

HIS EXCELLENCY THE RIGHT HON. LORD AUGUSTUS LOFTUS, G.C.B., &c., &c., &c.,

PRESIDENT:

H. C. RUSSELL, B.A., F.R.A.S.

VICE-PRESIDENTS:

W. A. DIXON, F.C.S.
Dr. W. MORRIS.

HON. TREASURER:

H. G. A. WRIGHT, M.R.C.S.E.

HON. SECRETARIES:

Prof. LIVERSIDGE, F.R.S.
Dr. LEIBIUS, M.A., F.C.S.

MEMBERS OF COUNCIL:

Hon. Prof. SMITH, C.M.G., M.D., M.L.C.
CHARLES MOORE, F.L.S.
ROBERT HUNT, F.G.S.
CHR. ROLLESTON, C.M.G.
W. J. CONDER.
P. R. PEDLEY.

The following gentlemen were duly elected ordinary members of the Society:—

Baynes, Richard B., Sydney.
Haswell, Wm. Aitcheson, M.A., B.Sc., Sydney.
M'Cormick, Alex., M.B., Ch.M., M.R.C.S.E., Sydney.
Mills, Walter Wallace, Sydney.

The certificates of three new candidates were read for the second time, and of six for the first time.

The names of the Committee-men of the different Sections of the Society were announced, viz. :—

Microscopical Section.—Chairman: G. D. Hirst. Secretary: F. B. Kyngdon. Committee: Dr. Morris, H. G. A. Wright, M.R.C.S.E., P. R. Pedley, and R. Fraser.

Medical Section.—Chairman: Dr. H. N. MacLaurin, M.A. Secretaries: Thomas Evans, M.R.C.S.E., Dr. Hurst. Committee: Dr. Fortescue, Dr. Brady, Dr. Shewen, Dr. F. N. Manning, Dr. Oram, and Dr. Craig Dixson.

Two hundred and ninety-five donations were laid upon the table.

The Hon. Professor Smith, C.M.G., &c., President, then read his address.

Mr. Russell (the newly elected President) briefly expressed his thanks for the great honour done him, which he said was for the third time. He trusted that the Society would progress faster than it had ever done before. The paper which they had in their hands showed that 494 names were on the roll, and it was probable that the limit of 500 would very soon be reached. He hoped that the doings of the Society in the future would be of such a character as to bring it into repute in all parts of the world. The Council invited the members of the Society to a gathering on the third Tuesday in June, to be held in that room.

A vote of thanks was passed to the retiring President and Office-bearers.

About fifty members were present.

WEDNESDAY, 4 JUNE, 1884.

H. C. Russell, B.A., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society:—

Skirving, Robt. Scot, M.B., C.M., Sydney.
Syer, Frank Weston, Sydney.
Townsend, G. W., C.E., Sydney.

The certificates of six new candidates were read for the second time, and of four for the first time.

The President reminded the Meeting that the reception would be held on Tuesday the 17th instant, at 8 p.m., and requested members having exhibits which they thought might prove interesting to the Society to deliver the same at the Society's House the day previous.

Forty-six donations were laid upon the table.

A paper was read on "Rain and its Causes" by Mr. EDWIN LOWE.

Mr. WALTER SHELLSHEAR, A.M.I.C.E., read a paper on "The Removal of Bars from the Entrances to our Rivers."

A discussion followed, in which the following gentlemen took part, viz.:—Messrs. J. Trevor Jones, W. G. Murray, and the Chairman.

Dr. LEIBIUS, on behalf of Mr. Mansfield, exhibited a peculiar scum taken from a water-hole near Campbelltown, which possessed the property of changing its colour from red to green, and *vice-versa*, at different hours of the day. Upon examination under the microscope it was thought to belong to the *Infusoria*, of the family *Astasia*, viz., *Astasia hæmatodes*, Ehr.

Mr. E. L. MONTEFIORE presented to the Society a drawing of the skeleton of the *Iguanodon Bernissartensis*, found in the coal measures of Bernissart, in Belgium. The skeleton, which is placed in the Royal Museum at Brussels, is about 15 feet high, and 24 feet in length from head to tail, and bears a striking resemblance to the common kangaroo, only of gigantic size.

About forty members were present.

WEDNESDAY, 2 JULY, 1884.

H. C. RUSSELL, B.A., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society:—

Binstead, W. H., Petersham.
Lackey, John, M.L.A., Sydney.
Sands, Robert, Sydney.
Smith, F. Moore, M.D., Sydney.
Verde, Felice, Spezia.
Wiesener, T. F., Sydney.

The certificates of four new candidates were read for the second time, and of nine for the first time.

Fifty-four donations were laid upon the table.

Dr. LEIBIUS, M.A., F.C.S., read a paper "Notes on Gold."

A discussion followed, in which the following gentlemen took part, viz.:—Messrs. W. Neill, Dr. Rennie, J. Henry, Hon. Prof. Smith, Prof. Liversidge, Dr. Leibius, and the Chairman.

Professor Liversidge, F.R.S., made a few remarks in explanation and description of certain minerals which he had brought to the rooms for inspection. They consisted of a model of beautifully crystallized gold, in large crystals, joined end to end in branching arborescent forms, prepared from the original in the Museum of

Science and Art, Edinburgh, by Professor Archer, Director. Specimens of concretions of iron pyrites, containing septa of quartz, resembling the well-known septaria from the London clay, occurring at Sunnyside, Mitchell's Creek, Bathurst district; collected by Mr. J. M. Smith. Axinite, in large crystals of a clove-brown colour, from the Nundle district. Idocrase, with small well-developed crystals of red and colourless garnets, apparently of the variety known as grossularite. These, together with the axinite, were found by Mr. D. A. Porter, of Tamworth, a most diligent and painstaking collector of minerals, to whom the Society was indebted for the discovery of several minerals previously unknown in New South Wales. Mr. Cleghorne, of Uralla, has also done good service in working out the mineralogy of this Colony, and the credit is due to him of having brought to light the very fine specimens of tourmaline from Uralla, placed on the table; one very large specimen is crystallized in forms similar to those from the well known Bovey Tracy locality in Devonshire. With the scheelite, tungstate of lime, from Hillgrove, county Sandon, are some specimens of molybdenite and molybdenum ochre; in the same district antimonite, containing native gold, is met with—a very rare association. Lithomarge, a hydrated silicate of alumina, with native copper, from the great Blayney Copper mine. Hollow concretions of ironstone from the bed of the Macquarie River, found by Mr. Murdoch, near Dubbo. Professor Liversidge also submitted specimens of nardoo, yowa, munyeroo, and kootoo seeds, and small bulbs used by the aborigines of Central Australia for the purposes of food.

Mr. J. W. M'Cutcheon expressed his regret that the opportunities which had been given in this Colony for collecting crystallized gold had been completely thrown away, and he supposed that in a few years there would be no more crystallized gold, because the deeper they went the fewer crystallized specimens seemed to be found.

Professor Smith said crystallized specimens were not infrequent in the early days, but they were not so frequent in the present day. Large sums had been offered for specimens of the kind for the Museums, but they could not now be obtained.

The Rev. P. Macpherson, M.A., read a paper on "The Oven Mounds of Aborigines in Victoria."

A discussion followed, in which the following gentlemen took part, viz.:—Dr. Creed, Messrs. J. W. M'Cutcheon, J. Henry, and W. Neill.

Mr. W. Neill exhibited some very rich specimens of gold in quartz and mispickel from the new mine Wahaup, East Ballarat.

About twenty-five members were present.

WEDNESDAY, 6 AUGUST, 1884.

H. C. RUSSELL, B.A., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society :—

Barry, The Most Rev. Dr., D.D., D.C.L., LL.D., Bishop of Sydney.
Chesterman, Alfred H., St. Peter's.
Jones, L. C. Russell, Sydney.
Sunderland, Rev. J. P., Sydney.

The certificates of nine new candidates were read for the second time, and of five for the first time.

The following donations were laid upon the table :—327 vols. and pamphlets, seven charts, forty-six photographs (anthropological), and a collection of fossils.

The CHAIRMAN announced that the Conversazione would be held on the second Wednesday in October (Oct. 8), in the Great Hall of the University.

Mr. LAWRENCE HARGRAVE read a paper, "Notes on the Trochoided Plane," and exhibited various models to illustrate the same.

The paper was explanatory of some models of animal progression exhibited before the Society (at a recent reception by the Council), and gave in detail the opinions and deductions he had formed from his observations of the natural motions of animals. The author was of opinion that there was evidence to show that Nature almost universally used the trochoided plane for the transmission of force, and that its use by man opened up a wide field for engineers. Mr. Hargrave requested the Society to give its opinion whether or not there were grounds for believing that the trochoided plane was a distinct mechanical power, and if not, under what head did the members class it ?

Some remarks were made by the Hon. Professor Smith and Mr. H. C. Russell.

The CHAIRMAN read a telegram which had been received by Mr. Ellery, from Kiel, respecting the position of Barnard's comet on the 1st August.

Some remarks were made by Mr. G. D. HIRST.

About thirty-five members were present.

WEDNESDAY, 3 SEPTEMBER, 1884.

H. C. Russell, B.A., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society :—

Cox, Saml. Herbert, F.C.S., F.G.S., Sydney.
Dowling, Edward, Sydney.
Gardiner, John, Sydney.
Gibbs, J. Burton, Sydney.
Gill, Rev. Wm. Wyatt, B.A., Lond., Marrickville.
Jenkins, Edw. Johnstone, M.A., M.B., Oxon, M.R.C.P., M.R.C.S., L.S.A., Lond., Sydney.
Kendall, Theodore M., B.A., L.R.C.S., L.R.C.P., Lond., Sydney.
Mackenzie, John Bower, M.I.C.E., Sydney.
Wood, Arthur Pepys, C.E., Sydney.

The certificates of five new candidates were read for the second time, and of three for the first time.

The following additional Rules, proposed by the Council, were duly agreed to, viz. :—Va, IXa, IXb, XIIa, XIVa, XXa, XXb, XXIIIa, XXVIa, XXVIb.

One hundred and five donations were laid upon the table.

Mr. H. C. Russell, B.A., F.R.A.S., read a paper on "A new form of Actinometer." The instrument, although not quite completed, was exhibited and described by Mr. Russell.

Some remarks were made by Messrs. G. D. Hirst, L. Hargrave, and W. A. Dixon.

Twenty-six members were present.

WEDNESDAY, 8 OCTOBER, 1884.

A Conversazione was held in the Great Hall of the University, under the management of a Committee composed of the President, Mr. H. C. Russell, B.A., Dr. W. Morris, one of the Vice-Presidents, the Hon. Secretaries, Professor Liversidge, F.R.S., Dr. Leibius, M.A., and Messrs. Charles Moore, F.L.S., Robert Hunt, F.G.S., and F. B. Kyngdon.

The Hall and the approaches were tastefully decorated with palms, ferns, and rare pot plants, by Mr. C. Moore, F.L.S., Director of the Botanic Gardens.

Messrs. J. Massey and F. Morley presided at the organ, and select pieces were played at intervals.

The number of guests present was between 800 and 900.

List of Exhibitors.

Balfour, James.—Views of Indian scenery.

Bolding, H. J.—1. Microscope. 2. Curious specimen of pine eaten away by white ants.

Cox, Hon. Geo. H., M.L.C.—Views of Indian scenery.

Crummer, H. S. W.—"New Zealand Illustrated," by George French Angas.

Delarue, L. H.—Microscope and objects.

Department of Mines (from Geological Survey Branch).—1. Collection of silver ores from the mines near Silverton, Barrier Ranges. 2. Collection of various minerals from New South Wales. 3. Collection of fossils from New South Wales. 4. Geological maps of New South Wales. 5. Coloured photographs of gold-workings at Temora and Adelong. (From Diamond-Drill Branch).—1. Sections of borings for water and coal. 2. Plans of diamond-drill connections, artesian tubing, &c. 3. Samples of cores.

Flavelle Bros. and Roberts.—1. Insulite galvanic battery. 2. Microscope by Ross, and objects.

Fraser, Robert.—Microscope showing *Chrisophrina Australis.*

Gipps, Fredk. B., C.E.—1. Omnimeter. 2. Model of an improved Poirie movable needle weir. 3. Rare book; History and Geography of Cashmere, written in Persian.

Hargrave, Lawrence.—The Trochoided Plane, and its relation to animal progression.

Haswell, W. A., M.A.—The Barnes automatic microtome.

Jenkins, Dr. Edward J., M.A.—"Australian Views" by Captain Wallis.

Knox, E. W.—1. Three polariscopes for sugar analysis. 2. Colorimeter, for comparing the relative amount of colour in two liquids. 3. Microscope showing a living *Acarus sacchari.*

Kyngdon, F. B.—Microscope and objects.

Liversidge, Prof., F.R.S.—1. Model of crystallized gold, Australian. 2. Specimens of crystallized and other gold, New South Wales. 3. New models of crystallographic axes. 4. Microscopes.

Little, Dr. William.—Microscope and objects.

Mackellar, Dr. C. K.—Microscope by Swift.

Makin, G. E.—1. Silurian and Devonian fossils from Yass and Murrumbidgee. 2. Fossils from Capertee Creek, Mudgee. 3. Fossils—Glossopteris, Phyllotheca, &c., from Joadja & Berrima Colliery. 4. Gems, garnets, rubies, &c. from town of Berrima.

Manning, His Honor Sir William, LL.D.—1. Microscope. 2. Medallion of Oliver Cromwell. 3. Malachite from Peak Downs, Queensland.

Martin, Rev. George.—Two microscopes and objects.

Morris, Dr. W.—Microscope and objects.

Robertson, Thomas.—1. Large photograph of the Moon. 2. Tellurium.

Royal Society of New South Wales.—1. Microscope by Swift. 2. Photographs, anthropological, &c. 3. Autograph letters from eminent men.

Russell, H. C.—1. Automatic circle-divider. 2. Harmonograph.

Sinclair, S.—1. Specimens of Greenland Flora. 2 Models of Greenland canoes, deer, dogs, &c., cut in bone by the natives, &c.

Smedley, John.—1. Two volumes of Japanese hand-painted works of illustrations of their legends and historical events. 2. Three books of original sketches in China and Japan. 3. Japanese enamel vases, &c,

Smith, Hon. Prof., C.M.G.—1. Electric reading-lamp. 2. Portable battery and bell. 3. Static induction machine driven by a Griscom motor. 4. Magneto-electric machine by Breguet. 5. Electro motor by Apps. 6. Electro motor by Ayrton & Perry. 7. Ammeter by Ayrton & Perry. 8. Spectroscopes.

Surveyor-General's Department (Trigonometrical Branch).—1. Large telescope of colonial manufacture. 2. Three electrical contact chronometers.

Technological Museum.—1. Enlarged models in papier mâché, plaster casts and fictile ivories, photogravures. 2. Official topographical map of Switzerland, 25 plates.

University (Chemical Laboratory).—1. Petrological microscope. 2. Cut and polished ornamental stones. (3) *Apparatus* to show the manufacture of sulphuric acid, (4) coal gas, (5) white arsenic, (6) water from hydrogen and oxygen by weight, (7) for drying gases, (8) the diffusion of gases, (9) for electrolysis. 10. Agate mortars. 11. Goniometers. 12. Furnace for heating sealed tubes. &c., &c., &c.

University (Medical School).—1. Microscopical preparations. 2. Physiological apparatus.

Walker, H. O.—Microscope by R. & J. Beck, and objects.

Watson, P. Fletcher.—Water-colour drawings, &c.

Wiesener, T. F.—1. Microscope and accessories, made entirely by apprentice. 2. Seven large photographs—Italian scenery. 3. Compound microscope. 4. Dissecting microscope. 5. Student's microscope, &c.

Wilkinson, C. S., F.G.S., F.L.S.—1. Photographs of interior of the Jenolan (Fish River) Caves. 2. View of cliffs at Bondi, showing structure of Hawkesbury Rocks. 3. Shoe made of feathers and human hair, used by the natives of Central Australia to conceal their tracks when marauding. 4. Paintings, &c. 5. Dutton's illustrations of the Grand Cañon District, United States, America.

Wright, H. G. A., M.R.C.S.E.—Microscope by Ross, and objects.

WEDNESDAY, 5 NOVEMBER, 1884.

H. C. Russell, B.A., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society :—

Lucas, John Hector, Five Dock.
Perdriau, Stephen E., St. Leonards.
Ross, Chisholm, M.B., C.M., Gladesville.
Williamson. Wm. Collir, M.D., Parramatta.
Yeomans, Allan, Gilgoin.

The certificates of three new candidates were read for the second time, and of four for the first time.

The following donations were laid upon the table :—115 books and pamphlets, thirteen charts, and one photograph.

The additional rules which had been agreed to at the last meeting (3 September) were unanimously adopted.

A paper was read by Mr. D. A. Porter, "Notes on some mineral localities in the Northern Districts of N.S. Wales.

Remarks upon the same were made by Prof. Liversidge, F.R.S., and Mr. C. S. Wilkinson, F.G.S.

The following extracts from a letter by Mr. Caldwell to Prof. Liversidge, dated Burnet River, Oct. 8th, 1884, were read :—

"Ceratodus has interfered with platypus. The platypus eggs were hatched three weeks ago, and I should have been in New England by now, but Ceratodus is much more important. Platypus embryos are quite easy to get. I can't understand how they have not been got before. The fact that the Monotremes are oviparous is the end of the research for many. They don't understand that it is the fact of the egg having a lot of yelk that promises to yield valuable information. Here are some of the principal points in the development of Ceratodus as observed on the whole embryos. I have not attempted to make sections yet ; you know what section-cutting is now-a-days. The egg measures about 2½ mm. diameter, and has the protoplasmic pole darker, as in Amphibia. The egg is surrounded by a strong closely investing gelatinous membrane about 3½ mm. thick. The segmentation is complete (holoblastic.) Part of the blastopore remains open, and persists as anus. The stages up to hatching closely resemble those of the newt Amblystoma. After hatching, the larva goes into the mud. It lies on its sides like Pleuronectidæ among Teleosteans, and the oldest stages I have reared still show no signs of external gills. The larval changes I expect will continue for many weeks, and I have two plans to save my waiting here, both of which I intend to put into execution at once. First, I shall leave an aquarium with a large number of the larvæ here on a station, where a friend has kindly promised to put a few of the fish in a bottle every day. Second, I shall bring a supply of eggs to Sydney, and attempt to rear them in my laboratory. I hope to get to Sydney in about a fortnight or three weeks' time. I have more than thirty blacks with me now ; they have found over 500 Echidna in the last six weeks."

The following exhibits were shown :—

Professor LIVERSIDGE, F.R.S., exhibited specimens of gems from river gravel at Berrima, together with other mineral specimens from the old gold workings near Mittagong, where gems had lately been found. Sapphires, zircons, the topaz, and diamonds were mentioned by the Professor as being met with in relation with other gems in the districts mentioned; and, in answer to a member's question, he stated that some of the diamonds, though small, were worth cutting, and remarked at the same time that wherever valuable gems were found there was always a good deal of rubbish as well, so that the discovery of so many small ones in N.S.W. should not discourage miners. The Professor further mentioned the interesting fact that flints occurred at the mines near Mittagong closely resembling those of the cretaceous formations at home, and he intended to make sections of them, to see if they contained those signs of sponges which appeared in the chalk flints.

Remarks were made by Messrs. H. E. Kater and C. S. Wilkinson.

2. Mr. C. S. WILKINSON, F.G.S., exhibited a large specimen of carbonate of lead, containing chloride of silver, from the Christmas mine, near Silverton; a specimen of tin ore in micaceous granite from Hodgson and March's lode, near Poolamacca, Barrier Ranges; a sample of gold-bearing quartz from the Red Jacket reefs, near Silverton; a specimen of lode-stuff containing argentiferous galena from Thackeringa; a fine specimen of native antimony in calcite, found by Mr. Newman in the New Reform mine, Lucknow; also, from the same mine, a specimen of dendritic gold and arsenical pyrites in massive serpentine.

3. The Hon. Prof. SMITH, C.M.G., exhibited a Hughes' Induction Balance and Sonometer.

Mr. CHARLES MOORE announced the discovery of a new species of the giant Australian lily on the high grounds between the Clarence and Richmond Rivers. Up to fourteen years ago, he said, only one species was known; but about that time another was discovered in Queensland, and now, strange to say, a third had been found—strange because so large a flower had escaped notice before in a populated district. The flower-stem was 9 or 10 feet high, and the species was quite distinct from the other two. He had stems of the three species to submit to the Society at its next meeting, when he hoped to be able to read some notes upon them, which he had been prevented from doing that night by official duties.

About thirty-five members were present.

WEDNESDAY, 3 DECEMBER, 1884.

H. C. Russell, B.A., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society:—

Henson, Joshua B., C.E., Sydney.
Kyngdon, Boughton, Sydney.
Strange, Fredk. R., Sydney.

The certificates of four new candidates were read for the second time, and of three for the first time.

The President stated that the Council recommended that the following gentlemen be elected honorary members of the Society:—

Sir George Beddell Airy, K.C.B., M.A., D.C.L., F.R.S., &c.
Professor John Tyndall, D.C.L., LL.D., F.R.S., &c.

The election was carried unanimously.

It was resolved that Messrs. P. N. Trebeck and W. G. Murray be appointed Auditors for the current year.

Thirty-nine donations were laid upon the table.

The President announced that the Council had considered the papers received in response to the Society's offer of its medal and £25 for the best communication (provided it were of sufficient merit) containing the results of original research or observation upon each of the following subjects, viz.:—

Series III.—To be sent in not later than September, 30th, 1884.

No. 9.—Origin and mode of occurrence of gold-bearing veins and of the associated minerals.

10.—Influence of the Australian climate in producing modifications of diseases.

11.—On the Infusoria peculiar to Australia.

12.—On Water Supply in the *interior* of New South Wales.

No essay was received on subject No. 10; eight papers had been received on No. 9, and one paper on No. 11, but none of the essays were considered to be of sufficient merit to be awarded the prize.

In the case of No. 12, "On the Water Supply in the interior of New South Wales" four papers had been sent in, and the Society's medal and prize of £25 had been awarded to Mr. W. E. Abbott, Abbotsford, Wingen.

Mr. Charles Moore read a paper, "Notes on Doryanthus."

In the absence of the author, Mr. T. K. Abbott read Mr. W. E. Abbott's paper on "Water Supply in the interior of New South Wales."

A discussion followed, in which the following gentlemen took part :—Messrs. C. S. Wilkinson, C. Moore, the Hon. J. P. Abbott, J. Trevor Jones, H. T. Wilkinson, and the Chairman.

Mr. C. S. Wilkinson, F.G.S., conducted an experiment illustrating the formation of comets. Assuming the existence of a large gaseous spheroid (probably of CO_2, CO, and H), with a central solid meteoric mass, or aggregation of meteorites, he suggested that the nucleus of a comet may be the point where the sun's light, on passing through the spheroid, is focussed or concentrated by refraction near the outer surface of the spheroid, and that the rays of light proceeding from this point illuminate the meteoric dust in space, and give rise to the appearance of a "tail" of a comet.

The President regarded the experiment as interesting. There were, however, many difficulties in connection with the tails of comets, and he feared Mr. Wilkinson had not solved them all. It would be well for astronomers, he thought, if comets had no tails. One great difficulty in connection with Mr. Wilkinson's theory was, that it supported the hypothesis that the tails consisted of reflected solar light on meteoric matter, whereas the spectroscope proved them to consist principally of incandescent gases. Another fact was that the tails of some comets extended themselves towards the sun, and in such an instance as that Mr. Wilkinson's explanation would not be feasible.

Mr. H. C. Russell, B.A., F.R.A.S., exhibited and read some notes upon a new self-registering Anemometer.

Between thirty and thirty-five members were present.

WEDNESDAY, 17 DECEMBER, 1884.

SPECIAL MEETING.

H. C. Russell, B.A., President, in the Chair.

Mr. Caldwell, of Caius College, Cambridge, exhibited specimens illustrating his researches into the embryology of the Marsupiala, Monotremata, and Ceratodus.

About eighty members were present.

ADDITIONS

TO THE

LIBRARY OF THE ROYAL SOCIETY OF NEW SOUTH WALES.

DONATIONS—1884.

(The names of the Donors are in *Italics.*)

TRANSACTIONS, JOURNALS, REPORTS, &c.

ABERDEEN :—The Aberdeen University Calendar for the academical year 1884–85. *The University.*

ADELAIDE :—Report of the Progress and Condition of the Botanic Garden and Government Plantations during 1883. *The Government Botanist.*

Meteorological Observations made at the Adelaide Observatory during 1881. *The Observatory.*

Transactions and Proceedings and Report of the Royal Society of South Australia. Vol. VI, 1882–83. *The Society.*

Final Report of the South Australian Institute, for the nine months ended 30th June, 1884. *The Institute.*

ALBANY (N.Y.) :—62nd, 63rd, and 64th Reports of the New York State Library, 1880, 1881, and 1882.

93rd and 94th Annual Reports of the Regents of the University of the State of New York, 1880–1881.

The Correct Arms of the State of New York. *The Trustees.*

AMSTERDAM :—Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen, Tweede Reeks. Deel. XVIII, 1883.

Jaarboek van de Koninklijke Akademie van Wetenschappen, 1882. *The Academy.*

AUCKLAND :—Report of the Auckland Institute and Museum for 1883–84. *The Institute.*

BALTIMORE (MARYLAND) :—

American Chemical Journal. Vols. II, III, IV.
,, ,, ,, ,, V, No. 6.
,, ,, ,, ,, VI, Nos. 1, 2, 3, 4.

American Journal of Mathematics. Vol. II.
,, ,, ,, ,, III, No. 3.
,, ,, ,, ,, IV, ,, 1.
,, ,, ,, ,, V, ,, 1.
,, ,, ,, ,, VI, ,, 3, 4.
,, ,, ,, ,, VII, ,, 1.

American Journal of Philology. Vol. III, Nos. 10, 11.
,, ,, ,, ,, IV, ,, 3, 4.
,, ,, ,, ,, V, ,, 1, 2.

Annual Report of the Johns Hopkins University (Seventh), 1882. *The Johns Hopkins University.*

BALTIMORE—*continued.*
Studies from the Biological Laboratory. Vol. II, No. 1.
" " " " " III, Nos. 1, 2.
University Circulars, Nos. 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23 Supplement, 24, 28, 29, 30, 31, 32.
The Johns Hopkins University.

BELOIT (WIS.) :—Geology of Wisconsin Survey of 1873–79.
Vol. I.
Vol. IV, and Final Report and Atlas.
The Governor and Chief Geologist, Wisconsin.

BERGEN :—Nye Alcyonider Gorgonider og Pennatulider tihhorende Norges Fauna ved Drs. J. Koren og D. C. Danielssen. *The Museum.*

BERLIN :—Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin. Nos. 38 to 53. 18 Oct. to 13 Dec., 1883.
" 1 to 39. 10 Jan. to 31 July, 1884.
Index. Erster Halbband Jan. bis Mai, Stück I—XXVI. *The Academy.*

BERNE :—Jahresbericht der Geographischen Gesellschaft von Bern. Vol. VI, 1883–84. *The Society.*

BIRMINGHAM :—Addresses delivered to the Birmingham and Midland Institute—
"On Freedom," by Prof. F. Max Müller.
"The Natives of India," by The Right Hon. the Earl of Northbrook.
"Science and Industry," by Dr. Chas. Wm. Siemens, F.R.S.
"A Lesson on Democracy," by J. A. Froude, M.A., LL.D.
"The Six Gateways of Knowledge," Prof. Sir Wm. Thomson, LL.D., F.R.S.
"On Democracy," by The Hon. James Russell Lowell, D.C.L., LL.D.
Report of the Council of the Birmingham and Midland Institute for the years 1881, 1882, 1883.
Programme for Session 1884–85. *The Institute.*
Proceedings of the Birmingham Philosophical Society—
Vol. I. Nos. 1 and 2.
" II. Parts 1 and 2.
" III. " 1 and 2.
" IV. Part 1. *The Society.*

BISTRITZ (in Siebenbürgen) :—Jahresbericht der Gewerbeschule zu Bistritz.
Part IX. 1882–83.
" X. 1883–84. *The Director.*

BONN :—Verhandlungen des Naturhistorischen Vereines der Preussischen Rheinlande und Westphalens in Bonn.
Jahrgrang XXXIX. Folge 4, Band 9, Halfte 2. 1882.
" XL. " " 10, " 1 and 2. 1883.
The Society.

BORDEAUX :—Académie Nationale des Sciences, Belles-Lettres et Arts—
Séance Publique du 26 Aôut. 1820.
" 15 Dec., 1822.
" 13 Mai, 1824.
" 10 Mai, 1825.
" 31 Mai, 1827.
" 5 Juin, 1828.
" 16 Juin, 1829.
" 22 Juillet, 1830.
" 5 Juillet, 1832.
" 8 Aôut, 1833.
" 28 Aôut, 1834.
" 10 Septem., 1835.
" 22 Septem., 1836.
21 Septem., 1837

BORDEAUX—*continued.*

Actes de l'Académie Royale des Sciences, Belles-Lettres et Arts de Bordeaux—

Année 1,	Trimestre	1, 2, 3, 4.	1839.
,, 3,	,,	4.	1841.
,, 4,	,,	1.	1842.
,, 5,	,,	2, 3.	1843.
,, 6,	,,	1, 2, 3, 4.	1844.
,, 7,	,,	1, 3, 4.	1845.
,, 8,	,,	1, 2, 3, 4,	1846.

Recueil des Actes de l'Académie des Sciences, Belles-Lettres et Arts de Bordeaux—

Année 10,	Trimestre	4.	1848.
,, 11,	,,	2, 3, 4.	1849.
,, 12,	,,	1, 2.	1850.
,, 14,	,,	1, 2, 3, 4,	1852.
,, 15,	,,	1, 2, 3.	1853.

Recueil des Actes de l'Académie Impériale des Sciences, Belles-Lettres et Arts de Bordeaux—

Année 16,	Trimestre	4.	1854.
,, 17,	,,	1, 3.	1855.
,, 18,	,,	1, 2, 3, 4.	1856.
,, 19,	,,	1, 2, 3, 4.	1857.
,, 20,	,,	1, 2, 3, 4.	1858.
,, 21,	,,	1, 2, 3, 4.	1859.

Actes de l'Académie Impériale des Sciences, Belles-Lettres et Arts de Bordeaux—

Année 23,	Trimestre	1, 2, 3, 4.	1861	(3rd Ser.)
,, 24,	,,	1, 2, 3, 4,	1862	,,
,, 25,	,,	1, 2, 3, 4.	1863	,,
,, 26,	,,	2.	1864	,,
,, 27,	,,	3, 4.	1865	,,
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,, 32,	,,	1, 2, 3, 4.	1870	,,

Actes de l'Académie Nationale des Sciences, Belles-Lettres et Arts de Bordeaux—

Année 33,	Trimestre	1, 2, 3, 4.	1871–72	(3rd Ser.)
,, 34,	,,	3, 4.	1872–73	,,
,, 35,	,,	1, 2, 3, 4.	1873	,,
,, 36.			1874	,,
,, 37.			1875	,,
,, 38.			1876	,,
,, 39 and 40.			1877–78	,,
,, 40 Supplement.			1878	,,
,, 41.			1879	,,
,, 42.			1880	,,

Table historique et méthodique (1712–1875).
Documents historiques (1711–1713).
Catalogue des Manuscrits de l'ancienne Académie (1712–1793). } 1 vol.

The Academy.

BOSTON (MASS.) :—Proceedings of the American Academy of Arts and Sciences—

Vol. IX,	New Ser.;	XVII,	Whole Ser.	June, 1881, to June, 1882.
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EXCHANGES AND PRESENTATIONS

MADE BY THE

ROYAL SOCIETY OF NEW SOUTH WALES,

1884.

The Journal and proceedings of the Royal Society of N.S.W. for 1883, vol. xvii, has been distributed as follows :—

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Presentations to the Society are acknowledged by letter, and in the Society's Annual Volume.

* Exchanges of Publications have been received from the Societies and Institutions distinguished by an asterisk.

ARGENTINE REPUBLIC.

1. **Cordoba.**—*Academia Nacional de Ciencias.

AUSTRIA.

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3. **Trieste.**—*Società Adriatica di Scienze Naturali.
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9. „ *K. K. Zoologisch-Botanische Gesellschaft.
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BELGIUM.

11. **Brussels.**—*Académie Royale des Sciences, des Lettres, et des Beaux Arts.
12. „ *Musée Royal d'Histoire Naturelle de Belgique.
13. „ *Observatoire Royal de Bruxelles.
14. „ *Société Royale Malacologique de Belgique.
15. **Liege.**—*Société Géologique de Belgique.
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18. **Mons.**—*Société des Sciences, des Arts et des Lettres du Hainaut.

DENMARK.

19. **Copenhagen.**—*Société Royale des Antiquaires du Nord.

FRANCE.

20. **Bordeaux.**—*Académie Nationale des Sciences, Belles-Lettres et Arts.
21. **Caen.**—*Académie Nationale des Sciences, Arts, et Belles-Lettres.
22. **Dijon.**—*Académie des Sciences, Arts, et Belles-Lettres.
23. **Lille.**—*Société Géologique du Nord.
24. **Montpellier.**—*Académie des Sciences et Lettres.
25. **Paris.**—*Académie des Sciences de l'Institut de France.
26. " *Depôt des Cartes et Plans de la Marine.
27. " Ecole Nationale des Mines.
28. " Ecole Normale Supérieure.
29. " *Ecole Polytechnique.
30. " Editor *Cosmos les Mondes.*
31. " Editor *Revue des Cours Scientifiques.*
32. " Faculté de Médecine.
33. " Faculté des Sciences de la Sorbonne.
34. " Jardin des Plantes.
35. " *L'Observatoire de Paris.
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37. " *Ministère de l'Instruction Publique et des Beaux Arts.
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39. " Société d'Anatomie.
40. " *Société d'Anthropologie de Paris.
41. " Société de Biologie.
42. " Société de Chirurgie de Paris.
43. " *Société d'Encouragement pour l'Industrie Nationale.
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48. " Société Mineralogique de France.
49. " *Société Philotechnique.
50. " Société de Physique.
51. " *Société Zoologique de France.
52. **Saint Etienne.**—Société de l'Industrie Universelle.
53. **Toulouse.**—*Académie des Sciences Inscriptions et Belles-Lettres.

GERMANY.

54. **Bremen.**—*Naturwissenschaftlicher Verein zu Bremen.
55. **Berlin.**—Deutsche Chemische Gesellschaft.
56. " *Königliche Preussische Akademie der Wissenschaften.
57. **Bonn.**—*Naturhistorischer Verein der Preussischen Rheinlande und Westphalens in Bonn.
58. **Braunschweig.**—*Verein für Naturwissenschaft zu Braunschweig.
59. **Carlsruhe.**—Grossherzogliches Polytechnikum zu Carlsruhe.
60. " Naturwissenschaftlicher Verein zu Carlsruhe.
61. **Cassel.**—*Verein fur Naturkunde.
62. **Chemnitz.**—*Naturwissenschaftliche Gesellschaft zu Chemnitz.

63. **Dresden.**—*Das Statistische Bureau des Ministeriums des Innern zu Dresden.
64. „ Verein für Erdkunde zu Dresden.
65. „ *General-Direction der Königlichen Sammlungen für Kunst und Wissenschaft zu Dresden.
66. „ *Königliches Mineralogische Museum.
67. **Frankfurt a/M.**—*Senckenbergische Naturforschende Gesellschaft in Frankfurt a/M.
68. **Freiberg (Saxony).**—*Die Berg Akademie zu Freiberg.
69. „ Naturforschende Gesellschaft zu Freiberg.
70. **Görlitz.**—*Naturforschende Gesellschaft in Görlitz.
71. **Göttingen.**—*Königliche Gesellschaft der Wissenschaften in Göttingen.
72. **Halle A.S.**—*Die Kaiserlich Deutsche Leopoldinisch—Carolinische Akademie der Naturforcher zu Halle A.S. (Prussia).
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76. **Jena.**—*Medicinisch Naturwissenschaftliche Gesellschaft.
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78. **Leipzig (Saxony).**—University Library.
79. **Marburg.**—*Gesellschaft zur Beförderung der Gesammten Naturwissenschaften in Marburg.
80. „ *The University.
81. **Metz.**—*Verein für Erdkunde zu Metz.
82. **Mulhouse.**—*Industrial Society.
83. **Munchen.**—*Königliche Baierische Akademie der Wissenschaften in München.
84. **Stuttgart.**—*Königliches Statistisch-Topographische Bureau zu Stuttgart.
85. „ *Verein für Vaterländische Naturkunde in Würtemberg.

GREAT BRITAIN AND THE COLONIES.

86. **Birmingham.**—*Birmingham Philosophical Society.
87 „ Midland Institute.
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89. **Camborne.**—*Miners' Association of Cornwall and Devon.
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94. **Dudley.**—Dudley and Midland Geological and Scientific Society and Field Club.
95. **Leeds.**—*Conchological Society.
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98. **Liverpool.**—*Literary and Philosophical Society.
99. **London.**—*Agent-General (two copies).
100. „ *Anthropological Institute of Great Britain and Ireland.
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103. „ Chemical Society.
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106. „ Entomological Society.
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111. „ Library, South Kensington Museum
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124. „ *Royal College of Physicians.
125. „ *Royal College of Surgeons.
126. „ *Royal Colonial Institute.
127. „ *Royal Geographical Society.
128. „ *Royal Historical Society.
129. „ *Royal Institution of Great Britain.
130. „ *Royal Meteorological Society.
131. „ *Royal Microscopical Society.
132. „ *Royal School of Mines.
133. „ *Royal Society.
134. „ Royal Society of Literature.
135. „ *Royal United Service Institution.
136. „ Society of Arts.
137. „ Topographical and Statistical Depôt.
138. „ Treasury Library.
139. „ War Office.
140. „ Zoological Society.
141. **Manchester.**—*Geological Society.
142. „ *Literary and Philosophical Society.
143. „ *Owens College.
144. **Middlesboro'.**—*Iron and Steel Institute.
145. **Newcastle-upon-Tyne.**—*Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne.
146. „ „ *North of England Institute of Mining and Mechanical Engineers.
147. „ „ *Society of Chemical Industry.
148. **Oxford.**—*Ashmolean Library.
149. „ *Bodleian Library.
150. „ *Radcliffe Library.
151. „ *Radcliffe Observatory.

152. **Penzance.**—*Royal Geological Society of Cornwall.

153. **Plymouth.**—*Plymouth Institution, and Devon and Cornwall Natural History Society.

154. **Truro.**—*Mineralogical Society of Great Britain and Ireland.

155. **Windsor.**—The Queen's Library.

CAPE OF GOOD HOPE.

156. **Cape Town.**—*South-African Philosophical Society.

DOMINION OF CANADA.

157. **Halifax (Nova Scotia).**—*Nova Scotia Institute of Natural Science.

158. **Hamilton (Canada West).**—Scientific Association.

159. **Montreal.**—*Geological Survey of Canada.
160. " *Natural History Society of Montreal.

161. **Ottawa.**—Academy of Natural Sciences.

162. **Toronto.**—*Canadian Institute.

INDIA.

163. **Calcutta.**—*Asiatic Society of Bengal.
164. " Geological Museum.
165. " *Geological Survey of India.

IRELAND.

166. **Dublin.**—*Royal Dublin Society.
167. " Royal Geological Society of Ireland.
168. " *Royal Irish Academy.

MAURITIUS.

169. **Port Louis.**—Royal Society of Arts and Sciences.
170. " Société d'Acclimatation.

NEW SOUTH WALES.

171. **Sydney.**—Australian Club.
172. " *Australian Museum.
173. " *Free Public Library.
174. " *Linnean Society of New South Wales.
175. " *Mining Department.
176. " *Observatory.
177. " School of Arts.
178. " Union Club.
179. " *University.

NEW ZEALAND.

180. **Auckland.**—*Auckland Institute.

181. **Christchurch.**—Philosophical Society of Canterbury.

182. **Dunedin.**—Otago Institute.

183. **Wellington.**—*Colonial Museum.
184. " *New Zealand Institute.
185. " Philosophical Society.

(Forwarded per favour of the Wellington Museum.)

QUEENSLAND.

186. **Brisbane.**—*Acclimatization Society of Queensland.
187. „ *Royal Society of Queensland.

SCOTLAND.

188. **Aberdeen.**—*Dunn Echt Observatory, Earl of Crawford and Balcarres.
189. „ *University.
190. **Edinburgh.**—*Editor, *Encyclopædia Britannica*, Messrs. A. and C. Black.
191. „ *Geological Society.
192. „ *Royal Botanic Garden.
193. „ *Royal Observatory.
194. „ *Royal Physical Society.
195. „ *Royal Society.
196. „ University.
197. **Glasgow.**—*Geological Society.
198. „ *University.

SOUTH AUSTRALIA.

199. **Adelaide.**—*Government Botanist.
200. „ *Government Printer.
201. „ *Observatory.
202. „ *Royal Society of South Australia.
203. „ *South Australian Institute.
204. „ *University.

TASMANIA.

205. **Hobart.**—*Royal Society of Tasmania.

VICTORIA.

206. **Ballarat.**—*School of Mines and Industries.
207. **Melbourne.**—Eclectic Association.
208. „ *Government Botanist.
209. „ *Government Statist.
210. „ *Mining Department.
211. „ *Observatory.
212. „ *Public Library.
213. „ *Registrar-General.
214. „ *Royal Society of Victoria.
215. „ *University.
216. „ *Victorian Institute of Surveyors.

(Forwarded per favour of the Melbourne Public Library.)

HUNGARY.

217. **Bistritz (in Siebenbürgen).**—*Direction der Gewerbeschule.
218. **Zagreb (Agram).**—*Société Archéologique.

ITALY.

219. **Bologna.**—Accademia delle Scienze dell' Istituto di Bologna.
220. „ Università di Bologna.
221. **Florence.**—*Società Entomologica Italiana.
222. „ *Società Italiana di Antropologia e di Etnologia.

223. **Genoa.**—*Museo Civico di Storia Naturale.

224. **Milan.**—Reale Istituto Lombardo di Scienze Lettere ed Arti.
225. „ Società Italiana di Scienze Naturali.

226. **Modena.**—*Académie Royale des Sciences, Lettres et Arts de Modène.

227. **Naples.**—Società Reale Accademia delle Scienze.
228. „ *Società Africana d'Italia.
229. „ *Stazione Zoologica (Dr. Dohrn).

230. **Palermo.**—*Accademia Palermitana di Scienze Lettere ed Arti.
231. „ Reale Istituto Tecnico.

232. **Pisa.**—*Società Toscana di Scienze Naturali.

233. **Rome.**—*Accademia Pontificia de'Nuovi Lincei.
234. „ Circolo Geographico d'Italia.
235. „ Osservatorio del Astronomico Collegio Romano.
236. „ *R. Accademia dei Lincei.
237. „ *R. Comitato Geologico Italiano.
238. „ *Società Geografica Italiana.

239. **Siena.**—R. Accademia de Fisiocritici.

240. **Turin.**—Reale Accademia delle Scienze.
241. „ Regio Osservatorio della Regia Università.

242. **Venice.**—*Reale Istituto Veneto di Scienze, Lettere ed Arti.

JAPAN.

243. **Yokohama.**—*Asiatic Society of Japan.

JAVA.

244. **Batavia.**—Kon. Natuurkundige Vereeniging in Nederl Indië.

NETHERLANDS.

245. **Amsterdam.**—*Académie Royale des Sciences.

246. **Harlem.**—*Bibliothèque de Musée Teyler.
247. „ *Société Hollandaise des Sciences.

NORWAY.

248. **Bergen.**—*Museum.

249. **Christiania.**—*Kongelige Norske Fredericks Universitet.

RUSSIA.

250. **Helsingfors.**—Sociéte des Sciences de Finlande.

251. **Moscow.**—*Société Impériale des Naturalistes.

252. **St. Petersburgh.**—*Academie Impériale des Sciences.

SPAIN.

253. **Madrid.**—Instituto geographico y Estadistico.

SWEDEN.

254. **Stockholm.**—*Kongliga Svenska Vetenskaps-Akademien.
255. „ Kongliga Universitetet.

SWITZERLAND.

256. **Berne.**—*Société de Géographie de Berne.
257. **Geneva.**—*Institut National Genevois.
258. **Lausanne.**—*Société Vaudoise des Sciences Naturelles.
259. **Neuchatel.**—*Société des Sciences Naturelles.

STRAITS SETTLEMENTS.

260. **Singapore.**—Royal Asiatic Society.

UNITED STATES OF AMERICA.

261. **Albany.**—*New York State Library, Albany.
262. **Annapolis (Md.)**—Naval Academy.
263. **Baltimore.**—*Johns Hopkins University.
264. **Beloit (Wis.)**—*Chief Geologist.
265. **Boston.**—*American Academy of Arts and Sciences.
266. „ *Boston Society of Natural History.
267. **Buffalo.**—*Buffalo Society of Natural Sciences.
268. **Cambridge.**—*Museum of Comparative Zoology, Harvard College.
269. „ *Editor, "*Science*."
270. „ *Cambridge Entomological Club.
271. **Chicago.**—Academy of Sciences.
272. **Cincinnati.**—*Cincinnati Society of Natural History.
273. **Coldwater.**—Michigan Library Association.
274. **Davenport (Iowa).**—*Academy of Natural Sciences.
275. **Hoboken (N.J.)**—*Stevens' Institute of Technology.
276. **Iowa City (Iowa).**—*Director Iowa Weather Service.
277. **Minneapolis.**—*Minnesota Academy of Natural Sciences.
278. **Newhaven (Conn.)**—*Connecticut Academy of Arts.
279. **New York.**—*American Chemical Society.
280. „ *American Geographical Society.
281. „ *New York Academy of Sciences.
282. „ School of Mines, Columbia College.
283. **Philadelphia.**—*Academy of Natural Science.
284. „ *American Entomological Society.
285. „ *American Philosophical Society.
286. „ *Franklin Institute.
287. „ *Zoological Society of Philadelphia.
288. **Salem (Mass.)**—*American Association for the Advancement of Science.
289. „ *Essex Institute.
290. „ *Peabody Academy of Sciences.

291. **St. Louis.**—*Academy of Science.

292. **Washington.**—*American Medical Association, Pennsylvania Avenue.
293. " *Bureau of Education (Department of the Interior).
294. " *Bureau of Ethnology.
295. " *Bureau of Navigation (Navy Department).
296. " *Chief of Engineers (War Department).
297. " *Chief Signal Officer (War Department).
298. " *Commissioner of Agriculture.
299. " *Director of the Mint (Treasury Department).
300. " *Hydrographic Office.
301. " *Office of Indian Affairs (Department of the Interior).
302. " *Ordnance Department.
303. " *Philosophical Society.
304. " *Secretary (Department of the Interior).
305. " *Secretary (Navy Department).
306. " *Secretary (Treasury Department).
307. " *Smithsonian Institution.
308. " *Surgeon General (U. S. Army).
309. " *U. S. Coast and Geodetic Survey (Treasury Department).
310. " *U. S. Geological Survey.
311. " *U. States National Museum (Department of the Interior).
312. " United States Patent Office.
313. " *War Department.

Number of	Publications sent to	Great Britain...	82
"	"	India and the Colonies ...	48
"	"	America	53
"	"	Europe	123
"	"	Editors of Periodicals ...	5
"	"	Asia, &c.	2
		Total	313

The Society's House, Sydney,
August 26th, 1884.

A. LIVERSIDGE, } Hon. Secretaries.
A. LEIBIUS, }

PROCEEDINGS OF THE SECTIONS.

(IN ABSTRACT.)

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(IN ABSTRACT.)

MICROSCOPICAL SECTION.

Preliminary Meeting, held APRIL, 1884.

Dr. WRIGHT in the Chair.

IT was decided to hold the meetings of the Section on the evenings of the second Monday in each month. The following gentlemen were elected office-bearers for the ensuing session:—Chairman: Mr. G. D. HIRST. Secretary: Mr. F. B. KYNGDON. Committee: Dr. MORRIS, Dr. WRIGHT, Mr. P. R. PEDLEY, and Mr. R. FRASER.

12 MAY, 1884.

Mr. G. D. HIRST in the Chair.

Dr. MORRIS presented nine slides of *A. pellucida*, mounted in the following media:—dry, balsam, phosphorus, oil cassia, liquid amber, sulphur, biniodide of mercury, biniodide of mercury and barium, monobromide of naphthalene.

Mr. KYNGDON exhibited a new microtome by Zeiss, a binocular microscope by Anderson, with a new combination fine adjustment and a new form of achromatic condenser.

Mr. PEDLEY showed a beautiful form of gorgonia spicule from the Amazon.

Dr. MORRIS exhibited a pus corpuscle, having radiating pseudopodia, from a case of chronic cystitis, stained by a new fluid and mounted in a new medium.

Mr. HIRST showed the bright scarlet stentor *Stentor igneus*, from a pond in the Botanic Gardens.

Dr. MORRIS—*A. pellucida*, mounted in phosphorus, beautifully resolved with Powell and Lealand's new $\frac{1}{4}$-in. oil immersion objective, having an angle of 112°.

9 JUNE, 1884.

Mr. G. D. HIRST in the Chair.

Dr. MORRIS exhibited Spencer's new $\frac{1}{10}$-in. homogeneous immersion objective, having a numerical aperture of 1·37, and balsam angle 127°—in every respect a superb glass; also a new fluid for homogeneous objectives, viz., oil of resin, used pure, or thinned with oil of cedar.

14 JULY, 1884.

Dr. MORRIS exhibited a series of slides of a filarial worm, *Strongyius bronchialis*, found in the extreme ends of the bronchial tubes of sheep.

Dr. WRIGHT showed a slide mounted by Mr. Hy. Sharpe, of Adelong, of the proboscis of the blowfly, mounted in biniodide of mercury, and showing minute membraneous structure whereby the insect appears to be able to close or protect the orifices through which it sucks the juices that form its food: also a series of test diatoms prepared by J. D. Möller in the highly refractive medium biniodide of mercury and iodide of potassium.

Dr. MORRIS showed *A. pellucida*, mounted by Prof. Smith, of Geneva, New York, in a medium known only to himself; also a slide of the same diatom mounted by himself in phosphorus, and resolving in a manner quite equal to Prof. Smith's celebrated slide.

11 AUGUST, 1884.

Mr. G. D. HIRST in the Chair.

The CHAIRMAN showed the supposed roe of an eel.

Dr. WRIGHT—Tolles' $\frac{1}{25}$-in. homogeneous objective, with a new front made by Green of Boston.

Dr. MORRIS—Four forms of parasites found in the body of a diseased sheep, viz., the liver fluke, *Distoma hepatica*; the stomach worm, *Strongylus contortus*; the tapeworm, *Tœnia expansa*; and the intestinal worm, *Dochmius hypostomus*.

8 SEPTEMBER, 1884.

Mr. G. D. HIRST in the Chair.

Mr. HASWELL described his new microtome based upon Mr. Caldwell's pattern, but with a new ribbon take-off of a very ingenious construction.

Dr. MORRIS exhibited a new mounting medium, having a refractive angle of 2·6, the highest known, and comparing favourably with the celebrated one of Professor Smith, of Geneva, New York.

Sulphur is melted on the slide, and the cover to which the diatoms are attached is dropped upon and pressed down upon the sulphur. The refractive index of sulphur is 2·, also selenium and sulphur ground and mixed together, and the slide prepared as above—R. index about 2·3; also selenium by itself—R. index, 2·6.

With all the above media *A. pellucida* was splendidly resolved. These experiments by Dr. Morris were undertaken with a view of enabling objectives of the older constructions and of less angular aperture to resolve the highest test diatoms as easily as the new wide-angled homogeneous lenses. Dr. WRIGHT showed several preparations of the feet of flies, mounted by Mr. Hy. Sharp of Adelong, in biniodide of mercury, and using Tolles' $\frac{1}{10}$ objective. The intention was to decide if the pulvili or the fine hairs fringing the feet exuded a fluid or had a cup-like termination, but sufficient data were not forthcoming. Mr. LANE exhibited three slides of C. Fasoldt's celebrated micrometric rulings, advancing from 5,000 to 120,000, 200,000, and 250,000 lines to an inch respectively. Mr. HASWELL, a slide of serpula prepared by Mr. Caldwell's automatic microtome, containing 100 consecutive sections $\frac{1}{3000}$ inch in thickness; Mr. WHITELEGGE, slides of mosses, gathered in the neighbourhood of Sydney, of the species *Phasium*, showing the capsules with spores in progressive series of developement.

13 OCTOBER, 1884.

Mr. G. D. HIRST in the Chair.

Dr. MORRIS exhibited Powell and Lealand's new solid front $\frac{1}{20}$ oil immersion objective, with a numerical aperture of 1·38; also a series of mounting media in which sulphur has been dissolved, viz., Canada balsam, liquid amber, chinoline, mono-bromide of napthalene.

17 NOVEMBER, 1884.

Mr. G. D. HIRST in the Chair.

Mr. HIRST exhibited *A. pellucida* resolved by Zeiss's $\frac{1}{8}$ water immersion objective, in a manner scarcely to be surpassed by the new oil immersion objectives. The diatom was mounted in sulphur—this proving Dr. Morris's theory that a highly refractive mounting media enables low-angled objectives to compete in resolution with the new oil immersions; also a brass turntable on Aylward's principle, made by himself. Mr. FRASER showed a slide of the micro-fungus, an œcidium that infests the orange trees of the Ryde district.

8 DECEMBER, 1884.

Mr. G. D. HIRST in the Chair.

Mr. PEDLEY showed several beautiful slides of spicules of sponges and gorgonia collected and prepared by Mr. Durrand, a visitor present, and a member of the Quekett Microscopical Society. Mr. WEISENER showed a collection of very choice slides by Wheeler of London. Dr. MORRIS—*A. pellucida* mounted in a film of pure metallic silver, and resolved easily by Powell and Lealand's $\frac{1}{4}$ water immersion objective—Refractive index, 2·3.

MEDICAL SECTION.

The Medical Section of the Royal Society held a preliminary meeting for the election of officers, on the 18th of April, 1884.

The following were elected:—Chairman: Dr. H. N. MacLaurin. Secretaries: Mr. Thomas Evans, M.R.C.S.E., and Dr. Hurst. Committee: Dr. Fortescue, Dr. Brady, Dr. Shewen, Dr. Manning, Dr. Oram, and Dr. Craig Dixon.

Five general meetings were held during the session; they were well attended, and were amply supplied with subjects for discussion.

Although in point of importance there were not so many papers read as during the previous session, yet, in exhibits of pathological and microscopical specimens and in the number of medical and surgical cases reported, it exceeded its predecessor; the remarks and discussions thereon always occupied a period longer than that allotted to the meeting by the rules of the Section.

Papers were read by Dr. Manning, on "Cases of Mental Disturbance after injury to the Head, with particular reference to Loss of Memory"; by Dr. Foreman, on "A case of Ovariotonus"; by Dr. Cosby Morgan, on "A case of Fracture of the Cervical Vertebræ"; "Two cases of Fracture of the Skull," and "A case of Hydated Cyst," by Dr. Chambers; on "A case of ruptured Ovarian Cyst, with recovery," by Dr. Williamson; on "A Lunatic who died after swallowing some metal buttons," by Dr. Eric Sinclair and Dr. Jenkins.

Exhibits were made by Drs. Carruthers, Evans of Balmain, Sinclair, Foreman, Professor Anderson Stuart, Drs. Deck, MacCormick, Jenkins, Knaggs, and Goode.

H. N. MACLAURIN, Chairman.

THOMAS EVANS,
GEORGE HURST, } Secretaries.

Cases of Mental Disturbance after Injury to the Head, with particular reference to Loss of Memory.

By F. NORTON MANNING, M.D., Inspector-General of the Insane.

[*Read before the Medical Section of the Royal Society of N. S. W., 20 June, 1884.*]

CASE 1.—Some years ago a neighbour and friend presented himself with a generally dishevelled appearance at my office, and informed me, with some minuteness of detail, that he had been thrown from his horse owing to suddenly putting up his umbrella, at which his horse, shied; that he was stunned for a short time; that a man had caught his horse and assisted him to remount, and that not feeling very well he had come direct to me. His manner was so strange that I thought it best to see him home, and during the short walk thither he repeated to me over and over again, with wearisome reiteration, the detailed story of his fall. I left him in bed, with strict injunctions to stay there, and then found the man who had witnessed the accident, and discovered that the account given to me was correct, that the head had struck the ground, and that there was insensibility for two or three minutes. The next morning my patient remembered everything up to the time of the fall, even the fall itself and the cause of it, but all else was a blank. The assistance rendered him to remount his horse, his visit to me, our walk to his home, and our talk by the way, had never been recorded on the tables of his memory. No serious symptoms followed; headache, at first troublesome, disappeared in two or three days, and after some days rest and quiet my patient resumed his ordinary professional work, apparently none the worse for the accident. Such cases are not uncommon, and are indeed met with by most medical men in active practice. Their main interest lies in the loss of memory, on which I shall have something further to say.

In the next case, which was under the care of Dr. R. J. Garden, the loss of memory extended over a longer period, and the injury was more severe.

CASE 2.—A man when drunk fell down a stone staircase, lighted on the back of his head, and was admitted into hospital on October 16. There was a contused wound of the scalp nearly 2 inches long and exposing the pericranium. No slit or depression in the bone could be found. Blood issued in moderate quantity from the nose and left ear. There was insensibility, with relaxed muscles, pallor, cold surfaces, regular somewhat dilated pupils, and shallow quiet breathing, with occasional sighing. Pulse 60, small and uneven. On the next day the insensibility had somewhat diminished; there was restlessness, some irritability when disturbed, and incoherence of speech when roused. Pulse 100, fuller and more even; temperature 101. No fluid from ear, and nothing to point to fracture of base of skull. On the 19th the insensibility had disappeared, the patient was restless, irritable, confused, and incoherent, with a pulse of 108, and an evening temperature of 103. Under cold to head, purgatives, complete rest and quiet, the temperature subsided, and the patient became more rational. Three weeks after the accident the memory continued much impaired; there was a loss of recording power for recent events, the manner was peculiar, there was occasional pain in the head and dizziness on standing up. He was deaf in the left ear, where a raw line extended across the tympanum. The pulse and temperature were normal. The memory slowly returned, and the patient progressed to complete recovery.

Case 3.—T. T., aged 46, a storekeeper, and sharp man of business, when inspecting a new store in process of erection, stepped back and fell into an excavation for a cellar about 12 feet deep, striking his head violently. He was attended by Dr. MacQueen, to whom I am indebted for particulars of the early symptoms. The first were those of concussion, and as these passed off symptoms of cerebral irritation supervened, and subsequently there were *hallucinations* of sight and hearing, complete loss of the sense of taste, great restlessness, and many of the symptoms of subacute mania. He was admitted into the Licensed House for the Insane at Cook's River, on October 27, 1881, one month after the accident, and I saw him on the following day. His expression was vacant and peculiar, his manner restless and fussy, he answered some questions rationally, but displayed a number of exalted delusions. He claimed as his own all the property around the asylum, had an exaggerated idea of his business capabilities, and spoke of having just ridden and won a horse-race. His memory was extremely defective. He had no knowledge whatever of his accident, and stoutly denied that he had been in any way ill or under medical care. No single event which had happened since the accident had made any impression on his memory. He had no idea even how he had travelled from home to Cook's River, and, further, he was considerably astray, as I ascertained from Dr. MacQueen and his brother, as to the events of his past life. With all this his manners were those of a gentleman, and on any reference to minor business topics he appeared shrewd and intelligent. The pulse ranged from 92 to 96, and the temperature was slightly more than normal. Three weeks after admission (seven weeks after the accident), when I again saw him, the pulse was less rapid, the temperature was normal, his manner was less fussy, and his general appearance had improved. He had no remembrance of having seen me before, and I found that, though he recognized intimate friends who visited him, and spoke to them freely, he had no remembrance at the next visit (even though the interval was only a day or two) of having recently seen them, and a few minutes after the visits had no remembrance of the conversation which had passed. There was no remembrance of the accident, and he gave a perfectly apocryphal account of how he came to the asylum, and imagined that he had started from some new diggings and not from home. The sense of taste had returned, and the exalted delusions, though still present, found less ready and frequent expression. By the middle of December, more than two months after admission, and more than three months after the accident, the delusions had all but vanished, and the memory had much improved; the registering or recording power for recent events was nearly, if not quite, re-established, and his account of his past history was connected and correct. The period from the accident until about one month after admission was an absolute blank. He was discharged at the end of December, went to Tasmania, and came and saw me in the beginning of February, 1882, apparently quite well. In October, 1882, Dr. MacQueen wrote of him as recently married, and added, "his memory appears perfect, and I notice no alteration in him, though his brother and partner says he is less attentive to business, and that liquor affects him more than before the accident."

In this case, and also in the two following, in addition to the amnesia, the marked exaltations and delusions of grandeur and wealth are interesting symptoms to the consideration of which I propose to advert in a subsequent part of this paper.

Case 4.—F.P.V., aged 49, a member of our profession, of temperate habits, and in active practice, was riding hurriedly to see a patient, in the middle of November, 1878, when his horse "propped" at a ditch, and he fell, pitching on to his head. He was picked up insensible, and remained more or less unconscious for a fortnight. There was bleeding from the ear, sub-conjunctival hæmorrhage, and other symptoms of fractured base of skull. When he recovered consciousness he was restless, fidgetty, and discontented; there was great loss of memory, and it was noticed that his mind was astray. He exhibited numerous extravagant delusions, and on one occasion was violent and made an attack on his wife. He was seen by Dr. Cox, by whose advice, after a short period of treatment, he was sent to Gladesville Hospital, on January 18, 1879. On admission (two months after the accident) the temperature was normal, and the chief physical symptoms were those of debility. He was thin and out of condition, and looked as if he had suffered from a long and exhausting illness. His demeanour was quiet and gentlemanly, and he answered ordinary questions rationally and freely. He had not the slightest remembrance of his accident, or of any event which had happened in the two months which had since elapsed, and insisted that he came from India eight days ago, to see a sister who was ill in the hospital. He could not remember that he had ever lived at Adelong, where he was in practice for years, and described himself as the Commander of a Russian man-of-war, and the absolute owner of several large ships, and of considerable wealth. He knew the attendants who were constantly with him, and recognized the medical officers at their daily visits, but in an hour or so forgot that he had seen them. He occupied himself in reading newspapers and books, but did not appear to retain what he read, and he was interested in the ordinary amusement and life of the hospital. A month after his admission (three months after the accident) his wife visited him; he recognized, and seemed very pleased to see her, but in a short time had no remembrance of her visit. The recording power seemed absolutely gone. He seemed to have forgotten all about his home and the practice of his profession, and even his professional knowledge seemed lost. His delusions (all having reference to wealth and importance) were very numerous, and he was at times irritable, especially as to his detention, though, as a rule, most gentlemanly and well-conducted. By the end of April, upwards of five months after the accident, he was much stouter, the delusions had almost disappeared, his memory was improving, and he began to speak on professional subjects. In June his delusions had altogether disappeared, and the memory had so much improved that current events were duly registered, and his past life easily recalled. His accident, and all events subsequent to it, until within the last six weeks, had, however, left no impression on his mind. He returned to the practice of his profession, and died in the year 1881, from causes unconnected (so far as I could discover) with his accident.

Case 5.—J. K., aged 40. Like the last patient was a member of the medical profession, and as I eventually ascertained, after much correspondence and trouble, was of intemperate habits, and had led a wandering and unsettled life. After some years practice in Ireland, he served as medical officer in the Paraguayan army, then lived for some time on the western coast of South America, was wrecked in the Pacific, landed on one of the South Sea Islands, was rescued by a ship bound to Melbourne, and in Melbourne was engaged by the agent as surgeon to one of the San Francisco steamers, which he joined in Sydney. In March, 1870, whilst his ship was in Sydney, he fell, whilst in a state of intoxication, from a first floor balcony of a house in Macquarie-street, and was taken to the Sydney Infirmary. He was unconscious for some hours, and on recovery was found to have lost his memory and to be peculiar in manner. He was admitted to Gladesville in the month of April, 1870, and was then in average general health, though somewhat thin and pale; the pulse was quiet and the temperature normal. He was exceedingly polite and gentlemanly in manner and correct in habits, and expressed himself as very contented with his surroundings. He had various extravagant delusions as to his importance and wealth, and spoke frequently of his knowledge of and association with eminent and wealthy people. He had not the slightest remembrance of the accident or of any events since, and beyond the fact that he was an Irishman and a doctor nothing as to his past life could be obtained from him. There was complete absence of the registration or conservation of new impressions. He did not even recognize the medical officers as they visited him from day to day, and though he read the newspapers, he had no idea what they contained.

Six months afterwards he was more intelligent, could remember the names of and recognize people he saw frequently, and gave some particulars of his past life when questioned, but recollection involved an effort, and, as he pathetically said, it was harder for him to remember these things than it was at one time to pass a college examination. A year after admission the extravagant delusions were somewhat less prominent, his memory for distant events was much better, but all his medical knowledge had absolutely vanished, and the impression made by current events was so slight that it seldom lasted beyond three or four days.

After this time some troublesome ulcerations appeared in various parts of the body, which were evidently syphilitic and yielded to iodide of potassium. There has been no further mental improvement, and no retrogression. He is now at Callan Park, and is always polite in manner and correct in habits. He is able to read and to play simple games, recognizes his immediate associates and frequent visitors, and his feelings and emotions are correct and apparently unimpaired, but the intellectual faculties and ideas, and professional knowledge, are almost effaced; the registration of new impressions is very faint, and the record when made seldom lasts more than a few days.

As a preliminary to discussing the pathology of the cases the notes of which I have read, it is necessary to point out, first, that though "there is memory in every nerve cell," to use Mandesby's words, in its highest forms it is an organization extending widely through the cortical layers of the cerebral hemispheres; and second, that in the three cases in which the loss of memory was both marked and prolonged, the parts of the memory most affected were those which are the first to fail in progressive amnesia due to old age, or accompanying the dementia of chronic brain disease. In these conditions forgetfulness, limited at first to recent events, extends to ideas, to intellectual acquisitions, the technique of science and professional knowledge. Then personal recollections are obliterated; whilst the feelings and emotions which are the most profound, the most common, and the most tenacious of the phases of mental activity, and the organic acquisitions, the aptitude for mechanical work, the routine of daily life, and the habits which become more or less automatic or instinctive, require only a minimum of conscious memory, and have their seat in the cerebral ganglia—the medulla and spinal chord,—remain until the last. Pathological destruction indeed appears to attack first, and in many cases to be limited to the most highly developed and most unstable forms of memory, to those which have a personal character, are accompanied by a consciousness and localization in time, and constitute what may be called the "Psychical memory." According to Ribot, "progressive destruction of memory follows a logical order, *it advances progressively from the unstable to the stable.* It begins with the most recent recollections which, lightly impressed upon the nervous elements, rarely repeated, and consequently having no permanent associations, represent organization in its feeblest forms, and it ends with the sensorial instinctive memory which becomes a permanent and integral part of the organism, and represents organization in its most highly developed state." From the researches of Griesinger, Foville, and others, it would appear that the pathological cause of this intellectual dissolution is "an atrophy *which first invades the exterior cerebral layers,* and then penetrates to the white substance, causing a fatty and atheromatous degeneration of cells, tubes, and capillaries of the nervous tissue," so that these elements, a prey to atrophy and degeneration, are no longer capable of the conservation of new impressions. If the perception is entirely new it is either not registered at all in the nervous centres, or if registered the impression is faint and soon effaced, whilst new modifications and dynamical associations of cells are either impossible, or if possible, are not permanent. Bearing these facts in mind, and turning to cases of more or less temporary amnesia, we cannot pass over the most common form with which we are acquainted—that due to epilepsy. In attacks of *petit mal* and epileptic vertigo, although the outward signs of disturbance are in some cases extremely slight, the temporary loss of memory is often complete, and the *mental automatism* is hardly distinguishable from that seen in some cases of injury to the head. The pathological condition in these cases is, according to Hughlings Jackson, who in the 5th vol. of the West Riding Asylum Reports enters at length into this question, one of exhaustion of the cells forming the highest nervous centres, due to a nervous "discharge" during the paroxysms, but there is probably at the same time a disordered condition of the cerebral circulation in the corvex, continuing for some time after the "discharge" has occurred, and interfering with the nutrition of the cerebral matter.

We may note in passing that the ultimate consequence of repeated epileptic seizures, especially in the form of vertigo, is the progressive and final destruction of psychical memory.

In all the cases which I have related the first symptoms were those of concussion—in the first case were limited to these—and it is necessary to inquire in what this somewhat mysterious condition consists. The theory put forward by Rokitanski and Nelaton, that the symptoms are due to minute extravasations of blood in the brain, may be passed over, because it has been repeatedly ascertained by *post mortem* examination that these small apoplexies are in some cases entirely absent, and all that can be inferred from their presence is that concussion and extravasation occasionally co-exist. Such was indeed probably the condition in the third case I have given, in which there was loss of taste, due to some injury or extravasation, caused by counter-stroke in the lower part of the temporo-sphenoidal lobe, where, according to Ferrier, the centres of taste and smell are localized in immediate relation to each other. The remaining theories of concussion are:—

1st. That propounded by Fischer, of Breslau, who believes that the blow on the head produces reflex paralysis of the vessels of the brain and serious interference with the nutrition of the cerebral ganglia, and points out that an empty state of the arteries and a congested state of the veins is the only condition which is found on *post mortem* examination constantly accompanying the symptoms which clinical observation discovers to be those of concussion.

2nd. A modification of the old vibration theory of Pott, which supposes a molecular disturbance of the protoplasm of the tissues of the brain, which is accompanied by an impairment or abolition of their functions.

It appears to me highly probable that in extreme and prolonged cases, such as some of those I have narrated, both these theories are required to explain the symptoms. Fischer's theory is no doubt sufficient to explain the symptoms of concussion, and the very temporary loss of memory which as a rule accompanies it, but it is difficult to imagine the reflex paralysis of the vessels lasting long enough to interfere with the nutrition of the cerebral elements, so as to cause anything like a prolonged wasting and loss of function, which there is every reason to believe existed in the three last cases cited, unless there had been some molecular disturbance in the nerve cells themselves; though of course it is possible that sudden changes in the blood supply may alone be sufficient to initiate these.

There can I think be no doubt but that the prolonged loss of memory in the cases mentioned was due to minute or molecular changes in, and to subsequent want of nutrition of, the nervous elements in the cortical layers of the cerebral hemispheres, and that as nutrition and health were re-established the memory returned. The whole history of the cases puts any question of coarse pathological changes out of consideration.

In the fifth and last case there was no return of function beyond a certain point, and in this there were the complications of syphilis and alcoholic excess. It is to the latter that I attribute the failure, as amnesia is one of the most frequent and marked symptoms of cerebral degeneration, due to chronic alcoholic poisoning. The mental exaltation, accompanied by delusions of grandeur, which was distinctly present in the 5th case, was extremely marked in the 3rd and 4th cases, and it is somewhat curious that I have not been able to find recorded any cases of brain affection due to injury in which similar symptoms have been observed, but they have been noticed in some cases of acute mania and of multiple schlerosis, and in rare cases of chronic cerebral softening or multiple thrombosis such as those recorded by Dr. Gasquet in the *Journal of Mental Science* for April, 1884. The existence of delusions in the cases I have detailed is no doubt due to the fact that the original injury or disease involved the highest co-ordinative plexuses of the cerebral corvex, and that with the temporary abolition of functions of these centres the lower centres, no longer controlled, were thrown or sprang into activity. The patients lived from moment to moment without memory of what they had been. But why the delusions took this particular form of grandeur and extravagance, and whether this was due to pathological or physical changes, or was due to temperament, I can offer no explanation, though I would point out that in all these cases there was a stage of irritation or inflammation with increased blood supply, involving an augmentation of functional activity. These delusions undoubtedly possess a diagnostic importance, and in the 3rd case a most careful examination was necessary to make certain that the patient was not suffering from that clinical entity which we know as *general paralysis*, and under which, owing to hasty examination, some very different forms of disease are at times included.

In the cases above mentioned there were no delusions as to muscular strength or personal beauty, and these are present in the great majority of cases of general paralysis, and materially assist in the correct diagnosis of that affection. I have brought these cases under your notice because they appear to me interesting by reason of the pathological problems involved in them, and as showing, as far as two of them are concerned, how completely psychical memory may be re-established, even after long absence, when the loss has been due to uncomplicated injury to the head.

APPENDIX.

ABSTRACT OF THE METEOROLOGICAL OBSERVATIONS TAKEN AT THE SYDNEY OBSERVATORY.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, $10^h\ 4^m\ 50{\cdot}81^s$; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

JANUARY, 1884.—GENERAL ABSTRACT.

Barometer At 32° Faht., but not corrected to sea-level.	Highest Reading... ...	30·144 inches on the 30th, at 10 a.m
	Lowest Reading	29·181 ,, on the 21st, at 12 a.m.
	Mean Height	29·697

(Being 0·071 inch less than that in the same month on an average of the preceding 25 years.)

Wind	Greatest Pressure ...	21·8 lbs. on the 17th.
	Mean Pressure	0·6 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 25 years, N.E.)

Temperature	Highest in the Shade ...	100·8 on the 14th.
	Lowest in the Shade ...	54·4 on the 18th.
	Greatest Range	36·5 on the 14th.
	Highest in the Sun ...	156·7 on the 14th.
	Lowest on the Grass ...	48·3 on the 30th.
	Mean Diurnal Range ...	14·8
	Mean in the Shade ...	71·6

(Being 0·3 greater than that of the same month on an average of the preceding 25 years.)

Humidity ...	Greatest Amount ...	96·0 on the 16th.
	Least	27·0 on the 21st and 22nd.
	Mean	67·1

(Being 5·6 greater than that of the same month on an average of the preceding 25 years.)

Rain	Number of Days	8 rain and 3 dew.
	Greatest Fall	0·337 inches on the 18th.
	Total Fall...	{ 0·513 ,, 65 ft. above ground. 0·856 ,, 15 in. above ground.

(Being 2·789 inches less than that of the same month on an average of the preceding 25 years.)

Evaporation	Total Amount	4·303 inches.
Electricity ...	Number of Days Lightning	2
Cloudy Sky ...	Mean Amount	6·0
	Number of Clear Days ...	0
Meteors ...	Number observed ...	0

Remarks.

At Sydney, pressure, temperature, and wind have been about the average; but the rainfall was only 0·856, or 2·789 inches below the average. In the country the weather has been hot and dry, particularly in the western districts, over a large part of which not a drop of rain has fallen, the rest of the Colony getting only light rains of little use.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, $10^h\ 4^m\ 50{\cdot}81^s$; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

FEBRUARY, 1884.—GENERAL ABSTRACT.

Barometer ... Highest Reading ... ... 30·179 inches on the 6th, at 10 a.m.
At 32° Faht., but not corrected to sea-level.
Lowest Reading ... ... 29·216 „ on the 3rd, at 2 p.m.
Mean Height ... ... 29·838

(Being 0·034 inch greater than that in the same month on an average of the preceding 25 years.)

Wind ... ... Greatest Pressure ... 13·0 lbs. on the 3rd.
Mean Pressure ... ... 0·8 lb.
Number of Days Calm ... 0
Prevailing Direction ... N.E.

(Prevailing direction during the same month for the preceding 25 years, S.)

Temperature Highest in the Shade ... 91·9 on the 22nd.
Lowest in the Shade ... 56·8 on the 25th.
Greatest Range ... ... 23·2 on the 22nd.
Highest in the Sun ... 143·0 on the 14th.
Lowest on the Grass ... 45·3 on the 25th.
Mean Diurnal Range ... 13·6
Mean in the Shade ... 72·0

(Being 1·2 less than that of the same month on an average of the preceding 25 years.)

Humidity ... Greatest Amount ... 96·0 on the 19th.
Least ... ... 41·0 on the 1st.
Mean ... ... 68·6

(Being 6·1 less than that of the same month on an average of the preceding 25 years.)

Rain ... ... Number of Days ... ... 8 rain and 0 dew.
Greatest Fall ... ... 0·254 inches on the 28th.
Total Fall... ... { 0·511 „ 65 ft. above ground.
{ 0·791 „ 15 in. above ground.

(Being 5·320 inches less than that of the same month on an average of the preceding 25 years.)

Evaporation Total Amount ... ... 3·412 inches.

Electricity ... Number of Days Lightning 1.

Cloudy Sky ... Mean Amount ... ... 5·6
Number of Clear Days ... 0.

Meteors ...Number observed ... 0.

Remarks.

This month has been cooler than usual and very dry; at Sydney the rainfall has been 5·320 short of the average, and over a very large part of the Colony this has been a very dry month, the majority of the stations having had less than an inch of rain, and only a few of the coast and high land stations have had more than two inches. Bingara heads the list with 4·22 inches. In very many cases the amount for January and February together is not equal to the requirements of one month, and it represents the total for two months,—a fact which shows the extreme dryness of the season.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, $10^{h}\ 4^{m}\ 50{\cdot}81^{s}$; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

MARCH, 1884.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·267 inches on the 6th, at 10 p.m.
At 32° Faht., but not corrected to sea-level.	Lowest Reading	29·548 „ on the 10th, at 3 p.m.
	Mean Height	29·961

(Being 0·071 inch greater than that in the same month on an average of the preceding 25 years.)

Wind	Greatest Pressure ...	15·1 lbs. on the 17th.
	Mean Pressure	0·5 lb.
	Number of Days Calm ...	2.
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 25 years, N.E.)

Temperature	Highest in the Shade ...	90·2 on the 1st.
	Lowest in the Shade ...	51·8 on the 17th.
	Greatest Range	22·3 on the 1st.
	Highest in the Sun ...	143·7 on the 9th.
	Lowest on the Grass ...	45·7 on the 17th.
	Mean Diurnal Range ...	13·9
	Mean in the Shade ...	68·4

(Being 0·9 less than that of the same month on an average of the preceding 25 years.)

Humidity ...	Greatest Amount ...	94·0 on the 12th.
	Least	41·0 on the 26th.
	Mean	67·2

(Being 9·1 less than that of the same month on an average of the preceding 25 years.)

Rain	Number of Days	9 rain and 2 dew.
	Greatest Fall	0·349 inches on the 18th.
	Total Fall...	0·670 „ 65 ft. above ground.
		1·260 „ 15 in. above ground.

(Being 3·720 inches less than that of the same month on an average of the preceding 25 years.)

Evaporation	Total Amount	2·647 inches.
Electricity ...	Number of Days Lightning	0
Cloudy Sky ...	Mean Amount	5·0
	Number of Clear Days ...	0
Meteors ...	Number observed ...	0

Remarks.

This month has been very dry in and around Sydney, and the barometer higher than usual. Inland, and on part of the coast near Sydney, there has been very little rain, but in the north and south-east districts there has been a moderate rainfall. Dry as the month has been, very few stations were without rain all the month, but in the great majority of cases the little rain that did fall was not sufficient to afford any relief.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10^h 4^m 50·81^s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

APRIL, 1884.—GENERAL ABSTRACT.

Barometer ... Highest Reading... ... 30·354 inches on the 30th, at 8 a.m.
At 32° Faht., but not corrected to sea-level.
Lowest Reading ... ... 29·547 „ on the 25th, at 1 a.m.
Mean Height ... ... 29·991.
(Being 0·062 inch greater than that in the same month on an average of the preceding 25 years.)

Wind ... ... Greatest Pressure ... 16·2 lbs. on the 7th.
Mean Pressure ... ... 0·7 lb.
Number of Days Calm ... 1
Prevailing Direction ... S.
(Prevailing direction during the same month for the preceding 25 years, W.)

Temperature Highest in the Shade ... 76·1 on the 15th.
Lowest in the Shade ... 53·9 on the 27th.
Greatest Range ... ... 19·5 on the 23rd.
Highest in the Sun ... 132·0 on the 6th.
Lowest on the Grass ... 48·1 on the 23rd.
Mean Diurnal Range ... 10·2
Mean in the Shade ... 64·5
(Being 0·3 less than that of the same month on an average of the preceding 25 years.)

Humidity ... Greatest Amount ... 100·0 on the 6th.
Least ... ... 51·0 on the 23rd.
Mean ... ... 78·6
(Being 1·1 greater than that of the same month on an average of the preceding 25 years.)

Rain ... ... Number of Days ... ... 20 rain and 8 dew.
Greatest Fall ... ... 6·453 inches on the 6th.
Total Fall ... ... { 10·196 „ 65 ft. above ground.
12·701 „ 15 in. above ground. }
(Being 3·581 inches greater than that of the same month on an average of the preceding 25 years.)

Evaporation Total Amount ... ... 2·844 inches.

Electricity ... Number of Days Lightning 2

Cloudy Sky ... Mean Amount ... ... 6·6
Number of Clear Days ... 0

Meteors ... Number observed ... 0

Remarks.

Very heavy rain fell at Sydney on the night of April 5th, and the measure on the 6th gave 6·453 inches, and the total for the month 12·701 inches. The excessively dry weather of the previous four months continued to April 18th, when a general rain began, in which all parts of the Colony participated, the coast districts as usual getting the heaviest: at Sydney, 12·70; Cordeaux River, 22·00; other places, south, 6 to 10 inches; north, 6 to 18 inches; Liverpool Plains, and thence to the mountains, 1 to 3 inches; Bourke, and west of it, 1 to 1½ inch; Wentworth to Wilcannia, along the Darling and towards Cobar, Hillston, and Hay, ¼ to ¾ inch; thence eastward, 1 to 3½ inches; in the district indicated by Deniliquin, Wagga, and Albury, ½ to 2 inches. The total since January 1st is omitted where the returns are incomplete.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

MAY, 1884.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading... ...	30·369 inches on the 1st at 11 a.m.
	Lowest Reading	29·410 „ on the 13th at 3 p.m.
	Mean Height	29·997

(Being 0·093 inch greater than that in the same month on an average of the preceding 25 years.)

Wind	Greatest Pressure ...	14·6 lbs. on the 13th.
	Mean Pressure	0·5 lb.
	Number of Days Calm ...	6.
	Prevailing Direction ...	W.N.W.

(Prevailing direction during the same month for the preceding 25 years, W.)

Temperature	Highest in the Shade ...	71·1 on the 4th.
	Lowest in the Shade ...	45·7 on the 26th and 27th.
	Greatest Range	22·0 on the 17th.
	Highest in the Sun ...	118·3 on the 6th.
	Lowest on the Grass ...	37·4 on the 17th.
	Mean Diurnal Range ...	12·1
	Mean in the Shade ...	58·3

(Being 0·3 less than that of the same month on an average of the preceding 25 years.)

Humidity ...	Greatest Amount ...	100·0 on the 4th, 13th and 24th.
	Least	43·0 on the 14th.
	Mean	79·9

(Being 4·0 greater than that of the same month on an average of the preceding 25 years.)

Rain	Number of Days... ...	17 rain and 9 dew.
	Greatest Fall	2·550 inches on the 25th.
	Total Fall... ...	5·078 „ 65 ft. above ground.
		7·288 „ 15 in. above ground.

(Being 2·124 inches greater than that of the same month on an average of the preceding 25 years.)

Evaporation	Total Amount	1·434 inches.
Electricity ...	Number of Days Lightning	3.
Cloudy Sky ...	Mean Amount	5·5.
	Number of Clear Days ...	3.
Meteors ...	Number observed ...	0.

Remarks.

At Sydney, the rainfall has this month been 2·124 inches in excess of the average; but temperature and pressure have been near the average. 4·118 inches of the heavy rain was recorded on the 24th and 25th. In the country west of the dividing range, generally from 1 to 2 inches of rain fell, but at too many places the fall was under 1 inch. While on the coast generally very heavy rains fell, at Lismore the record was 16·82 inches.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, $10^h\ 4^m\ 50{\cdot}81^s$; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

JUNE, 1884.—GENERAL ABSTRACT.

Barometer ... Highest Reading... ... 30·295 inches on the 30th, at 10 a.m.
At 32° Faht., but not corrected to sea-level.
Lowest Reading ... ... 29·491 „ on the 11th, at 2 p.m.
Mean Height ... ... 29·941

(Being 0·020 inch greater than that in the same month on an average of the preceding 25 years.)

Wind ... ... Greatest Pressure ... 9·2 lbs. on the 11th.
Mean Pressure ... ... 0·6 lb.
Number of Days Calm ... 2.
Prevailing Direction ... W.

(Prevailing direction during the same month for the preceding 25 years, W.)

Temperature Highest in the Shade ... 66·5 on the 1st.
Lowest in the Shade ... 43·4 on the 24th.
Greatest Range ... ... 21·0 on the 25th.
Highest in the Sun ... 106·2 on the 12th.
Lowest on the Grass ... 34·5 on the 19th.
Mean Diurnal Range ... 12·5
Mean in the Shade ... 54·4

(Being 0·1 greater than that of the same month on an average of the preceding 25 years.)

Humidity ... Greatest Amount... ... 100·0 on the 3rd, 15th, and 23rd.
Least ... ... 43·0 on the 11th.
Mean ... ... 76·5

(Being the same as that for the same month on an average of the preceding 25 years.)

Rain ... ... Number of Days... ... 14 rain and 6 dew.
Greatest Fall ... ... 5·170 inches on the 16th.
Total Fall ... ... { 4·905 „ 65 ft. above ground.
{ 6·370 „ 15 in. above ground.

(Being 1·232 inch greater than that of the same month on an average of the preceding 25 years.)

Evaporation Total Amount ... ... 1·006 inches.
Electricity ... Number of Days Lightning 0
Cloudy Sky ... Mean Amount 5
Number of Clear Days ... 3
Meteors ... Number observed ... 0

Remarks.

At Sydney, barometer, temperature, and wind, have been very close to the average, and the rainfall 1·23 inches above the average. In the country, moderate rains, generally from 1 to 4 inches, have fallen this month. On the coast the rain has been heavier, and at Sydney 6·37 inches. The winter so far has been mild, with very little frost, and the rains, though not heavy enough to produce floods, are generally sufficient for present wants.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, $10^h\ 4^m\ 50{\cdot}81^s$; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

JULY, 1884.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading	30·321 inches on the 19th, at 9 a.m.
	Lowest Reading	29·783 „ on the 9th, at 1 a.m.
	Mean Height	30·051

(Being 0·109 inch greater than that in the same month on an average of the preceding 25 years.)

Wind	Greatest Pressure ...	14·0 lbs. on the 4th.
	Mean Pressure	0·5 lb.
	Number of Days Calm ...	7
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 25 years, W.)

Temperature	Highest in the Shade ...	74·4 on the 12th.
	Lowest in the Shade ...	40·7 on the 20th.
	Greatest Range	26·1 on the 12th.
	Highest in the Sun ...	108·0 on the 22nd.
	Lowest on the Grass ...	30·1 on the 20th.
	Mean Diurnal Range ...	13·7
	Mean in the Shade ...	54·9

(Being 0·6 greater than that of the same month on an average of the preceding 25 years.)

Humidity ...	Greatest Amount ...	100·0 on the 8th.
	Least	51·0 on the 10th.
	Mean	81·7

(Being 6·8 greater than that of the same month on an average of the preceding 25 years.)

Rain	Number of Days... ...	15 rain and 11 dew.
	Greatest Fall	1·565 inches on the 3rd.
	Total Fall... ...	4·900 „ 65 ft. above ground.
		6·938 „ 15 in. above ground.

(Being 2·947 inches greater than that of the same month on an average of the preceding 25 years.)

Evaporation	Total Amount	1·969 inches.
Electricity ...	Number of Days Lightning	0
Cloudy Sky ...	Mean Amount	5·2
	Number of Clear Days ...	4
Meteors ...	Number observed ...	0

Remarks.

At Sydney the barometer has this month been 0·109 inches above the average, and temperature 0·6 higher than average, and the rain 2·95 inches above the average. Abundant rains fell along the coast and high lands this month, but very little in the western flat districts; in many cases the amount there is less than half an inch, and over a considerable area in the S.W. not a drop of rain fell. At Yallaroi the rain gauge leaked between 12· and 13·, and only 0·57 of rain was recorded. At the next station, 2·98 inches fell on the same day, and probably more fell at Yallaroi on that day.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10^h 4^m $50{\cdot}81^s$; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

AUGUST, 1884.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading... ...	30·319 inches on the 22nd, at 10 a.m.
	Lowest Reading	29·379 „ on the 26th, at 2 p.m.
	Mean Height	29·874

(Being 0·062 inch less than that in the same month on an average of the preceding 25 years.)

Wind	Greatest Pressure ...	25·9 lbs. on the 26th.
	Mean Pressure	0·7 lb.
	Number of Days Calm ...	3
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 25 years, W.)

Temperature	Highest in the Shade ...	82·0 on the 31st.
	Lowest in the Shade ...	42·8 on the 3rd.
	Greatest Range	27·8 on the 24th.
	Highest in the Sun ...	127·2 on the 31st.
	Lowest on the Grass ...	33·8 on the 3rd.
	Mean Diurnal Range ...	16·6
	Mean in the Shade ...	56·9

(Being 2·0 greater than that of the same month on an average of the preceding 25 years.)

Humidity ...	Greatest Amount ...	97·0 on the 2nd.
	Least	30·0 on the 26th.
	Mean	67·3

(Being 4·9 less than that of the same month on an average of the preceding 25 years.

Rain	Number of Days	9 rain and 8 dew.
	Greatest Fall	0·318 inch on the 21st.
	Total Fall...	0·540 „ 65 ft. above ground.
		0·829 „ 15 in. above ground.

(Being 2·206 inches less than that of the same month on an average of the preceding 25 years.)

Evaporation	Total Amount	2·086 inches.
Electricity ...	Number of Days Lightning	2
Cloudy Sky ...	Mean Amount	3·1
	Number of Clear Days ...	7
Meteors ...	Number observed ...	0

Remarks.

This month the barometer at Sydney has been slightly below and the temperature 2·0 greater than the average, and humidity was 4·9 below the average. Rain also was 2·21 inches less than the average. In the country, August has been a very dry month, and, with the exception of one or two comparatively small areas, the rainfall has been under 1 inch (and in many places less than ½ an inch). Even the coast has not escaped the dry weather. In Sydney, the total fall, January 1 to August 30, was 37·03 inches, and the average for the same period 38·62 inches. The weather was also remarkably warm for the season.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10^h 4^m $50{\cdot}81^s$; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

SEPTEMBER, 1884.—GENERAL ABSTRACT.

Barometer ...	Highest Reading	30·338 inches on the 5th, at 10 a.m.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29·356 on the 10th, at 2·30 p.m.
	Mean Height	29·896
(Being 0·020 inch greater than that in the same month on an average of the preceding 25 years.		
Wind	Greatest Pressure ...	15·7 lbs. on the 21st.
	Mean Pressure	0·4 lb.
	Number of Days Calm ...	3
	Prevailing Direction ...	N.E.
(Prevailing direction during the same month for the preceding 25 years W.)		
Temperature	Highest in the Shade ...	80·9 on the 23rd.
	Lowest in the Shade ...	42·8 on the 13th.
	Greatest Range	29·9 on the 20th.
	Highest in the Sun ...	130·0 on the 23rd.
	Lowest on the Grass ...	32·9 on the 12th.
	Mean Diurnal Range ...	15·7
	Mean in the Shade ...	58·9
(Being 0·2 greater than that of the same month on an average of the preceding 25 years.)		
Humidity ...	Greatest Amount ...	94·0 on the 17th and 30th.
	Least	36·0 on the 2nd.
	Mean	65·8
(Being 4·4 less than that of the same month on an average of the preceding 25 years.)		
Rain	Number of Days	11 rain and 5 dew.
	Greatest Fall	0·892 inch on the 27th.
	Total Fall...	0·760 „ 65 ft. above ground.
		1·125 „ 15 in. above ground.
(Being 2·103 inches less than that of the same month on an average of the preceding 25 years.)		
Evaporation	Total Amount	2·596 inches.
Electricity ...	Number of Days Lightning	1
Cloudy Sky ...	Mean Amount	4·0
	Number of Clear Days ...	3
Meteors ...	Number observed ...	0

Remarks.

At Sydney, temperature and pressure have been about the average for this month, but the humidity is again 4·4 below, and the rainfall 2·10 inches below the average. To the monthly rainfall for this month, which was published in the *Herald*, a column was added showing the rainfall of 1883 up to 30th September in that year, for comparison with the total rainfall of the present year up to September 30, from which it appears that generally 1884 has been drier than 1883. It will also show that the drought has been more severe on the coast than in the west. At Cape George the total rainfall of 1884 is 16 inches less than 1883, at Port Macquarie 13 inches, at Newcastle 7 inches, at Sydney 2 inches. On the high lands also the loss in many places has been serious. At Inverell it is 5½ inches, at Armidale 5 inches, Warialda 5½ inches. At other stations the rainfall of 1884 is greater; at Barraba 2¼ inches, at Boolcarrol nearly 4 inches, &c. In the flat country, for instance at Bourke, 1884, it is rather greater than 1883; at Louth 1 inch less, at Wentworth 1 inch more, at Deniliquin 2½ inches less, Hay 2¼ inches less, at Forbes 1 inch less, at Dubbo 8½ inches greater, at Wagga Wagga 1 inch less. When it is remembered how dry it was in 1883, the significance of the above statements will be seen.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10^h 4^m $50{\cdot}81^s$; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

OCTOBER, 1884.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·275 inches on the 14th.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29 137 on the 8th.
	Mean Height	29·791

(Being 0·040 inch less than that in the same month on an average of the preceding 25 years.)

Wind	Greatest Pressure ...	14 6 lbs. on the 10th.
	Mean Pressure	0·7 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	S.

(Prevailing direction during the same month for the preceding 25 years, N.E.)

Temperature	Highest in the Shade ...	89·9 on the 17th.
	Lowest in the Shade ...	49·3 on the 11th.
	Greatest Range	35·3 on the 17th.
	Highest in the Sun ...	143·8 on the 17th.
	Lowest on the Grass ...	40·1 on the 10th.
	Mean Diurnal Range ...	14·0
	Mean in the Shade ...	63·3

(Being 0·1 greater than that of the same month on an average of the preceding 25 years.)

Humidity ...	Greatest Amount... ...	93·0 on the 7th.
	Least	27·0 on the 17th.
	Mean	71·1

(Being 1·9 greater than that of the same month on an average of the preceding 25 years.)

Rain	Number of Days	21
	Greatest Fall	0·670 inch on the 22nd.
	Total Fall...	1·305 inches 65 ft. above ground. 2·185 „ 15 in. above ground.

(Being 0·952 inch less than that of the same month on an average of the preceding 25 years.)

Evaporation	Total Amount	3·342 inches.
Electricity ...	Number of Days Lightning	3
Cloudy Sky ...	Mean Amount	6
	Number of Clear Days ...	2
Meteors ...	Number observed ...	0

Remarks.

Barometer and pressure have again been about the average, and it is remarkable that while the humidity has been 1·9 greater than the average, the rainfall has been 0·95 inch less. During October moderate rains have fallen on the coast and high lands, and part of the western slopes south of Young; but generally rain is badly wanted, and the rains here recorded have done little or nothing to relieve this want; perhaps this may be better indicated by the fact that out of 325 stations reporting, 150 have had less than 1 inch of rain.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

NOVEMBER, 1884.—GENERAL ABSTRACT.

Barometer ...	Highest Reading	30·176 inches on the 9th, at 10 a.m.
At 32° Faht., but not corrected to sea-level.	Lowest Reading	27·508 on the 28th, at 2 a.m.
	Mean Height	29·867

(Being 0·067 inch greater than that in the same month on an average of the preceding 25 years.)

Wind	Greatest Pressure ...	12·5 lbs. on the 6th.
	Mean Pressure	0·8 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 25 years, S.)

Temperature	Highest in the Shade ...	79·9 on the 24th.
	Lowest in the Shade ...	51·8 on the 4th.
	Greatest Range	20·6 on the 12th.
	Highest in the Sun ...	143·2 on the 14th.
	Lowest on the Grass ...	43·5 on the 11th.
	Mean Diurnal Range ...	12·3
	Mean in the Shade ...	65·3

(Being 0·8 less than that of the same month on an average of the preceding 25 years.)

Humidity ...	Greatest Amount ...	91·0 on the 12th.
	Least	52·0 on the 16th.
	Mean	67·7

(Being 2·1 less than that of the same month on an average of the preceding 25 years.)

Rain	Number of Days... ...	18 rain and 6 dew.
	Greatest Fall	0·632 inch on the 17th.
	Total Fall...	1·221 inches 65 ft. above ground. 2·367 „ 15 in. above ground.

(Being 0·831 inch less than that of the same month on an average of the preceding 25 years.)

Evaporation	Total Amount	3·528 inches
Electricity ...	Number of Days Lightning	3
Cloudy Sky ...	Mean Amount	6·4
	Number of Clear Days ...	0
Meteors ...	Number observed ...	0

Remarks.

At Sydney, temperature and pressure have been close to the average, but the rainfall is again below it by 0·83 in., and in the country no station has been entirely without rain this month, but at a large percentage of them the fall has been in such small quantities at a time as to be of very little use. Some of the mountain and coast stations have had sufficient rain for present wants, but on the coast generally the rainfall to November 30, 1884, is less than the corresponding period of the dry year, 1883, and of many parts of the interior the same may be said. In a few places thunder-storms or other merely local rains in the spring have produced abundance of grass, but the areas of these favoured spots are not very great.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, $10^h\ 4^m\ 50{\cdot}81^s$; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

DECEMBER, 1884.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading... ...	29·914 inches on the 29th, at 10 p.m.
	Lowest Reading	28·986 on the 3rd, at 1 p.m.
	Mean Height	29·592
(Being 0·146 inch less than that in the same month on an average of the preceding 25 years.)		
Wind	Greatest Pressure ...	30·4 lb. on the 15th.
	Mean Pressure	1·0 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	E.N.E.
(Prevailing direction during the same month for the preceding 25 years, N.E. and E.N.E.)		
Temperature	Highest in the Shade ...	91·0 on the 3rd.
	Lowest in the Shade ...	56·4 on the 19th.
	Greatest Range	29·4 on the 3rd.
	Highest in the Sun ...	149·0 on the 3rd.
	Lowest on the Grass ...	48·2 on the 19th and 23rd.
	Mean Diurnal Range ...	16·5
	Mean in the Shade ...	70·4
(Being 0·8 greater than that of the same month on an average of the preceding 25 years.)		
Humidity ...	Greatest Amount ...	86·0 on the 6th.
	Least	24·0 on the 3rd.
	Mean	60·5
(Being 9·0 less than that of the same month on an average of the preceding 25 years.)		
Rain	Number of Days... ...	9 rain and 5 dew.
	Greatest Fall	0·540 inch on the 15th.
	Total Fall...	0·770 „ 65 ft. above ground.
		1·230 inches 15 in. above ground.
(Being 0·962 inch less than that of the same month on an average of the preceding 25 years.)		
Evaporation	Total Amount	5·279 inches.
Electricity ...	Number of Days Lightning	6
Cloudy Sky ...	Mean Amount	5·0
	Number of Clear Days ...	2
Meteors ...	Number observed ...	0

Remarks.

At Sydney the barometer this month was 0·146 below the average, and temperature 0·8 greater. Rainfall is again 0·96 below the average, this being the fourth month with rainfall below the average in Sydney. A glance at the figures will show that December was a very dry month in almost every part of the Colony, and the excessively hot and dry winds which prevailed in this month caused the stored water to evaporate much faster than usual; and coming as this dry weather did after so many weeks of previous drought, its effects upon any remaining vegetation were intensified. In the list are a number of rain stations that began to record late in the year. Speaking of the whole Colony, the years 1883 and 1884 have been remarkably alike as regards the amount of rainfall, and remembering the loss and suffering by the drought of 1883, the condition of the country in 1884 may easily be imagined. The coast districts north of the Macleay had more rain in 1884 than in 1883, but south of that all had less, about Wollongong much less. Speaking generally, all the country drained by the Darling, excepting a comparatively small area in the Dubbo district and a few other places, had less in 1884 than 1883, although not much less, and the same remark applies to the Lachlan, Murrumbidgee, and Murray country. Near Dubbo, 1884 rain was far in excess of 1883, but at Wellington this favourable condition ceases.

CURVES SHOWING THE HEIGHT OF THE WESTERN RIVERS OF NEW SOUTH WALES DURING THE YEAR 1884.

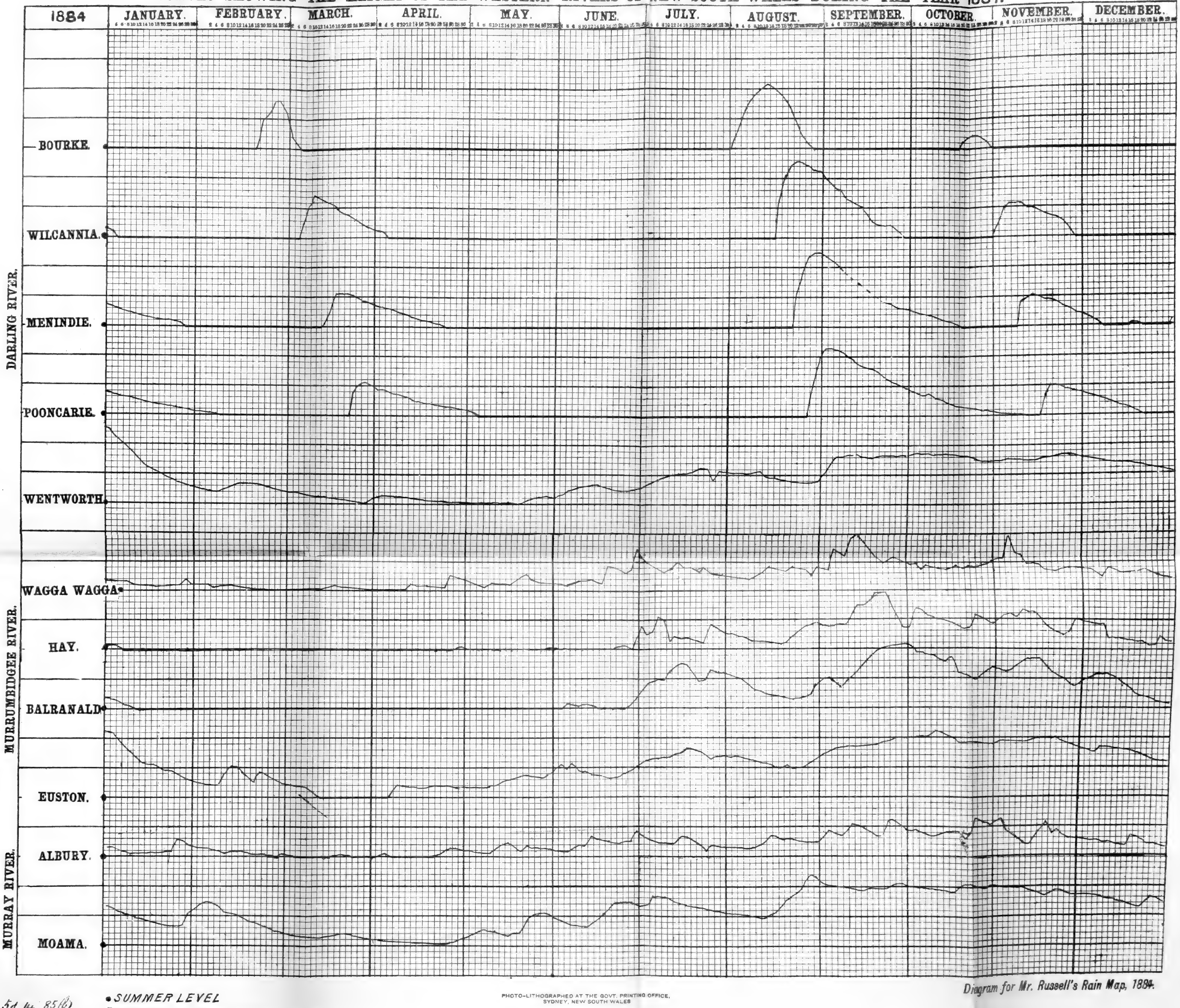


Diagram for Mr. Russell's Rain Map, 1884.

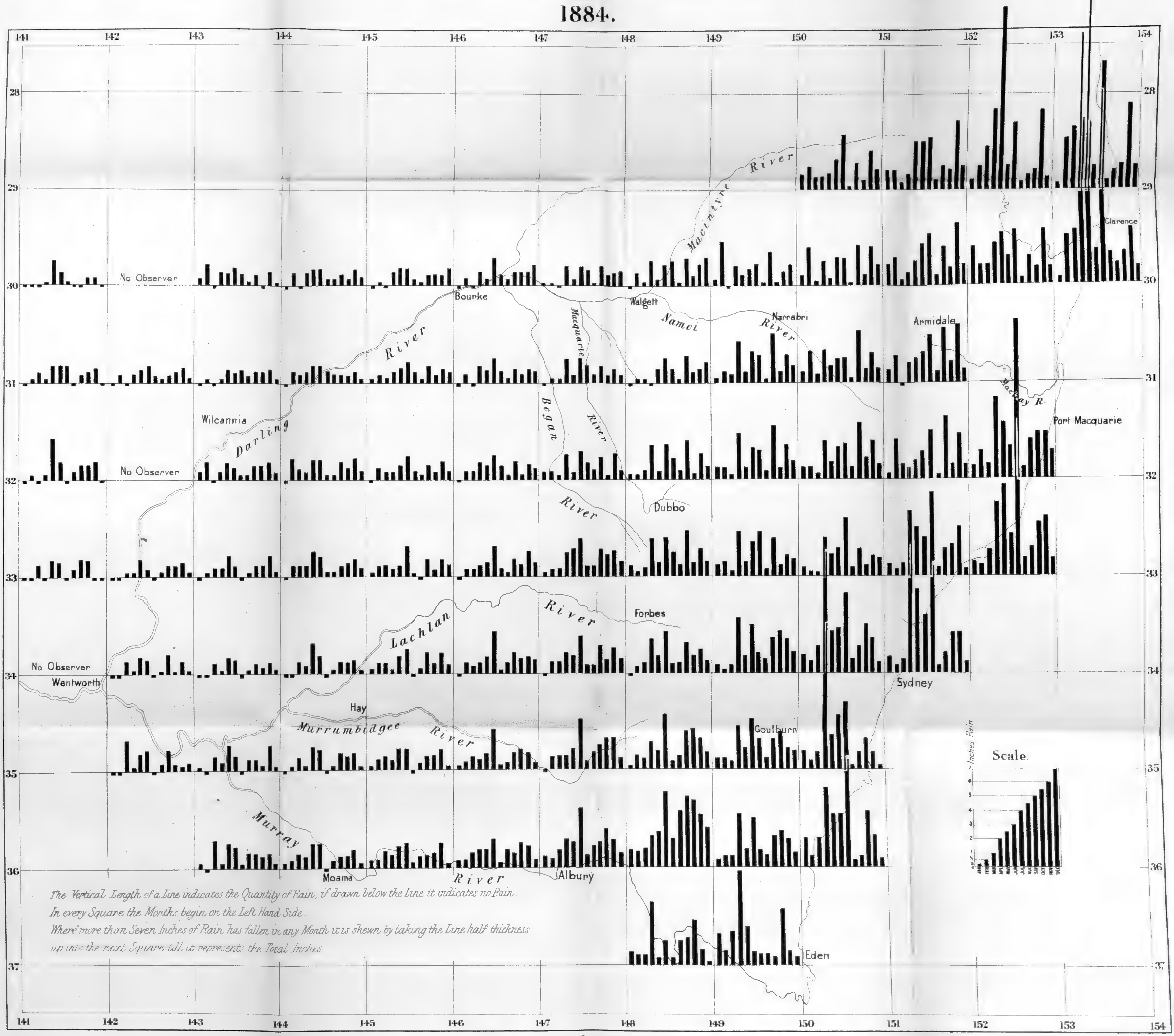
5d 4/ 85(b)

• SUMMER LEVEL

EACH VERTICAL SPACE EQUALS ONE FOOT

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE, SYDNEY, NEW SOUTH WALES

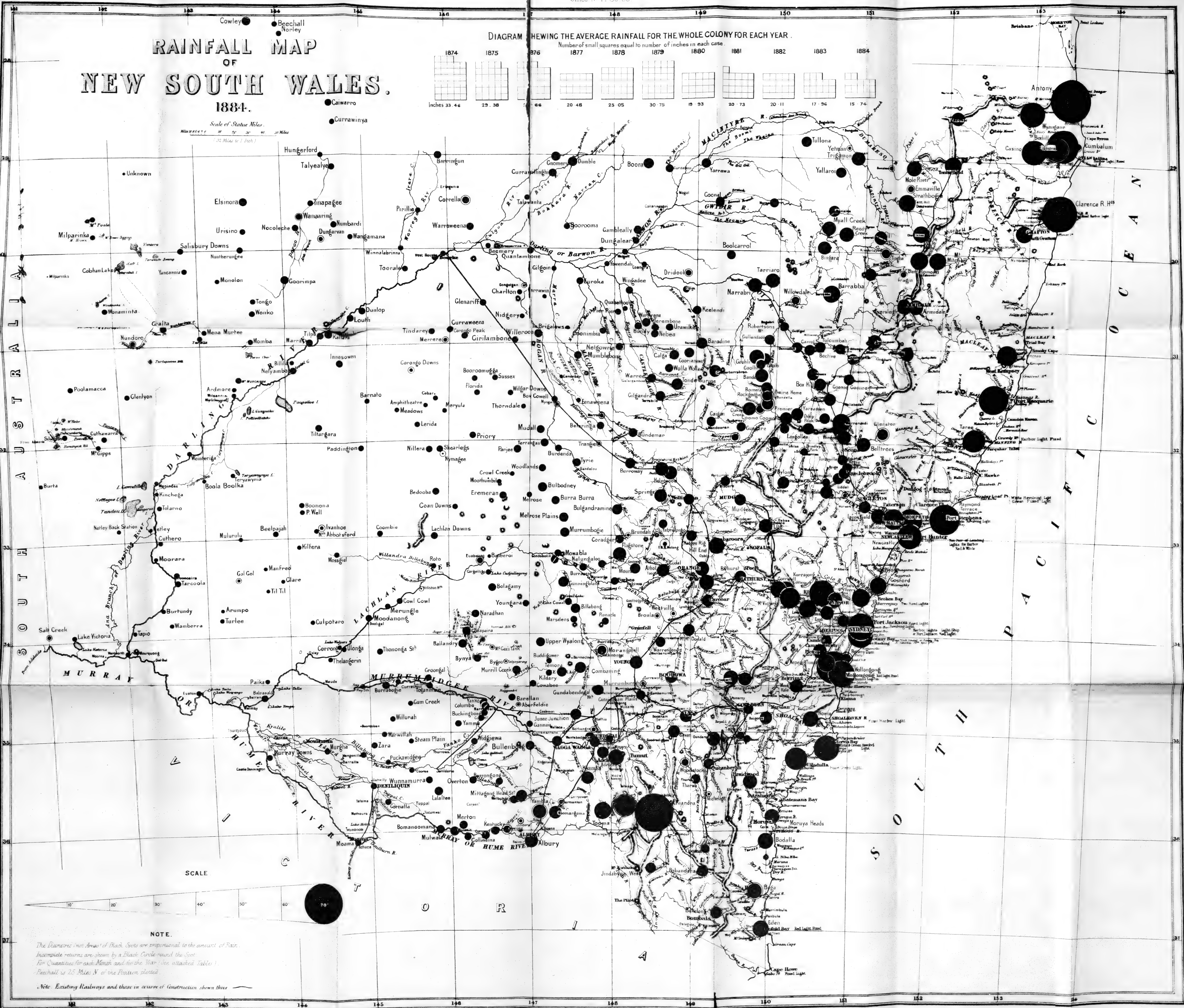
DIAGRAM
SHEWING THE MONTHLY DISTRIBUTION OF RAIN
in each Square Degree of
NEW SOUTH WALES
for
1884.



S. T. Leigh & Co. Lith. Sydney.

Diagram for Mr. Russell's Rain Map for 1884.

Office No. M 30.28



Surveyor General's Office, Sydney N.S.W. 1883

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(Edited by Prof. Liversidge, F.R.S.)

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