JOURNAL

AND

PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

NEW SOUTH WALES,

1882.

INCORPORATED 1881.

VOL. XVI.

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.

1883.

NOTICE.

The Smithsonian Institute, Washington, U.S.A., and Messrs. Trübner & Co., 57, *Ludgate Hill, London, have kindly undertaken to receive and forward parcels of books and printed matter intended for the Society.*

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NOTICE.

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

CONTENTS.

VOLUME XVI.

The Royal Society of New South Wales.

OFFICERS FOR 1882–83.

HONORARY PRESIDENT:

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

PRESIDENT:

CHRISTOPHER ROLLESTON, C.M.G.

VICE-PRESIDENTS:

ROBERT HUNT, F.G.S., &c.

F. N. MANNING, M.D.

HONORARY TREASURER:

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

HONORARY SECRETARIES:

PROFESSOR LIVERSIDGE, F.R.S., F.C.S., &c.

DR. ADOLPH LEIBIUS, M.A., F.C.S.

COUNCIL:

DIXON, W. A., F.C.S.
HIRST, G. D.
MOORE, C., F.L.S.
MURRAY, W. G.
RUSSELL, H. C., B.A., F.R.A.S. F.M.S., &c.
WILKINSON, C. S., F.G.S.

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 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.

CORRIGENDA.

Page 205, last line but seven. For "page 14" *read* "page 206."

" 214, last line. For "p. 13" *read* "p. 205."

" 218, line 6. For "page 15" *read* "page 207."

RULES.

(*Revised October 1st*, 1879.)

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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,

Sir, Sydney, 18 .

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,

Sir, Sydney, 18 .

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,

Sir, Sydney, 18 .

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, P.M., "The Priory," East Maitland.
1877	P 2	Abbott, W. E., Glengarry, 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, M.L.A., 122, Elizabeth-street North.
1868		Allerding, F., Hunter-street.
1873		Allerding, H. R., Hunter-street.
1856		Allwood, Rev. Canon, B.A. *Cantab.*, Vice-Chancellor, University of Sydney, Woollahra.
1881		Amos, Robert, "Barncleuth," 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.
1873		Austen, Henry, Pitt-street.
1876		Backhouse, Benjamin, "Ithaca," Elizabeth Bay.
1878		Backhouse, Alfred P., M.A., "Ithaca," Elizabeth Bay.
1877		Baker, E. A., Sydney.
1878		Balfour, James, The Oriental Bank, Pitt-street.
1881		Barff, H. E., M.A., Sydney University.
1876	P 4	Barkas, Wm. James, Lic. R. Col. Phys. *Lond.*, M.R.C.S. *Eng.*, Warialda.
1878		Barker, Francis Lindsay, 130, Pitt-street.
1879		Barraclough, William, Stephen-street, Balmain.
1875		Bartels, W. C. W., Richmond Terrace.
1876		Bassett, W. F., M.R.C.S., *Eng.*, Bathurst.

Elected.		
1878		Bayley, George W. A., Railway Department, Phillip-street.
1880		Beattie, Josh. A., Lic. K. & Q. Coll. Phys., *Irel.*, Lic. R. Coll. Sur., *Irel.*, Quarantine Station.
1875		Bedford, W. J. G., M.R.C.S. *Eng.*, Staff Surgeon, Victoria Barracks.
1868		Beilby, E. T., 91, Pitt-street.
1875		Belgrave, Thomas B., M.D. *Edin.*, M.R.C.S. *Eng.*, 153, Elizabeth-street.
1877		Belfield, Algernon H., Eversleigh, Armidale.
1875		Belisario, John, M.D., Lyons' Terrace.
1876		Benbow, Clement A., 24, College-street.
1869	P 2	Bensusan, S. L., Exchange, Pitt-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.*, Arthursleigh-terrace.
1878		Black, Reginald James, Union Club.
1878		Black, Morrice A., F.I.A., Actuary, Mutual Provident Society.
1880		Blackmann, C. H. E., 267, George-street.
1877		Bladen, Thomas, 31, Darlinghurst Road.
1872		Bolding, H. J., Commissioner of Crown Lands, Albury.
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, Nepean Cottage, Bourke-street, Redfern.
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, Eureka Terrace, St. Leonards.
1877		Bundock, W. C., Wyangarie, Casino.
1876		Burn, James Henry, 93, Palmer-street, Woolloomooloo.
1877		Burnell, Arthur, Survey Office.
1878		Burnett, Robt. H., C.E., Whitehall Club, London, S.W.
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, Gas Works, Sydney.
1878		Butterfield, George, 15 Macquarie Place.
1876		Cadell, Alfred, Vegetable Creek, New England.
1876		Cadell, Thomas, Wotonga, East St. Leonards.
1880		Caird, George S., Lillingstone, Ocean-street, Woollahra.
1882		Cameron, Alexr. L. P., Mulurulu Station, Balranald.
1876		Campbell, Allan, L.R.C.P., *Glasgow*, Yass.
1876		Campbell, The Hon. Alexander, M.L.C., Woollahra.

Elected.		
1868		Campbell, The Hon. Charles, M.L.C., Clunes, South Kingston.
1879		Cameron, John, Geodetic Surveyor, 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, William, Parkhouse, Parramatta.
1878		Chisholm, Edwin, M.R.C.S., E., L.S.A., &c., Ashfield.
1877		Clarke, William, care of John Wilson & Co., York-street.
1874		Clay, William French, M.A., *Cantab.*, M.D. *Syd.*, M.R.C.S. *Eng.*, Fellow of St. Paul's College, North Shore.
1876		Codrington, John Fredk., M.R.C.S., E.; Lic. R.C. Phys., L.; Lic. R.C. Phys., *Edin.*, Orange.
1878		Collie, Revd. Robert, The Manse, Wellington-street, Newtown.
1878		Colquhoun, George, 3, Mona-terrace, Rushcutters' Bay.
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, care of Mr. C. E. Riddell, Union Club.
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.
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, Rialto Terrace, Darlinghurst.
1877		Cunningham, Andrew, Lanyon, Queanbeyan.
1873		Daintrey, Edwin, "Æolia," Randwick.
1876		Dalgarno, John V., Telegraph Office, George-street.
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, F. M., M.A., Wentworth Court, Elizabeth-street.
1879		Davenport, Samuel, Adelaide, South Australia.
1878		Dean, Alexander, J.P., Elizabeth-street.
1877		Deck, John Field, M.D., Ashfield.
1856		Deffell, George H., Bayfield, Woolwich Road, Hunter's Hill.
1881		Delarue, Leopold H., 378, George-street.
1875		De Salis, The Hon. Leopold Fane, M.L.C., Cuppercumbalong, Lanyon.
1875		De Salis, L. W., junr., Strathmore, Bowen, Queensland.
1876		Dight, Arthur, Richmond.

Elected.		
1875	P 9	†Dixon, W. A., F.C.S., Fellow and Member Inst. of Chemistry of Gt. Britain and Irel., Lecturer on Chemistry, School of Arts; Chemical Laboratory, School of Arts, Sydney.
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., C.M., *Edin.*, 2 Kenilworth Lodge, Wallis-street, Woollahra.
1876		Docker, Ernest B., M.A. *Sydn.*, Carhullen, Parramatta.
1879		Docker, Wilfred L. Craigstone, William-street South.
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.
1876		Drake, William Hedley, Fellow of the Inst. of Bankers, Lond., Colonial Bank of New Zealand, Nelson, 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.
1878		Ellis, Thomas Augustus, C.E., City Engineer, Newcastle.
1876		Evans, George, Como, Darling Point.
1876		Evans, Owen Spencer, M.R.C.S. *Eng.*, Darling-street, Balmain.
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., 177, Macquarie-street.
1868		Fairfax, James R., *Herald* Office, Hunter-street.
1880		Ferguson, J. W. W., 70, Darlinghurst Road.
1881		Fiaschi, Thos., M.D., M. Ch., Univ. Pisa, Windsor.
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; 251, Macquarie-street.
1876		Fitzgerald, R. D., F.L.S., Surveyor-General's Office.
1856		Flavelle, John, George-street.
1880		Forbes, Alexr. Leith, M.A., Dept. of Public Instruction.
1863		Fortescue, G., M.B. *Lond.*, F.R.C.S., F.L.S., Lyons' Terrace.
1881		Foster, W. J., M.L.A., Temple Court, King-street.
1878		Fraser, Robert, 12, Barrack-street.
1882		Fraser, Rev. John G., M.A., Warden of Camden College, Glebe Point.

Elected.		
1875		Frazer, Hon. John, M.L.C., York-street.
1878		Fuller, Francis John, Harbours and Rivers Office, Fitzroy Dock.
1881		Furber, T. F., Surveyor-General's Office.
1879		Gabriel, C. Louis, care of Dr. J. J. Hill, Lambton.
1880		Gardiner, Rev. Andrew, M.A., Pyrmont Bridge Road.
1877		Garnsey, Rev. C. F., Christ Church Parsonage, Sydney.
1868	P	Garran, Andrew, LL.D., *Sydney Morning Herald* Office, Hunter-street.
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. 360, George-street.
1879		Gerard, Francis, Occupation of Lands Office.
1878		Giblin, Vincent W., Australian Joint Stock Bank, Sydney.
1876		Gilchrist, W. O., Greenknowes, Potts's Point.
1875		Gilliat, Henry Alfred, Australian Club.
1876	P 2	Gipps, F. B., C.E., Lindisfern, Cheltenham Road, Burwood.
1878		Goddard, William C., The Exchange, New Pitt-street.
1881		Goergs, Karl W., Riviere College, Woollahra.
1859		Goodlet, John H., George-street.
1876		Goode, George, M.A., M.D., M. Ch., Trin. Coll., *Dub.*, Enfield House, Camden.
1876		Graham, Hon. Wm., M.L.C., Stratheam House, Waverley.
1873		Greaves, W. A. B., Braylesford, Bondi.
1881		Griffin, T. H. F., Richmond.
1878		Griffiths, Frederick C., Macquarie-street.
1877		Griffiths, G. Neville, The Domain, Sydney.
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, 127, Pitt-street.
1878		Hall, Richard T., care of W. H. Quodling, Esq., Public Works Department.
1880		Halligan, Gerald H., C.E., "Eugowra," Hunter's Hill.
1882		Hammond, Mark J., Ashfield.
1882		Hankins, Geo. Thos., M.R.C.S.E., Liverpool-street, Hyde Park.
1874		Hardy, J., Hunter-street.
1881		Harcus, Lorimer E., Alt-street, Ashfield.
1877		Hargrave, Lawrence, 94, Upper William-street.
1881		Harris, John, "Grenville," Thomas-street, Ultimo.
1877		‡Harrison, L. M., Macquarie Place.
1878	P 2	Hart, Ludovico, Cheltenham, Victoria.
1878		Haviland, E. Cyril, 15, Bridge-street.
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., *Town and Country* Office, Pitt-street.
1881		Helms, Albert, Ph. D., *Berlin*, Sydney University.
1875		Helsham, Douglass, Eurimbulah, Port Curtis, Queensland.

Elected.

1877 Henry, James, 750, George-street.
1878 Herborn, E. W. L., Flinton, Burwood.
1878 Herborn, Eugene, Licensed Surveyor, Bathurst.
1880 Hern, Charles E., "Como," Ocean-street, Woollahra.
1876 Heron, Henry, solicitor, 49, Hunter-street.
1878 Hewett, Thomas Edward, The Observatory, Sydney
1879 Higgins, R. G., Clifford, Potts's Point.
1879 Hills, Robert, Elizabeth Bay.
1879 Hitchins, Edwd. Lytton, "Florence," Victoria-street North Darlinghurst.
1877 Hindson, Lawrence, Exchange Buildings, Pitt-street.
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.
1868 Holt, The Hon. Thomas, M.L.C., Sutherland House, George's River.
1876 Holroyd, Arther Todd, M.B. *Cantab.*, M.D. *Edin.*, F.L.S. F.Z.S., F.R.G.S., Master-in-Equity, 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., Cooma Cottage, Yass.
1878 †Hunt, Robert, F.G.S., Associate of the Royal School of Mines, London, Deputy Master of the Royal Mint, Sydney, *Vice-President.*
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.

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.*, 13, Lower Fort-street.
1879 Jefferis, Rev. James, LL.B., "The Retreat," Newtown.
1876 Jenkins, Richard Lewis, M.R.C.S., Nepean Towers, Douglass Park.
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, 345, George-street, Sydney.
1874 Jones, James, Bathurst-street.

Elected.		
1879		Jones, John Trevor, 356, Liverpool-street.
1863		Josephson, Joshua Frey, F.G.S., District Court Judge, Enmore Road, Newtown.
1876	P 1	Josephson, J. P., Assoc. Mem. Inst. C.E., 235, Macquarie-street North.
1878		Joubert, Numa, Hunter's Hill.
1873		Keele, Thos. Wm., Harbours and Rivers Department, Phillip-street.
1877		Keep, John, Broughton, Leichhardt.
1879		Kemmis, Rev. Thomas, St. Mark's Parsonage, Darling Point.
1874		King, Philip G., William-street, Double Bay.
1877		Kinloch, John, M.A., 21, Wentworth Court, Elizabeth-street.
1878		Knaggs, Saml. J., M.D., Newcastle.
1881		Knibbs, G. H., Mem. Inst. of Surveyors, Surveyor-General's Office.
1874		Knox, George, M.A., *Cantab.*, King-street.
1875		Knox, Edward, The Hon., M.L.C., O'Connell-street.
1877		Knox, Edward W., "Lansdowne," Darling Point.
1877		Kopsch, G., Telegraph Department.
1878		Kretschmann, Joseph; care of Mr. Moss, Hunter-street.
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*, North Shore.
1876		Langley, W. E., "The Pines," Berry-street, St. Leonards.
1874	P 1	Latta, G. J., Hawthorne, Crystal-street, Petersham.
1876		Laure, Louis Thos., M.D. Surg. Univ. *Paris*, 138, Castlereagh-street.
1880		Leask, John L., M.B.C.M. *Edin.*, "Terra Bella," Pyrmont Bridge Road.
1859	P 5	†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.*
1874		Lenehan, Henry Alfred, Sydney Observatory.
1872	P 22	†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.

Elected.

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.
1877 Lord, George Lee, Kirketon, Darlinghurst.
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.

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, Oriental Bank, Sydney.
1859 MacDonnell, William, 312, George-street.
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 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 1 ‡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., "Friendville," Paddington.
1880 Mackenzie, R. M., The Exchange Corner.
1876 Mackellar, Chas. Kinnard, M.B., C.M., *Glas.*, Macquarie-street.
1881 Maclean, L. H. J., M.D., M.R.C.P., *Lond.*, M.R.C.S., 26, Alberto Terrace, Darlinghurst.
1882 Madsen, Hans. F., "Hesselmer" House, Queen-street, Newtown.
1878 Maitland, Duncan Mearns, junior, "Afreba," Stanmore Road.
1873 Makin, G. E., Berrima.
1880 Manfred, Edmund C., Montague-street, Goulburn.
1877 Mann, John, 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, Edgecliffe Road, Woollahra.
1873 Manning, James, Milson's Point, North Shore.
1876 P 6 †Manning, Frederick Norton, M.D. Univ. *St. And.*, M.R.C.S. *Eng.*, Lic. Soc. Apoth. *Lond.*, Gladesville, *Vice-President*.
1869 Mansfield, G.A., Pitt-street.
1878 Markey, James, L.R.C.S., *Irel.*, L.R.C. Phys., *Edin.*, Regent-street.
1878 Marklove, Robert J., Macquarie Place.
1880 Marano, G. V., M.D. Univ. *Naples*, Clarendon Terrace, Elizabeth-street.
1872 Marsden, The Right Rev. Dr., Bishop of Bathurst, Bathurst.
1876 Marsh, J. M., Edgecliff Road, Woollahra.
1876 Marshall, George, M.D. Univ. *Glas.*, Lic. R. Coll. S. *Edin.*, Lyons' Terrace.

Elected.

1876 Martin, Rev. George, Redfern.
1879 Masters, Edward, Lurlei, Marrickville.
1875 Mathews, R. H., Singleton.
1879 Matthews, Robert, Tumut-street, Adelong.
1879 Meslée, E. Marin de la, Surveyor-General's Office.
1868 Metcalfe, Michael, 9, Bridge-street.
1873 Milford, F., M.D. *Heidelberg*, M.R.C.S. *Eng.*, 3, Clarendon Terrace, Hyde Park.
1876 Millard, Rev. Henry Shaw, Newcastle Grammar School.
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 3 †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, Allan Bradley, M.R.C.S. *Eng.*, Lic. Mid. Lic. R. Coll. Phys. *Edin.*, Ashenhurst, Burwood.
1876 Morgan, T. C., L.R.C.S. *Edin.*, M.K. & Q. Coll. Phys. *Ireland*, 55, Castlereagh-street.
1865 P 1 Morrell, G. A., C.E., Pitt-street.
1877 Morris, William, Lic. Fac. Phys. and Surg. *Glas.*, Castlereagh-street.
1880 Moses, David, J.P., "Aurovida," Forest Lodge.
1882 Moss, Sydney, 5, Hunter-street.
1879 Mountain, Adrian C., City Surveyor, Town Hall.
1877 ‡Mullens, Josiah, F.R.G.S., 34, Hunter-street.
1879 Mullins, John, F.L., M.A., 211, Macquarie-street.
1865 Murnin, M. E., Eisenfels, Nattai.
1876 †Murray, W. G., 93, Pitt-street.
1876 Myles, Chas. Henry, "Dingadee," Burwood.

1873 Neill, William, City Bank, Pitt-street.
1879 Neill, W. J. Walter, London Hospital, Whitechapel, London, E.
1874 Neill, A. L. P., City Bank, Pitt-street.
1878 Newton, John, care of C. Newton, Bros. & Co., 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, Spring-street.
1875 Nott, Thomas, M.D. *Aberdeen*, M.R.C.S. *Eng.*, Ocean-street, Woollahra.
1878 Nowlan, John, Eelah, West Maitland.

Elected.		
1880		Oakes, Arthur W., M.B., C.M., L.R.C.P., L.R.C.S., *Edin.*, "Chiswick," Ocean-street, Woollahra.
1879		O'Connor, Dr. Maurice, 223, Victoria-street.
1881		O'Connor, Richd. Edwd., M.A., Wentworth Court, Elizabeth-street.
1878		Ogilvy, James L., Oriental Bank, Melbourne.
1877		Olley, Rev. Jacob, Manse, Manly.
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.*, Public School, Five Dock.
1880		Paling, W. H., "Wonden," Cambridge-street, Petersham.
1875		Palmer, J. H., Legislative Assembly.
1880		Palmer, Joseph, 133, Pitt-street.
1882		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.
1877		Perkins, Henry A., Pembrook, Johnson-street, Balmain.
1881		Philip, Alexr., L.K. and Q.C.P., *Irel.*, L.R.C.S., *Irel.*, Lylehurst House, Devonshire-street.
1856		Phillips, H., Pacific Insurance Company, 85, Pitt-street.
1876		Pickburn, Thomas, M.D. *Aberdeen*, Ch. M., M.R.C.S. *Eng.*, 40, College-street.
1879		Pittman, Edwd. Fisher, L.S., School of Mines, Sandhurst, Victoria.
1881		Poate, Frederic, Summer Hill.
1879		Pockley, Thos. F. G., Commercial Bank, Singleton.
1878		Poolman, F., Colonial Sugar Refining Co., O'Connell-street.
1881		Poolman, Fredk. W., "Esher," Nelson-street, Woollahra.
1882		Porter, Donald, Tamworth.
1878		Potts, F. H., Want-street, Burwood.
1876		Quaife, Fredk. Harrison, M.D., Mast. Surg. Univ. *Glas.* Hughenden, Queen-street, Woollahra.
1878		Quirk, Rev. D. Placid, M.A. *Syd.*, Post Office, Cook's River.
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, F., G.P.O., Sydney.

Elected.		
1874		Read, Reginald Bligh, M.R.C.S., *Eng.*, Coogee.
1868		Reading, E., Mem. Odont. Soc. *Lond.*, Castlereagh-street.
1881		Reid, William, Australian Joint Stock Bank, Sydney.
1881	P 1	Rennie, Edwd., H., M.A., London.
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.D., C.M., *Edin.*, 257, Elizabeth-street, Hyde Park.
1880		Riddell, C. E., Union Club.
1856		Roberts, J., George-street.
1868	P 3	Roberts, 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, 91, Pitt-street.
1882		Robertson, Rev. James Thomas, M.A., The Manse, Tumut.
1856	P 7	†Rolleston, Christopher, C.M.G., Auditor-General, Castlereagh-street, *President.*
1878		Rose, W., 257, George-street.
1881		Roser, Carl, M.D.
1865		Ross, J. Grafton, O'Connell-street.
1881	P 1	Roth, Henry Ling, F.S.S., F.M.S., Foulden Estate, Mackay, Queensland.
1882		Rothe, W. H., Union Club.
1876		Rowling, Dr., Chas., Mudgee.
1864	P 26	†Russell, Henry C., B.A. *Syd.*, F.R.A.S., F.M.S., Hon. Mem. S. Aust. Inst., Government Astronomer, Sydney Observatory.
1882		Russell, H. E., 88, Pitt-street.
1875		Sahl, Charles L., German Consul, Consulate of the German Empire, Wynyard Square.
1876		Saliniere, Rev. E. M., Glebe.
1880		Sandy, James, "Rothgael," Croydon Road, Ashfield.
1876		Schuette, Rudolf, M.D., Univ. *Göttingen*, Lic. Soc. Apoth. *Lond.*, 10, College-street.
1856	P 1	‡Scott, Rev. William, M.A. *Cantab.*, Hon. Mem. Roy. Soc. Vic., The Parsonage, Bungendore.
1880		Scrivener, Charles Robert, Berlin Cottage, Fotheringham-street, Stanmore
1876		Sedgwick, Wm. Gillett, M.R.C.S., *Eng.*, Newtown.
1877		Selfe, Norman, C.E., M.I.C.E., Rockleigh, Balmain.
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.
1879		Shepard, A.D., Adelong.
1881		Shepherd, T. W., "Norwood," Milson's Point, St. Leonards East.
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*, Gladesville Asylum.

Elected.		
1877		Slattery, Thomas, Premier Terrace, 169, William-street, Woolloomooloo.
1877		Sloper, Fredk. Evans, 360, Liverpool-street.
1881		Smedley, John, "Arlula," 139, Queen-street, Woollahra.
1882		Smith, Bruce, 103, Elizabeth-street.
1852	P 6	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.
1878	P 1	Smith, Marshall, Glanville-street, Glanville, South Australia.
1875		Smith, Robt., M.A. *Syd.*, solicitor, Spring-street.
1874		‡Smith, John M'Garvie, Pitt-street.
1878		Smith, E. E., "Clytie," 70, Darlinghurst Road.
1881		Smyth, F. L. S., M.A., F.R.G.S., Wentworth Court, Elizabeth-street.
1879		Spry, James Monsell, Union Club.
1881		Starkey, John Thos., Castlereagh-street.
1882		Steel, John, L.R.C.P., L.R.C.S., *Edin.*, 52, College-street, Hyde Park.
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, South Kingston.
1879		Stephen, Alfred F. H., Pyrmont Bridge Road.
1857		Stephens, William John, M.A. *Oxon.*, Professor of Natural History in the University of Sydney, 233, Darlinghurst Road.
1876		Stopps, Arthur J., Surveyor-General's Office.
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.
1876		Suttor, Wm. Henry, M.L.A., Cangoura, Bathurst.
1879		Tarrant, Harman, M.R.C.S., M.L.A., Macquarie-street.
1874		Taylor, Chas., M.D. *Syd.*, M.R.C.S., *Eng.*, Parramatta.
1862	P 10	Tebbutt, John, F.R.A.S., Observatory, Windsor.
1879		Thomson, Dugald, 20, Charlotte Place.
1870	P 1	Thompson, H. A., Adelaide, S.A.
1875		Thompson, Joseph, Bellevue Hill, Double Bay.
1877		Thompson, Thos. James, 139, Pitt-street, Sydney.
1876		Thomas, H. Arding, Narellan.
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.*, "Carlisle," Petersham.
1876		Toohey, J. T., "Moira," Burwood.
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.
1876		Trouton, F. H., A.S.N. Company's Offices, Sydney.
1877		‡Tucker, G. A., Ph. D., Superintendent, Bay View Asylum, Cook's River.

Elected.

1868 Tucker, William, Clifton, North Shore.
1875 Tulloh, W. H., "Airlee," Greenwich Point Road, North Shore.
1875 Turner, G., 3, Fitzroy Terrace, Pitt-street, Redfern.
1882 Twynam, George Edwd., L.R.C.P. *Lond.*, M.R.C.S.E., "Cleone," West-street, Petersham.

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.
1877 Warren, William Edward, M.D. and M.Ch., Queen's Univ. *Irel.*, 243, Elizabeth street, Sydney.
1876 Watkins, John Leo, B.A. *Cantab.*, M.A. *Syd.*, 121, Elizabeth-street.
1876 Waterhouse, J., M.A. *Syd.*, "Waima," Cavendish-street, Stanmore.
1876 Watson, C. Russell, M.R.C.S., *Eng.*, Morevale, Newtown.
1877 Watt, Alfred Joseph, Hastings, Moore Park Road.
1859 Watt, Charles, Government Analyst, Treasury Buildings.
1876 Waugh, Isaac, M.B., M.C., *T.C.D.*, Parramatta.
1876 Webster, A. S., Gresham Chambers.
1882 Webster, Rev. William, Manse, Wilcannia.
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, Hunter-street.
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., 1, Lawrening Terrace, Elizabeth-street.
1879 Wilshire, F. R., P.M., Berrima.
1879 Wilson, F. A. A., Mercantile Bank, Sydney.
1874 P 1 †Wilkinson, C. S., F.G.S., Government Geologist, Department of Mines.
1876 Wilkinson, Henry Toller, Department of Mines.
1878 Wilkinson, Rev. Samuel, Regent House, Regent-street, Petersham.
1880 Wilkinson, Robt. Bliss, 12, Spring-street.
1878 Wilshire, James Thompson, C.P.S., Scone.

Elected.		
1876		Williams, Percy Edward, Treasury.
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.
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.
1879		Young, John, Town Hall, George-street.

Honorary Members.

Limited to Twenty.

M, recipients of the Clarke Medal.

1875		Agnew, Dr., Hon. Secretary, Royal Society of Tasmania, Hobart Town.
1875		Barlee, His Excellency F. P., C.M.G., Governor of Honduras.
1879	M	Bentham, George, F.R.S., V.P.L.S., C.M.G., The Royal Gardens, Kew.
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.
1879		Darwin, Dr. Charles, F.R.S., M.A., F.G.S., F.L.S., &c., &c., Beckenham, Kent.
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, 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.

Elected.		
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 R., 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.
1875		Schomburgh, Dr., Director of the Botanic Gardens, Adelaide, South Australia.
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 13	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.

1880	P 1	Clarke, Hyde, V.P. Anthropological Institute, 32, St. George's Square, London, S.W.
1879	P 2	Etheridge, Robert, junr., F.G.S., &c., The British Museum.
1880		Miller, F. B., F.C.S., Melbourne Mint.
1880		Ward, Sir Edward, K.C.M.G., Major-General, R.E., Cannes, France.

Obituary, 1881.

Ordinary Members.

1876		Alston, Dr. John Wilson.
1880		Hill, Dr. J. J.
1880		Hodgson, Dr. Wilfred.
1873		Kennedy, Hugh, B.A.
1862		Prince, Henry.
1878		Roberts, William.
1878		Skinner, J. H., B.A.
1876		Smith, R. S.
1879		Taylor, Dr. C. L.

Honorary Members.

1879		Darwin, Dr. Charles, M.A., F.R.S., &c.

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 Richard Owen, C.B., F.R.S., The British Museum.

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.

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.

ANNIVERSARY ADDRESS.

By H. C. Russell, B.A., F.R.A.S., &c., President.

[*Delivered to the Royal Society of N.S.W., 3 May, 1882.*]

Gentlemen,

By a sort of tradition the President of a Society like ours is expected to make his annual address a compressed history of the science of the year; but our distance from the metropolis of science places your President at a disadvantage, for our first meeting is long enough after all the kindred meetings in Europe to give us in the various periodicals reports of what has been said by the happy Presidents whose duty has been to select the best out of a superabundance. I confess I cannot feel happy in going over ground which has been so well "prospected," nor could I do so if I felt as competent as those who have preceded me. I hope, therefore, you will not be alarmed at the innovation if I do not follow the traditional path, but endeavour to occupy your attention for a short time with some remarks upon matters, one of which is of great scientific importance, and the other of increasing local interest.

The report of the Council has been placed before you, and I wil only refer to one or two matters which I think the Council has not made so prominent as it should have done. And first, with reference to our own work during the past year, the report or the address should, I think, contain a list of the papers read, as evidence of our work.

The list of papers read before the Royal Society of New South Wales, session ending December, 1881, is as follows :—May 4 "Anniversary Address," by the Hon. J. Smith, C.M.G., M.L.C.

M.D., LL.D., &c. June 1, "The Climate of Mackay, Queensland," by H. Ling Roth, F.S.S., F.M.S.: "Notes of a Journey on the Darling," by W. E. Abbott. July 6, "On *Smilax glycyphylla*," by C. R. A. Wright, D.Sc., and E. H. Rennie, M.A., B.Sc.: "On New Zealand Kauri Gum," by E. H. Rennie, M.A., B. Sc.: "Astronomy of the Australian Aborigines," by Rev. Peter M'Pherson, M.A.: "The Spectrum and Appearance of the recent Comet," by H. C. Russell, B.A., F.R.A.S., F.M.S. August 3, "On the Inorganic Constituents of some Epiphytic Ferns," by W. A. Dixon, F.C.S.: "On New Double Stars and Measures of some of Herschel's," by H. C. Russell, B.A., F.R.A.S., F.M.S. September 7, "On Comet II, 1881," by John Tebbutt, F.R.A.S. October 5, "On the History, Varieties, Qualities, and Uses of Wool," by P. N. Trebeck. November 2, "Census of the Genera of Plants hitherto known as Indigenous to Australia," by Baron Ferd. von Mueller, K.C.M.G., F.R.S., &c. December 7, "On the Transit of Mercury," by H. C. Russell, B.A., F.R.A.S., F.M.S.: "On the Importance of a Comprehensive Scheme of Water Storage and Canalization for the future welfare of this Colony," by F. B. Gibbs, C.E.: "The Influence of Australian Forest Trees on the Vapourization of Water," by T. W. Shepherd. A list which speaks of the satisfactory activity of our members.

Turning now financial matters, I suppose it is right to accept with some degree of satisfaction the financial report for last year. We have paid off a part of our debt, and we have bought some books in addition to the periodicals, but I think, upon reflection, you will agree with me when I say that we ought not to be in debt at all. With a roll of nearly 500 members, a debt is the last thing that we should allow to hamper us. Even now we have to pay £75 a year as interest upon our liability, while a moderate effort would at once set this money free, and enable us to apply it to many purposes of great value to the members. Last year a number of members agreed to double their subscription, on condition that the addition went to the building fund. If we all joined in this, our liability would grow rapidly and beautifully less, especially when the 10s. given to us by Parliament is added to every pound subscribed. This premium upon our liberality ought to be effective as an inducement to wipe out the building debt. I hope the members will feel with me in this matter, and then our indebtedness will speedily cease.

Closely connected with this—in fact owing to it—is our inability to publish as soon as read the papers given to the Society. We all know that in the present day, when scientific workers are found the world over, it is often difficult to decide as to the priority of discovery, and the date of publication is accepted as the final appeal. Now, with us, papers are read months before they are published, hence valuable papers prepared here are sent to the old world for publication. Surely we ought to make an effort to prevent this, and secure for the Colony the credit of all its intellectual activity and to authors the benefit of immediate publication.

You will observe in the Council's report that our contributions to the biological laboratory at Watson's Bay amount to £25 from the Society and £23 18s. from individual members, making a total of nearly £50. The contribution from the Society has given us the right to nominate a worker, who will be received into the laboratory, with right to use all its appliances free of charge. This is a fine opportunity, and should not be lost. Any member wishing to take advantage of it should send in his application to the Secretaries.

Some of the criticisms upon the last volume of our "Transactions" have contained strictures upon the Society for the small amount of work done by the Sections. Our critics have evidently misunderstood the purpose for which our Sections were formed. In kindred Societies elsewhere the Sections work much as do independent Societies devoted to one branch of science, and get through as much work as they can. Our Sections do not stand in the same relation to the Society. They were formed, as the rule says, "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 meeting of the Society"; and when any member has prepared a paper it is understood, though not contained in the rules, that he is not to hide his light by reading it to a small Section, but bring it to a general monthly meeting of the Society, for the information of the members there assembled. Hence the Society and not the Section is credited with it in the annual volume. In the British Association a Section is formed of members who band themselves together with the object of doing a certain work. In ours the member incurs no such liability as compulsory work, and it is probable that there would be fewer members of the Sections if they had to accept such a responsibility when they joined.

The experiment which we are now making, by offering small prizes for essays or papers upon subjects which we have named, gives promise of success; inquiries have been made by many intending competitors, and some essays have been already sent in. It is satisfactory to learn that so many students of science have received the Society's announcement in the spirit in which it was made, for we did not intend the money prize to be the inducement to work, we know that to the scientific worker his work brings its own reward, in the consciousness that he is adding to the sum of human knowledge, while he is striving for the first place amongst the competitors. But in these matters it is, as it ever was, the philosopher is often poor, and, without some patron to lend a helping hand in the expense of experiments or printing, his work cannot go on. It is just this place of "patron" that the Society is trying to take, and when we get the essays we are prepared to undertake the expense of publishing those that may be deemed worthy. Some day, when the Royal Society attains the power which we are all working for, we may offer more valuable rewards; but I will not believe that "money" is the greatest inducement we can offer to scientific workers.

Turning now from these matters affecting the operations of the Society, I wish to speak for a short time upon two scientific questions which concern us particularly, owing to local circumstances. Astronomers looked forward to the transit of Venus in 1874 for a solution of one of the most difficult questions—What is the distance of the sun? It was thought by those most competent to offer an opinion, that there had been so many advances since 1769 in the quality of instruments, in the means of determining positions on and dimensions of the earth, and such an advantage in the use of photography, that the error in the solar parallax would not exceed 0·01 of a second. The result, as we all know, did not come up to the expectation. The experience of the observers of 1769, which was made the text-book for those of 1874, proved misleading, and the phenomena observed were so unexpected that it was in many cases impossible to tell the times of contacts within many seconds. And the photographs from which so much had been expected proved a failure, for owing to the irregular distortion of the pictures taken with the English photoheliograph, it was found impossible to measure them with anything like the required accuracy. For a time the idea of using the transit of 1882 as another means of finding the solar parallax was almost given up, so great was the disappointment at the comparative failure of the methods used in 1874; but when the first surprise was over and a calm estimate of the work of 1874 made, it was found that the English and Australian contact observations gave a better value of the parallax than had been obtained before, and there had been a real gain as to the parallax, and very much learned about the phenomena of the transit which will be of immense value to those who observe the next, although it is acknowledged that atmospheric conditions so largely affect the phenomena that the old estimate of possible accuracy must be given up.

In 1881 the result of the measurements of the American photographs was published, and it is said they give a good result. The publication of the result from the American photos., and the discussion which has been going on in Europe and America, has thrown much light upon the question at issue; and within the last few months (February, 1882) statements have been made as to the accuracy with which photos. can be measured, which may materially alter the intentions of those charged with arranging the work of observing the coming transit. Professor Pritchard has published in the *Observatory* for February, 1882, his experience as to the "admissibility of photography among other means of accurate measurement of celestial phenomena." The results of his experiments made at the Oxford Observatory, in measuring the diameter of the moon, are as follows:—Seven photos. were taken and the extreme difference between the values of the moon's diameter derived from these was only 0·71″, and the photos. are so small that one second of arc is only 1-7000th of an inch (006), and the probable error of determining the position of any point on the photos. is only 0·35, and he remarks: "When such are the results of the Oxford lunar photos. and the American solar ones, it seems to me a matter of regret that the International Committee, assembled in Paris recently, determined not to adopt the photographic method in European expeditions. And in a paper by D. P. Todd, assistant in the office of the American Nautical Almanac, published in June, 1881, he discusses the value of the American photographs as a means of determining the solar parallax, and arrives at the conclusion that the probable error of a single photograph is only 0·88″, and the probable error of the parallax derived from the whole number (213) is 0·034″, and the resulting parallax is 8·883″.

The same photographic instruments which were used by the American observers of the transit of Venus were used again at the transit of Mercury in 1878, and 119 photos. were taken; and Professor Harkness, in an investigation of these as a test of the possible accuracy to be obtained from photographs, found that the probable error of the position of the planet obtained in this way was only 0·553″, or considerably less than that found for the photos. of the transit of Venus. As the photos. may be taken all through the transit, and contact observations can only be taken once, and that once perhaps interrupted by a passing cloud, Professor Harkness urges the use of this method, and thinks it would prove as good as the contact observations, where the acknowledged uncertainty amounts to 0·15″. He says:—"The photographic method cannot be defeated by passing clouds, is not liable to any uncertainty of interpretation, seems to be free from systematic error, and is so accurate that the results of a single photo. has a probable error of only 0·553. If the sun is visible for so much as 15 minutes, thirty-two photos. of the sun can be taken, and these will give as accurate a result as the observations of both internal contacts. In view of these facts, can it be doubted that the photographic method offers as much accuracy as the contact method and many more chances of success?"

The suggestions made by Professors Harkness and Pritchard have been strengthened by a paper read before the Royal Astronomical Society, by Mr. Maunder, who suggests as a method of avoiding the uncertainty in the measures of the photos. that they should be so taken as to show all the details of the sun's surface, and then Venus could be referred to a spot or other markings; in fact, that the distance measured on the photos. should be as small as possible. The idea was well received in the Society, though it does not seem to entirely avoid the difficulty, for the position of the spot must be determined, and this is almost impossible with the English instrument, as stated above. The American photoheliograph is nearly free from distortion of the field; and if at this eleventh hour it should be decided to make use of it, it will be too late for Australia to send to Europe for the instruments, and we should have to be content with the one I have, which is on the American plan, but has a longer focus, and would therefore give a larger and better picture.

With reference to the probable value of the solar parallax, I take the following from an important paper published in November, 1881, by Professor Harkness, in which he discusses the relative accuracy of all the different methods of determining the solar parallax. He classes them all under three heads:—

I. Trigonometrical, such as the transit of Venus; II. Gravitational, such as that by Le Verrier, who obtained the mass of the earth from its effect upon Venus and Mars; III. The phototachymetrical, that is, by the measurement of the velocity of light; and he has collected together a great number of the determinations which have been made. After a most elaborate discussion of these, he gives the following tabular statement, which shows the probable limits of the value of the parallax according to each method :—I. Trigonometrical: Meridian observations of Mars 8·84″–8·96″; diurnal observations of Mars, *i.e.*, observing as it rises and sets, 8·60″–8·79″; asteroids, 8·76″–8·88″; transit of Venus, 1769, 8·55″–8·91″; transit of Venus, 1874, 8·76″–8·85″; II. Gravitational methods: By the mass of the earth, 8·80″–8·94″; parallactic inequality, 8·78″–8·91″; lunar inequality, 8·66″–9·07″. III. Phototachymetrical: Velocity of light and equation, 8·72″–8·89″; velocity and aberration, 8·73″–8·90″. In addition to these we have the value derived from the American transit of Venus photos. in 1874, which is 8·883; but no value derived from the American contact observations has yet been published. We have also the results of the meridian observations of Mars in 1877, published by Professor Eastman, combining—Washington and Melbourne gives 8·971″; Washington and Sydney, 8·885″; Washington and Cape of Good Hope, 8·896″. I may mention here, that the Sydney observations of Mars, used in the above determination, were the first important ones made with the new transit instrument; and it is satisfactory to see that they give a value of the parallax nearer to the probable value than the others. As to the value of the parallax, you will see that the range is from 8·55h. to 9·07, *i.e.*, from 90 to 95½ millions of miles. Mr. Harkness says:—"We only know that the parallax seems to lie between 8·75″ and 8·90″ and is probably about 8·85″. Now, 8·846″ (92,400,000 miles) is the final value of the parallax derived from the English and Australian observations by Captain Tupman and accepted by Sir George Airy.

Reference has already been made to the International Conference of Astronomers which was held in Paris, in October, 1881, for the purpose of securing concerted action in observing the coming transit of Venus. Eleven European and three American States were represented at the Conference; but the United States were not represented, although it is known that extensive preparations for observing are being made there. Mr. Stone, who represented England, stated that England would have sixteen stations—the principal centres being: 1. The Cape, with three stations. 2. Australia, with the Observatories of Sydney and Melbourne. 3. New Zealand. 4. Jamaica and Barbadoes. 5. Madagascar, and possibly the Falkland Islands. He added that England would do little or nothing with photography; for although the American photos. had turned out better than was expected, the results had been published too late to give time to get the instruments made and adopt their method. It was announced that France would have eight stations, placed as follows:—Florida, Cuba, Martinique, Mexico, Santiago, Santa Cruz, Rio Negro, and Port Desire. Each station will have two equatorials, an 8 and a 6-inch, but photography will only be employed at two, which are not yet named. That Germany would have four stations, and would not make any use of photography. Two stations would be in North America—one in the Argentine Republic, and one in the Falkland Islands. That the Danish Government would send a party to St. Thomas; the Netherlands would send a party to Curaçoa or St. Martin; Portugal would have parties at Lisbon, Coimbra, and perhaps one of the Portuguese Colonies; Austro-Hungary will send a party to South America; Spain will send parties to Porto Rica and Cuba; Brazil will have three parties—one at Rio Janeiro, one on the hills 6,000 feet high, and one at Pernambuco—in all thirty-nine stations. The Conference agreed to instructions for observers, which were based upon the proposals of the British Commission, as to the phenomena to be observed at the contacts. It is therefore evident that the astronomical world is determined to make good use of the transit of 1882, and will spare neither money nor time to ensure a better result than that obtained in 1874. One of the strongest proofs of this is the concerted action that has already been taken. But I will not detain you now by quoting the instructions which have been issued. I hope to have another opportunity of placing them before the members.

You will have noticed that England counts the Observatories of Melbourne and Sydney in her list of stations; and I should like to detain you a few moments by saying what response Sydney is likely to make. Provision was liberally made by Parliament last year to enable the Colony to respond to this new call of science, and the money has been placed at my disposal for this purpose. With this I shall be able to provide four high-class 6-inch equatorials, similar to those which are to be used by the European observers, also two of $4\frac{1}{2}$ inches. We have remaining from the last transit of Venus one equatorial of $11\frac{1}{2}$ inches, one of $7\frac{1}{4}$, one of 5 inches, one of $4\frac{3}{4}$ inches, and one of $4\frac{1}{4}$ inches. With these I hope to be able to take up four stations, in addition to the Observatory, and place two observers and two telescopes at each point. I cannot yet decide as to the use of photography, for it is of little or no use here without corresponding observations on the other side of the world; but I have ready, if they are called for, one English photoheliograph and one of the American pattern. In Australia, along the east coast, we shall occupy the position which Sir George Airy thinks the best, viz., one where the sun is about 15 degrees above the horizon at the time that Venus makes egress. This gives the largest value of the parallax factor consistent with such an altitude of the sun as will probably admit of accurate observation. If it were not for atmospheric interference, or difficulty in seeing distinctly, the best position would be that from which the sun would be seen to be rising at the time Venus makes egress; and that point is in the centre of Australia. The gain in parallax factor in such a position, however, does not compensate for the uncertainty caused by the atmospheric defects close to the horizon. In order to make the best of our chances, I have selected elevated points on the east coast of New South Wales, where the observers, being from 500 to 2,700 feet above the sea, may fairly expect to have a clearer view of the sun an hour after sunrise, or when the egress takes place, than they would have if observing near the sea-level.

In observing the transit of Mercury in November last, the observers were stationed at Bathurst, Katoomba, and Sydney, places which I thought far enough apart to secure different weather; but to my surprise the weather was practically the same at all places, at the same hour. This led to unpleasant reflections,—it might be cloudy all along the coast on the 6th of December; and I was therefore glad, when the recent Commission went to Lord Howe Island, to take advantage of Mr. Conder's offer to make inquiry as to the suitability of that island as a station for observing the transit of Venus; and I am glad to say he thinks it very suitable. An elevated spot is easy of access, and the weather at the hour and season is almost sure to be fine. I will not detain you with further details; I think I have said enough to show that an effort is being made to make the best possible use of the opportunity and of the means at our command; and from the active part the Royal Society took in assisting me with certain portions of the work of preparation for the last transit of Venus, I am sure that this information will be at least interesting to the members here present.

In this bright land of ours we sometimes get too much of the sunshine; and our recent experience, indeed the present state of some parts of the Colony is such that I am sure I need make no apology for introducing some considerations which may help us to form a correct opinion as to the possibility of producing rain artificially. From time to time the rain-doctor appears, not with the old "tom-toms" it is true, but with certain modern counterparts of them. He works with nitroglycerine, with cannon, with electrical machines, with kites, &c. Now, I hope to be able to show you that in the opinion of the highest authorities there may still be a place left for the rain-doctor, if he works reasonably, but not otherwise; he must not pretend to pull down the clouds with a wire or to frighten them with a few crackers; there must be a correct understanding of cause and effect, if he is to retain his place in the modern social scale. One or two points in the history of this subject are instructive, showing as they do how circumstances alter cases.

M. Arago tells us that finding the practice of firing guns common in some of the Departments of France, he had tried to trace the origin of the custom, which probably began in 1769. It appears that a retired naval officer, who at sea had seen waterspouts destroyed by cannon shots, made his home in a district that suffered from violent rain and hail storms, and he determined to try the power of shot and shell upon these new foes; and setting up his battery, he fought his battles o'er again with such success that the district was protected from the violent storms—they could not face the cannon; and the practice became popular in France, and up to the year 1806, and even later, many Communes kept a battery of small guns for this purpose, and the Commune of Fleury even went so far as to get a cannon that used a pound of powder for each discharge. M. Arago could not trace what the effect had been, but he at least was not convinced that it had had any good effect, and after a time the practice became obsolete, in spite of the apparent success which had given rise to its general adoption. Volta's biographer says that "it is well known that Volta thought a possible advantage might be found in having large fires during thunder-storms." He does not give his reason, but it was probably that the smoke of a large fire would serve as a conductor for the electricity, and so prevent dangerous discharges. And Arago mentions the fact that near Cesena, Romagna, there is a parish which had suffered severely from hail-storms, throughout the extent of which, by the Curé's advice, the peasants placed, first mounds of stone every 50 feet, and on these heaps of straw and brushwood, which they set on fire all over the parish as soon as a storm was seen approaching, and for three years they had no hail-storms, while their neighbours, who had no fires, had their crops destroyed by hail as usual.

To test the effect of the discharge of artillery on the weather, Arago examined the weather record in the Paris Observatory for many years, especially on and before and after the days on which the regular gun practice took place in the fort situated 3,280 yards from the Observatory. The firing took place at this fort on certain days in the week, and from 7 to 10 a.m., and about 150 shots were fired. Now, if these discharges really had the effect then attributed to them it must be visible in the weather records, and he found that out of 662 days preceding the practice 128 were cloudy; out of 662 days of practice 158 were cloudy; and out of 662 days following practice 146 were cloudy, which he thinks goes to prove that the discharge of heavy artillery does not seem to have the effect attributed to it. *i.e.*, of dissipating the clouds.

Arago, at one time, struck by the amount of destruction caused by hail-storms, proposed to draw off the electricity by means of wires carried up to great elevations by captive balloons; but it was seen as soon as he came to the practical consideration of the scheme that each balloon would not protect more than perhaps a thousand square yards—a mere speck of France, and no Government could endure the expense of keeping up such a number of balloons as would protect the whole country, even if they were of any use; for it is evident that in a storm, when they would be most wanted, the wind would blow them down, and in later years he was led to doubt the value of such a means of protection. Arago tells us that in tracing the history of the use of cannons he found that bells, especially church bells, had preceded them; and it was at one time firmly believed that the vigorous ringing of church bells was sufficient to dissipate dangerous storms; and he says—"Savage nations in all parts of the earth send forth deafening clamours to terminate eclipses and destroy dangerous storms," and the habit seems to be still ingrained in human nature. It is evident, therefore, that up to 1810, or later, the popular idea was that storms might be destroyed or prevented by fire or guns, and I have been unable to find any reason for the complete change to the opposite opinion which has taken place since then, unless it be that the wants have changed. Australia, like Africa, wants the rain-doctor to make rain, not drive it away. It is not only in Australia, however, that the belief in the artificial production of rain exists. In America, during the Civil War, it was a matter of common observation that rain followed the great battles, and the belief in this became so general that farmers began the practice of making large heaps of brushwood on each farm, and when they wanted rain lighting them all together. I cannot find any reference to the results of this system in the Smithsonian publications, in which almost every subject of this kind is dwelt upon; but the practice seems to have been given up.

In 1870, Mr. Edward Powers, C.E., in a small volume entitled "War and the Weather, or the artificial production of Rain," endeavours to prove that rain can be produced by human agency, particularly by heavy discharges of artillery, and cites a number of instances in which great battles have been followed by a speedy downfall of rain. He mentions six cases of this kind in the Mexican war, 1846 and 1847; nine cases of battles or skirmishes followed by rain in the American Civil War of 1861, forty such cases in 1862, thirty in 1863, twenty-eight for 1864, and six for 1865; eighteen similar cases from the great battles fought in Europe during the past century, making a total of 137; and he says if these facts are insufficient to convince, it would be vain to expect to do so with a greater number. The meteorological editor of *Silliman's Journal*, in reviewing this book, justly says "that the writer has omitted to consider many necessary points in the proof, for in those parts of the earth in which the battles cited were fought, rain falls upon an average once in three days, so that the average interval between rains would be about two days. Now, battles are seldom commenced during rain; generally some hours elapse to dry the ground before the battle begins. Rain ought, therefore, to fall within about one day after a battle. Mr. Powers takes no precise account of the length of the interval between the end of the battles and the commencement of rain; nor does he attempt to show that the battle shortens this period; and, moreover, he says nothing of the cases opposed to his theory. In order to complete the proof, a much more careful analysis of the facts is required. We are inclined to the opinion that great battles do exert some influence in the production of rain, but we cannot accept Mr. Powers' discussion of the facts as proof." This opinion of the success of Mr. Powers' work is very valuable, because it comes from a very competent authority in America, where the majority of the cases are said to have occurred, and was within four or five years of the termination of the war, when the means of testing the facts would be within reach.

The editor of *Silliman's Journal* evidently believes that there are so many facts in favour of the theory that it deserves careful investigation; and another leading writer on meteorological subjects in America, whose opinions on many such matters have had great weight, was firmly convinced, not only that it was possible to produce rain, but that it might be done economically whenever it was wanted. He doubtless had what appeared to him to be sufficient reason for this opinion; but Professor Henry, Secretary to the Smithsonian Institute, and perhaps at the time the most competent man in the world to express an opinion upon this subject, said, in reference to Espy's idea:—"I have great respect for Mr. Espy's scientific character, notwithstanding his aberration, in a practical point of view, as to the economical production of rain. The fact has been abundantly proved by observation that a large fire sometimes produces an overturn in the unstable equilibrium of the atmosphere, and gives rise to the beginning of a violent storm; but it was not wise in him to insist on the possibility of turning this principle to an economical use."

In 1874 this subject was taken up by Mr. R. D. Belcher, who read a paper before the British Association on "The disturbances of the weather by artificial influences, especially battles, great explosions, and conflagrations." In it he gives many instances, from the siege of Valenciennes in 1793 to the Ashantee and Carlist wars of 1874, to prove that storms follow immediately upon battles. It is said Solferino was lost through a heavy thunder-storm which came on and prevented the officers from seeing the movements of the troops, and a similar storm occurred at Sadowa. Further, the sham fights at Aldershot on May 19, June 19 and 20, July 8, 20, 21, 27, and 29, 1874, were in every case followed by a thunder-storm.

Referring to Mr. Belcher's paper, which the British Association did not think worth publication, Professor Everett, President of the Meteorological Society, said—"The subject (cannons and rain) was not a new one. In several parts of America the farmers, in order to produce rain, gather a large quantity of wood and burn it on their respective farms on the same day. He believed that great battles and great fires tended to produce rain, but rain did not necessarily follow battles or fires." Not wishing to detain you over the multitude of observed facts, I have endeavoured to give a condensed account of them, and of the opinions of some of the leading scientific authorities upon the possibility of producing rain artificially. It must, however, be borne in mind that the facts observed may easily mislead, and it would appear that the criticism of the editor of *Silliman's Journal* is justified; for there is a want of scientific accuracy in Mr. Powers' investigation, and the matter is so difficult of proof that the mere collection of favourable instances, omitting the important element of the interval or time between the battles and rain, as well as all battles and explosions not followed by rain, cannot be considered satisfactory evidence. As it is impossible for me to fill in these details here, I have endeavoured to collect the records bearing upon this matter in Australia. Battles are supposed to be prime movers in such effects; fortunately, in one respect we have none to refer to; but it is unfortunate for our present discussion, because the climate of Australia is peculiar, and instances of the effects on the spot would have been very valuable. We can only refer to the mimic battle in April, 1881. When this is compared with previous occasions even, we got through a good deal of powder For several days before the sham-fight the weather had been very wet, and on the morning of the day of the fight it began to clear and the day became bright and fine as the firing went on; and although heavy rain had just ceased, which was proof of abundant moisture in the air, there was no return of the rain, except indeed a little shower next morning, when 0·01 inch fell as the rain finally cleared off; our one battle therefore produced no rain.

We come next to the great fires which have occurred in Sydney; and in examining these fires I have assumed that if a fire produced rain, the rain would fall within forty-eight hours. I think in strictness, for reasons which will appear presently, the time allowed should be much shorter. I have gone back to 1860 (or twenty-one years), and I have not taken every fire, because many were so small that it would not have given a fair expression of our experience to include them. I have, in fact, only taken the large fires and serious explosions, and as I read over the following list you will remember that many of them were enormous conflagrations, causing a constant rush upwards of heated air for many hours in succession; and if a fire can upset the unstable equilibrium of the atmosphere by causing an uprush of air, some of these fires were just of the character to do it, confined as they were within four walls, and burning furiously for many hours.

March 1, 1860, Dean & Co., auctioneers; no rain for days. October 3, 1860, Prince of Wales Theatre; light rain before and after, does not seem to have been affected by fire. January 24, 1861, Boylson's flour-mill; no rain for days. June 20, 1861, Curran's furniture shop; no rain for many days. August 3, 1862, J. and E. Row, chemists; raining for two days before, and cleared off the night of the fire. June 20, 1865, St. Mary's Cathedral; no rain for many days. July 20, 1865, J. Frazer & Co.'s stores; the wind had been westerly for days, and changed before 3 p.m. to S. and S.S.E., and the humidity rapidly increased; the fire was announced at 8.30 p.m., and it began to rain at 9.30 p.m., and during the night and next day 0·60 inch fell. November 16, 1865, 2½ tons gunpowder exploded at Penrith; no rain at Sydney. December 14, 1865, Walsh, grocer, three shops; change of wind to south next day, and light rain at 6.30 p.m., or fourteen hours after, evidently an ordinary change. December 21, 1865, Hill's furniture shop; no rain for days. January 16, 1866, Wearne's flour-mill; no rain for two days afterwards, and then with change of wind to south; barometer falling days before. March 4, 1866, explosion of nitro-glycerine in Bridge-street; no rain for two days, and then with a regular change. April 18, 1867, Sands' fire; no rain within forty-eight hours. March 1, 1868, Holdsworth's; no rain within forty-eight hours. January 5, 1869, St. Mary's Temporary Cathedral; no rain within forty-eight hours. February 9, 1870, Blackwall wool stores, great fire; no rain within forty-eight hours. September 20, 1870, six houses in Hunter-street; no rain within forty-eight hours. December 11, 1870, Pemell's mill; no rain within forty-eight hours. January 6, 1872, Prince of Wales Opera House and four houses in King-street; had been a showery afternoon; at 9 p.m. cleared up, and was fine weather; shower fell at 3.30 a.m. of the 7th, but this and the other showers together only measured 0·04 inch; no other rain fell for two days. May 17, 1872, Barker's tweed factory; shower at noon, clearing at 9 p.m.; showers after 4.30 a.m. of 18th; total, 0·08 inch; rain hanging about on 16th and 17th. December 14th, 1874, Booth's saw-mill; no rain for many days. August 3, 1875, 11·40 p.m., Lane and Chester, large fire; rain 7·45 p.m. to 9 p.m., then no rain till 6·45 a.m. of 4th; clearing up, no rain for many days after. September 21, 1875, 12·30 p.m. store and three dwellings, Kent-street North; hot wind all day, changed to S. at night, and next morning light rain; only 0·21 in. October 1, 1875, extensive bush fire, Rose Bay hill; no rain for many days. November 2, 1875, Fairfield, Liverpool, large bush fire; railway station caught fire, and 1,000 tons of wood were burnt, together with shed near railway station; no rain for many days. December 26, 1875, 5·58 p.m., Mort and Nicolle, meat-preserving works; there was a heavy shower on the 25th and rain was hanging about; on 26th it was cloudy, and clouds cleared in the evening, thunder-storm next day. September 16, 1876, 2·35 a.m., M'Lauchlan, carpenter's shop; large fire; strong gale sprang up and extended fire; no rain for days. April 23, 1877, 4·27 a.m., Hanks' grocery store and other premises; no rain for days. September 8, 1877, 10·30 p.m., boatbuilder's place, Balmain; began to rain two days after, with change of wind to S.E. February 26, 1878, 3·38 a.m., Olsson, general dealer, ten small shops and some timber; light rain thirty hours after fire. May

12, 1878, 2.40 a.m., Dixon-street, fuel merchant, large fire; no rain for days. August 6, 1878, 1.55 a.m., Flagstaff Hotel, large house; no rain for days. November 27 1878, 12.18 a.m., hay and corn dealer's and other buildings, 681, George-street, large fire; change of wind day before fire, to E.S.E., 0·006 in. of rain fell on the 27th. January 3, 1879, 12.34 a.m., Burwood Congregational Church; no rain for days. July 16, 1879, 10.33 p.m., store, 687, George-street, and other premises; no rain for days. October 28, 1879, 1.20 p.m., two 3-story produce stores, very large fire, no rain for days. January 11, 1880, 7.13 p.m., music store and other premises, 610, George-street; no rain for days. May 6, 1880, 1.37 a.m., Fresh Food and Ice Company, large fire; no rain for days. May 26, 1880, 10.35 p.m., hay shed, cottage, stable, &c., Foss-street, Glebe; raining all 26th till evening, and again during the night; rain only 0·11 in. May 28, 1880, 6.7 a.m., Shale, and Oil Company, 150 barrels of oil burnt; raining on 27th, cleared up on 28th. July 22, 1880, 11.40 p.m., Victoria Theatre, large fire; no rain for ten days. July 25, 1880, 12.25 a.m., Read's carpet warehouse and other premises; no rain for days.

We have here forty-two fires, extending over a period of twenty-one years, and there is not one instance in which rain has followed within the forty-eight hours as an evident consequence of the fire. Now several of these fires began when it was raining, and seemed to produce no increase in the fall—indeed, in many cases it looks as if the fire had stopped the rain; and if these instances had been taken out to prove that large fires drove away the rain, the evidence would seem almost conclusive. It may perhaps be said that none of these fires were large enough to make it rain; but if fires ever have such an effect, some of our fires, occurring as they did under most favourable conditions, should have done it; for instance, when the Prince of Wales Theatre and houses in King-street were burnt. The afternoon of the day on which the fire took place had been showery, very light rain fell, showing the air was at the point of saturation, and when the fire came on, and for some hours after, the rain ceased, and at 3.30 a.m., another very light shower fell, and that was all for days. Now the shower at 3.30 a.m. and all those in the afternoon, only made up a total 0·04 inches; the rain was therefore little more than mist; sometimes one night's dew will measure more than that. Again, when J. and E. Rowe's fire (wholesale chemists) took place, it had been raining for two days before, and the next morning after the fire the weather cleared up.

You would notice that amongst the list of fires I have put two important explosions—the first that of 2½ tons of gunpowder which was on a dray at Penrith, and was accidentally exploded, without any rain following; the other the great explosion of nitro-glycerine on March 4, 1866, when two stone stores were destroyed, and no rain fell; and one fire at Liverpool, where in the midst of a great bush fire 1,000 tons of wood and a shed were burnt without any rain following. This gives us a measurable quantity of heat, and must have been very far in excess of any ordinary city fire. Now, with regard to bush fires, it is a common belief that they produce rain, and I have had some cases reported to me where rain has followed the fire, apparently caused by it, but in my own long experience of bush fires I cannot recollect one instance in which it was obvious that rain followed the fire; and I think I need only mention the great fires which have raged in the neighbouring Colony of Victoria as well as here, during the last three months, as proof that such fires frequently take place without a drop of rain following. And if these fires had not sufficient intensity, we can refer to the memorable Black Thursday, February 6, 1851, in Victoria, when, as if to make a culmination of all the fires that had been burning in Australia for weeks, there came a fearful hot wind, which fanned the flames in Victoria until in their mad career they leaped from tree to tree, and became so hot and furious that it seemed as if all nature was on fire. Yet, violent as was this disturbance, no rain followed it for many days.

A correspondent in the country, who believes that rain may be produced artificially, sends me the following instances of the effects of bush fires :—On January 1, 1881, a heavy bush fire came across from the Darling to Cobar, and burnt up the heavy grass on some unstocked country ; it continued burning for ten days, and on January 10 we had 1·48 inch rain. Another case was observed in the Wimmera district, Victoria, where, during a heavy bush fire in the mallee scrub, a thunder-storm gathered and put out the fire with rain. Another observer worked at three large bush fires, and each time the fires were put out by rain. These instances are given as evidence in favour of the idea that the fire caused the rain ; but none of the meteorological circumstances are stated, and it is impossible therefore to say that there would have been no rain if there had been no fire ; but, as the date of one instance is given, I am able, by reference to the weather maps, which are published daily, to say with some degree of certainty that if there had been no fire there would still have been rain. The date of the rain is January 10, 1881 ; on January 7, 8, and 9, southerly and S.E. winds had been blowing on the coast, causing a fall of temperature, which did not reach the interior generally until the 10th, and the temperatures of the 10th show a great fall from 20° to 25° in the interior, and especially in the district Bourke to Dubbo ; the result was that rain fell at nineteen other stations in addition to the one referred to near Cobar. At Euston 2·59 inches fell, at Wentworth 1·85 in., Moree 0·32 in., and others which need not be mentioned. Now, it would not be safe to assume, without further evidence, that the fire about Cobar caused a general southerly wind and a fall of 20° in the temperature, and rain at such distances from the fire as Wentworth and Euston ; but it is highly probable that the fire had nothing to do with the rain.

It would be interesting if we could examine every case of this sort and see if the rain was due to the fire or to ordinary meteorological changes. From what has been said already, it is evident that some of the most competent authorities in England and America think that under certain circumstances rain may be produced artificially. Unfortunately for us, they all carefully avoided saying what the circumstances were. But I think we may form some idea of what they are from a consideration of the natural conditions under which rain is deposited. I am not going to ask you to follow me through the elaborate investigation of this question by Sir W. Thompson, M. Peslin, Dr. Hann, and others. It will be sufficient to say that they have proved that the principal cause in the formation of rain is the ascent of saturated or nearly saturated air, and that the rain caused by the mixing of two currents of air bears a very small proportion to the whole. Their investigations have further taught us that air as it rises, whether from the effect of heat or up-draught, loses 1° of temperature for every 180 feet which it ascends; but if, as it ascends, the dew-point is reached, a cloud is formed, and the latent heat given out by the condensed vapour warms the air so much that it has to rise 286 feet to lose 1° of temperature. Its upward velocity is therefore accelerated, and its moisture rapidly precipitated; and this must go on until it loses the excess of moisture and reaches the temperature of the surrounding air. These are facts which have an important bearing upon our inquiry, and these laws may be seen in operation any calm fine day in the formation of cumulus clouds. Where the sun acts upon moist earth or water, it causes, first heat, then evaporation and an upward motion of the moist air, which, when it reaches the altitude and the temperature of the dew-point, condenses into a cumulus cloud; the central parts, heated by the heat given out by condensation, rush upwards, rolling masses of cloud out of the top as the condensation increases—the extent of the cloud forming a measure of the activity of the forces which gave rise to it.

A curious and instructive instance of this phenomenon in nature is found in the equatorial region of calms. Here the sun almost invariably rises in a cloudless sky, which remains clear until about noon, when heavy masses of cloud begin to collect and, rapidly increasing, form a dense black covering from which rain pours down in torrents; towards evening the rain gradually ceases, the clouds disperse, and the night is serene and fine, and the weather remains so until the heat accumulates on the following day to reproduce the same effects. These phenomena are strictly in accordance with the known laws of atmospheric condensation. At the Equator the calm belt is supplied with air from the trades, which are almost saturated with moisture, and this air, resting on the ocean under a vertical sun, the saturation necessarily becomes complete. Now the series of effects we have just considered comes about in this way: the sun, as it gains power in the forenoon, heats the stratum of air which rests on the water, and gives rise to evaporation from the sea; the moist heated air begins to rise rapidly; but so soon as its cooling, from elevation and expansion, reduces its temperature to the dew-point, then moisture is deposited as cloud, and the ascending rate, accelerated by this deposition, leads to increasing clouds above, and to rapid cooling down of the air below; for the heavy clouds stop the sun's rays and throw all below them into shade and a much lower temperature; hence the heavy rain which speedily brings down the moisture that had been carried up; the cloud particles left after the heavy rain fall slowly down, and melt as they fall; the sun having meantime by his westerly course lost the morning's power, the evaporation is not renewed, and the sun sets in a clear sky.

This process carried on in the calm belts is just that which may be seen on a calm day, and I may mention here, as an illustration, a recent observation in Sydney. April 20, 1882, the morning was fine and bright and the air very moist; at 9 a.m. the difference between the wet and dry bulbs was only 1·7°. It was perfectly calm all the morning, and there were only a few cirrus and small cumulus clouds about at 9 a.m. As the morning wore on the sun got very powerful, and the little cumuli grew into great ones, rolling out great masses from the top, and so forming a shade for the clouds and earth below. The base of these clouds seemed to spread out into dense stratus, and about noon I could see that those in the W.S.W. were depositing rain, and now and then a downstroke of lightning, followed by low rumbling thunder. The clouds grew rapidly, and, forming over the Observatory, obscured the sun and caused a sudden fall in the temperature, shown by the metograph to be $6\frac{1}{2}°$; only a few drops of rain fell, and the temperature rose again about 2°. As I watched the cumulus and the rain in the W.S.W., the clouds slowly descended and became lost in the haze. If we may assume that the air at the Observatory was in a similar condition to that all round, we find that at noon, and before the sun was covered, the difference between the dry and the wet bulbs was 5·9° ; and on that occasion a fall of $6\frac{1}{2}°$ in the temperature produced a few drops of rain ; but in order to cool this air to the dew-point by elevation, its temperature would have required reduction by 10·4°, or to be raised up 1,870 feet. It is probable, therefore, that the clouds forming over Sydney on that day were about 1,800 feet high.

These instances are illustrations from nature of the conditions under which the leading scientific meteorologists of the day tell us that rain is formed. If, however, it so happened, as in temperate latitudes it might, that there was a cold wind blowing over the warm saturated one when this up-current was started, then the heated air would rush up into it, and when once the stream was started there would be a great downfall of rain—in fact we should have a case in which the "unstable equilibrium" of the atmosphere having been upset, the downfall of rain would be disproportionate to the cause which set it in motion ; but this condition, viz., a cold current blowing over a warm moist atmosphere, is a very uncommon one, for the cold air being the heavier seeks the lower position, and can only take the upper one when moving with considerable velocity. It would therefore rarely happen that an up-current, even when once started, would continue for any length of time unless the cause of it were maintained—in fact, the cause which uplifts the atmosphere must have a definite relation to the amount of rain deposited. Of course this relation would vary with the humidity of the air, with the relative temperatures of the layers of the atmosphere, and with many other conditions ; and it would be quite impossible to say definitely how much uplifting force would be necessary at any particular place until all these conditions were well known, and then it would be an easy matter to calculate exactly how much powder or fuel would be required to effect the desired result. Some of these conditions, however, especially the relative temperatures of the several layers of the atmosphere, cannot be ascertained, and others are exceedingly difficult to measure. We may, however, get some idea of the amount of force necessary by studying certain phenomena of rainfall which are presented to us in various parts of the earth. Many illustrations of the fall of rain from ascending currents might be selected; but the following will suffice for our present purpose. The island of Port Rico in the West Indies extends 90 miles east and west, and only 30 miles north and south; a chain of mountains, from 1,500 to 3,700 feet high, extends along the island from east to west. Throughout the year the N.E. trade wind blows on to the island every day from 9 a.m. to sunset, and at night there is a strong land breeze toward the ocean on all sides. During the rainy season, that is from the end of May the end of October, the rain falls every day on the northern portions of the island from 2 p.m. to sunset. This is due to the mountains, which turn up the trade winds, saturated as they are with vapour in the afternoon, into the colder regions, and thus cause precipitation of rain. But this is all on the northern slope; for on the south side not a drop falls from this wind, and sometimes this part of the island suffers from drought for more than a year without interruption. So well known and so constant is this condition that it is proposed to tunnel through the mountains, and thus bring some of the superabundant waters of the north to the south side for the purpose of irrigation. It is instructive to notice here what a very moderate rise will cause constant rain from a wind that is nearly saturated with moisture; but I am sorry I have not got observations of the actual state of the air, and the effect of the mountains in quantity of rain.

Again, the celebrated rainy spot in India where the annual rainfall is counted by hundreds of inches is a place of exactly similar character. It stands 4,200 feet high, on a range of hills on the north of the Bay of Bengal, and at a distance of 200 miles from the sea. The range rises abruptly to between 4,000 and 5,000 feet high, and has between it and the sea a belt of low and swampy land. The S.W. monsoon, coming over the Indian Ocean, arrives at this part of the coast laden with moisture, which is not abstracted, but rather added to, by the warm swampy belt at the foot of the hills. Directly the wind begins to mount the hills the precipitation commences in earnest, and the rain comes down as it does nowhere else. At Cherra Pungee, a town on these hills, 4,200 feet high, the annual rainfall is 600 inches, and of this enormous quantity about 500 inches fall from April to September. On one occasion the rain fell at the rate of 30 inches per day for five days, and in 1861 the total rainfall for the year reached the enormous quantity of 805 inches. No better example of the effect of hills on rainfall than this could be chosen. On the coast of New South Wales we have the same law in operation, and as a result 58 inches of rain falls at Cordeaux River, 1,200 feet high (about), for 39 inches at Wollongong, the foot of the same hill; and Kurrajong, at an elevation of 1,800 feet, gets 53 inches of rain for every 33 inches which fall at Windsor. At Kurrajong and Windsor the same proportion is maintained in heavy storm rains with easterly wind; but under such circumstances the rain at Cordeaux is double, and sometimes 230 per cent. of the rain at Wollongong.

If we can get a measure of the force required to produce these effects, it will serve as a guide in estimating what would be required to make rain. At Sydney the average relative humidity is 73, and at Windsor it is rather less; and we have just learned that such atmosphere lifted from Windsor to Currajong, 1,800 feet, deposits 60 per cent. more rain. If we could make it rise up over Sydney 1,800 feet we might fairly expect to get 60 per cent. more rain. Now, a wall built 1,800 feet high, and of considerable length, so that the wind would not divide and go round it, but go over, would have the desired effect—*i.e.*, to lift the air and cause rain; but anything that would do this would serve the purpose, and it may be done by fire, but of course the fire must have the effect of lifting the atmosphere up. It will not do for the products of the fire to rise up slowly, mixing with the air, and making it drier as they rise. If it is to have the effect of a wall—that is, making the whole of the air passing over rise up 1,800 feet—it must act as an explosion, would do suddenly; or by a constant uprush of such violence that it would rise up 1,800 feet. The force necessary to do this is easily computed, and we can in this way get a money value for the work to be done. At Sydney the average velocity of the wind is 11 miles per hour, and all the air passing over is to be lifted, and the weight of it on the surface is, say, $14\frac{1}{2}$ pounds on the square inch, and $13\frac{1}{2}$ pounds at 1,800 feet high. At least for our present purpose these figures are sufficiently exact. The average weight to be lifted, therefore, is 14 pounds on the square inch. The fire must have the same length as the proposed wall, for the same reason, and a breadth equal to the forward motion of the air in a given time. We have, therefore, to lift a weight of 14 pounds on the square inch over a surface of 1,000 feet by 10 miles (52,800 feet), and raise it up 1,800 feet every minute. To do this we will assume that coal is employed, and that, as it is burnt in the air, the whole of its heat will be effective. The mechanical equivalent of good coal is fourteen millions of foot pounds for each pound of coal used. We have therefore—

$$\frac{14 \times 12 \times 12 \times 1{,}000 \times 1{,}800 \times 5{,}2800}{14{,}000{,}000 \times 112 \times 20} = 6{,}110 \text{ tons per minute} = 8{,}800{,}000 \text{ tons in a day,}$$

or nearly 9,000,000 of tons of coal per day, to increase the rainfall 60 per cent., at a cost, at 10s. per ton, of £4,500,000.

Of course this is only a theoretical experiment, and ignores all the heat lost by radiation and imperfect combustion; but it serves to give some idea of what is necessary to disturb the course of nature, and I think shows how utterly futile any such attempt would be, even near the sea, where the air is moist. Inland it is a common thing in summer to find 20° between the dry and wet bulb thermometers; and when that is the case, the air would have to be lifted 6,000 feet to form a cloud, and in such weather no cloud could form until either moisture were taken up from the earth or the temperature of the air lowered about 34°.

I may perhaps just mention, as an illustration of the tremendous forces in operation about us, but all unheeded, the mechanical power of the sunshine. It appears from the experiments of Sir John Herschel, confirmed by Pouillet, that ordinary sunshine exerts a force on every 14 feet of surface of 1-horse power, and on an acre of 3,200 horses; or, to put it in another way, if we could utilize the sun's heat falling on a single acre of ground, we should have a steam-engine of 3,200 horse-power, working steadily in sunshine, or a power equal to lifting 47 tons of water 1,000 feet high every minute. If we try to conceive of this power accumulating on a square mile or 100 square miles, or the whole country, we shall get some notion of the forces at work in the production of rain, and what it means if we try to interfere with them. But at the same time one cannot contemplate such an enormous force without seeing that it is a possible solution of the real difficulty of our sunny interior. There abundance of water lies below the surface, and sunshine often too plentiful above it. We have only to supply the sun-engine, and forthwith sunshine draws up water in abundance.

It is often said that if we could tap the clouds and let off the electricity we should at once get plenty of rain; but this is a pure assumption. Science has not yet been able to ascertain what part, if any, electricity plays in the suspension of clouds. Franklin's memorable experiment is often quoted as a proof that rain would follow if a conductor were sent up to the clouds; but the facts must be overlooked, for the rain fell before there was any appearance of electricity, and hundreds of similar experiments were made subsequently without bringing down the rain; and if there were any truth in the supposition the facts would be patent enough in large manufacturing districts with tall chimneys, lightning-conductors, and smoke extending upwards as a continuation of the conductors, for there would be such frequent downpours as would convince the most superficial observer. And Crosse's experiments proved that lightning could be withdrawn from a cloud by miles of wire without producing rain. But has electricity so much to do with rain? Experience teaches us that the great bulk of rain falls without any electrical manifestation—even heavy tropical rains; and it is no uncommon thing for clouds to give rise to tremendous electrical discharges and not a drop of rain. It is evident, therefore, that the two have no necessary connection.

I have not yet referred to the vibrations of sound as a cause of rain. The laws under which water is held in the atmosphere are well understood, and, to any one who knows these conditions, the idea that vibration will cause its precipitation is absurd. Sound-waves do not alter the temperature or tension of the air except in a very slight and temporary way, and without change in one or both water cannot be deposited. If it is said that the firing of cannon has caused rain, the reply is that the statement rests upon the incomplete testimony of a few persons who did not inquire into the facts as carefully as they ought to have done; and, on the other hand, there is the testimony of two generations in France, who by constant experiment were convinced that the sound of guns had the opposite effect; and severe as M. Arago was upon them for their belief in fine weather made by cannon, they had quite as much evidence in favour of their view as those have who hold the modern one. It is estimated that in the battle of Sedan about 300 tons of gunpowder were used during the three days that the fight lasted; and the enormous amount of heated gases thus set free, and the heat of, say 300,000 men, together with the actual moisture set free might, if circumstances were favourable, disturb the equilibrium and cause rain; but none fell during the three days. On the fourth day, that is, the first after the battle, it did rain; but, even if it was a result of the battle, which is doubtful, the price is a heavy one to pay. It seems therefore unreasonable to hope for the economical production of rain under ordinary circumstances; and our only chance would be to take advantage of a time when the atmosphere is in the condition called unstable equilibrium, or when a cold current overlies a warm one. If under these conditions we could set the warm current moving upwards, and once flowing into the cold one, a considerable quantity of rain might fall; but this favourable condition so seldom exists in nature that I think we must abandon the idea of making rain artificially.

I hope I have not been tedious; but when so many proposals are put forward, some even going so far as to propose that our Government should take to cannonading the sky, it was time some one took the matter up; and I have tried as briefly as possible to place the important facts before you.

The Deniliquin or Barratta Meteorite.

By A. Liversidge, F.R.S., Professor of Chemistry and Mineralogy, University of Sydney.

(Second Notice.)

[*Read before the Royal Society of New South Wales, 8 December, 1880.]

A preliminary notice of the history and general structure and chemical composition of this very interesting meteorite was laid before the Royal Society of New South Wales in 1872, and published in its volume for that year. Since then I have been able to do a little more towards its examination.

Without repeating the details of the description already given, I may remind you that the meteorite belongs to the class known as siderolites, *i.e.*, it is made up of a mixture of various silicates with some metallic nickeliferous iron. Externally it is covered with a blackish fused skin, and the outer portions, to the depth of about an inch, are distinctly laminated. This laminated or concentric structure is probably due to the unequal expansion of the outer portion when the meteorite was intensely heated during its passage through the earth's atmosphere.

The structure is chondritic. Most of the grains consist of enstatite, grey or brownish in colour, and earthy-looking. The majority vary in size from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch in diameter. Under the microscope, these are seen to have an imperfect crystalline structure. Intermingled with them are a few particles of a green mineral like olivine, and of others which are not readily recognizable.

Intermingled with the earthy portions is more or less metallic nickeliferous iron. In one experiment, 86·716 grammes were powdered in a hard steel diamond mortar, and 3·3983 grammes of metal were obtained, equivalent to 3·93 per cent.; but in other cases the amount was much less, in two cases it was not even one per cent.; the metal is very irregularly scattered through the meteorite and some portions are almost devoid of it altogether.

The specific gravity of the laminated crust is 3·382; of the interior or body of the meteorite 3·503, *i.e.*, there is a difference of ·221. Mr. Russell, the Government Astronomer, who took the specific gravity of the whole mass, weighing 145 lbs., found it to be 3·387. Hence there must be considerable differences in the structure and composition of different portions of the mass.

* The publication of this paper has been delayed on account of the il trations.

After prolonged digestion in strong hydrochloric acid, only 47·47 per cent. of the meteorite was found to be soluble.

On an analysis of the whole, it was found to have the following

Chemical composition.

Silica	40·280
Copper	·182
Tin	absent
Iron	14·966
,, sesquioxide	3·930
Alumina	1·843
Chromium	traces
Nickel	4·219
Cobalt	traces
Manganese monoxide	·734
Lime	1·400
Magnesia	23·733
Potash	1·024
Soda	·997
Sulphur	2·288
Phosphorus	·617
Carbon	traces
Oxygen, by difference	3·787
	100·000

The alkalies were determined by Prof. Lawrence Smith's process. All the iron is stated as metallic iron, except that existing as sesquioxide, on account of the difficulty of accurately estimating the amount in the free state, in the presence of protoxide, sulphide, and phosphide of iron; the sulphur was determined by the potassium chlorate and nitric acid process, the phosphorus was also oxidized by means of potassium chlorate and nitric acid, and the phosphoric acid precipitated by ammonium molybdate in the usual way. The other constituents were determined after fusion with the mixed carbonates of potassium and sodium.

Another portion was crushed, and the flattened metallic particles separated by means of a fine sieve of nearly 8,000 holes per square inch, and analysed separately.

This metallic portion was first fused with pure caustic potash, to remove as far as possible any adherent earthy matter, and carefully washed with distilled water until the washings no longer gave an alkaline reaction.

Analysis.

Silica &c., insoluble in HCl.	6·617
Iron	79·851
Nickel	7·340
Cobalt	·431
Phosphorus	·240
Sulphur	traces
Oxygen, &c.	5·521
	100·000

The iron in the above became somewhat oxidized during the washing and drying.

A second specimen of the metallic portion from a different part of the meteorite yielded the following results :—

Iron	91·25
Nickel and cobalt	7·20
Undetermined, silica, &c.	1·55
	100·00

In the first case the cobalt and nickel were separated by the potassium nitrite process.

Attempts were made to estimate the amounts of schreibersite, troilite, &c., but none were sufficiently satisfactory to warrant their publication.

When at Paris, in 1878, I submitted sections of the meteorite to Prof. Des Cloizeaux, Director of the Mineralogical Museum, Jardin des Plantes ; and in a letter dated December 9th, 1878, he says, after having examined them under the microscope :—" Malheureusement elles n'offrent pas de forme nettement définie, et tout ce qu'on peut dire, par analogie avec des autres pierres, c'est qu'il existe de l'enstatite à structure fibreuse avec de l'olivine."

Prof. Daubrée, Director of the School of Mines, Paris, has provisionally classified this meteorite, of which there are some sections and a fac-simile in the collection of meteorites in the Paris Natural History Museum, with those from Tadjera, Orvinio, and Koursk.

The meteorite is essentially a mixture of the silicates of magnesia and iron (enstatite), with smaller quantities of other silicates, together with some nickeliferous iron, sulphide and phosphide of iron.

[Three plates.]

Plate I.

FIG. 1. THE BARRATTA METEORITE, N.S.W.

LENGTH, 24¾ INCHES; HEIGHT, 17 INCHES; WEIGHT, 145 LBS. SP. GR. [illegible]

Plate II.

FIG. 2. THE BARRATTA METEORITE, N.S.W.

LENGTH, 24½ INCHES; HEIGHT, 17 INCHES; WEIGHT, 145 LBS. SP. GR. 3·387.

Plate III.

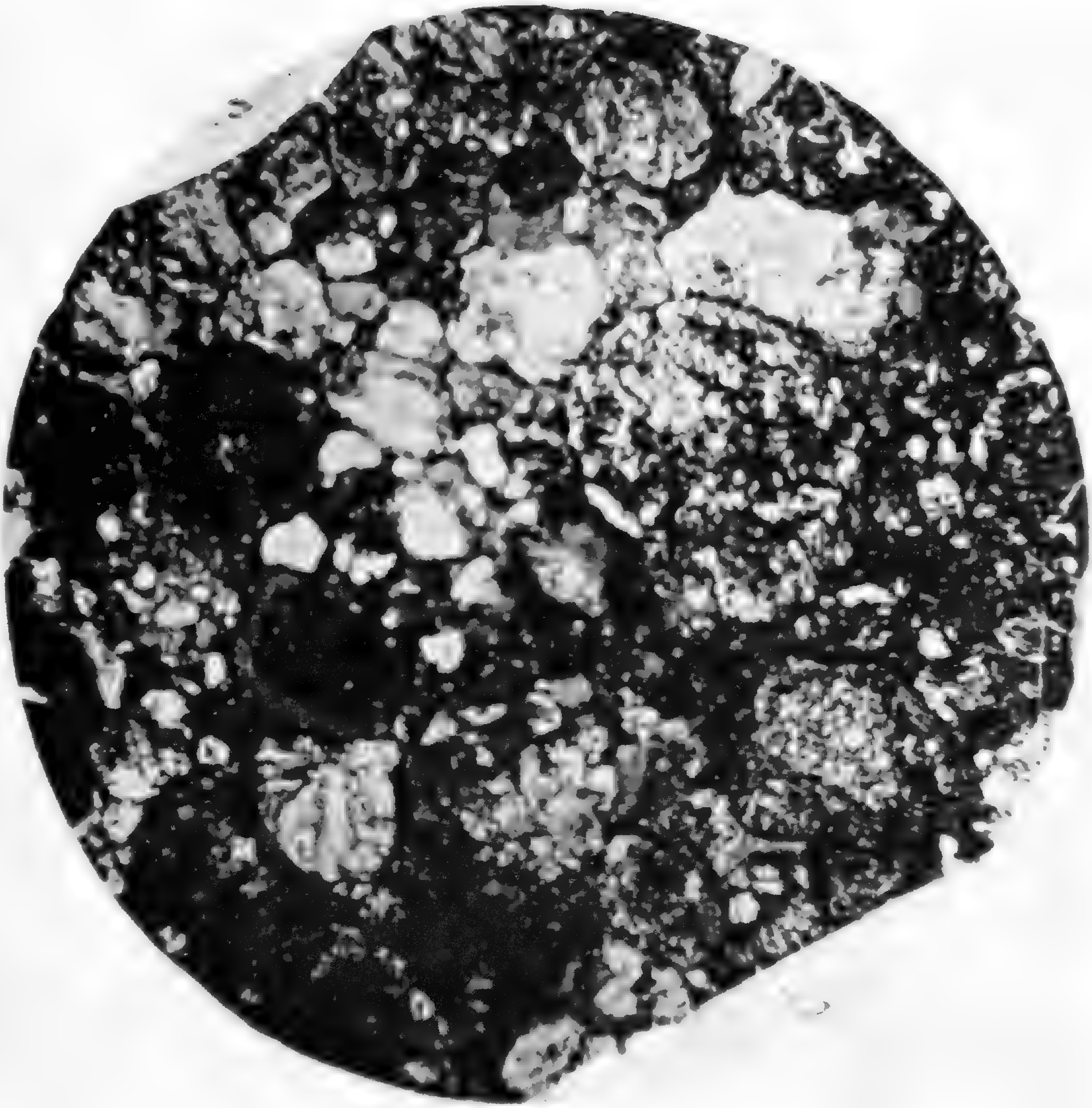


FIG. [illegible]. BARRATTA METEORITE.

MICRO-PHOTOGRAPH OF SECTION, ENLARGED 20 DIAMETERS.

On the Bingera Meteorite, New South Wales.

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

(Preliminary Notice.)

[* *Read before the Royal Society of N.S.W., 8 December, 1880.*]

This meteorite was found by some gold-miners in the course of their work at Bingera, and was placed at my disposal for examination by the Mining Department in Sydney.

In form this meteorite roughly resembles a pear; it is about 2 inches in length and 1½ inch across at the thick end, tapering down to about ½ an inch at the other; it does not possess any sharp angles, the corners being well rounded off.

The surface is covered with a black closely adherent skin of magnetic oxide of iron, formed by fusion during its rapid course through the earth's atmosphere, except in one place where it had been rubbed off by the miners. This burnished spot is readily recognized in the photo-heliograph as a white patch. (*See* plate No. 4, fig. 2.)

The skin is hard, brittle, of about the thickness of stout writing-paper, and possesses a laminated structure. At the thin end of the meteorite where the scale is thicker it is wrinkled and puckered, as shown in the photograph; in other places it is marked with small sharply defined cracks, which are evidently connected with the internal crystalline structure, since some of them are seen, where the crust or skin is scaled off, to pass through the crust into the mass of metal itself. These cracks are clearly the outlines of Widmanstätt's figures, probably developed in the crust by the contraction of the fused scale of oxide after cooling.

There are also a few pits on its surface, the most remarkable being a double depression, rather obscurely shown in fig. 2, plate 4.

It has fairly well marked polarity, the thin end repelling the south pole of the needle.

The total weight of the meteorite was 240·735 grammes, at 22·8° C., and its specific gravity as a whole 7·834; the specific gravity of some fragments cut off with a cold chisel was found to be slightly higher, viz., 7·849.

* The publication of this paper has been delayed on account of the preparation of the illustrations.

It does not appear to "deliquesce" at all like the Greenland and some other masses of meteoric iron; this is probably due to the entire absence of chlorine.

The flat side of the meteorite was carefully chipped away with a cold chisel, to obtain material for analysis and to prepare a smooth surface for the development of the Widmanstätt figures. It proved to be very tough and difficult to cut. On analysis the following results were obtained :—

Chemical Composition.

	I.	II.
Carbon	·137	·668
Matters insoluble in hydrochloric acid	·553	
Tin	traces	
Copper	,,	
Iron	93·762	
Nickel	4·391	
Cobalt	·668	·484
Phosphorus	·195	·270
Sulphur	absent	
Sodium	trace	
	99·706	

The matter insoluble in hydrochloric acid consisted mainly of iron oxide with a trace of silica. The second determinations were made on a separate set of chippings.

The amount of tin present is apparently slightly larger than that of the copper; but both exist in such small quantities that it would have been necessary to have cut up much more of the meteorite in order to estimate the amounts, and this was considered undesirable.

All the elements which were at all likely to be present were carefully sought for by the ordinary means as well as by the spectroscope, but only the above were detected, although larger quantities might have revealed the presence of others.

The carbon given in the analysis represents the portion left on prolonged treatment with hydrochloric acid; some may also enter into solution, but this I have not yet had time or opportunity to ascertain. Under the microscope this insoluble carbon presents the appearance of opaque black particles bearing a rough resemblance to crystal forms, but with very jagged and irregular outlines; its amount was estimated by direct weighing. On incineration it was found to still contain a trace of iron, in spite of the continued treatment with acid.

The cobalt and nickel were precipitated together as sulphides, and the cobalt estimated by the potassium nitrite process; the phosphorus, by ammonium molybdate, and the other constituents in the usual ways, every determination being made in duplicate.

From the illustration of the polished and etched surface, fig. 4, plate 4, it is at once noticeable that the structure is not uniform throughout, Widmanstätt's figures being fairly well marked, although by no means so well developed as in many of the larger meteoric metallic masses which have been met with elsewhere. Some of the crystals are much elongated ("beam iron"), whilst others are but small, and are arranged in a tesselated form.

Even the largest crystals are quite small; hence it would appear that the crystalline structure had been set up in the mass whilst quite small. Of course it may have been a fragment of a large meteorite with a small-grained internal structure, but most of the specimens which have come under my notice with largely developed crystals have been cut from comparatively large masses; others again do not present the structure at all.

It has been urged that if carbon and combustible gases be present in a meteorite it cannot have been in a state of fusion; but the argument does not carry much weight, since whether the combustible matter were burnt or not during the fusion would depend entirely upon the conditions; it might just as well be said that cast iron has not been fused because it contains carbon.

In places the acid has eaten freely into the metal, and more or less well developed cavities have been formed; in some cases these are much more numerous on one side of the "beam iron" crystals than on the other.

As soon as an opportunity presents itself I wish to continue the examination of this meteorite, especially with reference to the kinds and amounts of nickeliferous irons which are present, as well as to the question of occluded gases.

[Plate No. 4.]

Jour. Roy. Soc. of N S W., Vol. X

On the Chemical Composition of certain Rocks, New South Wales, &c.

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

(Preliminary Notice.)

[* *Read before the Royal Society of New South Wales, 8 December, 1880.*]

Freshwater Limestone, Newstead, New England District, N.S.W. —Of a grey colour, breaks with an earthy granular fracture and shows particles of included clay—evidently very impure. On analysis the following results were obtained :—

Chemical Composition.

	Hygroscopic moisture at 100° C	·736
*	Silica....................................	55·430
*	Alumina	14·116
†	Alumina	5·998
†	Iron sesquioxide	1·760
†	Manganese protoxide.......................	·989
†	Lime......................................	10·571
†	Magnesia	·575
†	Potash	·353
†	Soda	·598
†	Carbon dioxide (CO_2)	8·450
		99·576

* Insoluble in HCl. † Soluble in HCl.

Limestone, Windellama Creek, County Argyle.—Dark bluish grey in colour, and containing *atrypa* and other fossils.

Analysis.

Hygroscopic moisture at 100° C	·071
Silica....................................	2·208
Alumina with trace of iron	1·003
Lime......................................	54·602
Manganese	absent
Magnesia	trace
Potash	"
Soda	"
Chlorine	"
Carbon dioxide (CO_2)	42·369
	100·253

* The publication of this paper has been delayed on account of the illustrations.

Slate, Cox River.—Bluish-grey colour, somewhat weathered, slightly fissile. Of Devonian age.

Specific gravity, 2·706 at 21° C.

Analysis.

Hygroscopic moisture at 100° C	·861
Combined ,, by difference...	5·106
Silica..........	61·012
Alumina	21·343
Iron sesquioxide	3·704
,, protoxide..........	2·109
Manganese protoxide..........	·729
Lime	1·176
Magnesia	·887
Potash	1·223
Soda	1·850
	100·000

The combined water is estimated by difference, on account of the difficulty of completely driving off and collecting the whole of the water in the hydrated silicates of alumina.

Shale, Wallerawang, of a slate-grey colour, full of white impressions of *glossopteris* roots, fronds, &c.; fairly hard, and somewhat slaty. Contains a little carbonaceous matter.

Specific gravity, 2·304 at 20°6 C.

Analysis.

Hygroscopic moisture at 100°	1·115
Combined water and organic matter	6·391
Silica..........	71·854
Alumina and traces of iron	17·736
Lime	1·777
Potash	·466
Soda	·383
	99·722

Slate, Wollondilly River, from above Goulburn, of a dark bluish-grey colour, imperfectly fissile.

Specific gravity, 2·58 at 18° C.

Analysis.

Hygroscopic moisture at 100° C.	·301
Combined ,, with carbonaceous matter	3·990
Silica..........	75·566
Alumina and traces of iron	16·466
Manganese protoxide..........	traces
Magnesia	·106
Lime	·708
Potash	2·274
Soda	·820
	100·231

A second specimen yielded silica, 77·54, and only 10·76 % of alumina.

Granite, Gunning, County King.—Rather fine-grained. Composed of white felspar, quartz, hornblende and black mica.

Specific gravity = 2·779 at 20° C.

Analysis.

Hygroscopic moisture at 100° C.	·269
Silica	69·793
Alumina	14·693
Iron sesquioxide	3·148
,, protoxide	3·371
Manganese protoxide	trace
Lime	4·861
Magnesia	trace
Potash	2·610
Soda	1·970
	100·715

Granite, Hartley.—Composed of white and dull pink orthoclase felspar, with a little plagioclase felspar, quartz, black mica, some small crystals of hornblende, and a few minute crystals of staurolite.

The specimen from which fig. 1, plate V, was taken contains a small quantity of auriferous iron pyrites, shown as black spots in the micro-photograph.

Fig. 3 is from a specimen of granite from the same district. This rock is, however, much coarser in structure, and the crystals of felspar are fairly large and pink in colour; but in other places the felspar is granular or powdery and quite white, and bears galena in place of pyrites.

The galena is for the most part present in small cavities, which are usually lined with quartz crystals. Both gold and silver are present in small quantities in the galena, but the granite itself yielded no indications of either metal. The black portions of the micro-photograph are particles of galena. These specimens were collected by Mr. C. S. Wilkinson, F.G.S., the Government Geologist.

Specific gravity, 2·712 at 20° C.

Analysis.

Hygroscopic moisture at 100° C.	·257
Silica	70·302
Alumina	18·845
Iron sesquioxide	·730
,, protoxide	1·855
Manganese protoxide	trace
Lime	1·336
Magnesia	trace
Potash	3·361
Soda	3·174
	99·860

Granite, Moruya. Coarse-grained, composed of white felspar, quartz, and black mica, in rather large crystal groups, with some hornblende and other minerals.

Specific gravity, 2·678 at 21° C.

Analysis.

Hygroscopic moisture at 100° C.	·168
Silica	67·557
Alumina	16·391
Iron sesquioxide	1·246
,, protoxide	1·858
Manganese protoxide	·794
Lime	5·075
Magnesia	1·484
Potash	1·770
Soda	3·540
	99·883

The polished granite pillars at the General Post Office, Sydney, are of this rock.

Granite, Pomeroy, County Argyle. Red in colour. Collected by the late Prof. A. M. Thomson, D.Sc.

Specific gravity = 2·60.

Analysis.

Silica	72·200
Alumina	11·399
Iron sesquioxide	6·172
,, protoxide	absent
Manganese protoxide	traces
Lime	2·000
Magnesia	trace
Potash	4·490
Soda	3·910
	100·171

Graphic Granite, County of Bligh, on the road from Talbragar to Two-mile Flat. Collected by the late Prof. A. M. Thomson.

The felspar is a mixture of orthoclase and plagioclase varieties. Not yet analysed.

For micro-photograph see Plate V, fig. 6.

Syenite, Boro Creek, County Argyle.—Composed of grey orthoclase felspar, with some plagioclase felspar, hornblende, and dark-coloured mica.

Specific gravity, 2·74.

Analysis.

Silica	64·27
Alumina	16·40
Iron sesquioxide	7·86
,, protoxide	trace
Manganese protoxide	·81
Lime	3·88
Magnesia	trace
Potash	3·16
Soda	4·19
	100·57

For micro-photographic section see plate V, fig. 2.

Syenite, Reevesdale, Bungonia.—A dark-green compact rock. Collected by the late Professor A. M. Thomson, D.Sc.

Specific gravity = 2·64.

Analysis.

Silica	66·876
Alumina	19·640
Iron sesquioxide	4·060
Iron protoxide	trace
Manganese protoxide	·188
Lime	1·471
Magnesia	trace
Potash	2·677
Soda	4·887
	99·799

See plate VI, fig. 7.

Quartz Porphyry, Lumley Creek, County Argyle.—Dark grey, with scattered crystals of hornblende. Collected by the late Prof. A. M. Thomson, D.Sc., who states that it underlies a fossiliferous limestone.

Specific gravity = 2·67.

Analysis.

Silica	67·714
Alumina	18·530
Iron sesquioxide	4·488
,, protoxide	traces
Manganese protoxide	,,
Lime	2·857
Magnesia	traces
Potash	2·920
Soda	3·230
	99·719

For micro-photographic section see plate V, fig. 4.

Quartz Porphyry, Gurragangamore.—Somewhat friable in places from decomposition; of a pale grey colour, almost white, with disseminated quartz grains.

Specific gravity, 2·58.

Analysis.

Silica	75·195
Alumina, with trace of iron	17·603
Lime	1·313
Magnesia	traces
Potash	2·343
Soda	4·016
	100·470

For micro-photographic section see plate VI, fig. 9.

Quartz Porphyry, Mount Lambie, Rydal, consisting of a green base, containing small opaque white felspar crystals, of about $\frac{1}{8}$ of an inch in length. Contains some carbonic acid and combined water.

From a dyke cutting through Devonian rocks. This rock varies much in different parts.

Specific gravity, 2·727 at 15° C.

Analysis.

Hygroscopic moisture at 100° C.	·355
Silica	61·504
Alumina	16·792
Iron sesquioxide	3·483
,, protoxide	2·225
Manganese protoxide	1·222
Magnesia	1·958
Lime	5·436
Potash	2·380
Soda	4·780
	100·135

Felsite, Two-mile Flat, Cudgegong River.—A fine-grained greenish-grey rock, collected by the late Dr. A. M. Thomson, Professor of Geology in the University.

Specific gravity = 2·706 at 20·4° C.

Analysis.

Hygroscopic moisture at 100° C.	·104
Silica	72·120
Alumina	9·750
Iron sesquioxide	4·105
,, protoxide	3·224
Manganese protoxide	1·833
Lime	2·989
Magnesia	trace
Potash	2·756
Soda	3·420
	100·301

Fig. 8, plate VI.

Dolerite, Waimalee, Prospect Hills, Parramatta River. This is the rock spoken of as a magnetic *diorite* by the late Revd. W. B. Clarke, M.A., F.R.S., in his Southern Gold Fields.

It occurs in association with intrusions of basalt, largely quarried for road metal, which have forced their way through the Wianamatta shale.

It possesses a coarsely crystalline structure, but so decomposed as to be easily broken up, and is in parts more or less friable. Some portions contain so much magnetite as to readily deflect the needle.

Specific gravity, 2·780 at 18° C.

Analysis.

Hygroscopic moisture at 100° C.	·991
Combined water, by direct weighing	7·009
Silica	46·498
Alumina	17·620
Iron sesquioxide	8·251
,, protoxide	5·238
Manganese protoxide	traces
Lime	9·303
Potash	1·612
Soda	3·476
	99·998

Basalt, Pennant Hills, Parramatta.—Of a specimen of this rock, eruptive through the Wianamatta shales, the late Prof. A. M. Thomson made the following analysis :—

Silica	60·42
Alumina	10·29
Iron oxides	14·10
Lime	2·66
Magnesia	·96
Potash	1·81
Soda	2·39
Water, by difference	7·37
	100·00

From the large quantity of silica and the small proportion of alumina, lime, &c., in the above it looks as if the basalt had not been wholly brought into solution prior to analysis.

"*Greenstone,*" Gympie, Queensland.—Of a green colour, compact and hard, breaking with a somewhat conchoidal fracture. Fig. 11, plate VI.

This is really an altered ash or breccia, as is shown by the section, made up of particles of various rocks, with fragmentary crystals of felspar, augite, magnetite, &c., mingled with chlorite.

For a description of the mode of occurrence and analyses of other specimens of this rock, see Daintree on the Geology of Queensland, Quarterly Journal of the Geological Society, 1872, p. 272, &c.

Specific gravity, 2·86.

Analysis.

Silica	54·952
Alumina	16·643
Iron sesquioxide	2·410
,, protoxide	7·849
Manganese protoxide	traces
Lime	8·645
Magnesia	trace
Potash	1·540
Soda	6·647
Water, carbonic acid, &c., not estimated	1·314
	100·000

Trachyte, Gladstone, Port Curtis, Queensland.—From a dyke cutting through Devonian rocks. It consists of a grey crystalline felspathic base containing embedded sanidin crystals—some scales of red hæmatite and other minerals in smaller quantities. Very vesicular in parts, also compact and close-grained in others.

Specific gravity = 2·23.

Analysis.

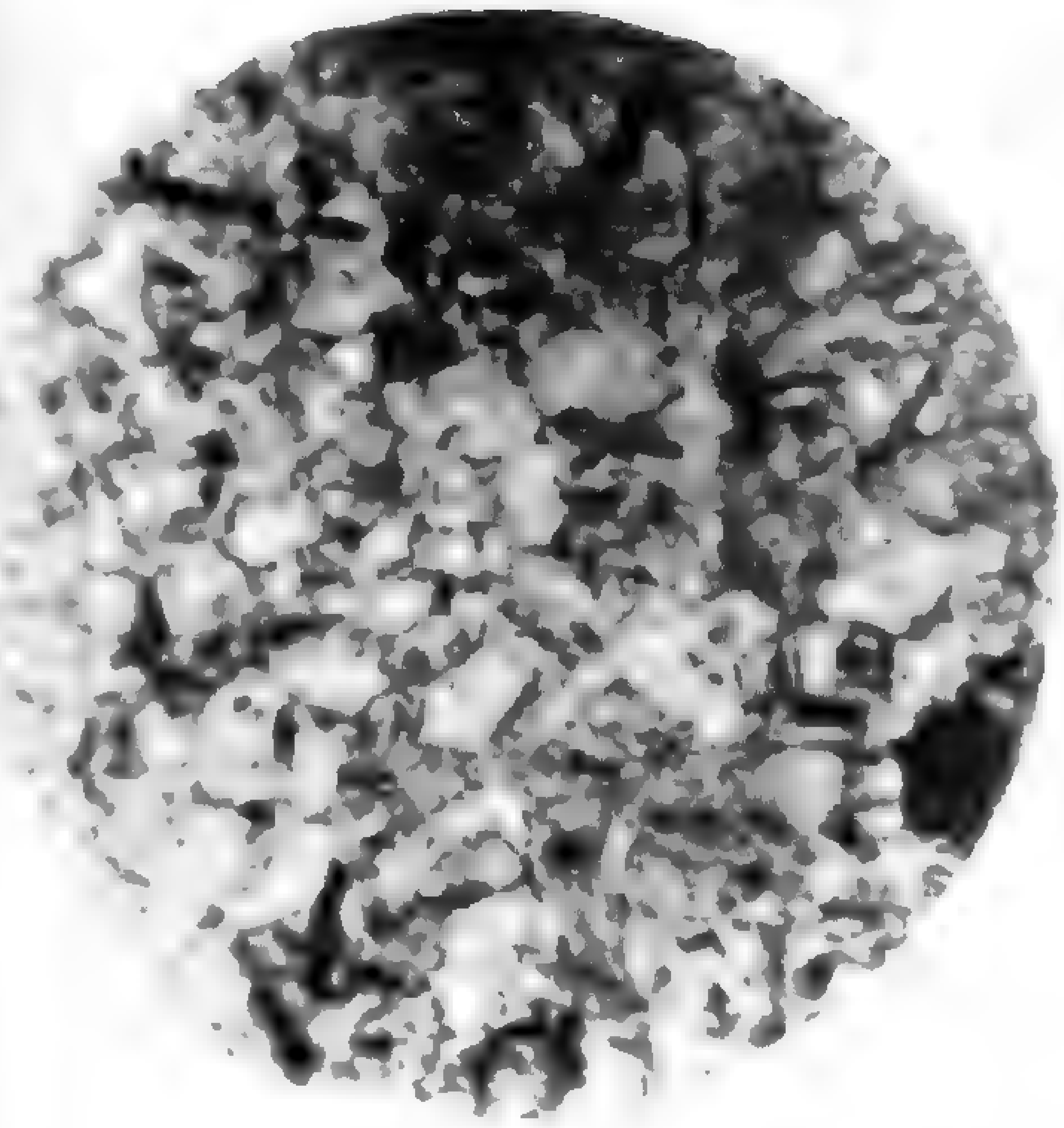
Silica	66·932
Alumina	19·902
Iron sesquioxide	2·410
,, protoxide	trace
Manganese protoxide	,,
Lime	·797
Magnesia	trace
Potash	5·290
Soda	4·820
	100·151

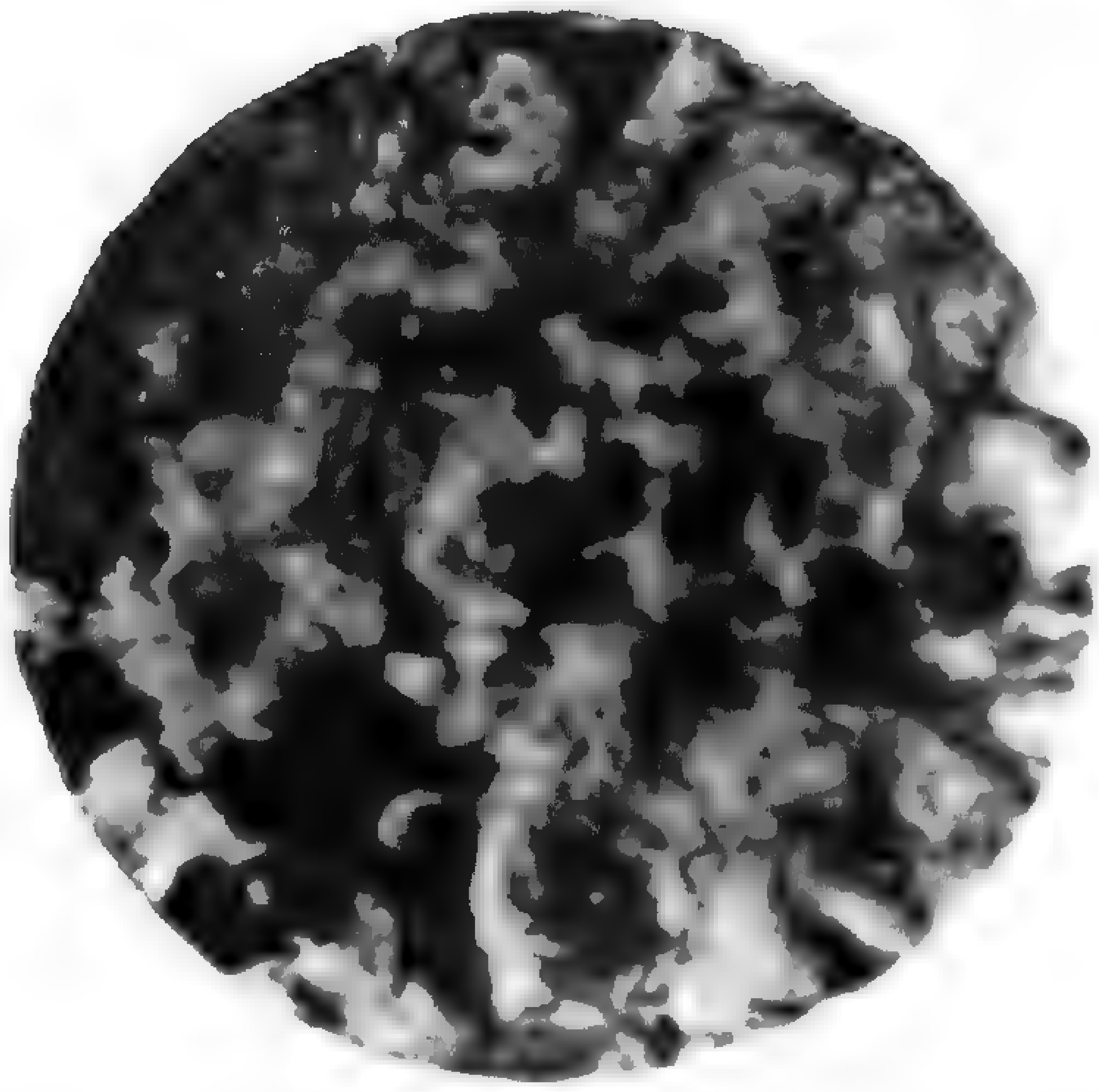
For micro-photographic section, see plate VI, fig. 10.

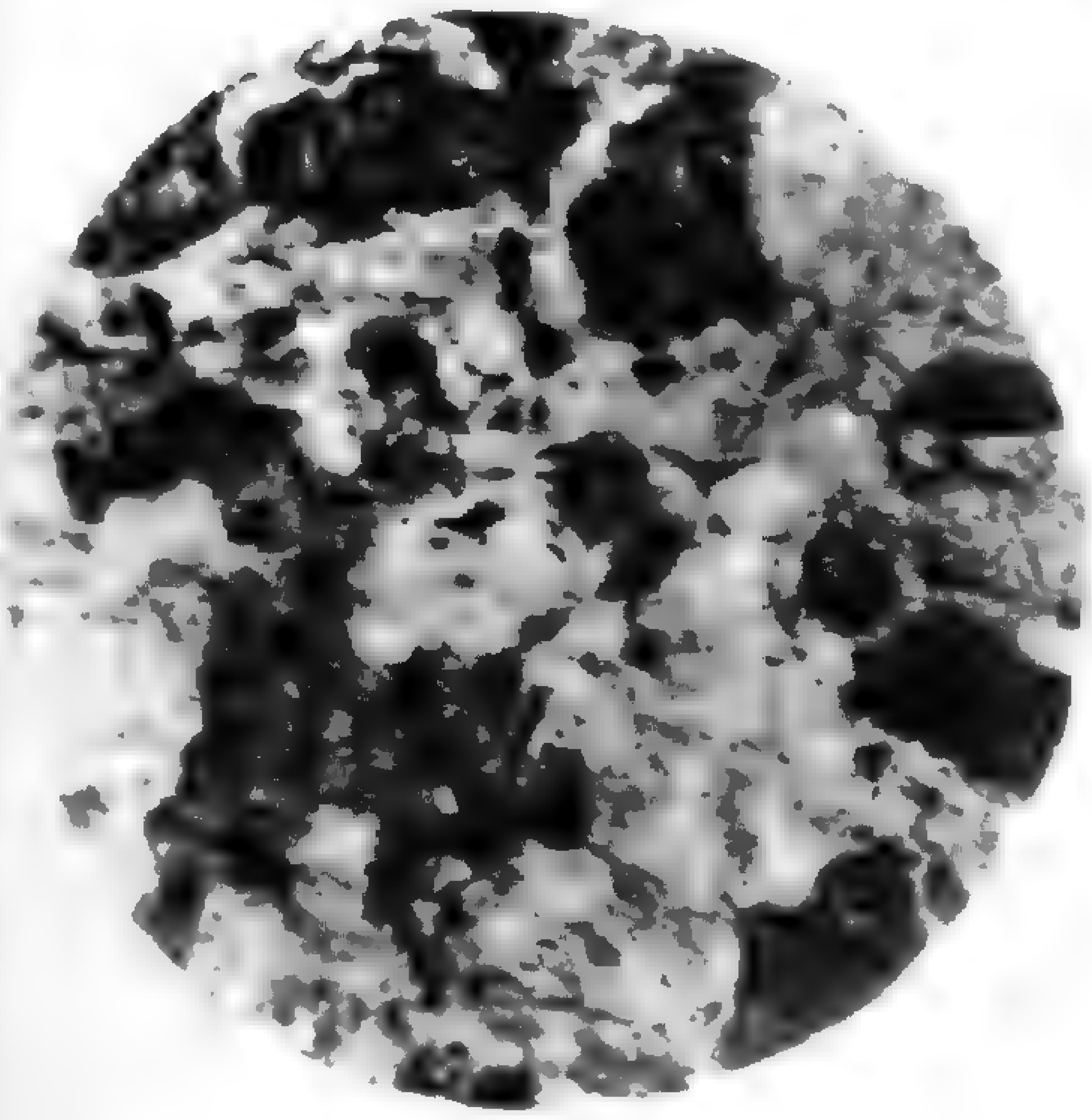
Fig. 12 is the section of a red porphyry from Stony Creek, Cudgegong, collected by the late Prof. A. M. Thomson. Not yet analyzed.

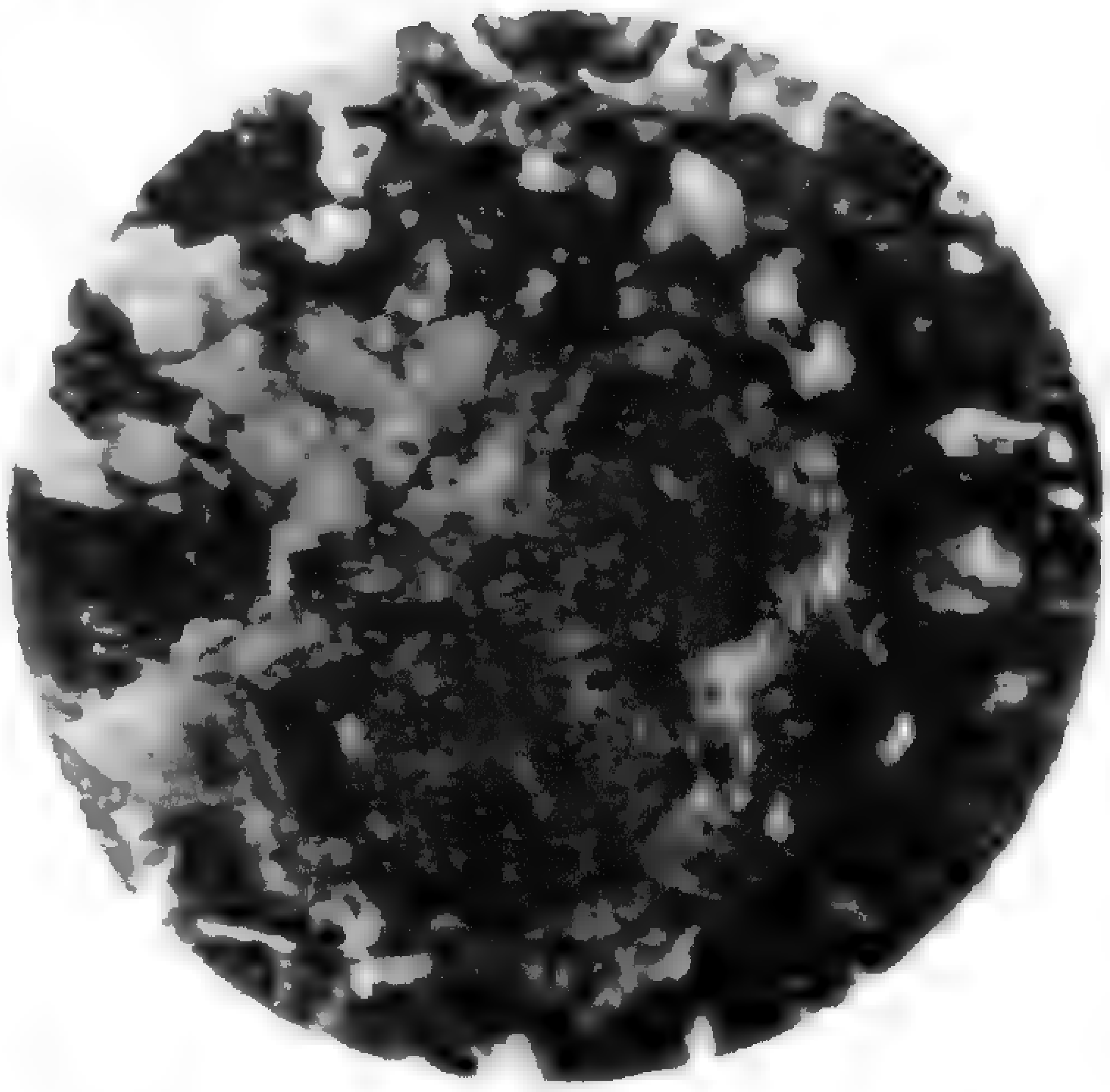
I take this opportunity to tender my thanks to Mr. J. M. Smith, of Sydney, for his great assistance in preparing the enlarged photographs of these and other rock sections, also to Mr. J. M. Muir, my late assistant, and to Dr. Helms, Demonstrator in Chemistry, University of Sydney, for their very valuable help in the analyses of these specimens.

At some future time I hope to be able to continue the examination of these rocks, especially with reference to their microscopical structure, this present note being merely a preliminary notice of the work which it is my wish to carry out.









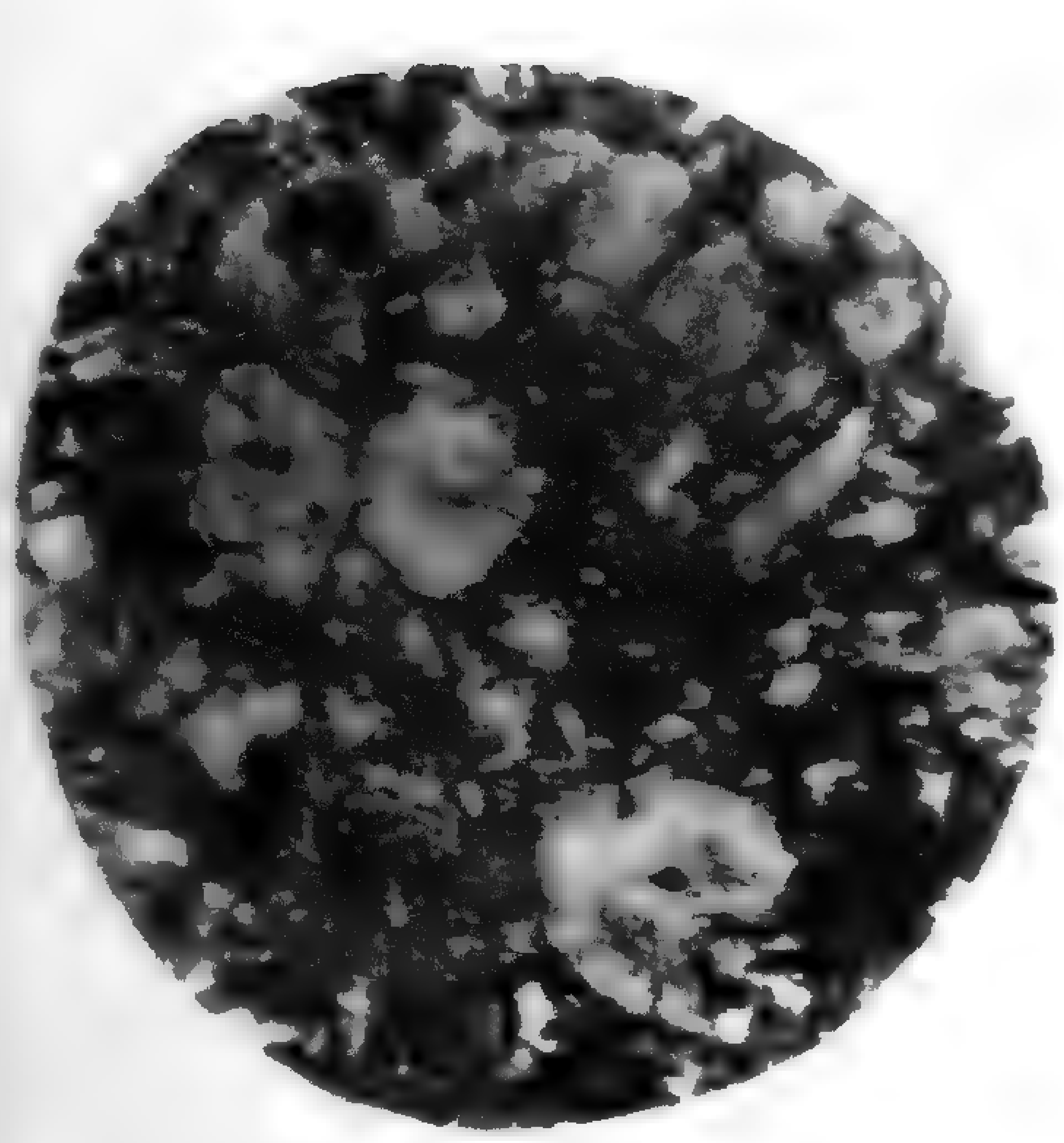


FIG. 5.
Syenite, Lumley Creek.

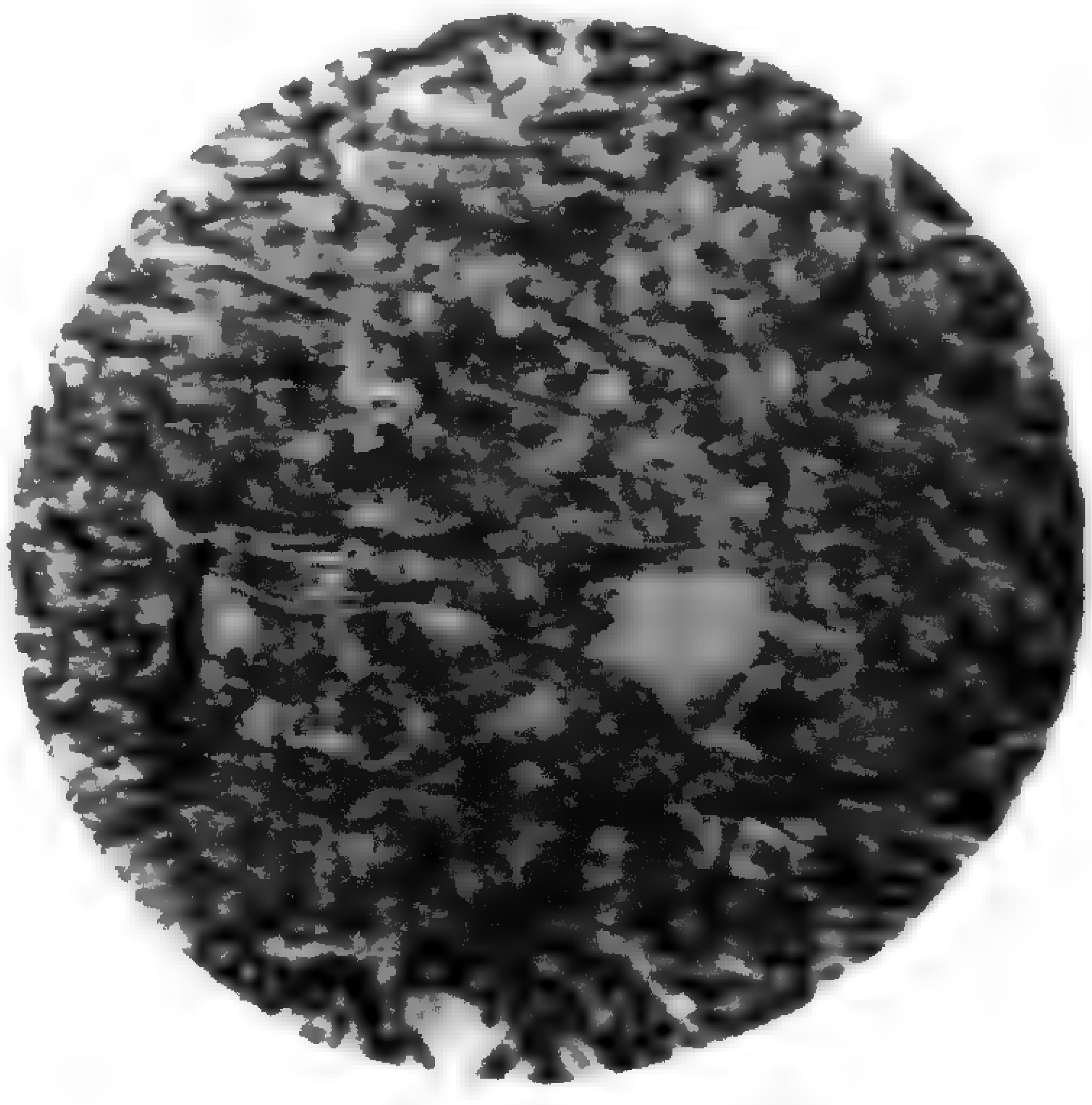


FIG. [illegible]
Graphic Granite, Co. Bl[illegible]

Jour. Roy. Soc. of N.S.W.,
Vol. XVI, 1882.

PLATE VI.

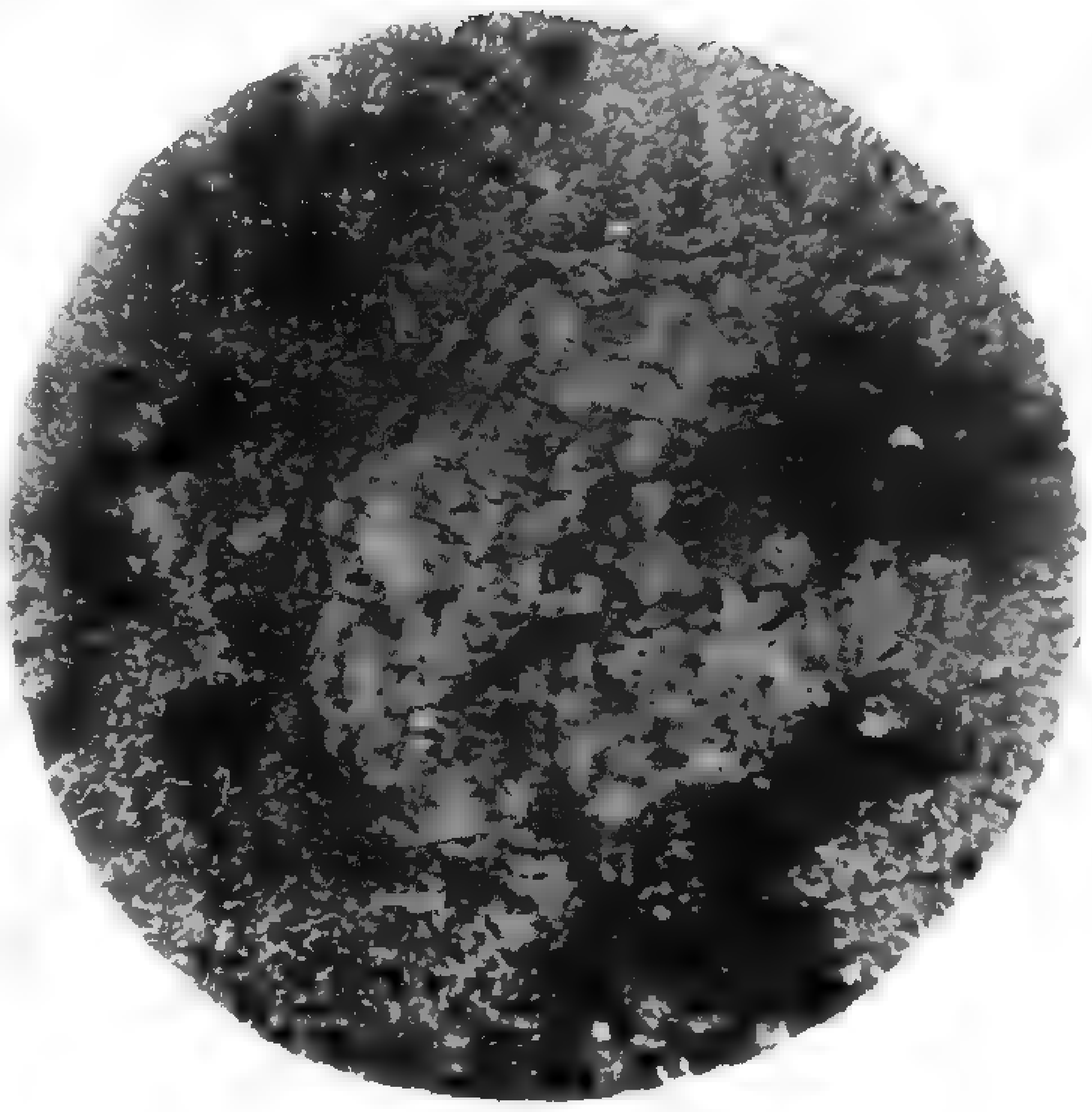


FIG. 7.
Syenite, Bungonia.

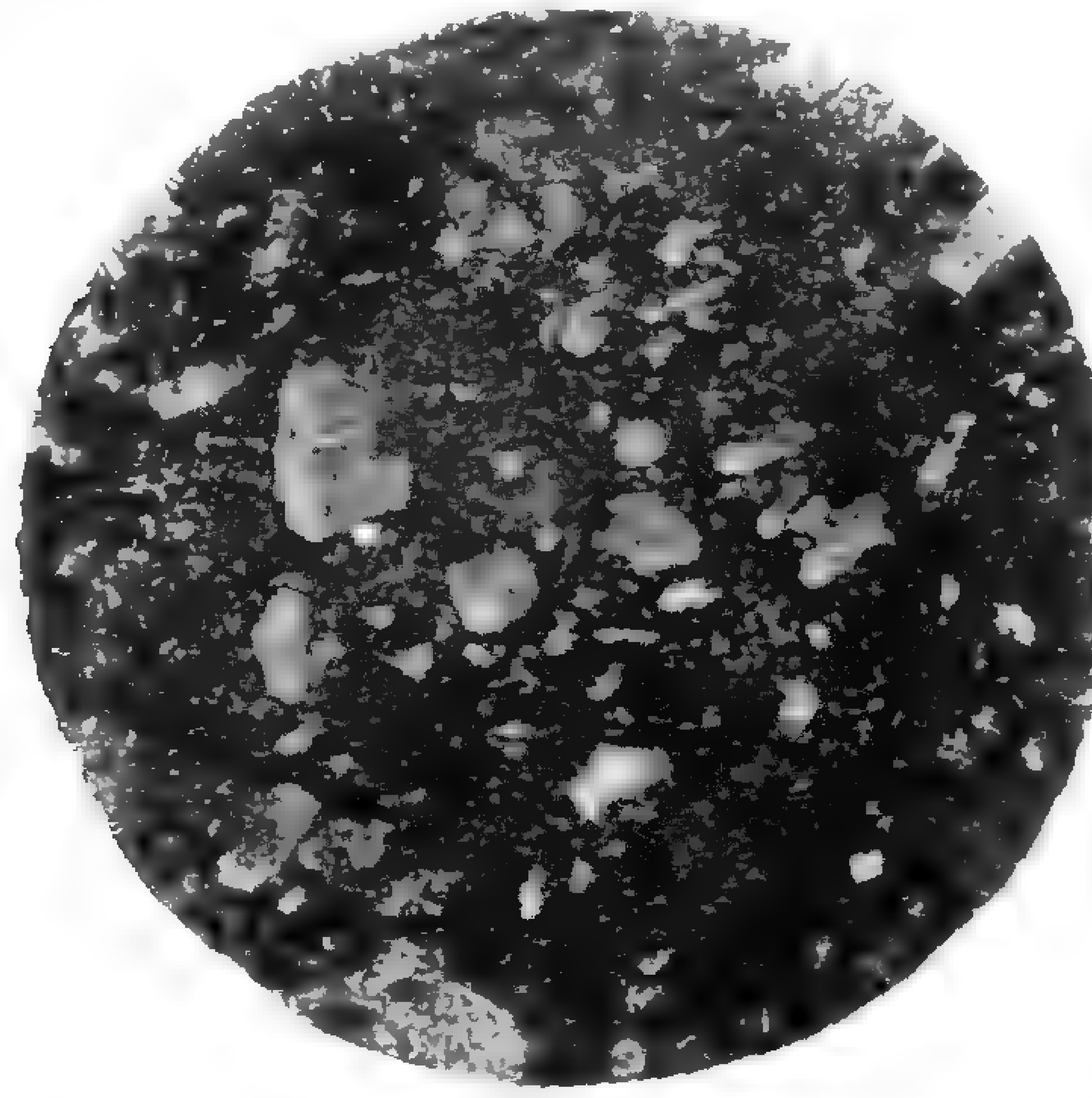


FIG. 8.
Felsite, Cudgegong.

MICRO-PHOTOGRAPHS

NEW SOUTH WALES

ROCKS.

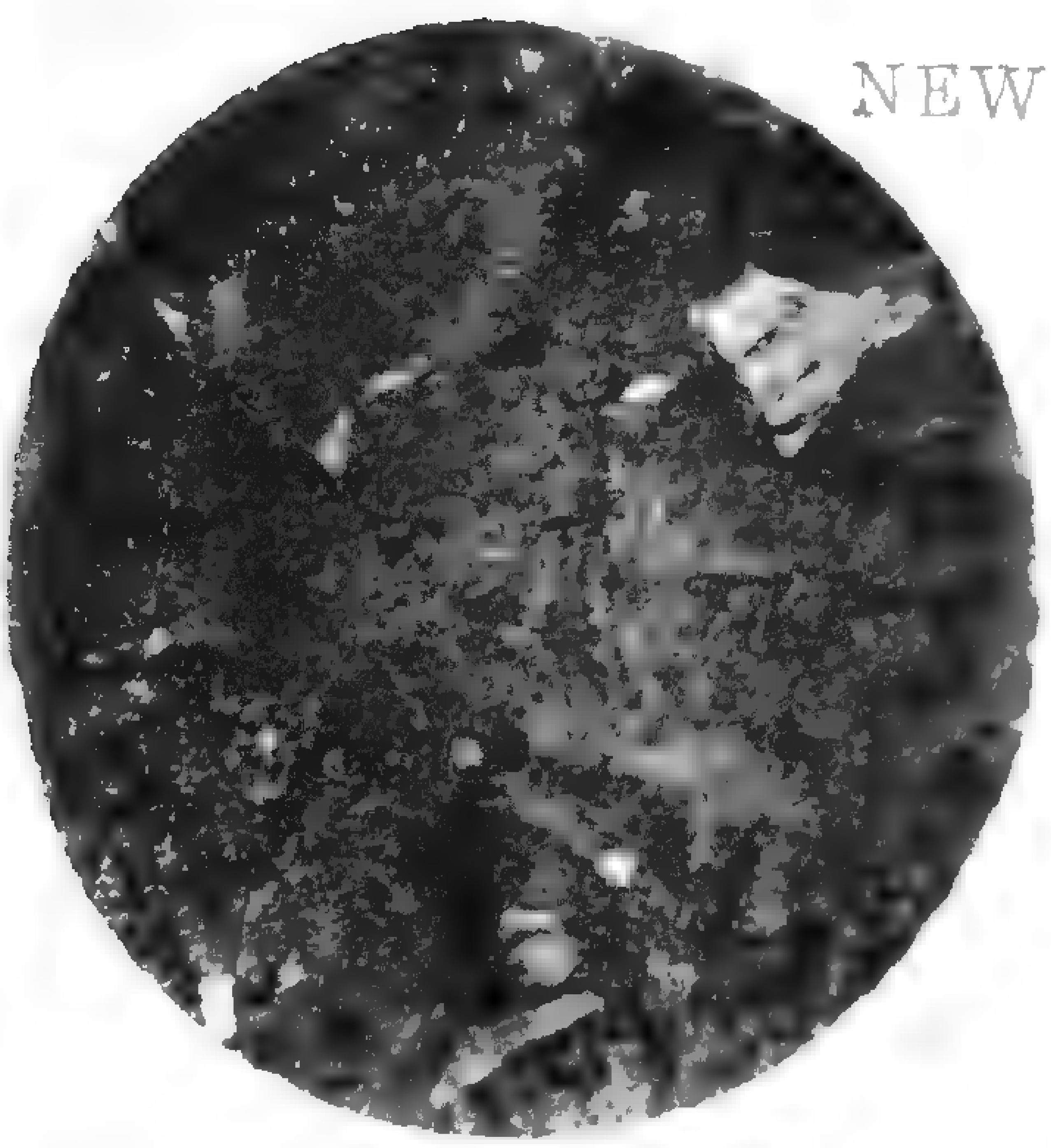


FIG. 9.
Quartz Porphyry, Gurragangamore.

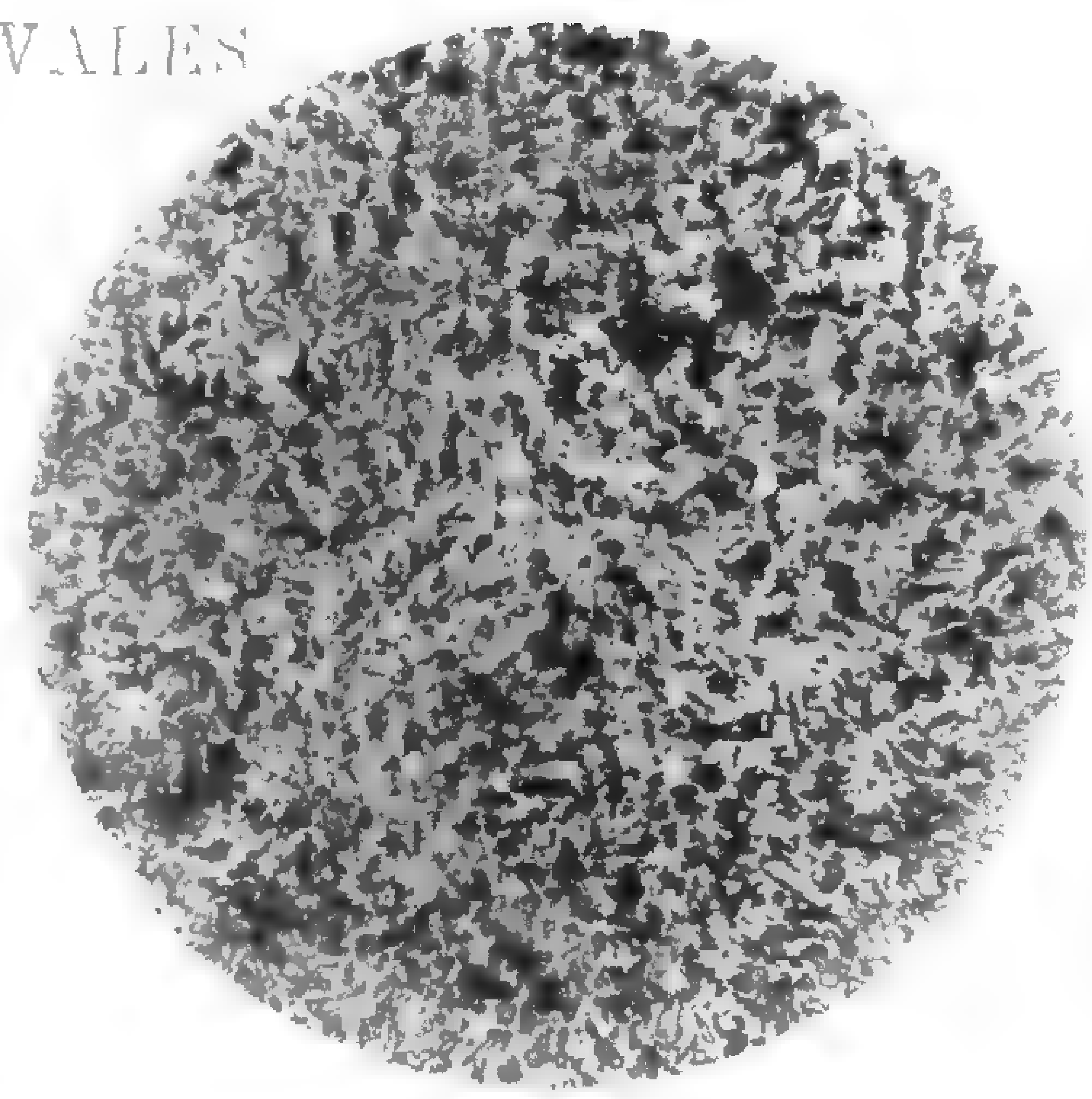


FIG. 10.
Trachyte, Gladstone, Queensland.

ENLARGED

7 DIAMETERS.

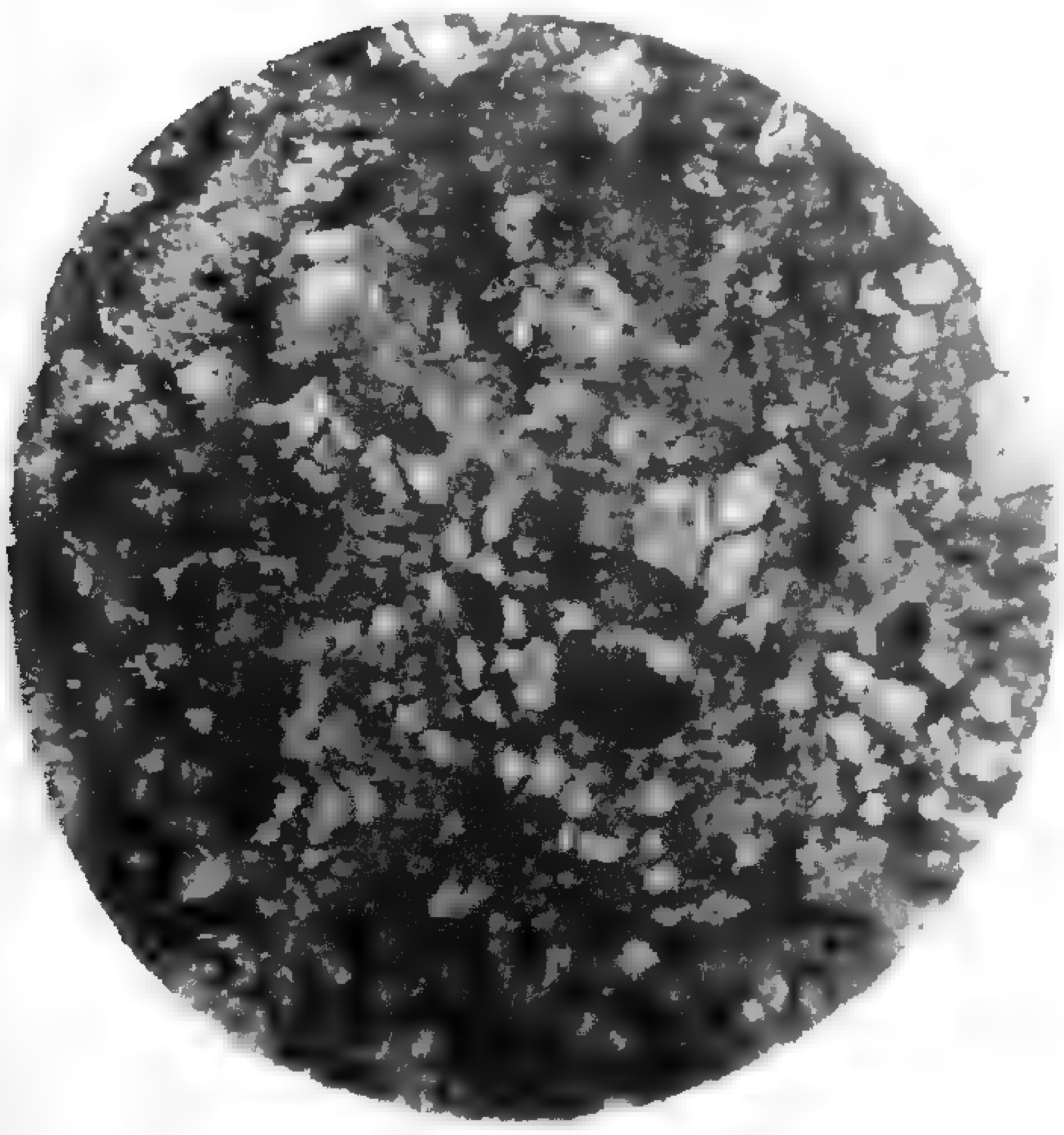


FIG. 11.
"Greenstone," Gympie, Queensland.

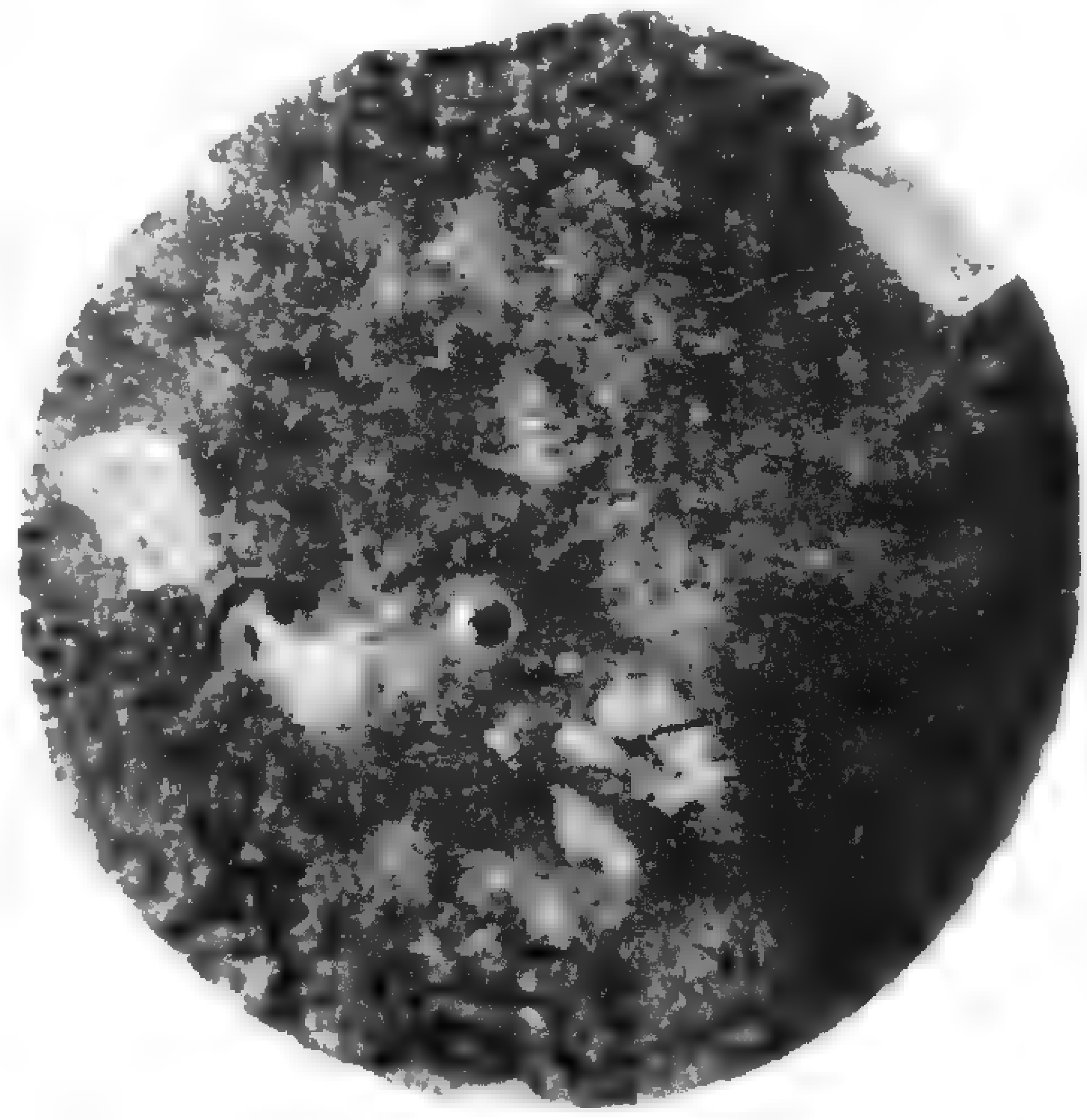


FIG. 12.
Quartz Porphyry, Cudgegong.

Rocks from New Britain and New Ireland.

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

(Preliminary Notice.)

[*Read before the Royal Society of N.S.W., 8 December, 1880.]

The specimens forming the subject of this notice were collected in the year 1875, by the Revd. George Brown, Wesleyan Missionary, to whom my thanks are due for the opportunity to examine these and other specimens which he has brought from the Islands from time to time.

Specimens from New Ireland.

Porphyry.—In the collection are several well rounded pebbles of porphyry. In all of them the felspar crystals are small but fairly well defined, embedded in a felspathic base or paste. In most cases the base is some shade of green, the colour varying from a light to a dark green; in one case the base is reddish brown or chocolate colour, and in this instance some of the felspar crystals are somewhat larger—one being about $\frac{1}{4}''$ across.

Diorite.—Composed of a white felspar and quartz, with dark green hornblende, without mica.

Calcite.—In the form of veins, some nearly an inch thick, running through a dark brown rock, which is evidently of igneous origin, and possesses a slightly porphyritic structure in part, with obscure white felspar crystals. Almost colourless, and readily yielding cleavage rhombs.

Limestone.—In various forms—one somewhat crystalline, with reddish brown streaks, might be described as a marble; does not appear to have been derived from recent coral rock.

A pebble of dark grey compact limestone, from the Mata-Kau River, but weathered almost to a white colour for about $\frac{3}{16}''$ from surface.

---

*This paper has been kept back so that photo-heliographs of sections of the rocks might be added; but to my regret, I have not had the opportunity to prepare them—it is therefore now printed as submitted to the Society.

A somewhat crystalline light grey limestone, from mountain 2,500 feet high. In appearance it somewhat resembles a coral limestone; none or but very obscure indications of organic structure—not even on the external surface, which is much weathered.

Amongst the specimens are two rounded nodules of calcareous mudstone, containing some remains of branching corals, probably recent or living forms, but they are so much rolled that their structure is very obscure.

Pale brown calcareous mudstone, looks at first sight much like a sandstone—contains much volcanic ash.

A difficulty in properly describing some of the specimens is caused by the fact that they are merely small detached and rolled fragments.

Ancient Volcanic ash.—Having the appearance of a dark coloured conglomerate, hard and compact, made up of red, brown, black and other pebbles embedded in a dark green felspathic base, which is porphyritic in parts, from the presence of disseminated white and grey crystals of felspar.

Jasper pebbles.—One of a beautiful deep red in part, with patches of white quartz. A cavity on one side is filled with a porphyry made up of a dark green base with small disseminated white felspar crystals. The porphyry resembles that of the old volcanic ash conglomerate, and is probably part of it; the jasper pebble, however, does not look fused at all, but merely rolled.

Sandstone.—Pale brownish grey, marked with thin dark parallel layers, evidently planes of stratification. The dark bands are rendered so by the presence of small hornblende or augite crystals, readily discernible under the microscope, being more or less transparent and of a green colour, but not with the unassisted eye.

Epidote rock.—A pebble apparently made up of a felspar with thin veins of epidote.

Decomposed Porphyry.—A red ferruginous pebble, breaking with an earthy fracture, darker mottlings in parts, and marked with a few white specks and very thin felspathic veins. Probably a decomposed ferruginous igneous rock.

Alluvial deposit, from the river. Brown in colour, very fine grain, perforated with worm-burrows.

Another specimen is labelled stones and earth from the interior of New Ireland, 2,500 feet. The earth is simply a light porous clay-coloured soil, but the stone looks like a much decomposed trachyte; under the microscope it is seen to retain traces of a crystalline structure, and green-coloured translucent crystals of what appear to be hornblende are abundant.

Lava, from river bank. A dusky purple slate-coloured igneous rock, full of small amygdaloidal cavities. The cavities are for the most part about $\frac{1}{8}''$ across, but some are nearly 1 inch long, but the width and depth not more than about $\frac{1}{8}$th to $\frac{1}{4}''$.

These cavities are arranged in fairly regular layers, and are drawn out in the direction of the flow of the once fluid lava.

Many of the cavities are filled with quartz; the central parts consist of small more or less perfectly developed transparent crystals, seated upon a lining of chalcedony. Some contain a thin velvety coating of crystallized chlorite, and others are completely filled with chalcedony.

Chemical composition.

Loss at 100° C.	402
Silica	67·664
Alumina	15·402
Iron sesquioxide	1·963
Iron monoxide	3·491
Manganese monoxide	·762
Lime	2·963
Magnesia	trace
Carbon dioxide	,,
Potash	1·220
Soda	6·010
	99·877

Tough, breaks with a fairly even fracture; the cleavage planes of elongated twin crystals of felspar, embedded in a granular paste, are well shown in places.

Specific gravity, in powder, at 17° C. = 2·694.

Amongst the New Ireland specimens is a rock with bright green mottlings, looking almost like a serpentine, but it is not serpentine, probably a decomposing igneous rock.

Specimens from New Britain.

Volcanic conglomerate.—Composed for the most part of rounded fragments of a dark-coloured igneous rock, probably basalt, with lighter coloured and greenish pebbles cemented together by black and dark green pastes. This specimen is very much less compact than those from New Ireland; the pebbles are so loosely bound together that they can be separated by the fingers, the paste being comparatively soft, and mixed with delessite (?) in parts.

Pumice.—Most of the specimens are black. One specimen is of a pale brown colour; and is rather more vesicular than the black pumice; this on analysis yielded the following results.

Chemical composition.

Loss at 100° C.	2·025
Combined water, by direct weighing	5·975
Silica	56·566
Alumina	17·820
Iron sesquioxide	2·910
Iron monoxide	2·645
Manganese monoxide	·841
Lime	5·106
Magnesia	traces
Potash	2·610
Soda	3·094
	99·592

Specific gravity, 2·359 at 21·2° C.

Lava, from the volcano, New Britain. With a dark grey base, almost black, containing crystals of glassy felspar.

Some of the specimens are of low specific gravity and very scoriaceous. Certain of the cavities contain a white powdery mineral partly soluble with effervescence in hydrochloric acid.

Chemical composition.

Loss at 100° C.	·119
Loss at red heat	·390
Silica	57·465
Alumina	19·200
Iron sesquioxide	3·833
Iron monoxide	3·223
Manganese monoxide	·974
Lime	9·353
Magnesia	·487
Soda	2·470
Potash	1·358
Carbon dioxide	trace
Sulphur trioxide	·225
	99·097

Specific gravity, 2·738 at 21·2° C.

Some of the small specimens of lava are vermiform or worm-like in shape, others are in the form of lapilli, &c.

Obsidian, or volcanic glass, from the volcano, New Britain. Some of it is black in colour, but greyish in parts; more or less parallel greyish bands also occur in it. One specimen of a pitchy black colour contains a few scattered felspar crystals, and another is in addition characterized by the presence of vesicular cavities.

Sulphur, from the crater of the volcano in Blanche Bay, in the form of small pieces, evidently broken off an incrustation, of about ½″ to ¾″ thickness, very clean and of a bright sulphur-yellow colour, probably very pure. The cavities in it are lined with small crystals, but for the most part it is somewhat friable and resembles flowers of sulphur.

Gypsum, also found in the crater with the sulphur, in the form of acicular crystals.

Aragonite.—In the form of nodular masses, seen on fracture to be built up of beautiful transparent columnar crystals arranged in a radiate manner. They look as if they had been set free from amygdaloidal cavities in igneous rocks.

Limestone.—White, granular.

Quartz.—Of a chalcedonic character.

Unfortunately none of the specimens contain fossils, so that they throw but little light upon the geological age of these islands. The rolled pebbles of porphyry, epidote rock, and others of the crystalline rocks from New Ireland indicate the presence of much more ancient rocks in that island than do any of those examined from New Britain; they cannot, however, without further evidence, be assigned to any particular geological period, for such metamorphosed rocks may belong to almost any of the older series. Most of the specimens from New Britain, on the other hand, are apparently of comparatively recent geological origin; some of the specimens of limestone may even be of existing coral growth, but there is no trace of organic structure remaining to indicate the age of the rock, the structure being subcrystalline.

The igneous rocks are all doubtless modern volcanic products.

The Hawkesbury Sandstone.

By the Rev. J. E. Tenison-Woods, F.G.S., F.L.S., &c., &c.

[*Read before the Royal Society of N.S.W.*, 10 *May*, 1882.]

The Hawkesbury sandstone is that peculiar formation which constitutes much of the Blue Mountains west of Sydney, and which is also so conspicuous in Sydney Harbour, at the heads and on the banks of the Hawkesbury River. Its name was given by the late Rev. W. B. Clarke, who thus describes it:—

"*Hawkesbury Rocks.*—Over the uppermost workable coal measures, which are of considerable thickness, is deposited a series of beds of sandstone, shale, and conglomerate, oftentimes concretionary in structure and very thick bedded, varying in composition, with occasional false bedding deeply excavated, and so forming deep ravines with lofty escarpments, to the upper part of which series I have given the name of Hawkesbury rocks, owing to their great development along the course of the river basin of that name. These beds are not less than from 800 to 1,000 feet in thickness, containing patches of shale, occasionally with fishes, with fragments of fronds and stems of ferns, a few pebbles of porphyry, granite, mica, and other quartziferous slates, and assume in surface outline the appearance of granite, from the materials of which, and associated old deposits, they must in part have been derived. On the summit of the Blue Mountains and along the Grose River the thickness of the series is very much greater than near the sea. Patches of very small area contain bits of coal, carbonate of iron, and sometimes represent miniature coal measures. Towards the base bands of purple shales are frequent, and ferriferous veins with specular iron, hematite, ilmenite, graphite, and other minerals sometimes occur. In places, as about the 'Yellow Rock' near the upper Wollombi River, in Ben Bullen, and above the deep excavation of the Capertee amphitheatre, salt and alum are found in cavities formed by decomposition; and in other places, as at Bundanoon Creek in the Shoalhaven District, at Appin, and on the Bulli escarpment of the Illawarra, and at Pittwater north of Sydney, stalactites have been formed under similar circumstances. There is an enormous mass of brown iron ore, highly carbonized, partly worked, at Fitzroy, near Nattai; another on Brisbane Water, and a smaller patch on the coast, a few miles north of Sydney, and other similar patches in intermediate localities. These are in part associated with specular iron, which occasionally lines the joints of the sandstones close at hand with well formed crystals. The uppermost beds of this formation, especially where they become conglomerates, exhibit isolated summits, imitating ruined castles, and have thus been traced by me at intervals all along the escarpments to the westward of Sydney, from the latitude of the Clyde River to that of the Talbragar, and in certain localities within the longitude of that line and the coast. In the deep ravines of the Grose and Dargan's Creek, the one eastward, and the other westward of the Darling Causeway traversed by the Western Railway line, the slopes are studded with fantastic pillars sculptured by denudation and decay into imitative architectural forms. Similar forms cap the extension of the coast range to the head of the Goulburn River. The tints are poikilitic, darkening from exposure and exhibiting imitations of landscapes, sometimes of striking charater. The semi-crystalline fragments of quartz and the disposal of colours (suggesting the idea of the action of gases removing the ferruginous tint in places) have caused me to believe that some transmuting agency has affected large areas of the Hawkesbury rocks. The glistening of the crystalline quartz particles reminds one of the same character observable in the millstone grit in England. It is impossible to understand how considerable masses of the sandstones could have received such a present structure without the metamorphism suggested, for the crystalline faces are quite unabraded and belong to particles that have been collected originally by water holding silica in solution. By washing in acids the colouring matter of the particles may be entirely removed, and then it is seen that they are imperfect crystals. But the cementing matter is not always ferruginous, a felspathic cement holds them together with used mica, evidently derivative, and sometimes with granite. Another variation in character of the Hawkesbury rocks is their cohesion. In 1850 I was Chairman of the Artesian Well Board, and remember the difficulty we had in procuring tools hard enough to pierce the quartzose sandstone at the gaol in Sydney. The boring after a small depth was abandoned, one of the workmen precipitating the conclusion by blocking the bore-hole. But in parts of the railway lines there have been instances, as stated to me by the Engineer-in-Chief, when the largest blocks have been shivered to atoms by a not very heavy fall over an embankment."—*Sedimen. Form, N.S.W.*, 4th edit., pp. 70 *et seq.*

Extent.—The extent of this formation about Sydney is considerable. According to the geological map of New South Wales compiled by Mr. Wilkinson from Mr. Clarke's notes, it forms an oblong mass about 140 miles long, with a width of from 40 to 80 miles. With the exception of a north-western spur, which is a narrow range extending 50 miles from the mass, the whole area seems to be between two degrees of latitude. A line drawn westward from Newcastle on the north, and another westward of

Shoalhaven on the south, includes nearly the whole of its north and south extension. A similar line north and south between Sofala and Goulburn would be outside all its western boundaries, with one small exception near Sofala. These boundaries and the actual extent and thickness of the formation, can only be considered as approximate until an actual survey can be made. The geological map of the Rev. W. B. Clarke is only a sketch, in which in the course of time great modifications will have to be made. Thus, for instance, the same formation is found at Dubbo and along many places on the western plains, often of large extent, which are not indicated on the map. The Dubbo sandstone quarries have many plant remains, in which large and beautiful specimens of *Thinnfeldia odontopteroides* appear not to be scarce. There are also faint impressions of a leaf like *Glossopteris* with mid-rib and oblique venation too faint for determination.

Geological position.—In the whole of the area thus described the formation lies horizontally upon rocks of different age. Sometimes it is upon the coal measures, or again upon Devonian or Silurian rocks. It is overlaid in many places by the Wianamatta beds, and by basaltic, or at any rate volcanic products. But in no place is there any sign of upheaval. There are, however, at the first Zigzag very many signs of a downcast or fault. There the beds are for a very short distance highly inclined against the range, having the appearance of an immense landslip from the failure or subsidence of the ground. The rock which is inclined appears to be bent down from the main mass, which is quite horizontal.

Looking at the appearance which the area of this formation presents upon the map, one is struck by the great difference there is between its outline and that of any other. The granite lies in generally meridional lines. The Silurian and Devonian forms nearly the whole substratum of the eastern portion of the continent. The volcanic is abrupt and irregular, just as we should infer from its paroxysmal origin. The shape of the Hawkesbury sandstone formation may give a clue to its peculiar origin, and I shall refer to it again.

Stratification.—There is only one point in the description of the Rev. W. B. Clarke which requires amendment, and that is where he speaks of the false bedding as being only occasional. On the contrary, false bedding is almost universal—it is the characteristic of the formation in nearly every portion. There are two distinct forms of stratification. One which makes the main lines of subdivision. These are undulating lines which seem to divide the stone into massive layers of ever-varying thickness. These divisions are either mere partings or full of a very irregularly or finely stratified mass which looks very fissile, and composed of fine grains like dust. The layers are also separated occasionally by red bands of ironstone, of which more subsequently.

Between these then are finer lines of stratification which are mostly inclined to the horizon. They are irregular in thickness and in dip: sometimes composed of coarse sand and sometimes of the very finest dust. They are occasionally interrupted by belts of small pebbles, always abraded and often rounded, but through the whole mass of the sandstone of the Blue Mountains the stone is exceedingly fine-grained, and there are rarely any pebbles larger than a pea except in the very lowest conglomerates. None of these finer strata extend from one great subdivision into another. The irregularity of the dip of the false bedding is surprising. In a few feet the dip will vary in almost every direction and angle, though rarely at a greater one than 25 degrees. I have noticed also that often when the angle is small the sand is rather coarse. Sometimes a series of strata with a high angle will be cut off above by another series dipping on an exactly opposite direction. This gives rise to a herring-bone appearance which is often repeated three or four times in the same greater layer. In order to prevent confusion by the frequent use of the word strata, I shall call the greater divisions of the horizontal sandstone "layers," and the smaller stratification "laminæ." Between the layers there is often a shale or slate deposit, the laminæ of which are thin, horizontal, and rather difficult to trace.

The ferruginous bands do not always follow the lines of the layers or the laminæ—they frequently descend irregularly through the stone in undulating lines or circles, in fact, in almost every shape. They are in this case no more than stains, seldom forming stripes or bands of ironstone. By ironstone, I mean a compact hard rock of brown colour, probably the limonite of mineralogists, and containing silicate and hydrated ferric oxide; of the chemical peculiarities of these stains and bands I shall treat subsequently. When examined by the aid of the microscope the ironstone is seen to be a mass of grains of sand cemented together by a limonite paste, so that the actual amount of ferric oxide is small. But there are also broad bands of red stone in which no grains of sand can be detected. There is one exposed in the upper cuttings of the second Zigzag. It is about 3 feet thick in places, but very irregular and undulating, with sandstone partings like a bed of shale, which I make no doubt it has been. The destruction of the vegetable remains has been effected in oxydizing the ferrous salts, as I shall explain hereafter.

Fossils.—In the extract from Mr. Clarke's paper reference has been made to the plant impressions in this formation. I think they are mostly confined to the stems and roots of plants. *Sphenopteris alata*, Brogn., has been identified, but the portion of the formation whence derived is not stated. *Thinnfeldia odontopteroides* has been found near Mount Victoria. There are also small lenticular masses of coal, or rather jet, in some portions of which a coniferous structure could be made out—at least in some specimens from Double Bay which I examined. In the same sandstone fossil fishes have been found, ranging from 16 feet below the sea (at Biloela) to over 3,400 feet on the Blue Mountains. Two species have been determined, *Cleithrolepis granulatus*, Egert., and *Myriolepis Clarkei*, Egert. The former is not heterocercal; the latter is not fully determined.

At the base of the Hawkesbury sandstone there are thick beds of ironstone, often intermingled with what seems like a green silicate of iron. The whole formation lies conformably upon the coal measures.* The passage from one to another is almost imperceptible—it is difficult to draw any well-defined line. The false bedding disappears as well as the layers, and soon a very hard and coarse conglomerate succeeds, with beds of shale and impure coal.

Escarpments.—A peculiarity of the Hawkesbury sandstone is its precipitous character. Wherever it is met it is always cut into abrupt escarpments and presents precipitous faces; even where outliers are seen on the summits of hills they have the same character, and, when the formation abuts on the coast, cliffs and gorges such as are seen in Port Jackson are present. Mount Pigeon House, so named by Cook from the resemblance of the summit of this mountain to a dove-cote, is a case in point. The cliffs at Jervis Bay, belonging to the same formation, are much like those at Sydney Heads. Rocks very like the Hawkesbury sandstone are found in various places on the eastern side of Australia and in the interior. They are largely developed in the neighbourhood of the Endeavour River, and northwards in Northern Queensland. They also lie on a coal formation, but not conformably; but they are quite similar in character. They have undulating layers and laminæ of false bedding. They have also beds of ironstone, and are cut into precipitous faces, as in Sydney. A mountain called O'Connor's Nob is very similar to Mount Pigeon House; Mount Mulligan is a detached mountain of inclined paleozoic rocks, perfectly crowned with precipices of horizontal layers exactly like the Hawkesbury sandstone.

Main Range, Queensland.—Along the main range, between Brisbane and Toowoomba, numerous precipitous cliffs precisely like the Hawkesbury rocks are to be found. In some places they seem newer than the rocks of New South Wales, but in others there is no difference in appearance. Many of the cuttings and tunnels are just like those of the Blue Mountains. At the Little Liverpool Range, and again at Murphy's Creek, the formation is the same, and, though less picturesque than the Blue Mountains, is evidently of the same character. The undulating layers are on the whole horizontal. The highest parts of the main range west of Brisbane

* Except in the Blue Mountains the sandstone is not constantly conformable to the coal measures.

are built up by the overflow of lava on the summits of this sandstone, and there has been no upheaval. The beds have occasional fragments of wood converted into jet, in which the coniferous character can plainly be traced.

To the west of the main range in Queensland a similar formation is frequently seen—this is Mr. Daintree's desert sandstone. After an attentive examination of its structure, I cannot say that I could perceive any marked difference in external aspect. It looks perhaps a little less altered, but I had no opportunity of comparing both microscopically. The desert sandstone was never seen by me in so compact a state that it would bear grinding down into thin films for the microscope. But this is rarely the case with the Hawkesbury sandstone. Daintree's desert sandstones rest directly upon the cretaceous rocks, and they are therefore probably tertiary. It is a formation which is very extensively spread. It has layers and laminæ of exactly the same character as the Hawkesbury rock, with bands of ironstone, fossil wood, plant impressions, and conglomerates of small pebbles. The two formations probably differ widely in age, but no one can doubt that they have been accumulated under precisely similar conditions. The outliers and patches of desert sandstone are scattered all over the western interior, and wherever found the formation is horizontal, and the rock always presents precipitous and unequally weathered escarpments.

Composition of the Sandstone.—Before entering into any speculations as to the origin of this formation, I may mention that I never could succeed in getting a film of any of these rocks thin enough for the microscope. The rock is too loose and friable. But in trying experiments I arrived at what I think is a good idea of the structure. In some fragments of stone from Manly Beach (the outside beach rocks), and some others from Mount Victoria, I found that the stone consisted of very small rounded grains of sand cemented together by a siliceous infiltration, in which the facets of small crystals of quartz were traceable. The sand was not all siliceous. There were fine particles of opaque white, yellow, or brown felspar, and many scales of mica. When powdered, the round grains generally remained intact, while the glassy, transparent, and jagged fragments I took to be the hydrated silica or hyalite which formed the cement. Under the polariscope it always showed beautiful colours. Most of the quartz grains were dimmed on the surface, like ground glass. I infer from this partial examination of the stone, that the sandstone in the localities from whence my specimens were procured is derived from the decomposition of a granitoid rock. Water has subsequently dissolved a portion of the ingredients, and the hydrated silica has acted as a cement between the particles.

In trying to account for this widespread sandstone, however different in age the deposits may be, we may at least conclude that they all arose under the same conditions and have the same causes. Mr. Clarke has already pointed out that they are not marine; they contain too many plant remains for that to be the case. The same illustrious geologist has, like Mr. Daintree, suggested that they might be fresh-water, the remains of some immense fresh-water lake. This I think is also quite untenable. Lacustrine formations are not at all of this character. The beds are horizontal, marly or calcareous, and false bedding is rare; besides, we should expect to meet fresh-water shells, which we do not. This is the case with the Wianamatta beds, which may well have been fresh-water. Mr. Daintree has suggested that the whole interior of Australia may have been, in tertiary times, a vast fresh-water lake. But the formation is found on both sides of the dividing range. Besides, we must repeat again that the formation is not like a lacustrine one. Mr. Chas. Darwin, in a passage in the "Naturalist's Voyage," which I shall give subsequently, says that the rocks were formed in a sea with irregular floor, and were drifted into high banks round submarine rocks. But again we answer that no marine organism has ever been found in the stone, while plants have been. Messrs. Feistmantel and C. S. Wilkinson have suggested ice action in shallow seas to account for the boulders and conglomerates. But several other characters of ice action are wanting, and in face of the marine difficulty, if another explanation of the boulders can be found, the ice theory will find little support, especially as the formations extend nearly to the equator and India.

Absence of upheaval.—One fact seems to be lost sight of in all these theories, and that is that there has been no upheaval. The beds are horizontal in nearly every case, and there has been very little alteration of level since they were deposited. This is true wherever the formation is found: it is a most significant fact connected with our eastern mountain range. The highest portions are recent volcanic, granitic, or horizontal sandstones, which have not been upheaved from the sea. There has been evident depression about such places as Sydney Harbour, but no elevation anywhere.

Wide Bay sand dunes.—In looking for examples of this formation in the Colony of Queensland I have seen one or two phenomena which may furnish a clue to the history of these rocks. At a place called Double Island Point, about 100 miles north of Cape Moreton, there is a formation of sand which forms cliffs for some 3 or 4 miles on the south side of Wide Bay. The southern boundary of the bay is formed by two somewhat conical hills, separated by a long interval of low land from a low range of volcanic rock forming Double Island Point. This is covered with green vegetation and light timber. From the west end of the point the sand cliffs ascend. They are densely covered with a light brush (*Melaleuca genistifolia ?*). The cliffs of sand are quite precipitous on the seaward side, and are from 100 to 200 feet high. On a close examination the cliffs present exactly the appearance of the Hawkesbury sandstone except in colour, and they are not consolidated. There are the same undulating "layers" of varying thickness, forming thick sinuous marks upon the cliffs, which can be seen at a great distance. The layers are entirely constructed of laminæ of sand with false bedding, which dips at every angle not outside 30°. The layers are of different colour, and they seem to preserve this colour throughout, giving the cliffs a curious ribbon-like structure. Some are white, others yellow, and some ochreous red. The formation is entirely one of blown sand. On the surface, where tea-tree brush does not grow, the sand forms the usual shifting dunes of rounded outline and great height. In places there are sand-slips on some of the dunes where the false bedding becomes revealed. The undulating lines which separate the various layers are found to consist of decaying vegetable matter, or rich loamy earth with roots, leaves, and land-shells intermingled. They represent the former surface of the drifting sand, where its shifting has been stayed by the growth of a dense brush. Thus it has remained stationary for years, until a change of wind or perhaps a bush fire has brought the sand on to the surface again and overwhelmed it. In part of the brush there are swamps of water, at least so I was informed, but I had not time to examine them.

Burdekin River.—Before I point out the application of such formations to explain the Hawkesbury sandstone, it is better perhaps to give one or two more illustrations. In crossing the Burdekin River in 1879, at a place close beside the present railway, I noticed a hill of loose drift-sand, not far from the bed of the river. It would not have attracted my attention had it not been for the large quantities of loose sandy soil that I found on many parts of the banks of the Burdekin. There was no doubt that this hill was composed of blown sand and dust from the river, which is of a very sandy bottom, and so I supposed that all the other sand was derived in the same manner. My little sandhill remained unexamined then, but two years afterwards I came by the same spot and found that it had been largely cut away for the purposes of ballast, exposing a beautiful section. The appearances were precisely those of the Hawkesbury sandstone, but on a smaller scale. There were the layers and the laminæ, with false bedding. From the way in which the hill had been cut down I was able to see more of the structure than in the hills at Double Island Point. The laminæ not only dipped at every angle from horizontal to about 23°, but also in every direction according to the wind. Another very interesting and important fact met me here. There were large flat or rounded pebbles in horizontal lines in this hill, generally near the layers. When I say large, I mean large considering the wind origin of the hill. None were over 2 inches square or thicker than ½ an inch, at least none that I saw, but they were numerous. The edges were rounded but this may have been because they came from the river-bed. Again, the laminæ were of various degrees of coarseness, some being very fine and others quite a coarse sand, just as if it had been sifted. I was able to account for this by what I witnessed. The wind was blowing in gusts from the east, as it usually does in the October mornings about 11 or 12 in the day. I noticed that where a strong gust came it carried all before it, even removing some of the small stones; but when the breeze was gentle only the fine sand would be removed, leaving a layer of coarser particles. So that in reality the coarse sand represented the sifting effect of light breezes rather than the heavier winds. I noticed here how the wind formed the laminæ. Strong breezes caused a steep dip in the deposition, and the length of the laminæ depended upon them, so that these laminæ rise and fall according to the velocity of the breeze somewhat in the manner of a wind-sail used for pumps. Other facts brought to light by this small eolian sand-hill I shall refer to by-and-by. I fully ascertained before leaving the spot that the hill had been formed by the wind, and not by the overflow of the river. In fact it was a moving sandhill, and had shifted its position considerably in the interval of short visits, during which there had been no flood in the river. Beds of river-borne sand have quite a different structure. It must be remarked that the bed of the Burdekin hereabouts is a flat channel about half a mile wide. In this there are two or three narrow and deep streams of water 40 or 50 yards wide. The rest of the bed is dry for the greater part of the year, and covered with rocks and loose drifting sand. A great many low eolian sand-hills consequently accumulate on its banks.

Pliocene aerial sands on the S. Coast.—Another instance can be seen on the south coast of Australia. It has been described in the "Geological Observations in South Australia," from localities where it is well exposed, that is at Cape Grant, near Portland, in Victoria, and at Guichen Bay, in South Australia. But it also appears in patches all along the south coast, from Port Phillip to the mouth of the river Murray, and always in connection with sand dunes. It was thus described in the work referred to. Round the coast a rock of dark brown colour is found to occur in patches of a rough and compact character; at times it forms sea cliffs of considerable height, and there it is seen to the best advantage. At a distance one would imagine the rock to be divided into large strata 14 or 16 feet thick; on a closer inspection another kind of stratification is discernible. In addition to the great divisions, which are so distinct that one would almost suppose that they were huge slabs of rock laid upon one another, the strata themselves are entirely made up of false bedding. This is a lamination which divides the beds into strata about 2 inches thick or even less. The laminæ are never horizontal, and never continuous across the great layers. The material of the rock appears like a sandstone, but under the microscope is seen to consist of fragments of shells and shore debris, with grains of fine siliceous sand and sponge spiculæ intermingled. There are no fossils, or at least they are rare. Professor R. Tate, who first asserted the formation to be eolian, found small shells in portions, and these were land shells—not marine, and of the kind now existing on the coast. When I first saw this deposit I imagined it to have been derived from marine currents; but a better knowledge of the floor of the ocean shows us that marine currents do not leave such stratification. Besides the land shells, and the fact that the strata show no signs of upheaval, I found in subsequent years, by various sections on the coast, that this deposit is only an indurated portion of the sand dunes with which it is always associated. It is an aerial rock, and is stratified by the wind alone. The only difference between this rock and the Hawkesbury sandstone is, that it contains a large quantity of lime, with brown coal occasionally.

Bermuda sandstones.—In the islands of Bermuda a similar formation is met with. Although generally very low, some parts of these islands rise to 250 feet above the sea-level, consisting of various kinds of limestone rock, sometimes soft and friable, but very often hard and even crystalline. It consists of beds which sometimes dip as much as 30°, and exhibit great contortions besides, with much false bedding. It has been put beyond a doubt, by a long continued series of observations, that the rocks are all due to the wind, which blows up the sand from the beach, and which itself is derived from coral and shells. The rain dissolves portions of the lime and consolidates it. In this limestone at Bermuda, as well as in the calcareous rocks of the south coast of Australia, we have those singular stalagmitic concretions which look like roots. In Bermuda the aerial rock contains a red earth some 2 feet thick under coral rock, and resting on a bed of calcareous sandstone, probably due to the decomposition of some minute organism.*

Aerial origin of Hawkesbury rocks.—We see from these illustrations what are the characters of aerial or wind-blown rocks. They are destitute of fossils, except land-shells or plant remains. They are not upheaved. They are most of all distinguished by

* Jones' *Guide to Bermuda*. More likely the red earth is due to the decomposition of vegetation which grew when this lower part was formerly the surface.

large irregular undulating layers, which are also subdivided by laminæ with every kind of dip and direction, rarely exceeding 23°. Now I am prepared to maintain that this structure only belongs to eolian rocks, and is never found in any other. The non-upheaval of the beds I take to be conclusive, without any other argument, yet still there are other facts quite as significant. We know of no marine formation which does not leave some marine fossils; that is to say, no matter how sandy the coast, or what the nature of the rock, marine remains are always found in the deposits. In all the records of deep-sea soundings, such a thing as an *azoic* formation has never been found. Even the very deepest sea had foraminifera, and it need scarcely be repeated that here there can be no question of a deep sea (of 2,000 or 3,000 fathoms for instance), as there has been no upheaval. The same objections lie against a river or estuarine deposit; the bedding is of a different character. The rocks in such cases are clayey and sandy, with frequent changes of mineral character, and last of all show alternations of marine, brackish, and fresh-water remains, with deposits of fine alluvial mud. And I might here point out the difficulties of an estuarine formation to account for a deposit which is found all over Australia. Where did the estuaries or rivers lead to or come from under such circumstances? Look again at the area of the formation upon the Blue Mountains. What kind of an estuary or river deposit would that be? Why, the Amazon or La Plata sink into insignificance beside it. Finally, take the known lacustrine formation, such as those of Auvergne, or what is better still, examine the sections exposed of any of the fresh-water lakes and swamps of the interior. This I have done in both places. I remember well the appearances presented by the lacustrine formations of Auvergne, and I have noted every section of the kind that I have seen in Australia. The appearances are totally different; impure limestone, with fresh-water fossils, beds of mud, all in fine horizontal strata. If by any chance a stream fed the lake, there is cross stratification, but quite of a different character. It is uniform in direction, and confined to a narrow area; it is the exception, not the rule.

Character of eolian sand.—But we may go further than this. The grains of sand themselves will give us some information as to their origin. The experiments of Daubrée and Phillips have shown, I think, very conclusively that water-borne sand breaks up after a certain distance into a certain fineness, and after this it does not break any more, while the small fragments always retain their angular character. Mons. Daubrée enclosed angular fragments of granite in a steel cylinder with water, and caused the whole to rotate at the rate of a progress of about 60 yards a minute. After the fragments had traversed a distance equal to about 20 miles the result was a formation in the tube of gravel, loam, and sand. The latter was never in larger grains than a quarter of a millimètre in diameter, but always in angular fragments. The felspar had disappeared, the sand was consequently entirely quartzose with a few scales of mica.

Messrs. Sorby and Phillips have both made sand particles the subject of special study. The latter has found that wind-blown sands have the grains nearly all rounded, especially if they have been exposed to the action of the wind for any time. The sands of the Egyptian deserts are all rounded. On the other hand, Mr. Phillips has found that fine sands taken from the beds of streams are always angular, and this even where there is good proof that they have been borne great distances by the water. The explanation of this fact seems easy to find. In the air there is nothing to prevent the friction of the particles on one another, and in water there is scarcely any impact or friction at all. At the end of this paper will be found all the observations which I have been able to make on this subject. As a rule I can confirm the conclusions of Mr. Phillips. I have microscopically examined all sands from all the rivers and creeks I have come across. The smaller particles are never entirely rounded unless the fragments are derived from a sandstone which was itself composed of rounded particles. On the other hand, some wind-blown sand, especially that composing sand dunes, is altogether abraded. This is well seen in the sand which forms the dunes at Moore Park, Waverley, and Bondi. Some yellow sand from the inner beach at Manly, which is no doubt derived from the sandstone cliffs near, is nearly all composed of abraded particles, but there are angular siliceous particles occasionally which I shall subsequently explain.

It will be remarked that I have said some wind-blown sands are abraded, because the grains composing the hillock already referred to on the Burdekin River were not at all abraded. The particles with very few exceptions were quite angular. They had been brought from the river-bed at no great distance, and had not been much blown about. I think it is only in the case of wind-blown sand, long exposed in loose drifting masses, that we can expect to find all the particles abraded. Then again, rocks composed of fine aerial dust, as some of the Hawkesbury sandstones have been, will show little of their origin except in their stratification.

Nature of the sand.—Now, in applying these principles to the Hawkesbury sandstone we find we are stopped by a difficulty which the age of the sandstones would lead us to expect. The rock has been completely altered by internal metamorphism. Reference is made by Mr. Clarke to this, and to the crystalline facets on portions of the rock. Any one passing across the Blue Mountains cannot fail to have noticed the sparkling of the sandstone rocks in the cuttings. A close examination will show that this is due to minute quartz crystals whose facets stud the surface of the stone. The ferruginous stains on the rock and the bands of ironstone will also show that another kind of metamorphism has been going on. Water percolating through the stone has affected the felspar grains which largely entered into the composition of these sands, the iron they contained has been converted into the reddish-brown peroxide which forms the ferruginous bands and stains. Much of the excess of silica has crystallized in minute crystals, or formed a siliceous cement around other grains and made the rock harder and more compact. Thus, in some portions of the stone which I examined, partly rounded grains could be seen with minute crystals upon them, while other fragments could be seen to consist of two or three grains cemented together by a siliceous cement. I was never able to obtain a portion of this sandstone sufficiently hard to bear grinding down into a section for the microscope. On the other hand, the rock, even in the softest or most friable portions, can never be broken up so as to separate the constituent grains. But after having examined a very large number of specimens of stone from this formation taken from widely separated localities, I am of opinion that it has originally been formed of abraded grains of sand, or of fine dust, such as we might expect from an aerial deposit. In some cases the sands derived from the weathering of the rock bear this out, as, for instance, the marine sands about the Heads, which have clearly been derived from the Hawkesbury rocks. Let it be remarked that abrasion in this case cannot be from marine action, as the sands collected by me in other places, and derived from such rocks as granite, were not at all abraded, though they had evidently been long exposed to the action of the surf. Sands derived from the weathering of the same formation in other places, such as Mount Victoria, Lapstone Hill, and the second Zigzag, were not all abraded; but the grains were coarse, with large crystals of quartz in the midst; in fact some grains were more or less altered and partly crystalline, but there were evidences of the original constituents in many rounded grains. When seen under polarized light some of the larger fragments would manifest their compound character, and by watching the effect of the light as the Nichol prisms were revolved, the forms of the rounded grains embedded in transparent silica could be made out. I also imagined that in the rich play of colours under polarized light I could distinguish the fragments of hydrated or opalized silica which cemented the grains, but I write with hesitation on this point, as I had no certainty that the specimens thus distinguished were always hyalite; at least I had no other test than that they showed the same rich and varied colouring which was manifested by hyalite. The grains imbedded in ironstone are well preserved, and admit of being seen in thin films by the microscope. Where they have not been decomposed they are all rounded and abraded. By abrasion I mean that sort of opaque surface which is seen in ground glass. Even grains of transparent quartz are thus affected. With a high magnifying power the minute pits and scratches can be seen. This can only be due to aerial action. Water, as we have seen, does not produce this. In all the fine water-borne sands that I have examined the particles were angular and not abraded.

The reason why the sands derived from the Hawkesbury rocks are occasionally so little like the original constituents, is because they are the result of decomposition from a rock often composed of fine dust, which has now become compact.* When granite decomposes, the sand resulting does not consist of separate crystals of quartz, felspar, and mica, but rather the angular grains contain portions of each of these minerals. This I have seen from the microscopic examination of many specimens of granite sand which I gathered in various localities. In like manner the Hawkesbury sandstones do not decompose into their original constituents, but rather into the fragments, according as they are affected by weathering; that is of course when they have become metamorphosed into a hard compact siliceous rock. But there are very many portions of the Hawkesbury sandstone where the metamorphism is not complete and the eolian character of the grains is quite visible. This is everywhere the case in a very similar formation on the Main Range between Brisbane and the Darling Downs, and again at an intermediate range called the Little Liverpool Range, an isolated sandstone formation many hundred feet thick. I can assert nothing positively about the age of this range, except that it is older than the tertiary lavas, and younger than the coal formations upon which it rests. It has not been upheaved, but is simply horizontal layers of sandstone exactly like the Hawkesbury rocks. It was considered by Daintree as desert sandstone. The sand is coarse in places, and consists of light brown opaque particles, often loosely cemented together with opaque siliceous cement. The particles are nearly all abraded, and some quite rounded. The Main Range is composed of a similar rock, five or six hundred feet in thickness. It is quite horizontal and abrupt, but is made much more so by the outpouring of lava which has covered it in tertiary times.

Recent contemporary observations.—Mr. J. A. Phillips has shown in his paper on the History of Grits and Sandstones† how a large number of the carboniferous Permian and Triassic sandstones are composed almost entirely of quartz crystals which have

* In the examination of sands from the Blue Mountains care must be taken to scrape the material from the rock itself. Sands found in the gullies and water tables by the railway are derived for the most part from the surface and broken up by the transit into angular particles.

† Quart. Journ. Geol. Soc., vol. 37, p. 6 *et seq.*

been produced *in situ*. Numerous fine-grained sandstones, particularly among those of Triassic age, are composed of quartz grains so completely rounded as under the microscope to resemble water-worn pebbles. These grains are variously coloured red or brown by variously hydrated oxides of iron; in some cases, minute perfectly formed and beautifully transparent crystals of quartz have been developed on their surfaces. He further adds that, on examining a considerable number of modern sands, none of them except such as had been long subjected to the wearing effects of wind action, were found to resemble those of the "millet-seed" sandstones. Those which resembled them most were blown desert sands. In the discussion which ensued on this paper, Mr. Blandford said that some years ago he had examined the Indian desert, and found the grains of sand well rounded. They were mostly of quartz, with a few felspar grains, and occasionally of hornblende. The strongest wind there blows from the west. The sands had come from the coast and the river Indus. He further stated that the sands appeared to be unstratified, and this I can confirm in the appearance of all desert sands, but when a section is made the peculiar false bedding is immediately seen. Mr. Rutley on the same occasion called attention to the presence of felspar on many of the sandstones described, and suggested that it was quite possible for such sandstones to be changed into felstone. There was often much difficulty in distinguishing between the finer grained igneous and sedimentary rocks.

Summary.—To sum up these facts: I may state that observation has proved that wind-blown action seems alone competent to round grains of sand; angular fragments of quartz having a diameter of less than $\frac{1}{50}$ of an inch remain unrounded by the long continued action ot currents, or by the continuous action of breakers after many years; yet the rounded character of the fragments of a wind-blown sandstone is often difficult of detection in a compact rock which has undergone internal metamorphism.

We now come to the inquiry as to the causes of those peculiar appearances in the eolian sandstones, such as the false bedding, the layers, and the ironstone bands and concretions.

False bedding.—It has been already noticed that the angle formed by the laminations never exceeds a certain value. This is due to the fact that rounded, or indeed small particles of sand of any kind, when perfectly dry, have a definite angle of repose. This angle is about 30°. With wet sand it is entirely different. It may lie at any angle as long as it is not completely saturated with moisture, so as to give the particles perfect freedom of movement one upon another, while mere dampness would increase the cohesive force and then the angle of repose would be increased. The pressure also of the grains of sand in dry masses is not direct but lateral. The angle at which the laminæ dip is therefore not so much an index of the force of the wind as of the quantity of sand conveyed by it. A slight steady breeze blowing for a day in one direction would tend to carry a good deal of sand, which as it heaped up in the places where it was deposited would slip down to the angle of repose just as we see happening in an hour-glass. But if the sand were very equally distributed by a strong wind which tended to smooth down rather than to accumulate heaps, then the angles of repose might be very low. I regard the laminæ as the result of periods of rest in the sand-drifts, and the thickness and direction as indications either of the duration or quarter of the wind.

Since my attention has been directed to this I have carefully examined every sand-heap that came under my observation, and also noted the effect of the wind upon them. I had a good opportunity for this at several of the coral islands inside the Barrier Reef. Most of them are formed of a fine-grained calcareous sandstone, partly cemented by the water and partly drifted by the wind. At Low Island I remained a week, and on my arrival noted the height and dimensions of a small heap of sand which was forming under the shelter of some drift-wood. By planting sticks at various places in the heap I was able, not only to measure each day's accumulation, but also the results of a change of wind or a calm. It was at the end of the month of October, when the trade winds blow generally from the south-east, but there are occasional calms and changes of direction, and these were in the morning. The sandhill was only a few feet high and a few hundred yards in superficial area, with a steep face on the leeward side. There were two long tongues of sand on the extremities which each day's accumulation brought further and further out. I found that the greatest accumulation on any one day was about 7 inches. This was during a light constant breeze. On cutting into that day's deposit it was found to be formed of four or five thin laminæ irregularly dipping at an angle of 30°. I could not account for the division into laminæ, but I supposed that they represented lulls in the wind. Again, on another day, when the wind was very unsteady both in force and direction, I was surprised to find how much had accumulated. On making a section through the day's work the laminæ were found to be extremely thin, almost in fact like the leaves of a book. They dipped in every direction and were inclined at various angles, and they differed in the degrees of coarseness. The coarser laminæ, as I have already observed, are not so much due to the stronger breeze as to the faint ones, which carry away the lighter particles from a layer of sand, leaving the coarser grains behind. I was surprised to find in this small sandhill rather heavy shells and fragments of coral, but I soon saw that what appears but a light wind easily carries such fragments along the sand. Some of the sand on these islands has become converted into a calcareous sandstone, in which both marine and land shells are embedded. These islands abound with *Helix Fosteriana*, Pfr., which is a good-sized but very light shell. It is to be remarked that though the sand on these islands is white yet the rocks derived from them are of a deep brown colour, which is the case with all rocks derived from coral that I have seen. It is also the case with calcareous aerial rocks generally.

Lamination.—It occurred to me that the cause of lamination might be explained by experiment. I had noticed, in watching the accumulation of heaps of sand in an hour-glass or in a common egg-boiler, that the sand formed a narrow pyramid on which the lighter particles gathered for a time into a little pinnacle of sand and then suddenly slipped down; thus the grains became distributed by a series of sandslips. Perhaps then a record of these slips could be preserved by using different-coloured sand. For this purpose I stained a quantity of fine sand with two or three different dyes. Using a very fine pipette glass fixed to a stand, I let the sand fall through on to a board. As soon as a sand-slip occurred I changed the colour. When a considerable heap had accumulated, I damped the centre and made a careful section with a piece of card. A beautiful series of laminations were exposed to view, the most of them having an angle of about 30° By covering the whole with red sand, and then varying the experiment so as to draw the glass gradually along and give rise to sand-slips, first in one direction and then in another, a section was produced which gave a tolerably fair illustration of a layer with false bedding at opposite angles, or as we frequently see, "herring-bone" lamination.

Wet sand, of course, may lie at a much higher angle. In those cases where estuarine deposits are found to be inclined, they have a constant angle which is often as high as 40°. Generally speaking, the layers of clay and shingle are perfectly horizontal. The mode of deposition of deltas from fluvial or estuarine remains is perfectly understood. They are composed of regular beds of rich alluvium and water-worn gravel. A section through the deposit at Lake Geneva at the mouth of the Arve shows occasionally inclined beds, but the angle is regular, and at the length of half a mile they become perfectly horizontal. There is no resemblance between the Hawkesbury sandstone lamination and that of an estuarine deposit, even if the area did not totally prevent such a supposition. In the Arve delta, of course, there are many fresh-water shells and alluvial remains of fresh-water plants and debris of all kinds. I do not think it possible to account for some of the irregular lamination in the Hawkesbury rocks except by supposing the materials to have accumulated as fine aerial dust. Water of any kind must have deposited it in a different manner.

On the other hand, at Bermuda, as already stated, the late Sir Wyville Thomson gives an account of a formation at those islands to which I have already referred. It is formed of very fine sand accumulated by the wind, and cemented by the slow infiltration of water. In a short time the whole of this will be a hardened rock, and if the observations of Sir Wyville Thomson happened to be lost, it might easily be regarded as a marine rock, were it not that the deposit is full of the trunks of cedar trees which the wind has blown down and mingled with the mass. I have very little doubt that much of the interior of Australia is composed of wind-blown sand to a considerable depth. In 1863 I was able to examine a section of a well, sunk in a sandy heath-like country about 300 feet above the level of the sea. There was 90 feet of laminated yellow, white, and red sands, resting upon fossiliferous miocene rock. The beds were in layers and laminations just like the Hawkesbury rock, except that they were quite loose, and not aggregated together. This was on the edge of the Murray Desert, where there are tracts of sand-hills 100 feet and more in height, covered with a light growth of heath-like vegetation, of which *Lepidospermum lanuginosum*, *Xanthorrea minor*, with various epacrids and sedges, form the principal plants. Every three years or so these are burnt off, and then the sand blows about quite loosely. The grains are quite rounded. Grassy level places are found in large tracts much below the level of the sand-hills, and then there is a stiff clay with swampy land. A sufficient accumulation of such deposits, hardening by lapse of time into stone, would give rise to a deposit exactly like the Hawkesbury rocks. The fine mud of the clay-pans in such country which retains the rains which fall in this desert in winter is often covered over with wind-drifted sands. This perfectly represents the curious stratified masses found between the layers in the Blue Mountains.

Ironstone.—The ironstone bands and markings must next occupy our attention. As already observed, these form a characteristic feature in the Hawkesbury sandstone. The rings of red or brown hydrated peroxide of iron and the thick bands of them in most of the formation cannot fail to arrest the attention; it is, moreover, not only a feature in the Hawkesbury rocks, but also in these laminated sandstones wherever they are found, as in the Darling Range, Little Liverpool Range, Dalrymple sandstones, desert sandstones, &c. Our inquiry here is limited to the sources from which these ores of iron are derived, and how they have come to be hydrated peroxides as we find them.

As to the sources, there can be no doubt that the sand of these rocks has not been entirely siliceous. It is often seen to be composed, even now, of fragments of mica, felspar, and fragments of hornblende and other derived minerals. Hornblende dykes are found to have penetrated many of the older rocks from which these wind-blown materials have been derived. In some hornblende rock there is sometimes as much as 14 per cent. of iron. According to Gustav

Bischof, there is no silicate in which silicate of iron does not enter. Proto-silicate of iron or green earth is found in drusy cavities of many basaltic and doleritic amygdaloids, in augite, augitic porphyry, and forming a coating upon chalcedony. Another source of iron is that much of the carboniferous rocks from which some of this sand has been derived is coloured green by proto-silicate of iron. It is important to observe that the iron in these cases is in the form of a protoxide, and either colourless, bluish, or greenish in tint. There is a powerful affinity between silica and protoxide of iron. The alkaline silicates, says Bischof,* convert carbonate of iron in water into protosilicate of iron. The green earth contains these silicates of iron and water, and gradually converts them into a persilicate. The reduction of persilicate into a protosilicate and its conversion into carbonate of iron has been proved by Gustav Bischof's experiments.† It followed from his investigations that decomposing organic substances in the presence of carbonic acid reduced hydrated peroxide of iron to protoxide, and also persilicate of iron into protosilicate and carbonate of iron. In most of the ironstone bands thin sections placed under microscope showed round cavities filled with red ferric oxide. These represented grains of some highly ferruginous mineral, entirely decomposed by water and carbonic acid.

These chemical relations will appear more significant by making use of Mr. Sterry Hunt's beautiful illustration.‡ The chemist knows that the iron as diffused in the rocks exists chiefly in combination with oxygen, with which it forms two principal compounds, the first or protoxide which is readily soluble in waters impregnated with carbonic acid and other feeble acids; and the second or peroxide, which is *insoluble* in the same liquids. I do not here speak of the magnetic oxide, which may be looked upon as a compound of the other two, neutral and indifferent to the most natural chemical agencies. The combinations of the first oxide are either colourless or bluish or greenish in tint, while the peroxide is reddish brown and is the substance known as iron-rust. Ordinary brick clays are bluish in colour, and contain combined iron in the state of *protoxide*, but when burnt in a kiln they become reddish, because this oxide absorbs from the air a further portion of oxygen, and is converted into peroxide. But there are clays which are white when burned, and are much prized for this reason. Many of these were once ferruginous clays, which have lost their iron by a process everywhere going on around us. If we dig a ditch in a moist soil which is covered with turf or with decaying vegetation, we may observe that the stagnant water which collects at the bottom soon

* Chem. Geol., vol. ii, p. 132.
† *Op. cit.*, vol. iii, p. 4.
‡ Chem. and Geol., Essays, p. 227.

becomes coated with a shining iridescent scum, which looks somewhat like oil, but is really a compound of peroxide of iron. The water as it oozes from the soil is colourless, but has an inky taste, from dissolved protoxide of iron. When exposed to the air, however, this absorbs oxygen, and the peroxide is formed, which is no longer soluble, but separates as a film on the surface of the water, and finally sinks to the bottom as a reddish ochre, or under somewhat different conditions becomes aggregated as a massive iron ore. A process identical in kind with this has been at work at the earth's surface, ever since there were decaying organic matters, dissolving the iron from the porous rocks, clays, and sands, and gathering it together in beds of iron ore or iron ochre. It is not necessary that these rocks and soils should contain the iron in the state of protoxide, since these organic products (which are themselves dissolved in water) are able to remove a portion of the oxygen from the insoluble peroxide, and convert it into the soluble protoxide of iron, being themselves in part oxydized and converted into carbonic acid in the process.

Thus we see that decomposing organic matter has the property of reducing the oxides of iron and rendering them soluble, and in this process the organic matter is consumed and converted into carbonic acid and water. In this way we may regard the beds of hydrated peroxide of iron in the Hawkesbury rocks as representing destroyed vegetable matters. Some of the carbon is however still preserved in the shales. Lenticular masses of coal and vegetable impressions are common. In some of the concretions of hydrated ferric oxides casts of the tougher fruits may still be found. Thus in a sandstone on the Burnett River I have found a cone beautifully preserved, and closely resembling some mesozoic Cycas. This will form the subject of a subsequent paper. At Dubbo the vegetable impressions are often composed of peroxide of iron.

Any one crossing the Blue Mountains must have noticed the capping of yellow soil on the sandstone. This yellow colour is due to iron, and represents the oxydization of the underlying rock materials, produced by water holding carbonic acid in solution. This carbonic acid is derived from the decaying vegetation of the surface. If we ask what becomes of the trees and grass which grow on the surface, the yellow soil gives the reply. This represents the surface vegetation of ages. We need not wonder that few or no fossil impressions remain of so abundant a vegetation. The oxide of iron consumes all.

Mixed origin of the strata.—We must not suppose that in an immense deposit like the Hawkesbury rocks one explanation will suffice for all the appearances met with. We may expect to find other besides wind-blown strata. This will be best illustrated by a description of what is at present going on in one of the eolian formations of Europe. There are few who have not heard of the

Landes (Heaths) in the south-west of France. In this extensive tract there are over a million of acres covered by shifting sand. About six million cubic yards are carried along each year by the wind. A great many of the sand dunes exceed 225 feet in height, and some are over 300, their height depending on the thickness of the current of air. Pools of water are found on all the sand dunes, and often completely hidden by a coating of sand which does not sink, thus becoming a dangerous pitfall. These pools are carried along with the shifting sands, caused by the filling up with sand on one side, and thus pushing the basin along. The formation of lakes and marshes in the French Landes is one of the most remarkable features in them. A row of ponds differing in shape and size but generally parallel with the coast, is prolonged over a space of 125 miles. Some of these were originally at the sea-level, and are now 66 feet above it. One covers an area of 15,000 acres. Much of this area has been reclaimed by planting pines. Sometimes the advance of the sand is arrested by circumstances which favoured the growth of vegetation, and at Arachon forests of gigantic pines have covered one sand tract, with oaks which were 46 feet in girth some years ago. On the other hand, there are plenty of places in the Landes where there are traces of former forests now covered with sand.

Thus we may expect to find in the Hawkesbury formation traces of lacustrine deposits, with former marshes and lagoons. In these fishes would become entombed, and the way in which they are found in this sandstone may be explained as follows:—In one of Stuart's expeditions he found in Lake Eyre, in the central desert, at a time when the waters had become very low, a number of small fish all dried and caked in salt. Now it is easy to see how in the shifting sands which form the shores of this lake, these fish might be covered by an advancing sand dune, and thus entombed as fossils. Here they formed a belt along the shore about 12 yards wide.

Shale.—There is not much difficulty in accounting for the shale in these sandstone areas. They are the remains of fresh and salt marshes or lagoons, such as are now found in the central deserts of Australia. The process may be seen in operation on the Queensland coast. Near Maryborough, or rather Pyalba, on the shores of Harvey's Bay, and again on Great Sandy Island, there is a deposit on the site of former marshes which is very like turf or dark brown coal. It is full of vegetable remains such as roots and stems, with grains of sand sufficiently numerous to give the mass a loose consistency. In spite of its carbonaceous aspect it will not burn. Except that it is a younger deposit, it is like the carbonaceous shales often found in the sandstone rocks.

Creeks.—We must also expect to find in the Hawkesbury rocks the remains of creeks and streams with their denuding effects, which of course would be very great on a loose sandy deposit. It is thus I explain all those appearances which have been attributed to ice action. Mr. Wilkinson, the Government Geologist, thus describes such appearances.* "In the sections exposed in the quarries at Fort Macquarie, Woolloomooloo, Flagstaff Hill, and other places, may be seen angular boulders of the shale, of all sizes, up to 20 feet in diameter, embedded in the sandstone in the most confused manner, some of them standing on end as regards their stratification, and others inclined at all angles. They contain the same fossil plants that are found in the beds of shale from which they have evidently been derived. These angular boulders occur nearly always immediately above the shale beds, and are mixed with very rounded pebbles of quartz. They are sometimes slightly curved, as though they had been bent whilst in a semi-plastic condition, and the shale beds occasionally terminate abruptly as though broken off. Had the boulders of soft shale been deposited in their present position by running water alone, their form would have been rounded instead of angular. It would appear that the shale beds must have been partly disturbed by some such agency as that of moving ice, the displaced fragments of shale becoming commingled with the sand and rolled pebbles carried along by the currents. Occasionally in the beds above those which contain the angular boulders occur a few rounded pebbles of shale, showing that the currents had swept along for some distance a few of the angular fragments until they had become rounded. These pebbles are usually oval in shape, and are embedded in such a manner that the longer axis of the pebble is nearly always inclined or dips towards the south-west,—thus indicating that the transported currents had chiefly come from that direction; whereas the angular boulders in the beds below are, as before mentioned, confusedly heaped together without regard to size." In another place Mr. Wilkinson says:—"From their lithological character the Hawkesbury rocks appear to have been formed in a comparatively shallow sea, which was subject to rapid and changing currents. This sea was bounded on the west by the mountains which extend in a northerly direction from the Shoalhaven River to the head of the Goulburn River. It is in the rocks near the ancient shore-line that we should more especially expect to find ice-grooved pebbles, but none have yet been discovered. Its northern margin, owing to great denudation, cannot so readily be determined, but it probably did not extend north of the Hunter River; and towards the east its extension is lost beneath the waters of the South Pacific Ocean." Mr. Wilkinson compares these rocks with the Bacchus Marsh sandstones, and cites the opinions of Messrs. Selwyn and Daintree as to those formations being formed under ice action.

* Jour. Roy. Soc. N.S.W., vol. XIII, p. 106.

The difficulties in the way of such an explanation are insurmountable, as I shall show at the end of this paper. The way I account for these boulders is that they are the results of the action of creeks or flows of water in the loose sandy hillocks. These would easily undermine the beds of shale and break them up, tossing large fragments on end, and mingling them with water-worn pebbles of the watercourse. A few days' dry wind would soon entomb these ruins in sand and turn the course of the creek. What a sudden downpour of rain and a flooded creek will do in breaking up loose beds must be familiar to any observer. Here are a few examples :—In August, 1829, a fragment of sandstone, 14 feet long, 3 feet wide, and 1 foot thick, was carried by the river Nairn, in Scotland, a distance of 200 yards On the same occasion the river Dee swept away a bridge of five arches, built of solid granite, which had stood uninjured for twenty years ; the whole mass of masonry sunk into the bed of the stream and was seen no more. And the river Don, as we are assured on the authority of Mr. Farquharson, forced a mass of stone, *four* or *five hundred tons* in weight, up a steep inclined plane, leaving them in a great rectangular heap on the summit. A small rivulet called the College, in Northumberland, when swollen by a flood in August 1827, "tore away from the abutment of a mill-dam a large block of greenstone—porphyry—weighing nearly 2 tons, and transported it to the distance of a quarter of a mile."*

Glazed surfaces.—In these blocks of shale there is often a disposition to divide into small blocks of irregular form but curiously glazed surfaces. I have noticed the same in carbonaceous alluvium in other places. The creeks near Bathurst are, in the neighbourhood of the basaltic rocks, full of a dark brown shale much like what I have already described. When dry it breaks into irregular blocks with glazed surfaces. Again, the same curious appearance was noticed in a creek near Lytton on the Brisbane River, which also is close to basaltic rock. It is quite a recent formation, some of it having accumulated within the last few years. This must not be confounded with glazing from friction, as the shale is too soft to take a polish in that way.

Denudation.—There is nothing in connection with the Hawkesbury sandstone which has been matter for speculation more than the manner in which it has been denuded into such extraordinary precipices and gorges as are found in the Blue Mountains. It must be remembered that there is not the slightest evidence of upheaval or subsidence, except at the downcast already mentioned. As the beds were deposited, there they have remained. In the

* Lyell's *Principles of Geology*, 9th edit., p. 208, where similar instances are given in great number.

deepest gorges the horizontal beds on each side correspond in such a way as to make one believe they were once continuous. The difficulty is best expressed by the eminent Charles Darwin who, in the "Naturalist's Voyage," thus tells us how his visit to these mountains had puzzled him :—

Darwin's views.—"The first impression on seeing the correspondence of the horizontal strata on each side of the valleys and great amphitheatrical impressions is that they have been hollowed out by the action of water, but when one reflects on the enormous amount of stone which on this view must have been removed through mere gorges or chasms, one is led to ask whether these spaces may not have subsided. But considering the form of the irregularly branching valleys, and of the narrow promontories projecting into them from the platforms, we are compelled to abandon this notion. To attribute these hollows to the present alluvial action would be preposterous, nor does the drainage always, as I remarked near the Weatherboard, fall into the head of these valleys, but into one side of their bay-like masses. Some of the inhabitants remarked to me that they had never viewed one of those bay-like masses with headlands receding on both hands, without being struck with their resemblance to the bold sea-coast. This is certainly the case; moreover on the present coast of New South Wales, the numerous fine widely-branching harbours, which are generally connected with the sea by a narrow mouth worn through the sandstone cliffs, varying from one mile in width to a quarter of a mile, present likenesses, though on a miniature scale, to the great valleys of the interior. But then occurs the startling difficulty: Why has the sea worn out these great though circumscribed depressions on a wide platform, and left mere gorges in the openings through which the whole of the vast amount of triturated matter must have been carried away? The only light I can throw upon this enigma is by remarking that banks of the most irregular forms appear to be now forming in some seas, as in parts of the West Indies and the Red Sea, and that their sides are exceedingly steep. Such banks, I have been led to suppose, have been by sediment heaped by strong currents on an irregular sea-bottom. That in some cases the sea, instead of sowing sediment in a uniform sheet, heaps it round submarine rocks and islands, it is hardly possible to doubt after examining the charts of the West Indies; and that the waves have the power to form high precipitous cliffs, even in landlocked harbours, has been noticed in many parts of South America. To apply these ideas to the sandstone platform in New South Wales, I imagine that the strata were heaped by the action of strong currents and by the undulations of an open sea on an irregular bottom, and that the valley-like spurs thus left unfilled had their steeply sloping flanks worn into cliffs during a slow elevation of the land, the worn-down sandstone being removed either at the time the narrow gorges were cut by the retreating sea or subsequently by alluvial action."

None of the difficulties suggested by Dr. Darwin are met by his theory, and the absence of upheaval or marine remains is fatal to it. On the other hand, the aerial origin of the rock exactly explains the facts. These immense sandhills may have been always detached from one another, or if united, could have been easily cut into the gorges previous to their consolidation. No doubt they have become precipitous to some extent by weathering and by the sweeping away of outlying masses of loose sand. It is the tendency of loose aggregations of sand to consolidate in the perpendicular direction, and this is best seen in the deserts of Africa and Arabia, where the consolidated sand has formed the most abrupt precipices and gorges. I do not think that the denudation has been very great, for most of these aerial hills were never united. It used to be the custom to refer the small horizontal caps and outliers on the tops of mountains to the remains of an enormous formation which had been denuded away. I myself thought this of O'Connor's Nob, near Cooktown, and Mount Pigeonhouse, near Jervis Bay. Such stupendous denudation on horizontal strata, without any upheaval or subsidence, baffles comprehension; but when the aerial origin of these outliers is understood the difficulty vanishes. There has been little or no denudation. The sandstone has been deposited just where it is found, and was never much larger than we see it now. But the very boldest escarpment show fragments of rock at their bases which have broken away from the undermining of looser friable portions.

Hardening of sand.—A difficulty with many will be the immense height of these sandstone cliffs, some of them being most certainly about 1,000 feet almost perpendicular. Probably the actual amount of blown sand is less than half this, and sandhills of that height are found in other places. At Cape Bogador and Cape Verde they are over 600 feet in height. Another difficulty may be the consolidation of loose drifting sand into stone. That blown sand hardens into stone is certain, for even the recently formed sand dunes of Cornwall yield a stone which is used for building purposes. The accounts of all observers confirm the same fact of the hardening of sandstone from drifting sand in Africa and Arabia. Mr. James Haswell gives an interesting account of a sandstone in course of formation in Fifeshire.* The sandstone in question, near a railway bridge at Ardross, was resting upon carboniferous strata, above which was a bed of tenacious clay containing recent shells. Above this was blown sand which was washed down by the rain over the clay, and deposited on ledges formed by the projecting beds of shale, while the siliceous particles of which

*The paper was read at the Edinburgh Geological Society, January 21, 1869.

the sand was composed were cemented together by carbonate of lime held in solution by rain-water. It was derived from the recent shells which occurred not only in the sand but in the clay. The cementing medium was also partly composed of hydrated peroxide. The result is a hard sandstone, not unlike one of much older date.

It is a remarkable fact that stone derived from the wind-blown sand hardens by exposure, probably from the greater facility thus afforded for the formation of the great cementing medium, silicate of iron. The initial cause of the consolidation would of course be the pressure, and this is why we find in these formations the cores or centres of the highest and heaviest sand-hills. Still it must be remembered that the strata of all these mountains are of a compound nature, portions of them containing shales, which proves them to have been at one part of their history lagoons or marshes. The fine aerial siliceous dust of which much of this rock is composed would also consolidate very easily by the mere dead weight and pressure of sand above. The hydrostatic pressure, which is used to consolidate graphite, would be nothing to the effect of thousands of tons of sand.

Fine red sands.—Some of the Hawkesbury sandstone is of a very fine texture, and of a peculiar salmon colour, which is plainly seen in some fresh broken masses. I was struck by the resemblance of its colour and grain to a thick deposit of sand which fell on the Mosquito Plains on October 8, 1865. The spring of that year was particularly dry, and the hot winds set in rather early. At daylight of that morning the sky had a most peculiar lurid appearance, very much like dull copper in colour. There were no clouds, but an unequal tint or turbid appearance in patches which showed a rapid movement southward. The thunder was incessant, and with a harsh metallic sound very different from the booming echoes of heavy rain clouds. The lightning used to shoot across the sky in forked streams. In the middle of the day a steady rain of fine dust began to fall, which soon covered everything with a yellow or salmon coloured crust. I gathered quantities of it, and found it to consist of very finely divided grains of rounded ferruginoussand. At thattime I was interested in looking for Diatomaceæ. In referring to my notes on the subject, I do not find any reference to the presence of any angular particles, but the dust was so extremely fine that an inch objective did not suffice for its close inspection under the microscope. The wind was blowing strongly from the south, and the sand was moving in a contrary direction in an upper stratum of the atmosphere. The sand came from the edge of the desert about 500 miles to the north, as we learned from reports which reached us some ten days subsequently. There had been a tremendous northern hot wind in that locality, and the red sand had been blown away in large quantities, so as quite to expose the roots of the porcupine grass. The deposit of red dust was fully 2 inches deep in a few places on the Mosquito Plains where the wind had drifted it along the ground. It easily hardened where it had been moistened, and would bear considerable pressure before crumbling again. I have no doubt that some of the Hawkesbury sandstone is composed of such a deposit, which probably was derived from a desert interior, where the moisture was less.

Eolian sandstone in China.—Baron Richthofen, in his large work on China, describes a formation which covers vast areas in that country. He mentions it as forming cliffs or bluffs on the Yellow River, which in some places rise to a height of 500 feet. In many places, he says, it reaches a thickness of 1,500 feet. It extends inland over all the high plains, from the alluvial flats of the Gulf of Tshili, over the Taihhang-shan Mountains up to plateaux 1,800 mètres high, and even to an elevation of 2,400 mètres (over 7,500 feet) above the sea in the Wer-tai-Shan Mountains, Northern Shansi. It stretches south of the hilly grounds beyond the valley of the Yangtze, and up that valley in a westerly direction for an unknown distance. It can be followed up the course of the Han, to the watershed of that river, and it is known to extend up the valley of the Yellow River without interruption, into the province of Kansuh. This enormous deposit, according to Richthofen, is solely the result of atmospheric waste and wind action, and he has brought forward a large body of interesting and important evidence to prove his theory. He insists also upon the fact that the organic contents of this deposit pertain exclusively to terrestrial remains, as in the Hawkesbury sandstone.

Dr. Geikie, in his *Pre-historic Europe*, from which the above is taken, adds (p. 167):—"It may be that we have hitherto underestimated the action of winds as geological agents in dry continental areas like those of Central Asia, and that aerial currents have played a much more important rôle in the past than has been generally supposed. 'No one * can realize the capacity of wind as a transporter of fine material who has not lived through one great storm on a desert. In such a simoom the atmosphere is filled with a driving mass of dust and sand which hides the country under a mantle of impenetrable darkness, and penetrates every fabric. It often destroys life by suffocation, and leaves in places a deposit several feet deep.' But such rapid accumulation occurs, I presume, only in the desiccated desert or its immediate neighbourhood. Deserts of shifting sand increase their bounds by a gradual encroachment of the dunes of the peripheral regions, continually advancing in the direction of the prevailing winds. The lighter dust which is carried on the wings of the wind and frequently transported for distances of several hundred miles,

* Pumpelly, Amer. Jour. Science and Art, vol. 17, for 1879, p. 139.

leaves but a slight film upon the surface of the ground where it falls. And if this be so, one cannot but be amazed at the length of time required for the sub-aerial sifting of the material and for the transport from the dry central regions of Asia of that finest dust with which so large a portion of China eventually became covered, to a depth varying from 50 to 100 feet up to 2,000 feet."

Perhaps it is not entirely such a formation as this with which we have to deal in the Hawkesbury sandstone. Ours is a sand-dune area possibly not wholly like that of the Desert. It is no use at present encumbering ourselves with speculations as to whence this sand was derived. A very diligent and long continued examination of the constituents of the rock, taken from a very great number of places, and a better acquaintance with the physical characters of the older formations, will alone throw light on this question. We must not suppose either that the surface was wholly devoid of vegetation. If we remark how very little if any of the present vegetation is preserved in present soil we may be surprised to find so many impressions of ferns in the Hawkesbury sandstone. I should be inclined to think that the land around was a desert like Arabia, in which stand storms would be numerous and the accumulation of dust rapid. After the upheaval of the Permian strata the area may have been a desert region in which a few coal plants survived. A dry climate caused a rapid disintegration of strata and the accumulation of aerial sands. I do not pretend to assert that the upheaval took place immediately after the Permian period, but that it was not previous to that time, and may have been as late as the Cretaceous. The evidence of the plant remains is as yet insufficient to establish any period.

Stratified rocks not all aqueous.—At one time every formation not obviously fresh-water or intrusive was hastily concluded to have been derived from the sea, whether it contained marine remains or not. But we are no more justified in calling rocks marine without direct evidence than we are in calling them fresh-water. We are not acquainted with any existing sea-bottom utterly destitute of marine animal remains, no matter what the nature of the bottom. Foraminifera at least were always found, and these have existed from the earliest geological periods. But we have never heard of any marine area where the dredge brought up only plant remains and vegetable shale with sand destitute of lime and with small rounded pebbles. Mr. Selwyn, in his Notes on the Physical Geography, Geology, &c., of the Colony of Victoria,* refers to the absence of marine fossils from the lowest beds of the miocene rocks of Victoria, succeeding beds of evidently terrestrial character. This he calls a marine gravel. It is a wide-spread formation,

* One of the Intercolonial Exhibition Catalogues published in Melbourne in 1866.

being found over hill, plain, and valley. Much of the material composing it is rounded and waterworn, and Mr. Selwyn considered that there was evidence of too extensive and powerful an action to be ascribed to river floods. He adds that "very considerable areas now forming dry land in Victoria have been submerged in late tertiary times is unquestionable, and I believe that most if not all the older gold gravels, if not absolutely due to such cause, have at least been subjected to its influence, and in that case must be regarded as marine."* In answer to this, one might say that no marine remains are known to us of such a character. 2nd—That these gravel beds are very often found hundreds of feet above the level to which we know the tertiary submergence extended, viz. about 600 feet. 3rd—That their continuity is more apparent than real. 4th—That they often contain fossil wood, roots, and vegetable remains. 5th—That these drifts may well have been derived from the weathering of the carbonaceous conglomerates before the land was submerged at all. 6th—Finally, they may be the remains of a terrestrial formation such as I shall now describe.

Mexican eolian strata.—It has already been remarked that in many places in Europe there exists a recent formation at various altitudes which is more like a fresh-water deposit than any other, but yet found in situations which hardly admitted of any such explanation. Thus at Meudon, near Paris, there are deposits of an argillaceous fine gravel, resting unconformably on tertiary beds. It could not have come from the river Seine, which never reaches within 500 feet of the strata. A similar deposit is described in the Grecian Archipelago. It is a reddish loam, lying in horizontal beds at the highest altitudes. The explanation of these and similar facts has been given by Mons. Virlet-d'Aoust as the result of his observations in Mexico. †

Mons. Virlet-d'Aoust first remarked in Mexico a yellow deposit of clay or argillaceous marl, which not only completely enveloped certain isolated mountains, particularly volcanoes, but also constituted the sides and base of several chains of mountains such as those of Papocalepetl, Cetlatepetl, and Orizaba (17,370 feet). This formation is observed on the flanks of this giant of mountains, up to the height of about 12,000 feet above the sea-level, and it often attains especially in its lower part a thickness of from 150 to 300 feet. The deposit is somewhat of a miscellaneous composition, including angular fragments and rounded shingle derived from the underlying rocks. The enclosing cement or clay being of a very recent formation, has but a feeble consistency, so that where the torrents of tropical rain fall on it in the wet season enormous gullies or *Barrancas* are formed, into which the growing timber is precipitated and

* *Op. cit.* p. 25.

† See, for the full detail of these observations, *Bulletin de la Société de Géologie*, 2nd series, vol. XIII.

the whole debris carried as alluvium into the plains below. At first Mons. Virlet-d'Aoust imagined that this was an alluvial formation, derived from the washings from the mountain sides. But the deposit was found to cap the isolated mountains. It could not have been upheaved, for it was horizontal, and in any case inclnded fragments of pottery and articles of human manufacture, besides wood and plant remains. As for its recent upheaval by volcanoes, none of them have reached the height at which this deposit is found. At last a sufficient cause was found in the dust-storms which are exceptionally violent and frequent in this region. The whole plateau is distinguished by immense whirlwinds of dust, or "*remolinos de polvo*," as they are here called, which are whirling along from various points on all fine days, carrying up in their course stones of very considerable size and other objects. These were thrown to heights of nearly 2,000 feet above the plain. Often the higher stratum of the air is rendered quite like a yellowish cloud from the quantity of dust remaining suspended.

I need not give all the arguments or the details of the facts which establish beyond a doubt that the formation is an aerial one. The able observer who thus explains the formation draws attention to the fact that there are many similar deposits. He also remarks that if the intermittent effect of whirlwinds would produce such a result, how much more vast and regular would be the effects in those places where the winds are constant in direction and strong, while passing over desert regions. Thus in China, the trade winds which cross the great desert of Gobi often bring a continuous rain of dust and fine sand over the southern regions. Dr. Macgowan describes one which lasted several hours, and was so dense as to hide the sun.

At Fontainebleau.—The sandstone of Fontainebleau is admitted by most geologists to be a formation derived from sand-dunes. It contains beds of shale and lignite, and a peculiar hydrocarbon called "*alios*," which is also found in the sand-dunes of the Landes.* The sandstone referred to occurs at Cernay, and both there and in many other places it is distinguished by the absence of level horizontal and regular stratification and the absence of any fossils. Mons. Stanislaus Meunier† gives the evidence in support of such an origin for these rocks and the sandstone of Rilly. He says that the suggestion of their eolian origin occurs to the mind at once, but this idea becomes a certainty when we find that they have the characteristics of the true sand-dunes of the Landes, and they enclose the same shales with the peculiar "*alios*" found there.

* *Comptes rendus*, vol. 59, p. 64. Also an analysis of the substance by Cloetz, p. 38.

† *Comptes rendus*, vol. 85, p. 1240.

Conglomerates.—The only question which still remains to be dealt with in dealing with these sands is the presence of pebbles and conglomerates. These latter cannot be attributed to wind. That the smaller lines of pebbles are aerial I make no doubt. Until I began to investigate the subject I had no idea how easily pebbles are borne along and up into the air by strong winds. On every windy day for the last two years, whenever I could, I have been out amongst the dust examining the heaps of stones formed by the wind, and watching or stopping the pebbles as they were swept by. All those of large size and shape I put aside for comparison, and it was surprising how much the dimensions of some exceeded my expectation. The conclusions I have come to are that a very small amount of wind action is sufficient to round the edges of very hard pebbles; that the abrasion is even more rapid than in water, and the result very similar. Some are completely rounded like water-worn pebbles. It is not necessary to suppose that these pebbles were more than rolled up the gradual slope of the dunes, a slope which always exists on the windward side. The broad and flat stones in the sandstone are of larger size, from their being more easily carried along. It is not at all an uncommon thing for a strong wind to lift up and carry along pebbles of an inch or a little more in length and half an inch thick. Let it be further borne in mind that except in the lowest strata, pebbles are rare, and those that are found are very small and only such as would be easily carried by the wind.

Whatever be the origin of the conglomerates, those of large size or great extent are only common at the base of the formation. They belong more to the coal measures than the sandstone. All the other instances can well be accounted for by (1) the action of creeks, of which there must have been many; (2) extraordinary storms or tornadoes; (3) concretionary action. That the latter is not an insignificant cause can easily be seen from the experiments of Stanislaus Meunier,* who found by the infiltration of chloride of lime and silicate of potash through heated loose sand, that concretions were rapidly formed. Accident revealed another illustration. During the siege of Paris sand was heaped upon the floor of the Geological Museum, to deaden the effect of the shells falling into the building. A heap of this sand lay at the foot of an immense block of iron pyrites from Portugal. The rain which came through the roof deeply corroded the mass, and the water flowing from the iron on to the stone deposited so much hydrated oxide of iron on to the sand that it became an irregular consolidated mass, portions of which were exceedingly hard, like iron.†

* *Presse scientifique des deux Mondes*, tome 2, de 1866.

† *Les causes actuels en Géologie*, p. 298. 8vo. Dunod, Paris, 1880.

Concretions.—Concretions or fragments of rock broken small and the edges abraded present pebbles of every variety of colour and apparent consistency. This can be easily seen by the examination of pebbles at the bottom of any stream. The river Medway in Central Queensland flows through a sandstone in every respect like the Hawkesbury sandstone, though it may be older, as it is full of impressions of *Lepidodendron nothum* and other plants. The pebbles at the bottom of the stream are of every colour, and differ much in mineral character. Some have come from a distance, but not many, as the river is rarely anything but a mere brook. The conclusion I draw from this fact is that it is not impossible to account for the conglomerates by even wind action. Supposing a wind-blown sand to become much altered and concreted. This always takes place by pressure, moisture, and other metamorphic processes which we are not able to estimate in every case, but whose action is evident. Let the sandstone be disintegrated by simple aerial weathering. This is no forced hypothesis. The thing is ever taking place in the arid deserts of the world. What is the result? The lighter portions are blown away; the concretions remain to strew the ground as a thick bed of shingle. Here follows an illustration of the process.

Stony Deserts.—In Central Australia, or rather south of the centre, between the 28th and 29th parallels of latitude, the country is distinguished by two features which entitle it to the names of the Stony and the Sandy Desert. The latter is a series of red sand ridges, whose glaring colour and whose aridity render them most striking objects. 20 or 30 miles of such sand is a common thing; it is quite loose, and is blown about by every wind. To these sandhills succeed immense plains, which are strewn as thickly as possible with rounded fragments of quartz and sandstone. A day's ride from the sandhills will place the traveller out of sight of all high land, and these stony deserts are like an immense sea-beach with large fragments of rock scattered over the surface or buried in the ground by the force of waters. Such was Sturt's explanation of the stony desert, but he took an erroneous view of them from his limited knowledge of the country. In 1862 Mr. Howitt examined these deserts more thoroughly. He found they were a series of plains, some not over 17 miles wide, and others over 60. The stones are unequally distributed. They are very small in some localities, and form almost boulders in others. Many theories have been proposed to account for these stony deserts, the favourite of which is, that they are the remains left by some long-continued current of water running through the centre of the continent. In 1865 I wrote of this formation*:—"My own opinion is that these stones are the remains of a highly ferruginous

* Discovery and Exploration of Australia, vol. 2, p. 101.

sandstone which abounds in other parts of the continent. Where the strata contained a great deal of iron, there were formed siliceous concretions which resisted decomposition, while the rest of the rock fell away. * * * The red sand is certainly derived from a ferruginous sandstone. And if it be asked how the ridges should be so high and uneven, and the plains so low and flat, I answer that when the strata decomposed, the lighter portions drifted away into ridges, leaving the heavier remains scattered below on the plains." If the sand drifts again over these plains, and consolidates as it may easily do, we should have a wind-blown sandstone rock at the top, and a heavy rounded conglomerate at the bottom, and all this the result of aerial action alone. Such a deposit might be found over thousands of square miles, as it actually is so found in Central Australia, but no amount of ocean or river action that we know would produce such results. It is thus I offer to explain the wide-spread conglomerates which we find lying on the coal formation with very little change of character over thousands of square miles. Near Warwick and Stanthorpe, in Queensland, they are cemented together; at the Liverpool Range in New South Wales they are often found loosely aggregated. At the Endeavour River the same features manifest themselves, just as they do at the base of the Blue Mountains. A coast line might produce such a shingle, but there it would be of small width, and we should find marine remains, which here we do not. An ocean would not produce such results, and nothing of less extent than an ocean will meet the requirements of such an area; and then the presence of land plants, and the absence of marine remains, meet us again to destroy the ocean theory.

Ice action.—I have now a few words to say about the ice explanation for these rocks. It is true that there is a very scanty amount of fossils found in marine ice deposits, and also that they are quite wanting from some glacial beds; but, as a distinguished geologist has observed,—if we have not fossils, we have signs or marks, which are as clear indications of ice action as marine shells are of the presence of the sea. These indications are—(1) Till; (2) Moraines; (3) Glacial mud; (4) Boulder clay; (5) Ice grooves, scratches and polishing. *Till* is a deposit of excessively dense clay, stuck as full as it can hold of stones of all sizes, which are not arranged in any order, but look as if they had been forced and rammed in anyhow; big and little, angular and rounded together. Those fragments which are rounded, and in fact nearly all of them, show ice scratching and polishing. *Moraines* are confused masses of earth and stones jumbled together without regard to size, weight, or shape. The fragments are less grooved or scratched than in the till, because they have ridden on the top of the glacier; but they are always arranged in lines along a valley, or in a horseshoe-shaped heap across the end of it. *Glacial mud* is an extremely fine deposit of clay derived from streams issuing from the base of glaciers. It is formed by the impalpable mud which represents rocks ground down by glacier action. *Boulder clay* is a deposit formed partly by the drainage from glaciers, and partly of transported blocks of large size and various kinds of rocks. Boulder clay is stratified, but the stratification is often thrown into large folds and wrinkles, and ploughed up as it were on a gigantic scale by the former stranding of icebergs.

I do not think it necessary to go into detail in this matter any more than to say that we have none of these formations in the Hawkesbury rocks. The sand is utterly unlike any ice clay, and so are the included fragments. We have no such thing as ice scratches and grooves. Mr. Wilkinson mentions one instance of boulders which he attributes to ice action—this has been already referred to—and alludes to another which he does not describe. But if the ice interpretation were the correct one they should be the rule and not a rare exception in these vast deposits. I have every confidence in the wide experience and conscientious observations of my esteemed and learned friend the Government Geologist, and since I differ from him in the interpretation of these facts, I should like also to record here my high sense of the service he has rendered to geological science in New South Wales, the ready help he has given to me in these inquiries as well as on all other occasions.

But another difficulty is, that these glaciers must have come from an enormously high land to produce them on so grand a scale. We have no evidence that there has ever been such a mountain range. If there had been, it must have disappeared under a great and rapid subsidence. Yet it is upheaval, not subsidence, which we want, to account for the presence of the sandstone 3,000 feet and more above the sea. There is no parallel in all geology for the appearance and disappearance of mountain ranges in this manner. Moreover, we find this deposit far within the tropics, and where is the glacial system that would include such climatic changes? Finally, ice action is certainly unfavourable to the formation of coal and the luxuriant growth of ferns, yet these are the common remains in the sandstone. But really I do not think it is necessary to pursue this part of the subject any further.

Conclusion.—If these Hawkesbury rocks are the slow accumulation of aerial deposits since their upheaval from the sea, we have in them a monument which marks the extreme antiquity of this part of the earth's surface. We cannot fix precisely the age of the beds on which they rest. The advocates of the greatest age would rank them as Permian, while the most extreme opinions on the other side would not rank them as newer than the middle of the Mesozoic period. The plants give us no great clue. They are those which belong to the Upper Coal basin, such as *Thinnfeldia odontopteroides*. Probably the beds went on accumulating long after this; or the plant may have a long range in its life history. We cannot fix any age for these beds. Similar deposits overlay marine beds with chalk fossils in Queensland. These cretaceous deposits are inclined at angles of between 20° and 30°. We have no such beds here in New South Wales. The beds with *Thinnfeldia* in Queensland are similarly disturbed, so that the Hawkesbury sandstone has been less disturbed than the formations of other parts of the continent. Here then we may suppose has survived that ancient fauna and flora which represents a long past epoch in the world's natural history and perhaps a link which connects us with the present time. Whatever disturbance there has been relates to the period of volcanic activity. This was shared by all the eastern half of the continent in tertiary times. Some of these lavas have burst through thick portions of the strata and now form the highest parts of the range. This outburst of volcanic matter on such a gigantic scale was no doubt attended with an alteration in the drainage as well as the watershed. We have daily increasing evidence of what the flora was, from the vegetable fossils which are being exhumed from beneath the beds of volcanic ash. It was quite different from what grows around us now, as far as the fossils will guide us. I may thus summarize the results of this essay :—

1. That the Hawkesbury sandstone is a wind-blown formation, interspersed with lagoons and morasses, with impure peat.

2. That there has been no upheaval, but rather a subsidence, which probably extends from the base of the range to the sea.

3. That the peculiar lamination of the beds is due to the angle at which dry sand slips and rests when blown by the wind.

4. The beds of ironstone represent vegetable matter destroyed in oxidizing the iron, and this is why so few plant remains are found.

5. The irregular layers of the sandstone formation probably represent what was a tranquil portion of the surface for a time, on which there may have been a vegetable growth now represented by ironstone bands.

6. The smaller gravel may be wind-blown; the larger may have been derived from creeks. This is also the origin of the fragments of shale. The creeks have undermined them and broken them up.

7. Conglomerates may have been derived from stony deserts, such as we have in the centre of Australia. They represent all the stones of a sandhill district from which the sand has been blown away.

8. The precipitous cliffs of the Blue Mountains are the hard central cores of sandhills, the loose portions of which have been easily blown or washed away.

9. That in all respects the sandstone is like many desert formations of the interior.

10. That a large arid or desert region has existed in Australia in mesozoic times, while to the north and north-west there was a cretaceous sea.

11. That this desert was terminated by the outpouring of vast quantities of volcanic rock, which altered the drainage and probably changed the climate.

12. We have no means of knowing the eastern limits of this ancient desert, as there has been subsidence on that side.

13. This formation differs but slightly from other and more extensive aerial ones in other countries, especially in Mexico, China, Arabia, &c.

14. There is no evidence of ice-action, and all the physical features are against such a supposition.

APPENDIX.

The following illustration of an eolian rock in the oft-cited case of Bermuda will be interesting:—

BERMUDA.—From "Notes by a Naturalist on the 'Challenger.'" By H. N. Moseley, M.A., F.R.S.; page 18.

The islands are almost entirely composed of brown calcareous sand, more or less consolidated into hard rock. In several places, and especially at Tuckerstown and Elbow Bay, there exist considerable tracts covered with modern sand-dunes, some of which are encroaching inland upon cultivated ground, and have overwhelmed at Elbow Bay a cottage, the chimney of which only is now to be seen above the sand. The constant encroachment of dunes is prevented by the growth upon them of several binding plants, amongst which a hard prickly grass (*Cenchrus*), with long, deeply-penetrating root-fibres, is the most efficient, assisted by the trailing *Ipomœa pes capræ.* When these binding plants are artificially removed the sand at once begins to shift, and the burying of the house, and the present encroachment at Elbow Bay, are said to have originated from the cutting through of some ancient sand hills for military purposes.

The sand is entirely calcareous, and dazzling white when seen in masses. When examined closely, in small quantities, it is seen to consist of various sized particles of broken shells. By gathering samples from the shores where the material of which the sand is formed is first thrown up, and selecting portions where eddies of the wind have left the heavier particles together, a sand full of large fragments of shell, and containing even many whole shells of smaller species, may be obtained, and from the examination of these an accurate conclusion may be arrived at as to the main constituents of the finer and more comminuted sand, which is driven inland by the wind blown up into dunes, and from which the whole island above water has been formed.

The sand may be seen to be made up in by far its greater part of the shells of mollusca. Species of *Tellina*, *Cardium*, and *Arca*, contribute most largely to compose the mass, together with large quantities of pink-coloured fragments derived from a *Spondylus* which is common about the islands. A few gasteropodous shells contribute fragments, and a considerable number of foraminiferous shells occur in the sand, and no doubt careful examination would reveal the presence of fragments of tubes of *Serpulæ*, corals, calcareous algæ, *Bryozoa*, and Cirrhipede shells; but there can be no doubt that by far the greater mass is derived from the shells of mollusca.* Thus, although the foundations of Bermuda and its natural breakwaters and protections, without which it would not exist, are formed of corals; the part above water is mostly derived from another source, and even below the water the same is the case for some distance, for the same beds of sandstone were met with in an excavation carried to a depth of 50 feet.

The shells more or less broken are thrown up upon the beach and there pounded by the surf. As the tide recedes the resulting calcareous sand is rapidly dried by the sun, and the finer particles are borne off inland by the wind, to be heaped into the dome-shaped dunes. The rain charged with carbonic acid percolates through the dunes, and taking lime into solution re-deposits it as a cement, binding the sand grains together.† Successive showers of rain occurring at irregular intervals, some charged more, some less highly with carbonic acid, and forming each a crust on the surface of the dune of varying thickness, produce a series of very thin, hard layers in the mass of sand, alternating with seams of less consolidated sand which are to be observed commonly on the surfaces of fresh sand-dunes. These layers or strata of the hardened sand follow in form

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* It would be of great interest to determine, by careful microscopic examination, what are relative percentages of the various calcareous structures composing the calcareous sands of coral islands in different parts of the world. I collected specimens of all the calcareous sands accessible during the voyage of the "Challenger," with that object. They vary much in composition, some being mainly foraminiferous.

† The process is described by Jukes, in his account of Raines Islet, "Voyage of the 'Fly,'" p. 339.

the contour of the dunes, and thus, where these have been perfect domes or mounds, dip outwards in all directions, with curved surfaces from a central vertical axis. Such an arrangement is constantly to be seen where sections of the older rocks are exposed. I saw especially good instances of it in a small island, near Castle Island in Harrington Sound. Where banks or long ridges of sand have been formed, strata following the surfaces of these in inclination are produced.

All kinds of curious irregularities in arrangement are to be found in the bedding of the strata, resulting evidently from the encroachment of one dune upon the edge of another, or the action of various eddies of wind, or the burying of a small dune in the edge of a larger one. In some cases an already hardened dune, after having suffered denudation by the action of the waves, has become buried in a more recent sand mound, and this process may have been repeated several times, as the accompanying diagram showing the arrangement of bedding in some rocks at Castle Harbour will show. I saw no rock in Bermuda with an inclination in its bedding of more than 35° 30′, which is not much more than the slope of some of the sand-hills.

Dana terms this calcareous sand rock "drift-sand rock."*

Nelson terms it "eolian formation," in his account of the geology of the Bermudas.†

Jukes observed that in Heron Island the main strata of calcareous rock composing the island dipped outwards from the longitudinal axis of the island towards the shore, north and south, with an inclination of from 8° to 10°, and Nelson observed similar dispositions of the strata at Bermuda.

The rock at Bermuda presents all degrees of consolidation, from beds of mere unagglutinated friable sand to extremely hard compact stone. The main component rock is a good deal softer than Bath stone. A much harder rock occurs at two places in the islands only, and is quarried for the construction of forts. The red fragments of *Spondylus* shell are especially well preserved in it. *A bed of lignite* was found at a depth of 40 feet *below the sea-level* in excavating for dockyard purposes, being evidently an ancient peat bed, such as those which now occur in the islands, overwhelmed with sand. Besides these primary sand rocks, a conglomerate is being formed on the shore in some places composed of beach fragments cemented together, as usually occurs in coral islands.

* Dana, *Corals and Coral Islands*, edition 1875, p. 182.

† Major-General Nelson, R. E., *On the Geology of the Bermudas*, Trans. Geog. Soc., London, vol. V, 1840.

Discussion.

Mr. Wilkinson, Government Geologist, read his paper in reply, as follows :—I feel it incumbent upon me to offer a few remarks upon the able and interesting paper which has been read, because in it Mr. Tenison-Woods has put before us a theory not only opposed to the views entertained by all previous observers as to the aqueous origin of the Hawkesbury sandstones, but also to the supposed evidence which I had the honor of bringing under the notice of this Society, of ice action having been concerned in the deposition of these rocks.

I am sure Mr. Tenison-Woods is desirous that we should freely express our views upon this very interesting question, for he kindly gave me a copy of his paper several days before it was read.

The paper, as you have heard, deals largely with the formation of blown sand deposits ; and the description given of these is, in nearly all respects, very accurate. I may, perhaps, be justified in thus endorsing Mr. Tenison-Woods' description, seeing that I have made many examinations of blown sand deposits during the past twenty years. I shall not, therefore, dwell further upon this part of the paper, but I must take exception to the theory he now propounds. Were it not that I have made careful examinations of the Hawkesbury series in numerous localities, I might have had some reluctance in questioning the opinion of such an eminent scientific observer ; and seeing that Mr. Tenison-Woods has happily given us a case in point, where Darwin's theory as to the formation of the Hawkesbury rocks has been proved faulty, I venture to be a little presumptuous, and say that my friend's theory may be at fault also.

Mr. Tenison-Woods thus summarizes the result of his essay :— "1. That the Hawkesbury sandstone is a wind-blown formation, interspersed with lagoons and morasses, with impure peat." I do not question the possibility of blown sand deposits occupying as extensive or even a larger area than that of the Hawkesbury formation. For instance, even in the Herbert and Diamantina district, beyond Cooper's Creek, there is a vast area, several hundred miles in extent, covered at intervals with blown sand ridges in the course of formation. My assistant, Mr. J. E. Carne, who has explored this tract of country, informs me that some of the sand ridges resemble huge railway embankments, and run for a distance of 12 miles without a break. They vary from 200 to 500 yards in width, and are about 60 feet high, and generally lie in the direction of the prevailing winds. Between them are mud flats, liable to inundation. In the dry weather the mud cracks, and numerous large and deep fissures open in all directions, so that in places you cannot ride across them, but have to take a circuitous route along the flanks of the sand ridges. The sand is of a red colour, and is evidently derived from the ferruginous quartzite rocks (probably Cretaceous), which, in a very fragmentary state, crop out at intervals, and form the Downs. I may mention another instance, though but a small one, with which you all are familiar. The valley lying between Sydney and Botany Bay is partly filled with blown sand deposits, while here and there occur small lagoons, in which carbonaceous sediment is accumulating. To a certain extent this illustration may serve to show sandstones and irregular shale beds in process of formation; but only in a small degree will they resemble the sandstones and shales of the Hawkesbury formation. The Hon. Francis Lord informs me that on the Coronulla beach, which is exposed to the easterly winds, the sand dunes have risen 10 feet during the last sixteen years, burying up as they advance on the lee side the trees and other vegetation. You cannot but be struck with the undulating and hilly surface of these blown sand areas. Now, if you look at the beautiful sections exposed in the cliffs along the Bondi coast, or in the smaller cliffs fringing the harbour, or better still, in those magnificent precipices in the Blue Mountains, the most prominent feature that you will notice is the horizontal stratification of the beds of sandstone; in fact, the parallelism of the main lines of stratification is a prevailing feature in the Hawkesbury formation, and this alone is evidence of the beds having been deposited under water. But in wind-blown formations such stratification is seldom seen to extend for more than a few yards.

Then, as regards the thinly-laminated shales, and fine-grained sandy ironstone shales, which sometimes occur between the main beds of sandstone, I do not see the necessity for ascribing their origin to dust-storms; for, in their laminated structure, they exactly resemble the aqueous rocks of the Coal Measures and other formations. Then, again, there are the carbonaceous shale beds, which Mr. Tenison-Woods believes to be of aqueous origin, and to have been formed in lagoons or morasses. But if you will closely examine these deposits—and there are many instances of them to be seen in the quarries and cliffs about Sydney—I think you will come to the conclusion that, after the sand had been laid down, strong local currents eroded channels and hollows in the sand beds; then quiet water succeeding, the fine earthy matter which could not settle in the currents which drifted the sand along, now settled down in the sheltered hollows and so far filled them up, until recurring currents either broke up the layers of mud, or overwhelmed them with fresh deposits of sand and pebbles. The evidence of such changes having taken place is very clear. I will adduce further proof of the aqueous origin of the Hawkesbury series, in replying to the other conclusions stated by Mr. Tenison-Woods.

The second conclusion is, "That there has been no upheaval, but rather a subsidence, which probably extends from the base of the range to the sea." This question does not bear directly upon the mode of deposition of the sandstones, excepting as tending to show that the rocks now below sea-level, if of wind-blown formation, must have subsided. It has always been the opinion of geologists that there has been a subsidence of the area between the sea and the base of the ranges near the Nepean, as stated by Mr. Tenison-Woods; but the arguments brought forward to show that there has been no upheaval I do not consider to be conclusive. It is said that there are no signs of upheaval, seeing that the beds lie in nearly a horizontal position. But then the same remark will apply to the Lower Coal Measures which occur near Wallerawang, at an elevation of 3,000 feet above sea-level, and are full of spirifers and other marine fossil remains. These beds exhibit no signs of disturbance, their bedding is nearly horizontal, like that of the Hawkesbury rocks overlying them, and yet the upheaval of them from the sea is unquestionable. In a similar manner they are found above sea-level in the Wollongong and Kiama districts. In fact, in most places where these marine beds occur in a horizontal position, we have the Upper Coal Measures and Hawkesbury sandstones overlying them; but where they have been locally disturbed and tilted up, as near Maitland, we find no Hawkesbury rocks, for it is clear that in this locality the overlying beds have been removed by denudation. At Mittagong, on the Great Southern Railway, the great mass of trachyte which forms the hill near the station has been upheaved through both the Hawkesbury beds and the more recent Wianamatta shales. We have evidence, therefore, on both sides of the Hawkesbury basin, of disturbance after the deposition of these beds; and I believe that the whole formation, and probably a great portion of the Dividing Range, was raised bodily from the sea without disturbing the horizontality of the strata, except, perhaps, in a few local instances. We see that the vast Mesozoic marine formation of Queensland, which extends into this Colony about the Darling and Mount Poole districts, has been upheaved in this manner.

The third conclusion states "that the peculiar lamination of the beds is due to the angle at which dry sand slips and rests when blown by the wind." This statement tends rather to weaken than support the theory of the eolian character of the Hawkesbury sandstones. The peculiar lamination, or "false-bedding" as it is usually called, referred to, is a structure not confined only to eolian rocks, but it is met with in almost all sedimentary formations, whether of marine or fresh-water origin, and is regarded as indicative of more or less strong currents in shallow water. I have seen it frequently in different aqueous formations. Mr. Selwyn, F.R.S., formerly Director of the Geological Survey of Victoria, and at present the Director of the Canadian Survey, whose long experience in geological surveying should entitle him to be considered one of the highest authorities upon the structure of rocks, speaking of the Mesozoic Carbonaceous formation in Victoria, says, "The character of the strata generally indicates that they have been formed in shallow water, under the influence of strong and constantly-varying currents, giving rise to much diagonal and wedge-shaped stratification or 'false-bedding.'" The formation referred to, which I have examined and surveyed in the Cape Otway, Geelong, and Gippsland districts, consists not only of sandstone and shales, but of beds of coarse pebble conglomerates. Mr. Selwyn also mentions that much "false-bedding" is observable in the sandstones of the older Grampian series. Jukes says, "That 'false-bedding' is a proof of frequent change in the direction and velocity of the currents which brought the sand and gravel into the water. * * Such appearances generally indicate shallow water, and are often seen in cutting through an old estuary or delta." Dana, in describing the structure of formations made from river and oceanic action combined, and referring particularly to sand-flats, such as that off the coast of New Jersey, which is 50 to 80 miles wide (nearly the area of our Hawkesbury formation), says, "The stratification or bedding is parallel to the general surface of the flat, because the successive additions are laid over this surface, consequently the bedding will be horizontal, or nearly so. The sand beds, where, in shallow water, and washed over by the tidal currents, have often the layers obliquely laminated. Where there are strong flows of the tides between islands and the mainland, or among groups of islands, the material may be in part pebbly, and oblique lamination may be a feature of the beds." Actual instances might also be quoted from Lyell, Rutley, and other writers, of the occurrence of false-bedding in fresh-water and marine deposits, as well as in blown sand-beds. With reference to the angle at which sand slips, and rests in air and in water, I have made numerous observations. The highest angle that I have found upon the slopes of blown sandhills is 36°. At Cape Otway, in Victoria, there are splendid examples of blowns and dunes. Some of them are about 50 feet high, and they are advancing inland at the rate of about 1 foot a year, covering up gum-trees in their course. The highest angle that I have observed by experiment of rolling sand in water is 31°. Now the greatest inclination that I have measured (and I have taken a great many measurements) of the false-bedding in the Hawkesbury sandstones is an angle of $26\frac{1}{2}$° ; the prevailing angle is about 20°. In blown sandhills the angles of 30° to 33° are very frequent. Surely, then, were the Hawkesbury beds of eolian origin we should have found angles of inclination greater than $26\frac{1}{2}$°. This is an important point, and tends to show that this false-bedding is due to currents of water. The prevailing direction of the dip of the false-bedding is towards the north-east, showing that the currents came from the south-west; but there are often seen beds with the dip towards other directions.

Mr. Tenison-Woods' conclusions Nos. 4 and 5 refer to the origin of the ironstones. I do not consider that the irregular bands mentioned represent old land surfaces, for the bands not only curve in all positions but are sometimes vertical. They may be well seen in the cuttings along the Great Western Railway between Penrith and Lithgow. Most of them have been formed from the oxidation of iron in solution in the water, permeating the sandstones and shales and the joints traversing them. Professor Liversidge has made analyses of these ferruginous bands.

Conclusion 6 states that "The smaller gravel may be wind-blown, the larger may have been derived from creeks. This is also the origin of the fragments of shale. The creeks have undermined them, and broken them up." The smaller and larger gravels are included in such a manner in the sandstone beds that they have evidently been brought by the same currents that transported the sand, and which I have already alluded to. It is very unusual to find creeks traversing for any great distance blown sand beds for such a distance as these must have done, for the rounded pebbles of the larger gravel (which are sometimes over 6 inches in diameter) consist of quartzite, black slate, quartz, silicious slate, &c., which may have been derived from the Hartley ranges, some 60 miles distant, which are the nearest formations of the character of the pebbles. Amongst the everchanging surface of wind-blown sands it is very improbable that the courses of creeks would have been sufficiently constant to have enabled pebbles to have been conveyed by them for such a distance; whereas the transport of pebbles for a great distance by marine or estuarine currents, and their deposition in the manner in which we find these, is well known. As regards the shale fragments, if you closely examine their mode of occurrence you will see that they have not been undermined by creeks, for many of the fragments lie immediately above beds of shale that have not been disturbed. The sketch placed before you shows one of the fragments, 12 feet in length, tilted up and laid upon the unbroken part of the shale bed. But I shall again refer to these shale boulders when speaking of evidence of ice action.

Conclusion 7 states that "conglomerates may have been derived from stony deserts such as we have in the centre of Australia. They represent all the stones of a sand-hill district from which the sand has been blown away." It is impossible that the conglomerates in the Hawkesbury series could have been derived in the manner just mentioned. To satisfy this theory the conglomerates must occur at the base of the series; but they do not. Rounded pebbles are certainly found all through the series from bottom to top, but the conglomerates occur principally in the uppermost portions. Our former distinguished Vice-President (the late Rev. W. B. Clarke) mentions this fact in the passage quoted by Mr. Tenison-Woods at the commencement of his paper; and Darwin also states that the pebbles increase in number and size in the upper beds. I have examined many sections of the Hawkesbury formation and have not observed conglomerates at its base. Near Govett's Leap the conglomerates are cemented by iron and manganese oxides; the pebbles are generally small, but some of them are over 2 inches in diameter; a specimen taken from this locality containing a hard sandstone pebble is now on the table before you. I also exhibit specimens of the conglomerate from the Woolloomooloo quarries, as they well show the different kinds of the large pebbles, as well as the angular fragments of shale. As you approach the western margin of the Hawkesbury formation, near Marulan, you will find the upper sandstone beds gradually pass into massive pebble conglomerates of great thickness. This is just what we should expect to find on the margin of an old estuary or lake. In the cliffs at Bondi, and elsewhere about Sydney, you may see small beds, 3 feet thick, of pebble conglomerate. In their mode of arrangement the pebbles are plainly seen to have been deposited by aqueous agencies.

Conclusion 8. "The precipitous cliffs of the Blue Mountains are the hard central cores of sandhills, the loose portions of which have been easily blown or washed away." The horizontality of the beds and their structure, which I have already described, is obviously against such a supposition as that now stated; I need not therefore again refer to this. The precipitous cliffs of sandstone, and the sloping surfaces of the underlying coal measures where exposed, plainly indicate the nature of atmospheric agencies that have given them their picturesque shapes. But as this opens the subject of the denudation, or scooping out, of the great valleys which furrow both sides of the Main Dividing Range, and as my views have already been published in the "New South Wales Railway Guide-book," I will not enter upon the subject at the present time.

Conclusions 9 and 10.—"That in all respects the sandstone is like many desert formations of the interior," and "That a large and arid or desert region has existed in Australia in Mesozoic times, while to the north and north-west there was a Cretaceous sea." In reference to these conclusions I will only remark that if many of the "desert formations of the interior" do *in all respects* resemble the Hawkesbury formation, then, from what I have already seen of this formation, I very much question that they were formed in "a large arid or desert region." And it is not improbable that the Cretaceous sea spoken of extended to Western Australia.

Regarding conclusion 11, we know that after the Cretaceous and during the Tertiary periods great volcanic activity was manifested along the elevated land which forms the Great Dividing Range; but with the exception of a few places along the crest of this range, I do not think that these eruptions altered the drainage, for we find that the old Tertiary drainage channels, or "leads," as the miners call them, took the same direction as the present ones; and the present range of Paleozoic rocks which extends through this Colony and Queensland, and the lateral range which branches off from it near Orange and stretches away to the Grey Range, must have existed in Mesozoic times, as they evidently formed the eastern and part of the southern margin of the Cretaceous sea.

Conclusions 12 and 13 I need not now refer to. No. 14 states that "there is no evidence of ice action, and all the physical features are against such a supposition." Now, the mode of occurrence of the angular boulders of shale, which I described in a paper which I had the honor of reading before the Society last year, I can only attribute to the action of ice. I do not see that the physical features of the period when the Hawkesbury rocks were deposited may have been against this supposition; on the contrary, I think they may have favoured it, for on the western margin of the Hawkesbury area, near Bowenfells, we find that at least a thickness of 10,000 feet of the Devonian formation has been removed by denudation. This is no supposition; it is fact, ascertained by actual measurement of the denuded strata, as shown upon my geological map of that district. What may not then have been the denudation of the remaining margin of the Hawkesbury area? Besides, we do not know the extent of the subsidence of the eastern margin of the Hawkesbury area, as Mr. Tenison-Woods has justly stated in his 12th conclusion. I do not look for any of the signs of ice action mentioned by Mr. Tenison-Woods, but I do for certain signs that he has not mentioned, and they are the signs of *ground ice*. At different levels in the series are thin beds of shale, and the sandstones immediately above these shale beds frequently enclose angular boulders of all sizes up to 20 feet or more in diameter. These boulders have been torn up from the underlying beds of shale and embedded in a very confused manner in the sand and rounded pebbles brought by the transporting currents. The angular form and mode of occurrence of these boulders of soft shale evidently show that the shale beds have been disturbed by moving ice. Professor Julius von Haast, Ph.D., F.R.S., Director of the Canterbury Museum, New Zealand, has also examined these boulder beds, and expressed to me his opinion that the underlying shales have been broken up by "ground-ice." In December, 1879, I contributed a paper on this subject to the Royal Society of New South Wales, and Professor W. J. Stephens, M.A., communicated to the Linnean Society of New South Wales the results of similar observations made by himself of the Hawkesbury rocks in the Upper Nepean district.

Professor STEPHENS said: When I heard last Wednesday a most ingenious account read by Mr. Woods on the geology of our sandstone, I felt I should like to have some opportunity of answering at least one or two details, but as the time was short on that evening, it was suggested and resolved that the discussion should be deferred to an adjourned meeting. On Saturday, accordingly, when the last instalment of his paper appeared in the *Sydney Morning Herald*, I set to work upon the subject with so much good-will that by yesterday morning I had completed something like forty octavo pages of matter. Fast writing is proverbially slow reading, and haste precludes brevity. I have therefore excised the greater portion of what I had prepared, and offer for your consideration only the following remarks.

Mr. Tenison-Woods states that "we are not acquainted with any existing sea-bottom utterly destitute of marine animal remains, no matter what was the nature of the bottom. Foraminifera, at least, were always found, and these have existed from the earliest geological periods." Now, so far as sea-bottoms of sand or calcareous matter are alone regarded, this proposition is in all probability correct; and thus, so far as the formation of the Hawkesbury rocks is alone under consideration, the argument which depends upon it is just. But I do not suppose that Mr. Tenison-Woods needs to be reminded that the same observer, the late Professor Sir C. Wyville Thomson, F.R.S., who was the first to demonstrate the existence of a previously unsuspected abundance and variety of animal life at almost abysmal depths, is also our authority for the occurrence of vast beds of an argillaceous ooze, which are perfectly destitute of any vestige of life or organism, and are now in process of deposition over large areas of still greater profundity. Moreover, whatever our present seas might indicate, we must not forget that there are many ancient marine formations, not metamorphic in structure, and composed of materials highly capable of preserving animal remains, which are, nevertheless, for thousands of feet in thickness together, absolutely devoid of any evidence of contemporaneous life, although isolated fossils found after long searching—one here and another there—show that a great variety of animals of highly complex organizations, and *a fortiori* more of a simpler structure, were in existence at the time of their deposition. The weight which Mr. Woods' authority naturally lends to every statement which he makes renders it necessary to notice this, lest an incautiously worded sentence which, after all, is generally true, might be accepted as one of absolute and universal application.

Under the head of Stratification, Mr. Tenison-Woods gives an account of the false-bedding or oblique lamination so characteristic of the Hawkesbury sandstones, and insists with perfect justice on the extreme prevalence of this phenomenon in their stratification. On one point, however, I must express my doubts. He states that " the irregularity of the dip of the false-bedding is surprising; in a few feet the dip will vary in almost every direction and angle, though rarely at a greater one than 25°." Now, I have for many years habitually examined every example of false-bedding that has fallen under my notice; but I have done this only in order to see in what direction these particular sands were moving when they formed these laminæ, or, in other words, according to my own view of the formation, to ascertain what was the general direction of the currents which drifted the said sand. Consequently I never took special note of the amount, but only of the direction of dip, or, which comes to the same thing, I disregarded dip, and regarded only strike. I can, therefore, only state my strong impression, without actual measurement, that the angle of dip is almost constant, varying very little indeed. I should in any case have paid little attention to sections, as in these the true obliquity of lamination is only seen when the plane of section happens to be at right angles to the strike of the laminæ, the angle gradually diminishing as this plane becomes more nearly parallel to the strike, until, when the section is along the line of strike, all obliquity disappears. In other words, the apparent inclination of the laminæ, as seen in section, varies from (say) 25° to 0°, as the angle which the section-plane makes with the strike varies from 90° to 0°. This consideration has always led me to examine the false-bedding only where its *planes* are thoroughly exposed, as in the water-tables of mountain roads, river beds, and in those flagstone quarries where this structure gives special value to the stone. And my impression—I am sorry that I cannot substitute a more positive term—after observing many hundreds of examples, is that the angle of oblique lamination is very nearly constant, and very near, but I should have thought less than 25°. I am quite alive to the absurdity of opposing mere impressions to exact observations, and do not expect to have my general recollections weighed, even for a moment, against the statements of Mr. Tenison-Woods; but this impression is so strong upon my mind, that I could not refrain from putting it before you as part of the defence of Water against Wind. I have not been able to leave Sydney since the original paper was read, and am therefore unable at present to verify my statements, as of course I am bound to do or surrender the point. On this head Darwin is clearly in error, first in stating that the dip of the laminæ is frequently as high as 45°, and, secondly, in referring them to disturbances of the sea during storms in which "the bed of the ocean is heaped up during gales into great ripple-like furrows and depressions, which are afterwards cut off by the currents during more tranquil weather, and again furrowed during gales." For my own part, I have no doubt that this lamination is in general caused by the flow of water carrying sandy or other detritus from one level to another. As the grains fall over the verge they arrange themselves in sloping beds, descending to the lower level. This slanting front is immediately covered by another thin course, dipping at the same angle. This process I have often watched in the sands of Morecambe Bay. It is, in fact, this drift of wind-and-water-shifted sands that changes with such rapidity the river courses in that estuary. The channels are continually but gradually altering at every tide, but the principal cause of their sudden and dangerous alterations is, I believe, the action of the wind on very thin sheets of water covering very quick sands. And the layers so deposited are, when solidified, the laminæ of the oblique or cross or false stratification of which we have such abundant illustration in the Hawkesbury beds.

The broad band of red stone exposed in the upper cutting of the second Zigzag deserves further investigation. I do not presume to question Mr. Tenison-Woods' views as to its formation, but only to indicate that it appears to form a distinct member of the upper beds, which may serve as a geological bench-mark to which other portions may be referred. For not only is it continous along the range of Hassan's Walls to Bowenfels, and back to Mount Victoria and the neighbouring cliffs to the east, but a similar rock appears at the top of the Bulli Pass, and similar beds of much greater thickness were pierced by the diamond drill at Sutherland. I think that Dr. Hector was inclined to suppose that in the latter case, at least, it marked the passage from the Carboniferous to the Hawkesbury beds; and though this step in the ascending scale would throw the lower portion of the western cliffs into the coal measures, yet the idea deserves consideration.

The undulating character of the true surfaces of stratification is frequently and emphatically referred to by Mr. Tenison-Woods. And if such irregularities of deposition were anywhere observed in the Hawkesbury rocks as are generally to be seen in sections of wind-blown sands, where the planes of stratification are never, or hardly ever, even approximately horizontal, but dip in any direction according as the wind might veer from time to time during their formation, it would be impossible to question the completness of his demonstration; but the horizontality of these Hawkesbury beds is their principal feature. They do indeed thicken here and thin out there, and their surfaces are therefore not truly horizontal ; but they are horizontal enough to be called, as they are by Darwin, Clarke, and Mr. Tenison-Woods himself, horizontal rather than undulating, and to show that water was concerned somehow or other in their levelling. We may admit that where exposed sands are saturated at a certain depth with water, the friction of strong or continous winds will plane down all elevations above that horizon of saturation, and leave a surface as flat as those in question ; but is it conceivable that wind, independently of water, should blow sands into horizontal beds ?

Again, the materials of which the partings which separate these beds are composed are arranged in laminæ, which are "thin, horizontal, and rather difficult to trace." They are sometimes not to be traced at all ; and, where they do exist, they may quite as well have been the result of the burying up of fresh-water algæ or other aquatic plants by successive layers of sand under water, as of a similar overlaying of a land vegetation, including, I suppose trees, stems, and branches, with hard woody tissue, or at least with nuts or the like, which might as well have been preserved in the partings, as casual fragments of the kind have been in the intermediate thickness of the beds. Now, Mr. Woods does, indeed, allow the action of water in swamps or pools, and in creeks, of which action the shales intercalated in the sandstone give frequent indications. They have been, he says, deposited in the swamps, and subsequently eroded by the creeks. And this would account for many, but not for all of the phenomena presented. I quote Darwin again : "In several parts of the sandstones I noticed patches of shale, which might at the first glance have been mistaken for extraneous fragments ; their horizontal laminæ, however, being parallel with those of the sandstone, showed that they were the remains of thin continuous beds. One such fragment (probably the section of a long narrow strip) seen in the face of a cliff, was of greater vertical thickness than breadth, which proves that this bed of shale must have been in some degree consolidated after having been deposited, and before being worn away by the currents. Each patch of the shale shows also how slowly many of the successive layers of sandstone were deposited." Examples of similar erosion are common ; an excellent one occurring in a quarry to the west of Rushcutter's Bay, which is duplicated by a nearly parallel section at the foot of the cliff to the east of Woolloomooloo. The evidence in favour of the existence of strong currents of water is unmistakable. They have cut channels through sands and shales, and filled them up again, sometimes with stuff derived from the immediate neighbourhood, containing fragments of the already indurated beds, and sometimes with clean sand which may have been drifted some distance. Such rivers are not to be found in a system of sandhills, unless the dunes be formed by the river, or intervene between it and the sea.

Though the sandstone is generally fine-grained, yet it often becomes gritty and coarse-grained, sometimes so much so as to pass rather into a conglomerate. And the conglomerates of the Hawkesbury rocks are, so far as my observation extends, of two distinct characters. One, in which the pebbles are chiefly or entirely of quartz, very imperfectly rounded and almost always cemented by iron sandstone. Such rocks are common near Mount Victoria, Katoomba, and many other spots on the mountains and elsewhere. In the immediate neighbourhood of Sydney, however, there is a locality very easy of access and examination, in which this formation may be observed. I mean Clark Island, off Rose Bay. (Specimen produced.) Where the iron cement is absent I observe the quartz pebbles to be smaller, whiter, and very easily separated, as in many places about North Head, *e.g.* Clifton Heights. The larger pebbles are often, as may be seen, traversed by ferruginous veins, which, however, may not have been impregnated previously to their being imbedded in the composite mass. The second form of conglomerate is much rarer, is not very ferruginous, and contains larger and well-rounded pebbles of various rocks or minerals. I observed a good instance last year, in company with the Rev. Dr. Woolls, in the gorge of the Grose River, about a mile, as I should guess, from the junction of the Springwood Creek, or two miles below that of the Burralow. It is here intercalated with and passes into the sandstones, and has very much the appearance of a reconstruction of the materials of an older and more massive conglomerate, such as is found at Winburndale, near Kirkconnell. It may, indeed, be supposed that at the point which I have mentioned the coal measures have been cut into and exposed by the river. Perhaps this is the fact, as it certainly is a few miles higher up. I can only say that, with the strongest desire to find indications to that purport, I was at last obliged to acquiesce in their absence. Now, whatever may have been the origin of the first class, or quartzose conglomerates, the second are undoubtedly of aqueous, and in many cases probably of fluviatile origin. But if the first are, as in some localities they may appear to be, of aerial origin, owing their coarseness of grit to the sifting action of the wind, one is puzzled to account for the quartz being able to travel so far to the eastward, under constant attrition by blowing sand during the whole period of that protracted travel, and yet to remain rough and angular, instead of becoming perfectly rounded and polished. It may, indeed, be that origin of these fragments is to be sought much nearer their present abode, in some of the trap dykes which intersect the sandstones. If this be not the case, I cannot but think that their general character is adverse to the pneumatic theory. There is no difference of character that I can see between these two specimens (produced), one of which is from Katoomba, and the other from Clark

Island. If, indeed, any of our conglomerates were composed of concretionary lumps, I might accept Mr. Tenison-Woods' theory so far as they were in question.

Once more, as to the horizontality of the beds. The general slope of the original surface from the base of those eminences, such as Mount King George, Mount Tomah, and Mount Hay, which have been preserved from denudation by their caps of basalt, down to the eastern escarpment, is of course determined for us by the summit levels of the various ridges which remain as watersheds of general drainage. This slope, which is at the rate of 100 feet per mile, presents all the appearances which would lead one to suppose that it was a plane of marine denudation. I am confident that no one contemplating it for the first time could come to any other conclusion. But, as Mr. Tenison-Woods justly urges, marine action is out of court.* The "plane of marine denudation" must therefore have its name erased from the evidence, in spite of its extreme plausibility. And we shall be assured that no mistake has been made in this when we observe that the underlying coal measures slope in precisely the same manner towards the same quarter. Then the question occurs,—Were both formations constructed upon a pre-existing slope, to which their own bedding was accommodated; or has there been a general movement of elevation in the west, and depression in the east? I am certain from examination of the phenomena of the Hawkesbury valley that its bed must at one time—perhaps as far back as the period which we call Cretaceous—have been several hundred feet above the sea, and that within the Tertiary epoch it must have been at least 200 feet higher than at present. These considerations induce me to conclude that there has been a movement, though not perhaps to a very great extent, and certainly not such, either in direction or extent, as to raise any marine formations above the sea, but rather the contrary.

The portions of Mr. Woods' paper which deal with the shape of the sand-grains are exceedingly interesting and important. The recrystallization, or epicrystallization of the quartz had indeed been previously considered by the late Rev. W. B. Clarke; but no one, so far as I am aware, has previously attempted to apply to the Hawkesbury rocks the tests of roundness and angularity, as distinguishing water sands from wind sands. And although metamorphic action has obliterated, as the author laments, the characteristic form on which he relies, there are abundant instances where the grains have remained unaltered, and testify to their having at one time or other suffered attrition, or rather contrition, under long protracted periods of sand-drift. But though their

*I think it does not follow that all operations of water on the great scale are excluded also. There are other water-gods besides Neptune.

sphericity testifies to their having once been blown sands, yet that is a character so hard to destroy in such a material as quartz, excepting by molecular change or metamorphism, that it cannot be relied upon as a proof that all sandstones composed of such globules are of aerial origin. Nay, the same sand-grains may have been rounded and polished in times so remote as to have formed eolian beds as far back at least as the lowest Silurian; for the Potsdam sandstone, which is regarded as homotaxial, if not contemporaneous, with the Lingula beds, is largely composed of such materials, forming, evidently, an aerial deposit. Such rocks may have been—or rather perhaps have generally been—again reduced into their constituent grains, which have again been composed into a later sandstone, either aerial or aqueous, and that either marine or lacustrine. Out of the ruins of this another is built up, and out of this, in course of time, another, while nevertheless, in spite of their vicissitudes of association, the individual grains retain their sphericity, unimpaired from age to age. At the same time, it seems not improbable that the Hawkesbury sands were actually in the wind-blown condition immediately before their consolidation, and until they reached the water in which they were to be arranged; and I am ready to accept, in deference to the authority of Mr. Tenison-Woods, his explanation of certain phenomena in certain localities as a satisfactory account of their causes. It is very possible that, while certain portions of this huge sand-drift were being arranged and consolidated in water, on a large scale, other portions may have been similarly consolidated on land. It is only with reference to the relative importance of the two processes in these rocks that I venture to differ from the author*. No other hypothesis has ever been presented, I feel confident, which so satisfactorily accounts for the collection of the greater part if not all of the Blue Mountain sands, in their north-western range, as this which has now been proposed by Mr. Tenison-Woods. It may seem doubtful, however, whether the southern and coast ranges are of exactly similar origin, on account of the great height of the dividing range to the west of them. But if the basalt of the Crookwell and Grabbengullen ranges be, as it may very well be, of more recent origin than the sandstone, then the sands may have blown up along the present lines of the Lachlan and Abercrombie valleys, at that time probably nothing like so rugged as at present.

If I should venture to propose an hypothesis which should account for the geographical position or local fixture of, at least, the western portion of this great sandstone, I should point to the

*I suppose these sands to have been, in the main, derived from the weathering of the Carboniferous and older sandstones which appear to the westward, though I would not venture to say that a portion of the finer sand may not have been blown from the far interior; but I should think the nearer source the more probable for the formation as a whole.

unbroken line of igneous eruptions which marks the whole course of the dividing range, from the ridge between Cassilis and the Talbragar, itself volcanic, down to the culminating points of the Blue Mountain Range. The summits between the Cudgegong and Turon on one side, the Goulburn and Colo on the other, Mounts Wilson, Tomah, King George, and Hay, which are all understood to be capped with trap, lie nearly in this line, which is then unbroken by visible eruptions along the line of the upper Cox drainage, until similar outbursts again appear on (approximately) the same axis, west and east of the great Wollondilly hollow. Now these visible cappings of volcanic rocks are later than the sandstone, and have therefore had no influence on its deposition; but it is reasonable to suppose that they are only later outbreaks of the same energy which had previously formed a (possibly broken) range, penetrating the carboniferous beds in the position and direction above mentioned, just as the main Liverpool range does, running, as we see, nearly east from Casilis, and therefore almost at right angles to its southern extension towards the west. From the terminal point of this extension we see upon the map a most extraordinary streak of sandstone, forming the Main Dividing Range, but at right angles to the south-western extension of the range. It is like the handle of a frying-pan, when the pan itself represents the Hawkesbury basin, and, until I had the pleasure of hearing Mr. Tenison-Woods' paper, appeared to me quite inexplicable. Now, on the contrary, it appears the most natural thing in the world. Grant that a sand-drift existed from the westward, blowing for ages unchecked along the broad open of the Talbragar, and rising to the crest of the dividing range at this point—itself of then recent origin—then, it would assuredly form on the lee, if not also on the windward side of the elevation such a stripe of sands—ultimately to become sandstones—as we find there. If this volcanic ridge extended along the range to the southward—and what can be more probable?—similar sand-drifts up the valley of the Turon and Macquarie would, in like manner, accumulate about it, to be in time also converted into sandstones, and to be capped in particular points by subsequent eruptions along the same general line. The sands, or sandstones, not protected by this capping, have been subsequently removed, partly, I am ready to believe, by wind, but partly also by the action of water.

In illustration of Mr. Tenison-Woods' argument, I may refer to the wind-drifted sandstones of the Namoi. In the open valley between the Nandewar and Willela ranges, there are no sandstones above the general level, except those of carboniferous date, which have often been hoisted to a great height on masses of erupted felstone, as I should term it; but large hollows in the original valley have been filled by a fine white quicksand, evidently of eolian formation, in which water is abundant, as for example, at Killarney

Station, north of Narrabri. Similar formations, very little above the general surface level, and below the sometimes emerging sandstones and conglomerate of the Upper (?) Coal, are seen along the Bullawa Creek and elsewhere. The only fossils I could obtain in these are obscure remains of vegetable structure, with a few well-marked fragments of cycadaceous plants. Here, I repeat, in the broad open valley which runs without a break up to the head of Breeza Plains, or rather to the Gap, where there is a station on the Narrabri railway line, there are no sand-hills worth mentioning; but to the southward of Boggabri, where the ranges which separate the Terrabeile Creek from the Brigalow form a breakwind, we have a capping of undoubtedly eolian sandstone. This, the Willela range, has a very gradual slope to the west, but ends in a very steep escarpment upon the east, resting there upon beds of shale which are so ferruginous as to deserve the name of iron ore, and which overlie conformably the sandstone and conglomerates which there cover very thinly the actual coal. These rocks are something like some of the upper beds of the Hawkesbury rocks between Blue Mountain line and Mount Victoria; but they are not indurated like the greater part of the formation, and are much shallower. From their position, overlying as they do the Carboniferous beds, they may be really coeval with the Hawkesbury's, and the vegetation is very similar though richer.

At the same time, the general appearance of the stratification and composition of the rocks forming the Willela range is so very different from that of any portion of the Hawkesbury series that, while I admit that its geographical position and evidently eolian character serve to illustrate, and to a certain extent to corroborate the views which Mr. Tenison-Woods has so vigorously maintained, I am nevertheless bound to fix my attention upon the points of dissimilarity rather than on those of resemblance; and to infer that different modes of deposition have been followed in the two cases. If the Willela range is of entirely aerial origin, as seems certain, then it also seems probable that the Blue Mountain beds are not.

I regret that, for reasons already stated, I am obliged to defer the further statement of my own opinion upon this very interesting subject to a future opportunity. Meanwhile I should desire to express, in as emphatic a manner as possible, my sense of the great obligation under which Mr. Tenison-Woods has laid all our geologists, even though his views may not in all respects meet with unqualified approbation or assent. It is a great thing to have made the first sketch: details and corrections will be added from time to time.

Professor Liversidge said:—I am sorry to say I have not prepared any written criticism upon Mr. Tenison-Woods' paper, and that, in consequence, as compared with the previous speakers, I am very much in the position of a guest unprovided with a wedding garment; but I made a few notes at the time Mr. Tenison-Woods was reading his paper, on the copy he kindly placed at my disposal, and I may now, perhaps, be allowed to refer to them. I think I was appealed to by Mr. Tenison-Woods in one or two cases, and perhaps it will be best for me to comment upon those matters in the first instance.

If I recollect aright, Mr. Tenison-Woods appealed to me in reference to the composition of the cementing material of the Hawkesbury sandstones. There is, I think, no doubt that for the most part this material is of a felspathic nature. Even on the most superficial examination the sandstone is at once seen to be made up of more or less rounded grains of sand, upon many of which a crystalline structure has been developed by metamorphic action, cemented together by a felspathic paste; in addition, scales of mica are usually visible, and smaller quantities of less common minerals. This sandstone has been probably derived from the disintegration of a granite or similar rock; the grains of sand represent the quartz, and the felspathic cement the felspar of the orignal rock; the mica scales, being light and more easily decomposed, have for the most part disappeared; some of the rarer minerals present in the sandstone were also derived from the original granitoid rock, but others have doubtless been formed in it subsequently.

Then there was a question as to the presence of hyalite—a hydrated form of silica. I am not quite satisfied that hyalite is present in quantity. The impossibility of obtaining a good section of the sandstone renders it very difficult in some cases to say whether the fragments are particles of crystallized quartz or particles of the non-crystallized hyalite. When you can prepare a good section of a rock for the microscope, the use of polarized light will generally enable you to distinguish between the two, but the sandstone is far too friable to permit of this; accordingly I am not satisfied that "hydrated silica has acted as a cement between the particles," as stated by the author of this paper.

The next question was as to the origin of the masses and layer of ironstone in the Hawkesbury rocks. There can, I think be no doubt that the theory first put forth by Gustav Bischof, and now suggested by Mr. Tenison-Woods as an explanation of the presence of the oxide of iron in these rocks, sufficiently accounts both for the presence of, and for the peculiarities presented by, much of the ironstone, but not for all. Probably some of the larger horizontal bands or layers have been formed much as we see bog iron ore deposits accumulating at the present day. The larger veins have perhaps been formed by infiltration, but the smaller irregular veins, and the nodular concretionary masses, have probably been formed in a somewhat different way. In the first instance, it may be assumed that the oxide of iron was fairly uniformly diffused throughout the rock, but has since gradually segregated together until it has formed a compact mass, vein, or layer. It seems to be an order of nature for certain like particles to collect together. In many cases you will see a nucleus of brown hematite in this sandstone surrounded by concentric bands of a brown colour (also oxide of iron), which get fainter as the distance increases from the central nucleus; and I think that in most cases, certainly, there is no doubt that this oxide of iron was originally uniformly distributed throughout the mass of the rock. The calcareous and other concretions found in clays and shales often afford striking instances of the tendency of certain substances to separate out from the materials through which they are diffused and collect together to form nodules and veins.

I do not agree with Mr. Tenison-Woods that there is no evidence of upheaval; it is true that the beds have not been tilted to any extent, but if the rocks were deposited under water, then there must have been upheaval to account for their present great elevation in many parts. My own idea as to the origin of these Hawkesbury rocks has hitherto been that they had been deposited by water, and had since been elevated or upheaved; but now that I have heard Mr. Woods' paper I candidly confess that I should like to study them afresh, to turn aside all prejudices, and start *de novo.* I regarded them as of fresh-water origin. Of course, if they should prove to be of eolian origin, then there is the same necessity to assume that upheaval has taken place. Mr. Tenison-Woods states that the area occupied by these rocks is far too great for them to be of fresh-water origin; but I do not think that there is very much importance to be attached to this objection, since the area covered by them is not very many times greater than that now occupied by the Caspian Sea, the water of which is almost fresh, or by the Canadian and North American lakes, all of which are forming fresh water or lacustrine deposits of large extent.

It is stated, too, that aerial or wind-blown rocks are characterized by certain peculiarities, and that "they are most of all distinguished by large irregular undulating layers, which are also subdivided by laminæ, with every kind of dip and direction, rarely exceeding 23°. Now I am prepared to maintain that this structure only belongs to eolian rocks, and is never found in any other." I think this statement is open to discussion. The peculiar "herring-bone" lamination is not, I think, confined to eolian sandstones; a similar structure is not at all uncommon in the sandstones of the English Coal Measures and in the Greensand beds of the Cretaceous rocks. Nearly all writers upon geology refer to instances of false bedding of this particular kind in sedimentary rocks, and figures of such structure are given by De la Beche, Lyell, and others.

I agree with Mr. Tenison-Woods that the evidence as to ice action in the Hawkesbury rocks is not at present sufficient to warrant us in attributing the presence of the shale boulders to its agency. It is true that I have not made a special study of glacial deposits, but I have examined many of them of various kinds in the old country, and I have seen nothing here resembling them. The mere presence of angular masses and fragments of shale is in itself not sufficient evidence of either ground ice or other form of glacial action. I think it is probable that by some agency the beds of shale have been undermined, whether by running water or the action of the weather, and that the talus of broken-off angular fragments has become covered up with sand, and since consolidated. The screes or accumulations of rock fragments which form at the base of cliffs, both inland and along the coast, are either ground down into rounded pebbles, giving rise to conglomerates and sands, or they may be covered up without losing their angularity of form, and the latter appears to have been the case in this instance. Subsequent investigation may however bring to light indisputable signs of ice agency.

Mr. Tenison-Woods speaks of the consolidation of the loose sand into a solid rock by the mere dead weight and pressure of the sand above. Now I have no objection to take against this at all, for the effects of thousands of tons of pressure should have a very great deal to do in bringing about the consolidation of a mass of loose and porous sand, but I think that the cementing material has played a much more important part. It has long been a very interesting question to me, but one which I have not yet had an opportunity to tackle, whether there is any appreciable difference between the specific gravity of a rock taken from the surface and of another portion of the same rock taken from a depth, *i.e.*, whether the deep-seated portions of a mass of rock have undergone greater consolidation from pressure than the superficial layers. At first sight the question looks a simple one to settle, but I do not think that it would so prove, for many matters would have to be taken into consideration. I merely throw this out as a suggestion, with the hope that some one may take it up.

In speaking of the Stony Deserts, Mr. Tenison-Woods attributes their formation to the fact that certain portions of the loose sand have been consolidated, and that the lighter uncemented portions were drifted away by the wind, leaving a mass of stones behind; on this layer being again drifted over "we should have a wind-blown sandstone rock at top and a heavy rounded conglomerate at the bottom. It is thus I offer to explain the widespread conglomerates which we find lying on the coal formation, with very little change of character over thousands of square miles." But I do not think this would account for the very heterogeneous character of the pebbles composing these conglomerates; it would not account for the presence of pebbles of jasper, vein quartz, slate, and of numerous other materials such as we find in these conglomerates. If they had been derived in the way suggested, then, I think, they would be almost entirely composed of quartzite, or of ferruginous and sandstone pebbles, *i.e.*, they would practically be composed of the one material; in other words, of sand in a more or less hardened form mixed with ironstone; in fact, they would resemble in composition the masses of consolidated sand found lying on the surface of the ground in Wiltshire, and known locally as *greywethers*, from their fancied resemblance to sheep at a distance; or Sarcen—*i.e.*, Saracen stones—from the old idea that they had been brought over by the Saracens. The huge blocks of stone of which the Druidical temple of Stonehenge is built consist merely of masses of sand converted into quarzite and afterwards set free by the removal of the loose Eocene sand by which they were originally surrounded.

In summing up, Mr. Tenison-Woods states that "the precipitous cliffs of the Blue Mountains are the hard central cores of sand-hills, the loose portions of which have been easily blown or washed away." I think that there are a great many difficulties in the way of this explanation. The Hawkesbury sandstone seems to have been fairly uniformly deposited over its whole area, and I still think that the mountains are mountains, because the matter which once filled up the valleys and connected cliff with cliff has since been scooped out by the action of the weather and running water. But, as I have said before, I wish to again examine these rocks with the new light which Mr. Tenison-Woods has thrown upon the subject of their probable origin.

Before concluding, I should like to state how much gratification I have derived from Mr. Tenison-Woods' paper, and to express how deeply we are all indebted to him for having drawn attention to the subject in such an able way. It is a most valuable and suggestive paper, and I hope it may prove to be the commencement of a new era in geological work in connection with this Society. It is certainly one of the most interesting which has been brought before the Society upon geological matters for a long time, and bears the impress of hard continuous labour and investigation. There is nothing to equal a good, healthy discussion for elucidating questions of this kind.

The Rev. J. E. Tenison-Woods said:—In rising to reply to the objections which have been made to my paper, let me first congratulate the Society on the spirit in which the discussion has been carried on. As I am convinced of the truth of what I hold to be the origin of these rocks, I am sure that a full discussion of the question will serve to elucidate the facts, and render the explanation I have to make more apparent as the correct one. I shall take the objections *seriatim*. First, I do not consider that all those of Mr. Wilkinson touch my argument. He says that "the parallelism of the main lines of stratification is a prevailing feature in the Hawkesbury formation, and this alone is evidence of their having been formed under water." I answer that the parallelism is neither more nor less than is seen in sand-blown formations. The real question is this: Do these sandstones correspond in every particular with exposed sections of aerial sands? This I have answered by showing from many actual instances that they do, and Professor Stephens has supplied other instances, equally convincing. "You cannot but be struck," says Mr. Wilkinson, "with the undulating and hilly character of these blown areas"; and he goes on to prove that nothing of the kind is seen in the Hawkesbury rocks. But I maintain that the undulating character is a conspicuous feature in the formation. Let any one look down into the valley from Piddington's Hill and see whether the whole contour of the ridges and ranges are not strongly suggestive of aerial sandhills. Why, what could be more undulating than the gorges and gullies of the whole mountain system? and though on the whole the greater layers are horizontal, as seen in large masses, they are clearly undulating when examined in detail. In fine, the external contour and the internal stratification is that exactly of all the aerial sandhills I have examined.

I think that I have not been quite understood about the absence of upheaval. I have stated that these beds are found just in the way they have been deposited by the wind, and that they have not been upheaved by the sea. Now, though horizontality may be no argument in small areas, yet when we trace the same thing over an immense territory, and see no tilting or inclination, then the evidence of non-upheaval is strong. In South Australia, for instance, we have the marine Miocene formation, which at about 90 miles from the sea is about 270 feet above the sea-level. Now, a fall of 3 feet in a mile is utterly inappreciable in a section, but can readily be traced over long distances. But here, at less than 50 miles from the sea, can we trace any tilting inclination, though the beds must have been raised at the very least some 4,000 or 5,000 feet? Observe, also, that it is not a question of the Blue Mountains merely. The same formation, or a very similar one, is found scattered over the whole continent. But whether we find it far away to the westward, on the summits of mountains, or on the east side of the divide and close to the sea, it is always the same, with no tilting or inclination, but just as it was deposited in its peculiar undulating layers and laminated false-bedding. When we add to this that the structure is that of wind-blown rocks the argument is very convincing. To say that the whole continent has been uplifted in one mass without any break or tilting is rather an extreme hypothesis. But these beds may have been fresh-water, it is objected. But the fossils are not fresh-water fossils. The ferns are land ferns. *Thinnfeldia* is a land fern, so is *Gleichenia*, and so are all the ferns I have met. The few water ferns that are known in existence are so peculiar that a very little experience would distinguish them. We have none of these in the sandstone. We ought also to have fluviatile shells or other fresh-water remains, but we find none except two species of fish, which are rarely found in what I readily admit may have been lagoons or creeks in this formation. Then again, if it be objected that land plants might easily be drifted down by rivers, I should admit such an explanation if we found them associated with other fluviatile remains, but there are no such things to be found. Again, if the ferns drifted long in the water they would soon rot and be broken up. How different is the state of those beautiful fronds found preserved in the sandstone at Mount Piddington and Dubbo. It seems to me easy to understand it if we attribute their preservation to an advancing drift of sand which covered them over and entombed them just as they grew.

Mr. Wilkinson objects to my interpretation of false-bedding, lamination, &c., because he thinks that the same structure is found in other rocks which are clearly aqueous. Some of the instances which he alleges are not cases in point, because it is not certain that the beds are aqueous. I am inclined to attribute to some of the Victorian sandstones an origin like our own. The use of Mr. Selwyn's name for opinions as to the nature of rocks would have great weight if we knew that the present question was ever fairly put before him. It is a comparatively new one in geology, and therefore the names of Dana, Jukes, and others must require the support of their reasons for any opinion which they give before they can command our assent. At present, I still maintain the proposition that the peculiar character of the stratification in the Hawkesbury rocks can only arise from eolian origin, and I must see strong reasons for abandoning this opinion. Mr. Wilkinson says, "Mr. Tenison-Woods' conclusions Nos. 4 and 5 refer to the origin of the ironstones. I do not consider that the irregular bands mentioned represent old land surfaces, for the bands not only curve in all positions but are sometimes vertical. They may be well seen in the cuttings along the Great Western Railway between Penrith and Lithgow. Most of them have been formed from the oxidation of water containing iron in solution permeating the sandstones and shales and the joints traversing them." In this Mr. Wilkinson overlooks the fact that I admitted the stains and vertical fissures to have been caused by infiltration. But I am sure he forgets how this oxidation is explained by all chemists. His words, "oxidation of water containing iron in solution," are obscure as an explanation. I repeat that water alone will not dissolve peroxide of iron. It must have the aid of decomposing organic matter. The only way in which this can be explained is by the surface vegetation. In this matter the conclusions are not mine, but are received by all chemical geologists, from Bischof to Sterry Hunt. In reply to the objections against one of my explanations for conglomerates, I must repeat that these things are rare in the formation, and the pebbles are of small size for the most part. Mr. Wilkinson says that "it is impossible that the conglomerates in the Hawkesbury series could have been derived in the manner just mentioned. To satisfy this theory the conglomerates must occur at the base." But why? May not a part of a sandhill be blown away by small degrees, leaving all the heavier pebbles behind on the surface as a thick layer to be subsequently covered up by new layers of drift sand?

I thought I should have had the concurrence of my friend, Mr. Wilkinson, with regard to the change of drainage following the outpouring of tertiary volcanic lavas on the summits of the divide. He admits, however, that the old channels were often filled up by these igneous outpourings, and a new system formed. That a higher watershed was formed is not to be denied. That a change of climate was probably the result is not, I think, a far-fetched inference. The whole of the igneous table-lands in New England —sometimes 4,000 feet above the sea—have originated in the period I refer to, and any one must see what an important influence this has had in effecting climatial changes. It is one of the causes which I suggest may have given the desert area of the Blue Mountains a more humid climate, and thus encouraged a vegetation by which the shifting sands were permanently moored. To the rest of Mr. Wilkinson's objections, as they are more matters of opinion than facts in dispute between us, I shall not refer more particularly. The ice theory and the drift theory are now both before the world, with the observations by which they are supported, and they must now rest upon their own merits.

I think on the whole that I must thank Professor Stephens for the support he has given to my views in this matter. On one or two points he has misunderstood me. One is with regard to the "Challenger's" dredgings and the azoic regions of the deep. If I said that these were not destitute of signs of life, I meant life which was doubtless derived from the surface. Thus, in what is called the Globigerina ooze, there were abundant traces of foraminifera. Now, these organisms have existed in all seas from the earliest or nearly the earliest geological periods, and some of the species have come to us from very remote antiquity. They are found in all seas; they are also very easily preserved in rocks. I cannot imagine any marine remains destitute of such organisms, unless they belong to the early paleozoic rocks. There is no question that these are often azoic, as Professor Stephens states, but they are hardly cases in point. Even the Caspian Sea has its peculiar mollusca, and the Dead Sea, which supports but little marine life and no mollusca, has its shores strewn with fresh-water shells brought down by the waters of the Jordan. It is said that there may have been fossils, but they have been carried away by the infiltration of waters. Now, whenever such a thing takes place we have either the casts of the shells remaining empty or filled with other material, or we have a disturbance of the strata by the filling in of the spaces occupied by fossils. The latter case is almost unknown in geology. But would it not be a strange thing to find land plants and other delicate vegetable organisms perfectly preserved, and every other fossil so completely swept away as to leave not a trace behind? I agree with Professor Stephens, that a case may occur in which rounded grains of sand, in certain cases, may be found in a formation of aqueous origin, having been originally derived from the weathering of an aerial rock; yet the case would be an extreme one. Consolidated sandstones hardly ever weather into their original grains, as I have explained in my paper. But the evidence in this case is cumulative; the round grains and a wind-blown structure to the rocks are found together. The connected origin of both is the reasonable explanation.

In the matter of the dip of the laminations, I am not quite sure that I understand Professor Stephens; but if we mutually explained our views I think we should find our observations to agree in most particulars. Practically, the dip is not always at right angles to the strike, that is, when the dip is quaquaversal, as it is very commonly in rounded accumulations of sand. In this case, a section diagonal to the axis will give almost every angle to the laminations. That the variation is due to this in many instances I have no doubt; but I also think that another cause had been in operation, and that is the variation in the strength of the current, aerial or otherwise, by which these sands have been deposited. But the question does not seem to affect my theory to a great extent. What my learned friend says of the quartz pebbles is somewhat new to me, and, as he says, the formation must be rare in the Hawkesbury rocks. It has always been a puzzle to me why the pebbles of quartz are so little abraded. But this would be a greater objection to the aqueous theory; for, be it remembered, though water does not affect the outline of the finest particles of sand by abrasion, it is quite the contrary with large fragments of half an inch and upwards; these rapidly assume a rounded outline in running water. I have related Daubrée's experiments on this subject. There is another test in this matter which is familiar to everyone, and that is the generally ovoid shape of water-worn stones. We need not be surprised at the angular character of pebbles (especially of the harder felspars or quartz), even though the surface has been polished by the action of blown sand. Through the kindness of Professor Stephens, I am enabled to place before the members of the Society to-night some specimens of granite and felspar from the first cataract of the Nile. These are continually exposed to the action of blown sand from the desert, and the members can judge of the effect of this from actual inspection. It can be seen that the constant impact of blown sand has given the stone a most brilliant polish, but at the same time not a single angle has been worn away. If the pebbles found in the Hawkesbury rocks do not bear a more evident polish, the cause must be looked for in their long entombment. But the facts remain that the surfaces of the pebbles are generally abraded, not rounded as they would be were the action that of running water. The exceptions may well be due to creeks, as they are so uncommon.

With regard to Professor Liversidge's remarks, I have first to thank him for the information he has afforded us on those matters about which I especially appealed to him. I have not expressed myself decidedly about the hyalite, though I threw it out as a suggestion that polarized light gives a good test for its detection. But we must not expect very great results from this method, because if the original grains were derived from granite, some of the quartz from that rock presents under the Nichol prisms the play of colours observed in colloid silica. In the beginning of my microscopic work in this matter, I was inclined to think the polarized light and the selenite plate would give me definite results; but when I varied the experiments, using rock crystal artificially pulverized, and various kinds of felspar, with true hyalite, the results were conflicting. I am going to try again at getting thin sections of the rock, and then I am in hopes that the grains in the cementing medium may be better seen. My friend, Mr. Wilkinson, does not believe that the grains of sand will afford any clue; yet I may state a fact which will be significant in the matter. Since my paper was read, Professor Liversidge wished to bring my theory to the test by the microscopic examination of sands. With this view he asked my opinion on about a dozen slides of dry sand, the origin or locality of which was entirely unknown to me. In every instance, except one, I was able to state, after a short examination, whether the sands were river, desert, or aerial sands.

I think that in the matter of conglomerates I went out of my way to explain a feature which, whether explained or not, does not affect my theory. Still, I differ from Professor Liversidge as to what concretions may do in forming pebbles in such a formation as this. It must be remembered that we have here silica, alumina, both oxides of iron, with smaller quantities of magnesia, potash, soda, and occasionally sulphur and manganese. The colours and forms of silicate of alumina and iron alone are endless, and those when worn down into pebbles would give almost every colour and appearance. Besides, before these beds were finally consolidated, the trap rocks began to have their influence. We must not forget how rapidly sandhills are cut down and form again by the wind. Thus a conglomerate in the middle of a sandstone may belong to a late portion of its history, and its pebbles belong to a trap rock now separated from it by many feet of sandstone. However, as Professor Liversidge says that he prefers to approach the subject cautiously and will carefully weigh my observations in a review of the formation, I can leave the facts to the painstaking and impartial examination which I know he and others will give them. To him and to Professor Stephens and Mr. Wilkinson my best thanks are due. What has been so kindly said as to the value of this paper I have heard with gratification, for the sake of this Society. The subject has been a labour of love to me, but if it has also been useful to the Society I am more than amply repaid.

Mr. Wilkinson exhibited a large number of maps, diagrams, and specimens in illustration of his views. Professor Liversidge showed a series of slides of eolian and water-formed sands and sandstones.

The President conveyed the thanks of the Society to the Rev. J. E. Tenison-Woods for his valuable paper.

Tropical Rains.

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

[*Read before the Royal Society of N.S.W., 14 June, 1882.*]

For some years past I have been collecting all the available rain records for this Colony, not only for their value as statistics, though that is very great, but also as data for studying the causes and limits of our rains, in the hope that by so doing some light might be thrown upon questions of great practical and scientific importance.

At the present time rain observations are sent to me by about 270 observers. Of these by far the greater number are private observers, that is, gentlemen who keep the rain-gauge for their own information, but are willing to give me a copy of their rain measures. The majority live in places where there are no official observers, and it is obvious therefore that but for their assistance it would be quite impossible to make the records as complete as they are, or to hope for any success in investigating the difficult question of rainfall, &c. There are, however, still many large areas in the Colony from which I get no observations, and some from which the rain is sent without any notes as to the direction of the wind when it rained, or to the character of the storm; and when I come, as in the present instance, to make use of the observations in tracing the rain-storms, the want of this information is a great drawback. Already the observers are numerous enough to show us roughly the limits of droughts, and that we must not assume that because serious drought affects one district, that therefore the whole Colony is suffering, and the freedom with which "drought in New South Wales" is spoken of must be somewhat curtailed by the addition of the name of the district affected, for it would appear that the Colony as a whole seldom suffers from want of rain. The published rain measures show us that particular districts may suffer for many months for want of rain, and that others may have an undue share. They show us that others are always dry, from local circumstances, others again always wet, for the same reason, and we naturally ask why these things are so. Past labours have answered in part only; but we hope that the widespread interest in the subject will make the observers so numerous as to collect the rain and collateral information for every part of the Colony, and ultimately for every part of Australia. So far as we have gone, the main features of the meteorology of our continent island are very simple, if we are to judge of the part unknown by that which has been investigated; but, with the exception of the observers on the overland telegraph line, more than half of Australia is meteorologically unknown, and it is just that part within the tropics where we may reasonably look for valuable information of approaching seasons. The trade winds and the monsoon come round with wonderful regularity; and as each change appears, it is stamped with characteristics which, if properly read, would give us many a valuable hint of coming weather. It will take Queensland and South Australia some time to cover their northern areas with observers, unless the private observers there will come to the rescue, as they are doing in New South Wales; where in tracing the characteristics of a heavy rainfall, I am able to give the observations of thirty persons in a district from which a few years since I only got those of one observer.

In February this year a remarkable rainfall took place, and the attempt to trace the causes in operation at the time has opened up some very interesting subjects of inquiry, which would take a longer time to investigate than I can at present command, so that I have been obliged to hurry the preparation of this paper in order to bring it before the Society this month, leaving several matters for a more convenient season. The heavy rain referred to began on February 4 (*see* map),* but the storm of which it formed the culmination began in the north-west some days before that. The observations taken at Bourke show that the winds had been from S.E., and variable for some weeks before, being in fact part of the S.E. trade wind; the temperature had been high, 100° to 110° in the shade, and the barometer began to fall slowly on the 24th; the total fall to the 30th, when it began to rise, was only 0·20 inch. At 7 a.m. on the 29th, this weather was interrupted by a strong breeze from the N.E., and during the day heavy, stormy-looking clouds came drifting over from N.W., and at night there were several thunder-storms. On the 30th the wind was from N. to N.W. all day, after which the easterly wind returned and blew strong for some time. For several days the weather was showery, and the heavy rain began at noon on 5th. It appears, from the valuable observations of wind and clouds taken at Yallaroi Station, that for several weeks they had a steady N.E. wind; but on February 1st heavy clouds began to pass over from N.W., and on the following days the clouds continued passing, only their velocity seemed to increase as the N.E.

* It will be observed that the scale used for the rain spots in these maps differs from that in the annual maps. The change was necessary in order to show such small quantities of rain as had to be represented at some places.

wind, which was still blowing, gained strength; and it is recorded that on the evening of the 6th, scud began to come in with the N.E. wind; and at 8.30 a.m. of the 7th it began to rain. It is therefore evident that the N.W. monsoon, which attains its greatest force about the beginning of February, was forcing its way right across the continent to New South Wales, and in contact with the easterly trade gave rise to thunder-storms and rain; these two winds charged with moisture had brought into the district abundant rain ready to fall the moment there was a sufficient cause. At Thargomindah, a station 200 miles N.W. from Bourke, the heavy rain began on February 4, and over 5 in. fell; at Caiwarro, 60 miles nearer to Bourke, 9 in. fell. The consequence of such a heavy fall in a flat country was a heavy flood that covered everything but a few slight elevations. Two thousand sheep were drowned before they could be driven to a place of safety, three men had to remain all day up a tree in sight of the town, and the mailmen were three days and nights without food; in short the flood was high enough to prove how general the heavy rain had been. At Bourke, as I have said, the heavy rain began at noon on the 5th; at Baradine, 190 miles E.S.E. from Bourke, it began at 6 a.m. on the 6th; and at Eversleigh, near Armidale, another 150 miles, it began at 4 p.m. So that the rain advanced at the rate of 12 miles per hour throughout the 340 miles, and this, be it remembered, against a steady opposing wind. You will see on reference to the map that the line of progress was S.E. from Thargomindah to Bourke, then it appears to have been checked until it got to the valley of the Macquarie, when it resumed the S.E. direction to Coonamble, and thence turned to E.N.E. We want more observations to follow it in detail, but some things are very remarkable. At Kallara, a N.W. surveyed line forms the boundary between that station and Dunlop, and this formed the limit of the rain, and this well-defined margin was traced in the same direction for some 20 miles beyond the Paroo—in all about 100 miles. Yet the direction of this margin is abruptly changed at the river Darling, as if the river formed a barrier, and it then followed the river round till the Macquarie seems to have helped it on in its S.E. course until, on reaching Terembone, 11 inches fell, and the direction changed again. It will be seen on reference to the map that the heavy rain did not follow the rivers beyond Terembone, but from that point travelled eastward, or rather E.N.E., and was not so heavy at any other station. Looking at the stations which had heavy rain, they seem to be arranged in a great curve, as if it were part of a great passing storm; but there is no barometric evidence of such a storm, and the steady N.E. winds for so many days is proof that the winds were not of cyclonic character, but formed part of the S.E. trade current then blowing over the greater portion of the northern part of Australia. For reasons already given, we are unable to trace in the tropics the weather which preceded this rain-storm, except along the telegraph overland line, where there was no depression. On the east coast of Queensland, however, we find the barometers steadily falling at the end of January, and the lowest reading was 29·64, at Townsville on February 3, and this was followed by a heavy S.E. gale on the coast near Cooktown; but it did not extend to Brisbane, which proves that the storm was small, and if the centre did pass north of Bourke its effect could not extend into this Colony. But we have already seen that the slight fall in the barometer at Bourke, which may have been connected with a storm centre passing a long way north of that town, reached its minimum on January 30, four days before the minimum at Townsville; and yet the two places only differ in longitude by about 60 miles, which, at the rate the storm was progressing, would only occupy five hours, so that the depression at Bourke seems to have had no connection with that at Townsville. I once before traced a storm across the northern parts of Australia, and found that it travelled at the rate of 8 miles per hour. So that it would appear that the easterly drift of the atmosphere in the northern parts of Australia is at the same rate as it is in the south, where abundant observations show that the rate is from 8 to 12 miles per hour. This drift has an important bearing upon our subject; for if a heavy storm started a downpour of rain, an uprush of the air at that point would result, and the incoming winds would go on depositing rain at the point of disturbance. But as the whole atmosphere is drifting eastward, this point would travel with it, and the deposit of rain go on until all had fallen. Now, looking at the map, it would seem that this heavy rain in February last began in Queensland, N. W. of Bourke, and continued for several days, and that meantime this point of disturbance travelled to Coonamble, where the very heavy rain ceased, and the clouds drifting eastwards deposited very light rains. This would account for the very heavy rains in the line I have mentioned, and the light ones outside that line. And from the facts I have already stated, it is obvious that a strong N.W. monsoon had reached to Bourke and Yallaroi, and that this was opposed by the incoming trade wind, hence thunder-storms and rain; coincident with this, the temperature fell 36 degrees. Great part of this was due, no doubt, to outside causes (cosmical), which give rise to a sudden fall in the temperature every February, and this coming upon the already supersaturated air at and north-west of Bourke, a sudden and violent rainfall resulted; and it would appear, from the direction in which the rain moved forward, that the north-west wind, though above and out of sight, had considerable weight in directing the motion of the storm; in fact, just as the dust-storms move along with the upper current, so this rain-storm moved on with the north-west wind. For the purpose of tracing these February rains, which seem to fall in some part of the Colony every year, I have had those of the last five years plotted on maps, so that a glance shows the limit of the rain—in fact, its character; and for the purpose of contrast we will take next that of February, 1878 (*see* map). Here it appears that from Sydney southwards, along the coast, rain was so heavy that the black spots almost cover the map, but the excessive fall did not cross the mountains; heavy rains fell at Deniliquin and thence as far as Hay, also along the main passage north of Sydney, also at Mudgee and Dubbo and part of Liverpool Plains, but in the valley of the Hunter there was very little, and all the north-west of the Colony, especially where the rain was so heavy this year, none at all fell. You will see on the map that the winds were from E. to N.E., while in 1882 they were principally S.E. This year the rain began on February 3rd in Victoria, and on the 4th there were thunder-storms and rain; it then extended northwards, reaching Sydney on the 5th, and Brisbane on the 6th. From Mr. Todd's record of the weather in the tropics, it does not appear that the N.W. monsoon was strong at this time, as one might have inferred from the rain being a coast rain—that is, driven back by the N.W. wind; for the E. and S.E. winds were blowing over New South Wales, and thence to latitude 15° on the overland telegraph line. It appears from the weather map that a storm centre passed along the south coast just before this rain began, and probably the change of wind to S. started the rainfall, which extended northwards. For 1879 there are two falls—one from 1st to 4th, which was not very heavy and almost confined to the line indicated by Port Macquarie, Armidale, and Warialda, the winds being S.E. The second shows the rainfall from 11th to 19th of the same month, which was heavy only on the coast south of Sydney, and in the district 100 miles west of Dubbo, the rains in the Bourke district being very light, and in the Liverpool Plains nothing. This time the winds were from S.E. to S. It is worth noting that on the coast the humidity had been gradually increasing from the 2nd to the 16th, and that the fall of temperature was not so marked as usual, and instead of appearing between the 5th and 12th, as it generally does, it did not come until the 15th. We come next to 1880, and you will see that very little rain fell on the coast, and that it was abundant at and about Bourke, and in the district 100 miles west of Dubbo, and in part of the Albert district west of the Darling, the wind being S.E. to E. The map for February, 1881, shows that the rainfall, 2nd to 9th, was more general than for any other year of the five; but it was only at Mount Victoria, Kurrajong, and the valley of the Hunter, that it was heavy; you will observe that the direction of the wind was N.W., W., to S.W., totally different from either of the other years, and there was evidently not sufficient moisture present in the westerly wind to produce such a heavy downpour as we have recorded in other years. The fall in the temperature came as usual, and reached its lowest point on the 6th; at Sydney the fall was 15 degrees from the 2nd to the 6th, but it was insufficient to produce heavy rains. I have not yet had time to have these facts worked out for other years and periods in the year, excepting one fall in September, 1878, which coming as it did in spring, and with a N.W. wind, is interesting, as it is an instance of a fall coincident in time with the change of the monsoon, and seems to have been similar in character to the rains which fall in the tropics about that time of year. I was induced to take up the investigation of this question by the striking peculiarities of the rainfall of February this year. It seemed probable that such peculiarities would afford direct evidence of their cause; but I have not found it so, and the more I have extended the investigation, the more difficult it seems to trace the direct influence of the N.W. monsoon. Yet the rain falls every year just at the time when the wind is blowing with "full heart," and carrying fertilizing showers far down into Australia. We have seen that the N.W. wind was blowing over the N.E. in this instance; but the easterly wind is the cooler, and it is therefore improbable that it would mix with a warmer wind above it, certainly not to the extent required to produce these heavy rains; neither would its temperature be very much lower than the N.W. wind, yet we see that during the storm the temperature fell over 30°. Unfortunately I have not yet received the South Australian meteorological reports for February, 1882, so that I cannot compare the weather on the overland telegraph line with that in our northern districts; but in instances taken in other years for which I have the information, it does not appear that there is any direct connection as of cause and effect, but rather that the weather is changed from fine to rain at the two places, which are separated by some 1,500 miles, at the same date, as if affected by a common cause; and in other cases the S. E. or easterly winds blow right over Australia, and extend northwards to 15° of latitude, and still the February rains come in our Colony. Again, the rain of February, 1882, began in the west two or three days before it reached the coast—in fact, a steady easterly progress of 12 miles an hour was distinctly traceable, which is about the rate at which storm disturbances travel to the eastward; while in February, 1878, it began in Victoria on February 2nd, reached Eden on the 4th, Sydney on the 5th, and Brisbane on the 7th, clearly showing that it travelled up the coast and was a coast rain; little or none falling on the Darling or western districts; while in 1879 the rain began at Rockhampton on February 6th, was at Grafton on the 7th and Sydney on the 8th, and in this instance also was quite a coast rain.

In February, 1880, the rain again began on the coast about Clarence River on January 29th, with S.E. winds, and fell here and there about the Colony with winds south to east, until February 8th, when the wind got to N.E., and it began to rain heavily at Bourke. It is evident therefore that although the rain always comes about the beginning of February, at the time when, as we have seen, the monsoon is at its height, yet there is no obvious connection ; and it is reasonable to ask if there is any other cause which becomes effective when the earth reaches this particular part of its orbit ; and we find that there is, in the sudden fall in the temperature which is known to take place, at that period—a fall which is obviously due to some cause external to the earth, because it affects both hemispheres. In the north the time is so well known that we have ice saints for these days of freezing cold.

M. Saint Claire Deville, in searching meteorological records for evidence of this fact, found it in all, even in the most ancient meteorological documents—for instance, in the observations of the pupils of Galileo. These observations extend from 1655 to 1670, and show that the minimum was reached on February 12, and I have before pointed out that the same remarkable phenomenon is observable in Australian registers. And in searching for a cause, several Continental astronomers have not hesitated to say that there is little doubt that it is the intervention between the sun and the earth of great numbers of meteors; and the celebrated M. Erman pointed out that if the well-known meteor stream through which the earth passes in August is really a flat ring of meteors—as it probably is—revolving round the sun, then it would cross the ecliptic in such a position that part of it would be interposed between the sun and the earth from the 5th to the 11th of February, and so partially eclipse the sun, cutting off from the earth his light and heat ; and M. Erman considered himself justified by his investigations into meteorological records in saying that it did so. I have been for some years convinced that this is the only satisfactory explanation of the fall of temperature in February, and that there is sufficient evidence to prove that we must take the intervention of meteors between the earth and the sun as the cause of many of the remarkable variations in the temperature, which are so unaccountable if we ignore the effects which may be produced in this way. Astronomy has satisfactorily proved that there are meteors enough in the solar system to produce the remarkable corona which, in total eclipses, is seen about the sun ; and we all know that this coronal light is never concentric with the sun, and that it generally runs out in particular directions, and is never seen twice in the same form. Almost every drawing or photograph taken in eclipses proves that it is much brighter in some parts than in others—that is, that the matter which reflects the sunlight is not uniformly dense, and stops and reflects more of the sunlight proceeding in certain directions than in others; and any planet placed, so to speak, behind the extension of the corona, would suffer loss of light. If this coronal point be, as it sometimes is, of enormous extent, there must be a corresponding loss of light and heat, and to such variations of sunlight the earth is, beyond question, subjected. There are hundreds of meteor streams cut by the earth's orbit, which, as they all pass round the sun, must be concentrated, and hence it is more than probable that when we look at an eclipse, there is just as great an extension of the corona towards the earth, where we cannot see it, as we see to right and left of our line of sight. Unfortunately, suitable eclipses come so seldom that the recurring forms of corona which the fall of temperature in February, May, and at other dates, seems to indicate, cannot be seen; but we know that the meteor streams have definite orbits about the sun, and therefore would place each year about the same quantity of meteoric matter between the sun and the earth at a particular date. And it must not be too readily assumed that the effect of it is insignificant. Dull brown or black bodies such as meteors are receive far more light than they reflect, and yet at solar eclipses photographs of the light they do reflect can be taken in a very short time. At the solar eclipse of 1878 many photographs of the corona were taken by American observers. The plates were exposed for various intervals up to 60 seconds, and the shortest exposure was three seconds; even this was too long for some parts of it, and detail was lost in consequence. Probably one second would have been enough: and a photograph of the sun direct would take one-thousandth part of a second, so that even the light reflected by the meteors is considerable, although it must, for reasons given above, be but a small part of that intercepted by them. And it is reasonable to assume that the intervention of meteors under ordinary circumstances may perceptibly affect the sun's heat, and give rise to the sudden falls in February and May, to which reference has been made. The Director of the Naval Observatory at Washington has very kindly sent to me a photograph copy of their eclipse plate, No. 16 (1878), which shows the corona very satisfactorily. I may mention that this one (*exhibited*) was exposed 60 seconds, and that they found that the longer the exposure the more they got of the outer limits of the corona, but they lost detail nearer the sun, so they have made a drawing, taking from each plate the part that was best defined.

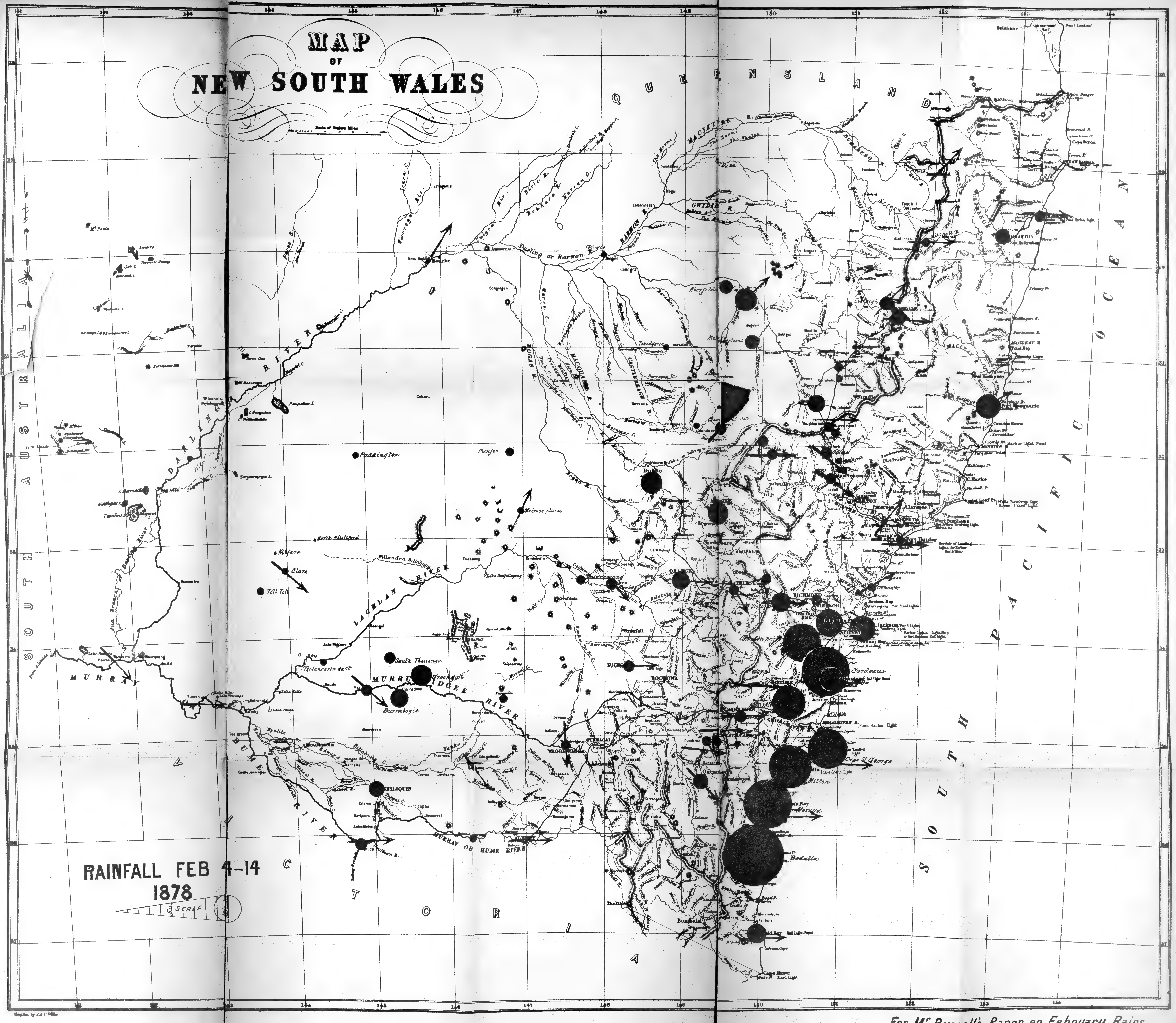
Discussion.

The Hon. G. H. Cox said that he had kept a careful register of the rainfall in his own district for the past eighteen years. With regard to the rainfall in February last, he was staying on the Blue Mountains at the time, and he saw by telegrams that there had been a considerable fall of rain in the northern part of Queensland; in fact that there had been a very heavy downpour, the water coming down in sheets. By the use of the telegraphic wires he traced its course to the south-east until it reached the mountains, when a cold wind sprang up from the south-east and all the clouds were blown away. But for this unfortunate wind we would have had a fair share of rain, and the Colony would thus have been saved from the disastrous consequences which had followed, in the death, he might say, of millions of stock. The bank of clouds extended at first in a direct line from Bourke to Coonamble, but gradually decreased as it got nearer to the mountains. He referred to the heavy rain which fell at the breaking up of the long drought in 1878, and which came from the south-west, he thought, and came to the conclusion that the rain depended upon the wind. As the wind prevailed, so the rain prevailed; if the wind changed suddenly, so the rain disappeared. If we only knew how we could control the winds we would be able to control the clouds; but whether the winds were controlled by heavenly bodies or not, he thought none of them were able to say. All his observations had tended to the conclusion that the rainfall altogether depended upon the course of the wind.

Mr. C. Moore said that in 1860 he was staying at Mr. Thompson's station on the Shoalhaven River, when rain began to fall at 4 o'clock in the afternoon, and before 3 o'clock next morning the river had risen upwards of 100 feet, but the cause of it was that there was a very high embankment, and the river rushing up against this embankment threw the water back. He afterwards visited a station about 60 miles further south and ascertained that there had been almost as great a rainfall there on the Saturday as had fallen in the district around Mr. Thompson's station on the Thursday. That was the greatest rainfall he had ever experienced during his pretty long career in this Colony.

Mr. Russell said he had not been able to finish all he wanted to say in regard to this rainfall. The fact was that he had to prepare the paper in a few days, whilst he was very busy with other matters. It was not very easy to get all the information that one wanted. As he had mentioned, he got a great many records, but many of them were, comparatively speaking, incomplete. He would like to call their attention to this fact—that whenever a tropical rainfall had been general, it did not appear that it was due to the south-east wind. The investigations of several leading astronomers into remarkable falls in the temperature had led them to the conclusion that they must be accounted for by other than terrestrial causes. The sun's heat was undoubtedly the cause of the winds, and to the variation in the sun's heat it would be most reasonable to look for unusual variations in the wind. There were four well-marked instances of fall in the temperature every year, which were probably caused by the intervention of meteors. There were many instances on record where the sun had been so affected from some cause or other that the character of the season had altogether changed; and one year when the ordinary fruits never ripened. Now there must be some outside cause, something that comes in between the sun and the earth which stops the heat from reaching the earth's surface, for it was impossible to suppose that the temperature of such an enormous body as the sun could change. Whatever was the solution of the matter, it was clear that we had a great deal to learn in reference to it.

Six maps.]



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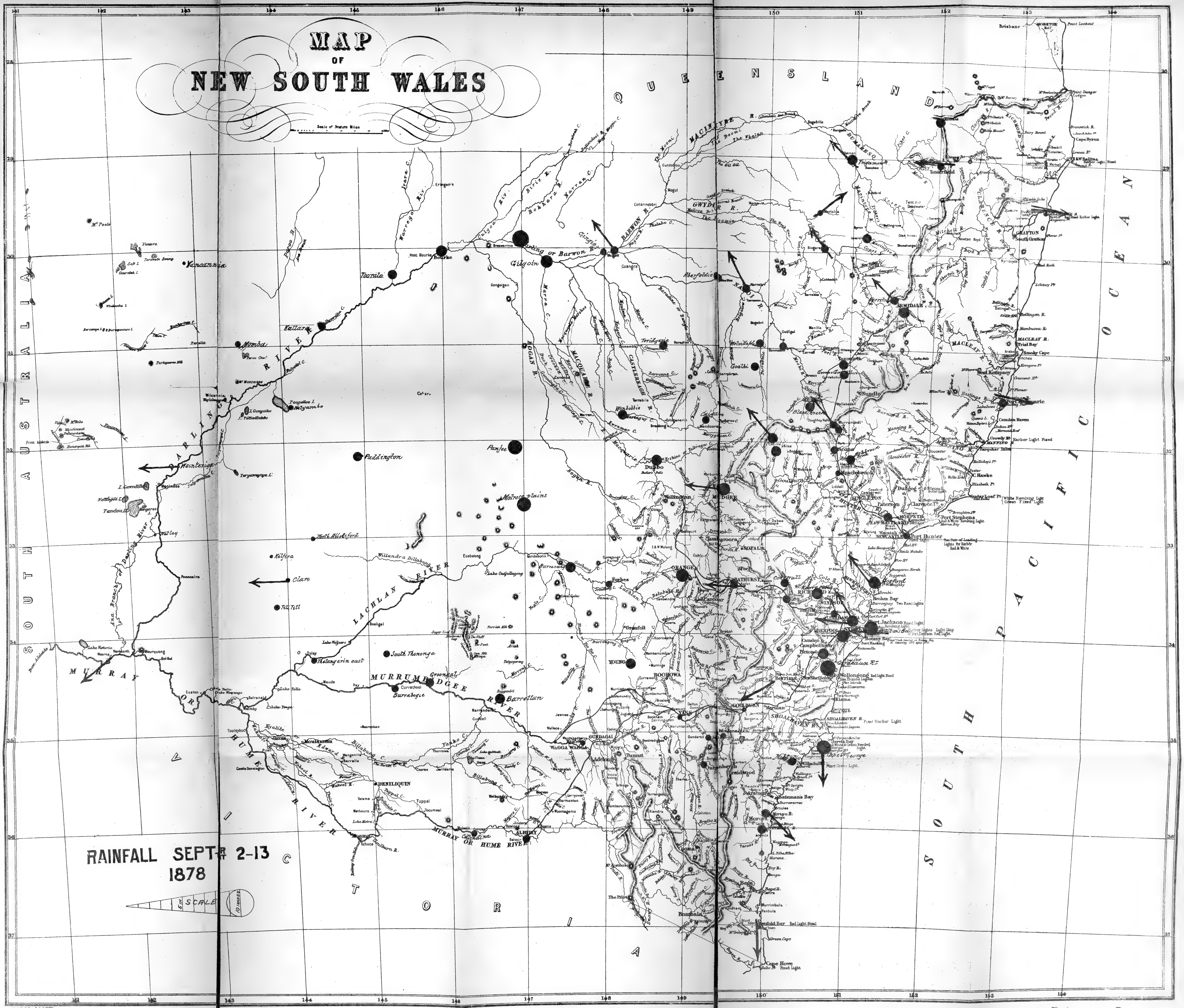
For Mr Russell's Paper on February Rains



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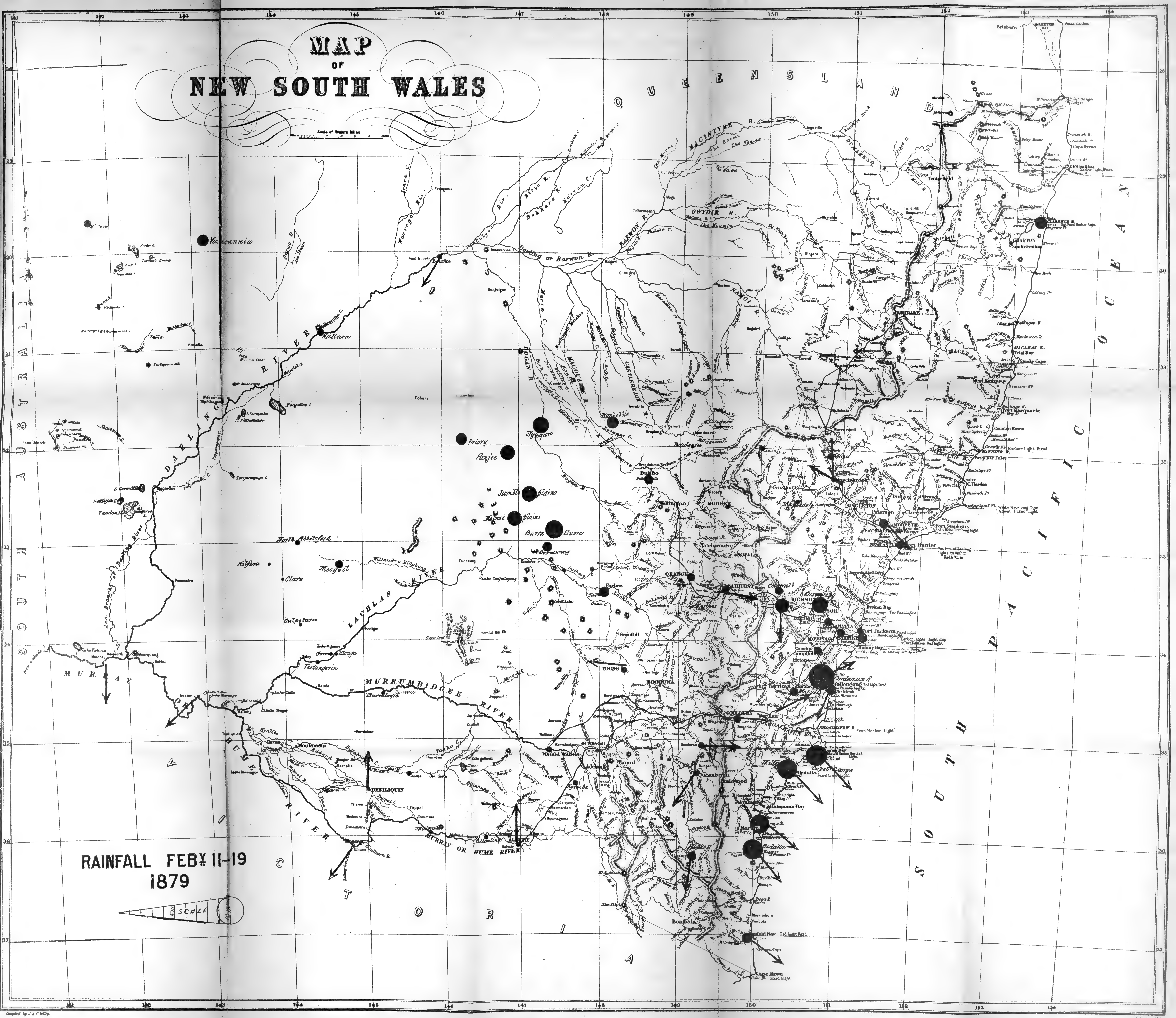

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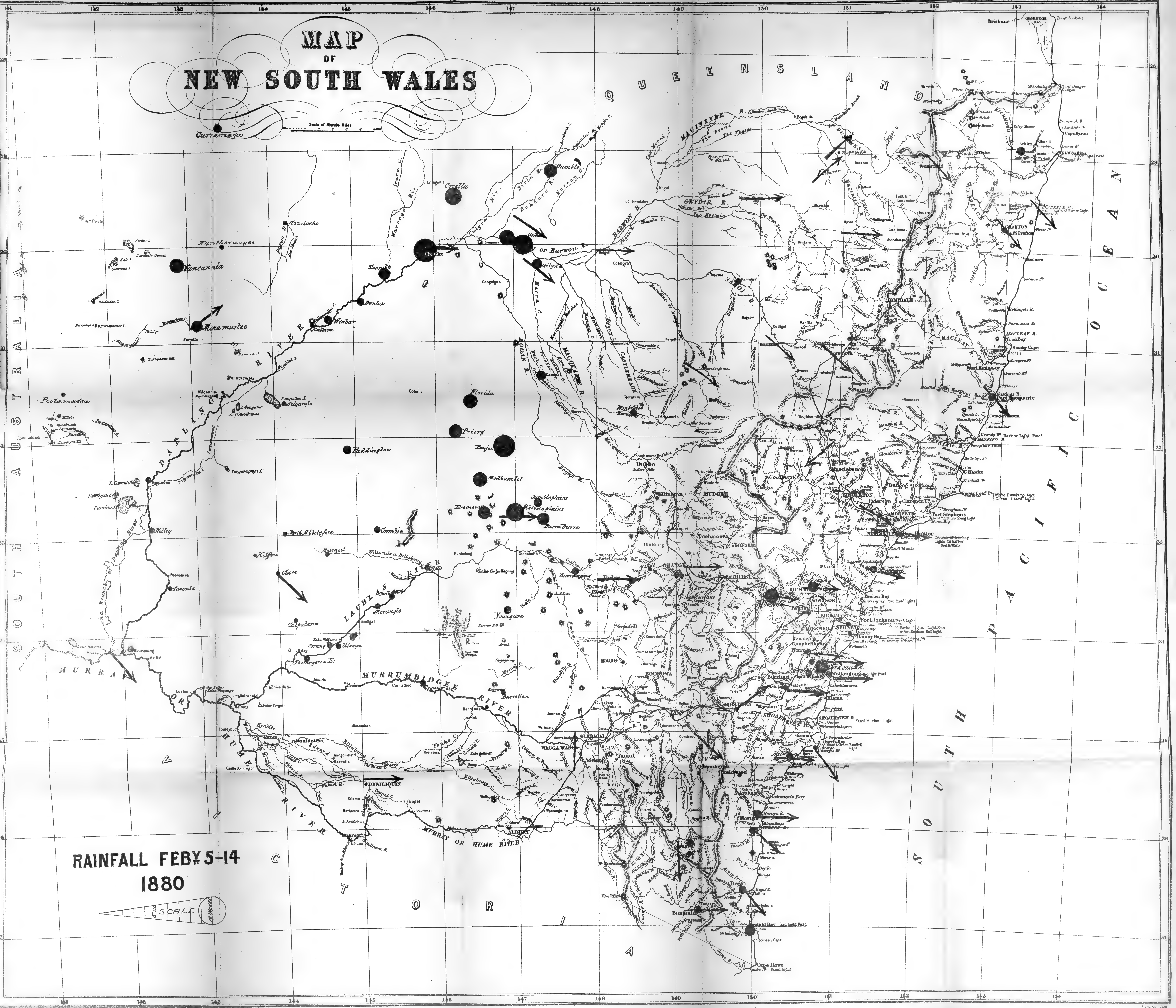

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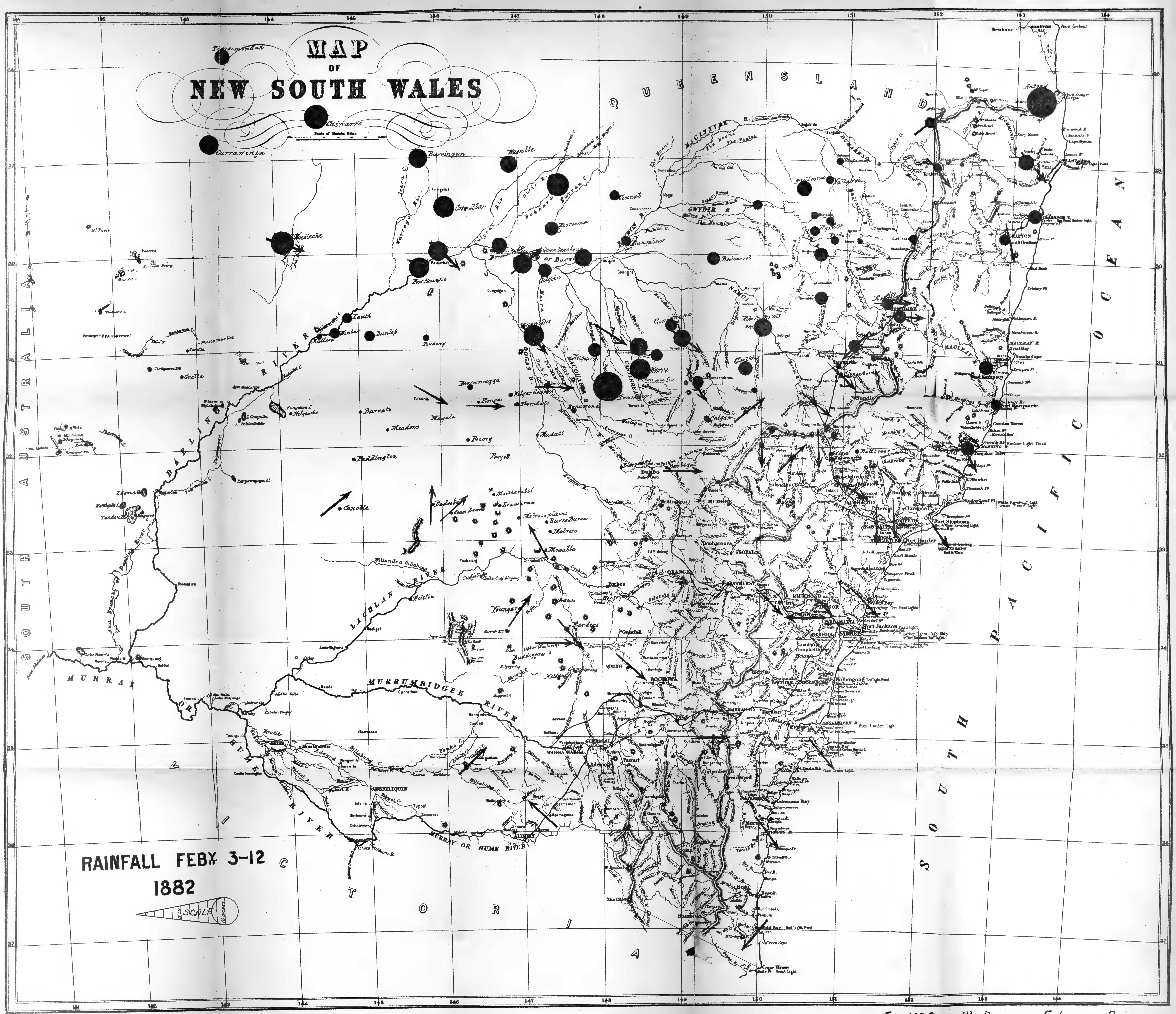

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For Mr Russell's Paper on February Rains

New Method of determining true North or South.

By J. S. Chard, District Surveyor.

[*Read before the Royal Society of N.S.W., 2 August, 1882.*]

This method is specially suited to this Colony and other places where surveying operations are extensively carried on, inasmuch as the true north or south is obtained very quickly and without calculation.

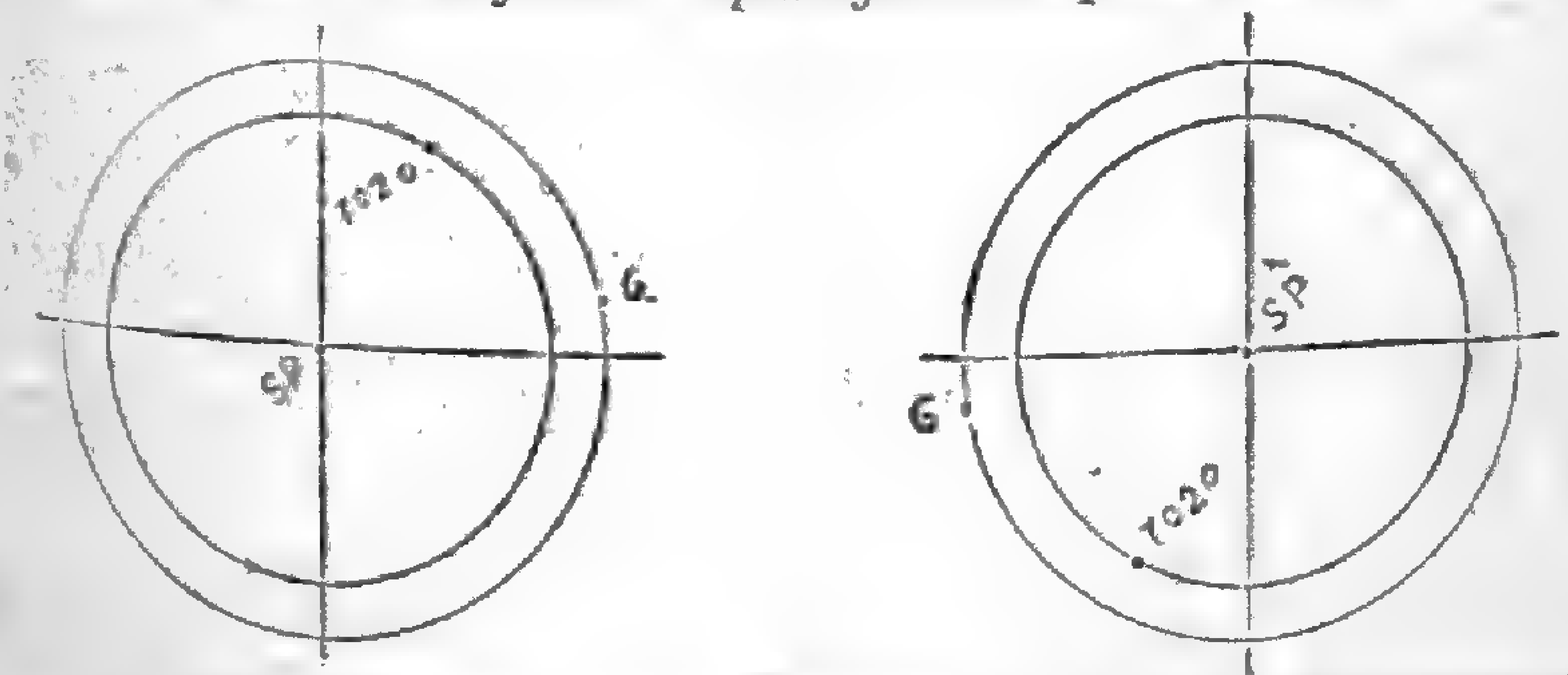
One of the chief features is the employment of a specially designed plane glass diaphragm within the telescope of a theodolite, instead of the ordinary spider-web.

There are drawn on the glass diaphragm a horizontal line, a vertical line, and with their intersection as a centre two circles. For the southern hemisphere the radius of the outer circle corresponds in angle with the south polar distance of σ Octantis, and the radius of the inner circle corresponds in angle with the S.P.D. of Octantis, B.A.C., 7020.

Owing to the difference in right ascension between these stars, viz., 2 hours 49 minutes approximately, when the outer circle is placed on σ Octantis and the inner one on Oct. B.A.C., 7020, care being taken to see that σ Oct. precedes the other in its path round the pole, the intersection of the vertical and horizontal lines points exactly to the south pole.

By taking an angle between this point and any terrestrial object as a referring mark, the true bearing of the latter is determined. When the intersection of the lines is pointing to the south pole, the reading of the altitude circle, minus refraction, gives at once the latitude.

Sketch of the Lines of the Diaphragm when placed on the Stars.



Actual position. Corresponding view through inverting telescope.

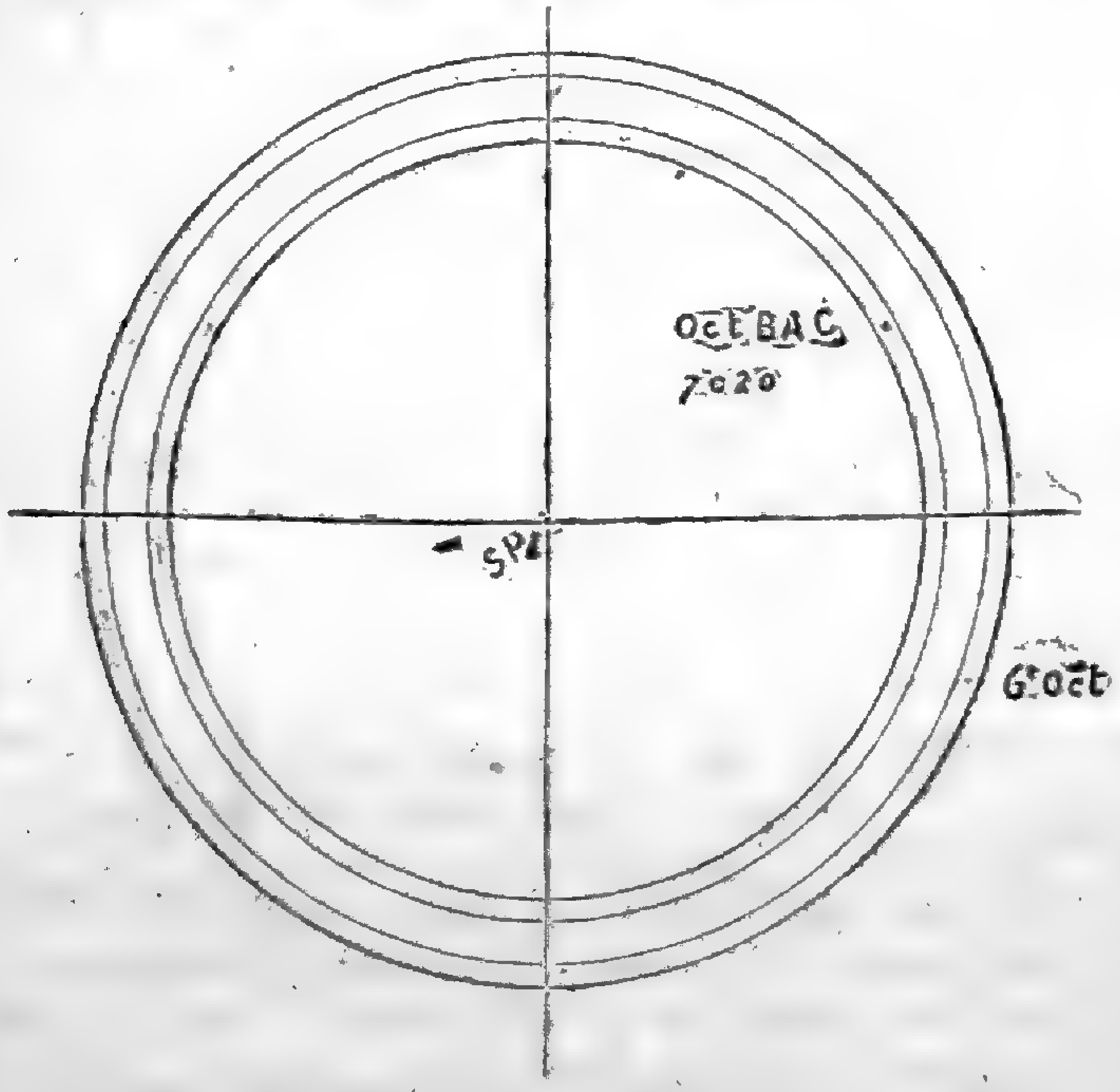
(σ Octantis in its path revolves round the outer circle, and Oct. B.A.C. 7020 round the inner.)

It will be seen that, irrespective of the hour angle, the intersection of the vertical and horizontal lines still points to the south pole.

The above is the principle of the method. I will now proceed to give more detailed information concerning the dimensions and construction of the telescope, and the exact design of the diaphragm, to ensure greater precision.

The telescope ordered for testing the method was constructed by Messrs. T. Cooke & Sons, York. It has a focal length of about 17 inches and object-glass $1\frac{3}{4}$-inch in diameter; it is fitted with a 5-inch vertical circle reading to 30″, and the pivots and clamp fit the ordinary 5-inch theodolite I have in use. Its weight is about 4 lbs., and it is placed in a separate box, as it need only be used for the purpose of determining true south. The extra focal length renders it necessary that the circles on the glass diaphragm be made larger, and consequently with greater precision, the angle in the field of view subtended by the circles being dependent on the radii and focal length. The size of the object-glass, $1\frac{3}{4}$-inch, was thought requisite to see the two stars, which are respectively 5·5 and 6·2 magnitude, when a full moon was shining and when the wires were illuminated. The pivots are of course pierced for illumination. The stars can be seen distinctly in the telescope under the above conditions, notwithstanding a slight loss of light caused by the addition of the glass diaphragm, but the outer circle is somewhat too close to the edge of the field of view, and I intend to remedy this defect by having the focal length slightly decreased.

Owing to the annual change and changes for time of the year of the south polar distances of σ Octantis and Oct. B.A.C., 7020, instead of one outer and one inner circle, two circles close together have been substituted for the outer circle, and two circles close together substituted for the inner. Convenient radii for the outer circles for the years 1883 to 1891 are 44′ 20″ and 43′ 20″; for the inner circles for the same years, 38′ and 37′.



Example.—On the 1st January, 1883, S.P.P. of σ Oct. is approximately 43′ 45″; S.P.D. of Oct. B.A.C. 7020 approximately 36′ 26″. In taking observations about this date, instead of placing the circles on the stars, the stars are made to appear between the circles by estimation according as the S.P.D. at the time lies between the angular radii of the circle. (See *Sketch.*)

It is usual to place an additional diaphragm in the telescope box, and such one is calculated for the years 1891 to 1897, the circles having radii 44′ 45″, 43′ 45″, 40′, 39′.

The double circles, instead of one for each star, have another advantage, for if they do not subtend the precise angles stated, the angles they actually subtend may be found by testing, and the stars placed accordingly.

The lines cut on the glass diaphragm by Messrs. T. Cooke & Sons, viewed through the telescope, are finer than the ordinary spider-web. I understand the circles can be cut in radius to 1-1,000 of an inch, which equals in angle in the telescope described 12″, but as the actual radii can be determined within a few seconds by testing, and the stars placed accordingly, the desired precision is secured.

Collimation and other instrumental errors are eliminated by reversing the telescope and taking the mean of the readings. The limit of error has yet to be determined accurately. Speaking from a few trials, I think, with ordinary care, the maximum error will be found to be less than 15″, which for all practical purposes of surveying is sufficiently precise.

It may here be mentioned that, to find the stars, the altitude circle should be set to the approximate latitude, the needle floated, and the horizontal circle set to the approximate magnetic bearing of true south; the two stars are then visible in the field of view.

I am further experimenting to adapt this method to the ordinary sized telescope of a 5-inch theodolite. The same precision will not be obtained, but it will still be enough for all practical purposes. The trouble of carrying about the additional telescope, as well as its cost, will, however, be saved.

Surveyors who have not the required knowledge of astronomy and spherical trigonometry to determine the true south by the usual methods hitherto adopted will be enabled to determine it as accurately and much more quickly by this one.

In this Colony the true south or north should be determined on an average about ten times a year by each of about 150 surveyors; and as the above method necessitates only half the time in the field now occupied, and also saves all calculation, its advantages are apparent. Hitherto in this Colony the magnetic north has been used as a cardinal point in laying out land; but till Mr. H. C. Russell's paper on magnetic variation in New South Wales, read before your Society in July, 1871, no attention was paid to the variations of the needle.

The more frequently the true south or north is referred to as a basis of bearings in the survey of land, the better will the boundaries thereof be determined hereafter when the marks have been destroyed, and the more accurate will be the maps of the counties.

Since writing the above I have adapted this method to a smaller telescope of 9·1 inch focal length, which is the ordinary size for a 5-inch theodolite. On a bright moonlight night, and with the lines illuminated, the stars can just be seen distinctly enough for observation. Very satisfactory results were obtained, and if the lines and circles are well drawn on the glass I estimate the maximum error of the method at about 15 seconds. The cost of substituting the glass diaphragm instead of the spider-threads will be about 10s.; the former serving also for field use may be permanently fixed. For ordinary surveying work, the separate and larger telescope which I thought at first necessary is now dispensed with.

I may mention that for the small telescope the lines on the glass should not be cut too fine, as moderately thick ones are seen with less illumination.

It will be noted that the stars above mentioned are only visible in the southern hemisphere, but α and λ Ursæ minoris may be similarly observed in the northern hemisphere. These two are suitable for small instruments, whilst for larger, other suitable stars nearer the pole may be selected.

For computing the sizes of the circles :—Linear radius of circle = focal length × tan. required angle, the angle for one circle being slightly over and for the next circle slightly under the N.P.D. of the star, similarly for the two circles for the other star.

I desire to express my thanks to Mr. H. C. Russell for his suggestions and help in working out the details of the mechanism.

Notes on the Progress of New South Wales during the ten years 1872 to 1881.

By CHRISTOPHER ROLLESTON, C.M.G., Auditor-General, President.

[*Read before the Royal Society of N.S.W., 6 September, 1882.*]

TEN years ago the privilege was accorded to me of addressing the Royal Society of N.S.W. on the subject of the progress of the Colony during the preceding decennial period. I purpose, after the lapse of ten years, to review the progress we have made, and to compare it with that of the previous decennary. I do not propose to use very elaborate statistics, merely sufficient to show the results of our advancement under the heads of (1) Population, (2) Production, (3) Trade and Commerce, (4) Accumulation.

1. POPULATION.

The Census taken on the 2nd April, 1871, resulted in a total population of 503,981 souls, of whom 275,551 were males and 228,430 were females, the increase over the population of 1861 being 153,121, or 43·64 per cent. The Census taken on the 7th April, 1881, revealed a population of 751,468 souls, of whom 411,149 were males and 340,319 were females, the increase in the ten years being 247,487 souls, or 49·10 per cent. Of this number 171,315, or 34 per cent., was the result of natural increase by the excess of births over deaths, and 76,172, or 15 per cent., was due to the excess of immigration over emigration. If the Colony were parcelled out amongst its present inhabitants, it would yield over 260 acres to every man, woman, and child in it; and it may be further remarked that, without exceeding the density of the population in the county of Cumberland, exclusive of Sydney, the Colony would carry a population approaching something like thirty times the number of its present inhabitants. Almost every branch of industry is retarded in its progress by the want of labour, and the experience of the last ten years amply justifies the assertion which I hazarded in 1872, that of all causes which create national wealth the power of population is the most influential.

2. PRODUCTION.

The statistics still show the pre-eminence of our pastoral wealth over every other industry. We commenced the decennial period to which this paper refers with the undermentioned live stock:

Horses, 304,100; cattle, 2,014,888; sheep, 16,278,697. We close the decennary with —Horses, 346,931; cattle, 2,180,896; sheep, 33,062,854. It is a noticeable feature in the returns of live stock that whilst the cattle increased by over a million head during the first five years of the period under review, they have decreased by nearly the same number in the last five years, and we have now to record an increase of only 166,006 head in the ten years. In our sheep-farming operations, the very opposite result is exhibited, as the numbers are more than doubled. We commenced the decade with rather over 16¼ millions, and we close the decade with over 33 millions. These figures are taken from the returns of the Registrar-General, but if we take the sworn returns under the Sheep Act for our guide, they give us at the close of 1881 no less than 37,279,205. In the face of the exceptionally dry seasons experienced during the last three or four years, it is a very remarkable feature in her history of progress that the main pastoral industry of the Colony should exhibit such expansion. In connection with this increase in the number of our sheep, the question that forces itself upon our attention is this: to what extent our pasture lands will enable us to increase our production of live stock, so as to supplement the deficiencies of the supply in Europe. It has been estimated that the production of meat in the United Kingdom is equal to 1,090,000 tons, whilst the consumption reaches 1,740,000 tons, showing a deficiency of 650,000 tons in the home supply. It is, moreover, known that the continent of Europe is not able to feed its own population, the estimated consumption being in excess of its production no less than 143,000 tons. The statistics also reveal the fact that the cattle of France and the sheep of Great Britain are declining in numbers, whilst the average increase of the population of Europe is advancing at the rate of three millions annually. The difficulties of conveyance have now been overcome, since a 70-horse power engine is able to maintain a temperature 6° below zero in a chamber capable of holding 10,000 frozen sheep or 250 tons of dead meat. Some idea of the magnitude of the question of meat supply for Europe may be formed by the information furnished in the statistics of the mother country. The importation of meat into the United Kingdom has risen from 144,225 tons, of the value of £7,708,000, in the year 1870, to no less than 650,300 tons, of the value of £26,612,000, in the year 1880. The increased consumption of meat in Europe, it may be observed, is not only attributable to the increase of population but in a greater degree to the higher wages that manufacturing industry has introduced amongst the masses.

It is not within the scope of this paper to follow this question further. My object is to point out facts revealed to us by statistics, leaving to others the investigation of their bearing upon the progress and well-being of this country. There is just one point more that I wish to draw attention to, and that is the diminution in the number of our cattle. The returns on March 31, 1881, showed 2,580,040, whilst those of March 31, 1882, showed 2,180,896, a deficiency of close upon 400,000 head in the twelve months. This is partly owing to losses through drought, but I believe may be attributed in a greater degree to the substitution of sheep for cattle on the pastures of New South Wales, and the demand for cattle to stock the vast plains in the Colony of Queensland, lately brought into occupation. And there is yet a further consideration which presents itself to my mind in connection with our pastoral industry, and that is whether without artificial aid we can maintain the rate of increase in our flocks which the last ten years has developed. I am disposed to think that we have arrived at the maximum which our native grasses will in ordinary seasons enable us to depasture. We are apt to regard moist seasons as the criterion of the capabilities of our pastures, forgetting that moist seasons are the exception and not the rule; and we are not readily disposed to make allowance for the deterioration of them by persistent overstocking, by the ravages of marsupials, and by the injurious effect of long continued droughts. There is no chance given to the best grasses and herbage to seed, and they are said to be dying out in many districts of the Colony It behoves us to look seriously to the injurious effect which this want of rest to the ground must inevitably produce not only upon our capability of supplying meat to the mother country but upon the growth and quality of our wool.

Wool.—In the year 1871 we exported the produce of our own Colony as follows: quantity, 65,611,953 lbs.; value, £4,748,160, estimated at a little over 1s. 5d. per lb. The clip of 1871 was estimated to have produced an average of 4 lbs. per sheep shorn; and it was further estimated upon its realization in the London market there would be a surplus returnable to the Colony of a million and a half sterling, or thereabouts. There are no means, however, of testing this estimate, and it must be regarded as an assumption only. In the year 1881 we exported: quantity, 139,601,506 lbs.; value, £7,149,787. The estimated value in this case is very little over 1s. per lb., as compared with 1s. 5d. in 1871, and this may be set down to the much larger proportion of wool going home in the grease, whilst the average weight of the fleece did not much exceed 4 lbs. over the entire clip. In the ten years since 1871 we have exported wool to the value of 55 millions sterling, or at the rate of five and a half millions per annum, calculated at the average rate of 1s. 1½d. per lb.

Live Stock, Preserved Meats, &c.—In order to arrive at the result of our pastoral industry, it behoves us to trace to what further profit our flocks and herds have been converted. In 1871 it seems that we exported seaward and overland live stock to the value of £956,223; preserved meats, £133,266; tallow, hides, &c., £317,604; total, £1,407,093. To these figures was added the value of wool exported, £4,748,160, bringing up the value of the total pastoral industry to £6,155,253. Now, we will see what we did last year. It seems that we have no record of the live stock driven overland to Queensland. The figures are therefore confined to the numbers exported seaward or across the border to Victoria. It appears, then, that the live stock exported was valued at £777,674; preserved meats, &c., £211,564; tallow, hides, leather, &c., £677,064; total, £1,666,302. If we add to these figures the value of the wool, as previously shown, £7,149,787, we arrive at a total of £8,816,089 as the produce of our pastoral industry in 1881—that is to say, an increase of over 2½ millions upon the returns of 1871. It is more than probable that the surplus over the advances on the clip of 1881 would bring up the value of our pastoral produce to considerably over ten millions sterling.

Agriculture.—In my review of the progress of our agricultural industry during the ten years 1862 to 1871, I find that I divided the period into two equal parts, as offering a better illustration of the advancement that had been made in this important branch of industry. I struck the average acreage under crop of each quinquennial period, in order to reduce the figures to a more reasonable compass, without impairing their usefulness or accuracy. What did we find then? We found that from 1862 to 1866 the average acreage of our principal crops under cultivation was as follows, viz.: wheat, 124,666 acres; maize, 101,225 acres; other crops, 125,614 acres—making a total of 351,505 acres; whilst the acreage of the second five years (1867 to 1871) was: wheat, 160,965 acres; maize, 118,361 acres; other crops, 155,738 acres. The average acreage under wheat had thus increased by 36,299 acres, or 30 per cent.; under maize, 17,076 acres, or 17 per cent.; and under all other crops by 30,124 acres, or 24 per cent. The average yield of the wheat crop over the whole decennial period was calculated at not more than 11 bushels per acre, which, at 7s. per bushel, was calculated to have given to the cultivator, in return for his expenditure and labour, somewhat under £4 per acre.

Well, now, let us see how we stand by the statistics of 1881, after ten years, as we would hope, of well directed industry. For the first five years, 1872 to 1876, we find an average acreage under wheat, 159,086 acres; maize, 117,872 acres; other crops, 173,109 acres; and for the second five years, 1877 to 1881, wheat, 208,293; maize, 122,634; other crops, 272,349. Now, we notice here that the figures indicating the acreage under crop for the five years '72 to '76, differ very little from those given in the years '67 to 71, showing a stagnation of agricultural industry during the earlier five years of the period under inquiry; whilst the average of the second quinquennial period shows an increase of, in round numbers, 50,000 acres under wheat, 5,000 acres under maize, and 100,000 acres under other crops. The number of occupiers of land, excluding pastoral tenants, it should be stated, increased in the ten years from 28,174 to 39,992, or about 37 per cent.; whilst the total extent of land under cultivation was 706,498 acres, or about 18 acres to each occupier. If we analyze the figures which denote the produce of the wheat culture, dividing them into quinquennial periods, we shall find the average result of close upon 14 bushels per acre for the first period, and close upon 15 bushels for the second. I really hardly know how to arrive at a satisfactory estimate of the value of the wheat crop per acre, taking the average of the ten years; but if I assume that it equalled the value per bushel set down as the average of the previous ten years, its fairness may not be questioned. Well, then, the average value per bushel for the ten years—1862 to 1871—is given at 7s. in Sydney; yielding at that rate to the growers about £3 16s. per acre; whilst the results of the last decade—1872 to 1881—show a return of over £5 per acre. This is satisfactory, as indicating either better husbandry or a more suitable soil or climate for wheat culture, brought into occupation by the extension of our railways. And we must not overlook the fact that the rainfall of the last ten years has been under the average. It may, therefore, be assumed that dryness of climate is less unfavourable to wheat-growing than it is found to be to other descriptions of grain crops.

Here again, as with her meat supply, Europe is no longer able to feed her population. If we sum up the total of grain crops in the various countries, and compare them with consumption, we find a deficit of 8½ million tons of grain, which must be imported from other countries. Statistics show us that the breadth of land under wheat is diminishing, not in England only, but in Germany and some other wheat-producing countries of Europe. America has hitherto supplied the deficiency; but the increased demand for grain ought to stimulate its production in Australia. We are told that South Australia raises a ton of wheat for each head of her population, and that Victoria and New Zealand are becoming wheat-exporting countries. When shall we follow their example? America has an enormous population of its own to feed. Whence, therefore, must Europe look for food to supply her increasing wants but to the Australian Colonies? It is manifest that the demands of the mother country must stimulate the growth of our agricultural and pastoral industries to a degree far beyond our present conceptions. Europe paid for grain last year no less than eighty-five millions sterling, and for meat 35 millions, all from beyond the seas. It should here be noticed that we imported last year into New South Wales—flour, 33,047 tons, valued at

£388,451, and wheat 260,118 bushels, valued at £58,642—£447,093; whilst in 1871 we imported—of flour, 18,161 tons, valued at £255,484, and wheat, 1,041,496 bushels, valued at £286,164—£541,648. I think it will be found that the importations of bread food have averaged half-a-million sterling annually, which represents five millions of hard cash gone out of the Colony during the ten years.

Sugar.—The expansion of our sugar industry has been very marked. On the 31st March, 1872, we had 4,393 acres under cultivation, of which nearly one-half was productive and yielded 1,241 tons of sugar. On the 31st March, 1881, we had under cultivation 10,971 acres, of which 4,465 were productive, and yielded 7,300 tons of sugar, at the rate of nearly $1\frac{3}{4}$ ton per acre, and of the aggregate value of over £200,000. Whether this is destined to become a permanent industry amongst us we cannot yet tell. It must of necessity be confined to the narrow limits of our northern seaboard. As yet there is no indication of anything prejudicial to the profitable cultivation of sugar in the way of disease or insects, such as the white ant in Northern Australia; but the cane is very susceptible to injury from the severe frosts which visit the higher lands removed from the coast.

Vineyards.—We commenced the decennary with 4,152 acres under vine culture, with a production of 413,321 gallons of wine and 1,765 gallons of brandy—value, for the reasons given, not estimated. We end the decennary with 4,800 acres, producing 602,007 gallons of wine and 6,628 gallons of brandy. There is noticeable a gradual but not a rapid development of this industry, whilst the quality of the wine produced has been very greatly improved. Our vignerons have received much encouragement from the praise bestowed upon their wines at the various Exhibitions where they have competed, and if we are rightly informed, we are made to understand that the samples sent to the Bordeaux Exhibition are receiving high encomiums from the most celebrated connoisseurs of Europe.

Gold.—The gold-mining industry has languished. In 1871 the mining population produced 321,468 ounces, of the value of £1,232,011, whilst in 1881 the produce was only 190,445 ozs., of the value of £396,954. The number of persons engaged in the search for gold during the decade 1862 to 1871 varied from 15,000 to 20,000, whilst by the late Census the number of persons engaged in gold-mining did not much exceed 10,000. There have been produced during the ten years under review 2,095,651 ozs., of the aggregate value of £7,643,635, as compared with 3,520,515 ozs., of the aggregate value of £13,113,205, during the decade which preceded it. I am not sure whether the decadence of the gold-mining industry should be regarded as injurious to the permanent progress of the country. I am disposed to think that the diversion of labour into other less uncertain and less fluctuating channels will be attended with greater benefit, not only to the best interests of the country but to the character and habits of the people.

Coal.—In the ten years 1862 to 1871 our coal mines produced 7,230,552 tons of coal, of the value of £3,149,776, or at the rate of a little over 9s. per ton. In the ten years 1872 to 1881 they produced 13,927,800 tons, of the value of £7,364,293, or at the rate of rather over 10s. 6d. per ton, estimated, I believe, as at the pit's mouth. The progress of this industry has been seriously retarded by the frequency of the unfortunate disputes between masters and men. Our export of coal has not kept pace with that of industries of much less promise. In 1871 it amounted to 565,429 tons, of the value of £256,690, whilst in 1881 it amounted to only 1,029,844 tons, of the value of £416,530. The home demand is with difficulty supplied, whilst the foreign trade is driven to other countries where the labour difficulty is less precarious; and this trade, which should hold the place as second only to that of wool, makes but a very poor figure in the general exports of the country.

I should not be doing justice to our mining industry were I to omit any mention of our tin, copper, and kerosene shale. Tin did not find a place in my review of the Colony's progress ten years ago, and the product of copper was set down at £47,275, and of kerosene shale at £34,050, making up the modest total of £81,325. For the following information I am indebted to the courtesy of the Department of Mines, and I give it to you as it is given to me:—"Previous to the year 1851 coal was the only mineral raised, and even up to the year 1871 the only minerals which had been worked were coal, shale, gold, copper, and antimony; but during the ten years ending December 31, 1881, tin, silver, iron, lead, asbestos, and bismuth have been added to our mineral products. Notwithstanding the decrease in the average value of the annual production of gold, from £1,259,864 in 1871 to £1,107,560 in 1881, there has been an increase in the annual production of all the minerals taken together of from £1,475,372, in 1871, to £1,755,635 in 1881. The development of tin-mining, which commenced in the year 1872, has mainly contributed to this result; but there has also been a considerable increase in the value of the output of coal and copper.

The important progress that the mining industry of New South Wales has made is apparent when we compare the value of the mineral production of the past ten years with that of the production of each of the four preceding decades: Value of minerals raised during the ten years ending 1841, £81,275; 1851, £634,937; 1861, £14,276,637; 1871, £16,638,574; 1881, £23,441,890. The value of the coal raised prior to 1832 is £4,194. Such returns cannot fail to show the increasing and national importance of the mining interests of New South Wales."

3. Trade and Commerce.

It was shown in my review of the progress of New South Wales during the ten years 1862 to 1871, that the total value of our imports seaward reached £84,832,363—not to embarrass you with the precise figures, nearly eighty-five millions sterling, or at the average annual rate of eight and a half millions; whilst the exports for the same period were valued at £74,148,876, or at the average annual rate of nearly seven and a half millions. The rate per head of the population was—for imports, £19 17s.; and for exports, £17 7s.; whilst during the past ten years (1872 to 1881) the imports amounted to £133,070,409, or at the average annual rate of £13,300,000; and the exports amounted to £129,609,204, or at an average annual rate very nearly approaching the imports, namely, £12,960,000. The imports were at the rate of rather over £21 per head of population, and the exports at rather over £20. But there is a noticeable feature in these returns, as indicating the growth of our trade during the latter half of the decennial period, viz., that whereas the imports from 1872 to 1876 reached £58,136,694, and the exports £58,856,046—together, £116,992,740,—the imports from 1877 to 1881 reached £74,933,715, and the exports £70,753,158—together £145,686,873. These figures evidence a commercial expansion of £28,894,133, or not far short of 25 per cent., in the last five years; whilst comparing the decade ending 1871 with the decade ending 1881, we find that our trade expanded from £158,981,239 to £262,679,613, being an increase of over one hundred and three millions sterling, or 65 per cent., on the last ten years. The question as to what extent this trade is carried on with borrowed capital is not one coming within the compass of this inquiry. The prestige which these Colonies have acquired as a field for the employment of money has doubtless very largely influenced its introduction and profitable investment, and the refinement of our banking system enables us to do a business that would be quite impossible if we had to depend upon our own resources, and were deprived of the powerful aid which the extraordinary banking development of the age affords to commercial and well directed enterprise of every description.

Shipping.—In order to carry on the trade just referred to, it would be interesting to notice the expansion of the shipping employed for that purpose. In 1871 there were entered inwards 1,891 vessels, equal to 706,019 tons; and outwards, 2,123 vessels, equal to 794,460 tons; together, 4,014 vessels, of the aggregate tonnage of 1,500,479 tons. In 1881 there were entered inwards 2,254 vessels, equal to 1,456,239 tons; and outwards, 2,103 vessels, equal to 1,330,261 tons; together, 4,357 vessels, of the aggregate tonnage of 2,786,500 tons. A comparison of the figures comprised in these two periods shows that whilst in the number of vessels employed in the trade there is no extraordinary expansion, yet in the tonnage of those vessels there is an increase of 1,286,021 tons, equal to 85 per cent. Fifteen or twenty years ago the larger sailing-vessels which frequented this port, of from 1,000 to 1,500 tons burthen, made not much more than one voyage in the year, whilst at the present time the trade is carried on by a fleet of powerful steamers averaging 3,000 tons, and making three trips in the year. The statistics of the mother country show us that the number and tonnage of vessels built last year in Great Britain exceeded anything before known, reaching in round numbers a million tons. Indeed, the carrying trade of her shipping seems to be rapidly monopolizing the commerce of the world, which in some degree at least may explain how it is that simultaneously with agricultural decline the wealth of the country seems to increase. The Australian Colonies must largely participate in the advantages which this extension of her commerce brings to the mother country; and New South Wales in particular, with her great maritime advantages, her unlimited supply of coal, her unrivalled harbour, and her free-trade sympathies, should of all others take the lead in the race of commercial progress which the facts I have stated present for our competition.

4. Accumulation.

At the close of the year 1871 there was, in coin and bullion, in the Royal Mint, in the Colonial Treasury, and in the several Banks of the Colony, £2,522,387; on deposit in the Banks, £7,043,885; and in the Savings Banks, £945,914—together, £10,512,186; that is to say, over ten millions and a half sterling, or about £16 per head of the population. The discount, mortgages, and liens on wool and crops amounted in round numbers to eight and three-quarter millions. Let us see how we stood at the close of 1881. We had coin and bullion in the Mint, Treasury, and several Banks, £3,538,313; deposits in the Banks, £20,318,016; deposits in Savings Banks, £2,698,703—making a total of £26,555,032, or at the rate of over £35 per head of the total population (£35 5s.), considerably more than double what it was ten years ago. These figures bear ample testimony to the great advancement in wealth which characterises the history of the last decade. There is no better test of the prosperity of a nation than the amount of deposits in the Savings Banks; and judged by this test, although far from being a thrifty people, we have evidence in the figures before us of a vast accession of wealth amongst the industrial classes. We see that whilst the average deposits ten years ago did not exceed £1 17s. 6d. per head, the average on the 31st of December last was within a fraction of £3 12s. per head. The savings represented by the two millions and a-half in the Savings Banks are not perhaps one-fourth of what they ought to be if our people were taught to exercise a little more self-restraint, and at the sacrifice of a little present enjoyment to make provision for the probable exigencies of the future. It is no exaggeration to say that there is no country in the world where the hours of labour are so short, the remuneration so liberal, the necessaries of life, on the whole, so moderate in price, and the means and opportunities of enjoyment so largely availed of; but we are a thriftless community, as is amply evidenced by the large amounts of eleemosynary aid contributed by the State and by voluntary contributions in support of charitable institutions, exceeding, as it does, £200,000 a year, or at the rate of 5s. 6d. per head for every man, woman, and child in the Colony.

The discounts at the several Banks at the close of 1871, and the mortgages on land and live stock, and the liens on wool and crops, amounted to nine and a-half millions sterling; whilst at the close of the year 1881 they amounted to:—discounts, £20,935,595; mortgages on land, £5,268,449; ditto on live stock, £4,623,914; liens on wool, £904,011; ditto on crops, £42,255; total, £31,774,224. The discharges during the course of the year amounted to £4,800,156,—leaving the sum of £26,574,068 as the net liability on the trade and industries of the Colony at the close of the last year. The net liability at the close of the year 1861 was £6,906,066; at the close of 1871 it was £8,733,847, and at the close of 1881, £26,974,068.

No greater evidence could be adduced in support of the conclusions to which this inquiry has brought us as to the marvellous development of the trade and resources of the Colony. I don't think that we have any occasion to be alarmed at the magnitude of our credit system. If managed with discretion there is nothing to fear. But money won't manage itself, and we have seen that we have more than three times the money to look after that we had ten years ago. It behoves us, then, to study and examine the system on which this large credit is worked, and assure ourselves of its soundness and rectitude. Our large monetary institutions are, perhaps, watched over by men of business habits as keen and able as are to be found in any part of the world, and they very readily recognize where capital can be safely advanced to persons capable of understanding the opportunities constantly presenting themselves in a new country like this, and making a good use of it.

At the conclusion of my review of the progress of the Colony from 1862 to 1871 I find these words:—"We appear now to be on the threshold of another epoch of excitement and prosperity, and whoever may live to see the decade out may have a marvellous story to tell of the country's progress, far outstripping that which I have been able to show you to-night." By the merciful providence of God, I see around me several of those members of the

Royal Society who listened to that paper, and they will be able to judge in how far the picture brought forward to-night transcends that presented in 1872. In 1871 the population of New South Wales was 519,182 souls, her revenue was £2,727,404, and her trade amounted to £20,854,540. In 1881 we have seen that her population had increased to 751,468 souls, her revenue to £7,377,786, and her trade to £33,458,829. The trade inwards and outwards, per head of the population, was—in 1871, at the rate of £40 3s. 4d ; and in 1881, at the rate of £44 10s. 6d; whilst the revenue increased from £5 5s. per head in 1871 to £9 16s. 4d., or nearly double, in 1881. Figures like these betoken a development which few countries can equal; but whether or no we can boast of a corresponding advancement in all those qualities which go to form a high national character it is beyond the province of this paper to discuss. The question admits of very serious doubt, and will be viewed differently, as it may happen to be regarded in its social, moral, or religious aspect. I would only express a hope that, with the increase of our wealth, we may not be unmindful of those measures which are necessary to promote the true happiness of the people, and to develop in the rising generation a love for all that is good and pure and lovable in our human nature, as well as conducive to their happiness hereafter.'

DISCUSSION.

MR. G. A. LLOYD hoped this paper would appear in print *in extenso*, so that it would give the members some opportunity of weighing it well over and discussing it at a future meeting. It disclosed some very remarkable statistics, which were well worth consideration ; and one very extraordinary feature, as it appeared to him, and of which he was not aware until it was stated to-night, was the comparative condition of our population. The President has shown that the increase in the population of New South Wales in 1881 was hardly more in proportion than it was in 1871 ; and it was surprising that people had not come to New South Wales in a larger proportion during the past ten years. It would be well, therefore, to think over this subject, and see whether some means could not be adopted to induce people to come out and settle in larger numbers than hitherto. It was gratifying to find from statistics quoted that there had been such an enormous increase in our sheep, and it was evidently more profitable to grow sheep than cattle, and that would account for the increase in the quantity of sheep and the decrease in the quantity of cattle ; but it was to be deplored that any such decrease in cattle should be found at this particular moment, when they had arrived so successfully at a solution of the question which had been studied so long, the first consideration of which was entertained by the late Mr. Mort, who spent a large amount of money in endeavouring to develop these shipments of meat to England. Now the means had been discovered for sending it they had not the article to transmit, and it was evident from figures quoted by the President that an enormous market was to be found in England for any quantity of meat sent there. It was true that there had been a falling off in the production of gold, but a similar declension was noticeable in California, another auriferous country. But then other branches of mining equally remunerative and important had been followed up by the people of San Francisco, and many persons had become immensely rich by following up silver-mining. There were large deposits of silver in this country, but unfortunately we were deficient in the necessary skill for developing this particular branch of mining business, and it was surprising that there were not before now men coming here from San Francisco accustomed to the working of this business. The remarkable increase in the tonnage of shipping was a gratifying circumstance, and it was a puzzle to business men how it could be possible for this country to employ the enormous amount of tonnage thrown into it during the last two or three years. He could well remember the time when a vessel came here once in six weeks, and when people went away in crowds to the Flagstaff to see it come up the harbour. But now, in lieu of the small vessels of former days, we had enormous floating palaces coming in, showing a development in trade at a rapidity unequalled in any other country. It would be pleasing to find in the future that these enormous vessels left a handsome profit to the shareholders of the respective Companies in return for their enterprise. All present must have felt highly indebted to the President for his very excellent paper, the discussion upon which might well be extended over to the next meeting of the Society.

Mr. Wilkinson, Government Geologist, quoted facts which dissipated all notions as to any falling off in the mining industries of the Colony, although the production of gold may have decreased; Mr. Chas. Moore, Director of the Botanic Gardens, briefly referred to the question of water conservation; whilst Mr. Alex. Dean commented upon the want of population, attributing the deficiency to a want of proper advertising at home.

On some Carboniferous Marine Fossils.

By the Rev. J. E. Tenison-Woods, F.G.S., F.L.S., Vice-Pres. Linn. Soc., N.S.W.; Hon. Mem. Roy. Soc., N.S.W., &c.

[*Read before the Royal Society of N.S. W., 4 October, 1882.*]

I exhibit to-night two good specimens of *Aphanaia mitchelli* (M'Coy), and a very large one of *A. gigantea* (De Koninck), which I think is larger and better preserved than any which have hitherto been found. As no account exists in English of the nature of these fossils, a few words will, I think, be useful to palæontological students. Amongst the fossils sent to Europe by the eminent explorer, Sir T. Mitchell, and also by the Rev. W. B. Clarke, to Professor Sedgwick, there were a few specimens from the sandstones of Glendon and Wollongong, which were described by Professor M'Coy* as a species of *Inoceramus*. It was, however, only with considerable doubt that it was referred to that genus. The diagnosis is as follows :—"Longitudinally ovate, one-fifth longer than wide, slightly oblique, inflated, hinge-line oblique, nearly equalling the width of the shell, forming a slightly compressed wing, beaks pointed, prominent, incurved, close to the anterior end, anterior side nearly straight, abruptly subtruncate surface, with numerous strong, concentric, irregular wrinkles of growth. The hinge margin of this species is much thickened, which removes it from *Posidonia*; while, as in many of the German cretaceous *Inocerami* it is not possible to observe any traces of the transverse ligamentary pits, nor can we be sure whether these species possessed them or not. Meanwhile I shall leave the present species in the same genus as its obvious allies alluded to; and even if future research should prove that ligamentary pits did not exist, we should form a distinct genus for those species which, like the present and the *I. vetustus* (Low), of the mountain limestone, are distinguished from the true semi-membranous *Posidoniæ* of the lias and paleozoic shales, with which they have been confounded by their thick shells, general form, and thickened hinge margin. Length, two inches three lines; width, one inch nine lines; thickness, about an inch and a-half. Dedicated to Sir Thomas Mitchell, one of the first to make known the existence of fossils in these rocks (Wollongong)."

* See Annals of Nat. Hist., vol. xx (1847), p. 299, plate 1, fig. 1.

It will be seen from this passage that Professor M'Coy, while placing these fossils in a mesozoic genus, recognized the palæozoic affinities of the form. It remained thus until the year 1876, when Professor De Koninck, in revising and describing the whole of our fossils, created for this species the genus *Aphanaia* [a Greek derivate (α and φαναιος), not shining, or non-nacreous], which he thus describes:—"Shell, inequivalve, inequilateral, gibbous, with an obtuse posterior wing. Hinge straight, apparently without teeth, separated by a hollow ligamental area. Surface, with deep concentric grooves, generally very unequal, and like certain species of *Inoceramus*. Muscular impressions of adductors double, very large, posterior nearer to the ventral than cardinal margin; diameter of one double that of the other; larger uniform, nearest to the ventral; smaller suborbicular. Foot impression (?) a little behind the hinge margin, and very small."* The generic character is, of course, mainly depending on the muscular impressions.

Relations and Differences.—Shells of this kind, certain species of which attain large dimensions in their general shape and ornamentation, resemble *Inoceramus*, but they are distinguished by their muscular impressions and hinge area. The same characters will separate them from the American genus *Ambonichia* of Hall, which also comprises several species often confounded with *Inoceramus*. The right valve of the latter has a little oreillette, which is never seen in *Aphanaia*. Hitherto, says Professor De Koninck, the genus only comprises two species, one known since 1847, the other of which he describes. "They belong to the Carboniferous formation (lower marine palæozoic), in which they were discovered by the Rev. W. B. Clarke, F.R.S. It is somewhat remarkable that the palæozoic formation of America and Europe, the fauna of which is so much richer in species than that of Australia, has furnished nothing which can be compared to these forms." See also Clarke's Sedimentary Formations, 4th edit., 1878, Appendix C, p. 141, &c.

Aphanaia gigantea, De Koninck: "Shell very large, transversely oblique, oval-pointed, the right valve much thicker and larger than the left, and bent upon itself by the elevation of the ventral margin. Umbones thick, straight, pointed, and terminal; surface covered with extremely deep, concentric, irregular sulcations. The test appears to have been extremely thin, the hinge only manifesting a somewhat thick rounded callosity. Adductor impressions enormous on the posterior and ventral sides and near the border; one oval, 3 centimètres in its greater

* Abridged from Recherches sur les Fossiles paléozoiques de la N. G. du Sud. Australie, par L. G. De Koninck. Brussels, 1876. In which figures of all these fossils are given on beautifully executed lithographs.

diameter, and mingling with the other, which is double its size, and rendered emarginate by the entry of the other. Foot impression very small and faint, situate towards the centre, and a short distance from the hinge margin. The specimen was found at Branxton, in a brown micaceous stone. The dimensions of that described, which was the only one ever found, were as follows:—Alt., 12 centimètres; diameter from the hinge to the ventral margin, 27; length of the hinge margin, 9; thickness in the hinge side, 7; and 3 at a distance of 6 from the ventral margin. The present specimen is a much longer and narrower shell, but in every way larger, measuring 35 centimètres in length, 11 in width, 9 in thickness at the thickest portion, and about 3 very close to the edge. It is probable that these fossils belong to an estuarine formation. The strata at the Cemetery Hill, whence these specimens were taken, are light yellowish brown micaceous sandstones, full of a coarse waterworn conglomerate, containing rounded stones and pebbles, varying from ½ an inch to 4 inches in diameter. Amid the pebbles and other remains are fragments of wood, which seem to be coniferous, a specimen of which I exhibit. I have not as yet examined them microscopically. The thinness of the shells, the deep sulcated growth, and the character of the shells themselves, all point to a brackish water deposit, such as we find at the mouths of rivers, where oyster-beds sometimes accumulate. It is very difficult to point out any affinities to these fossils among recent shells. They would seem to have some of the characters of *Ostrea*, *Unio* and *Mytilus*, and therefore we cannot affirm positively that they lived in either fresh or salt water. As far as analogy will guide us, we may say that the thin structure of the shell would imply nearly fresh water. With these fossils were associated *Spirifer glaber*, W. Martin; *Sanguinolites tenisoni*, De Kon.; *Pleurophorus carinatus*, Morris; and another *Pleurophorus*, which may prove an undescribed species. I may add that the specimen from which De Koninck's figure was taken was destroyed in the Garden Palace fire. That which I possess is at present the only one known.

EXPLANATION OF PLATES.

Plate IX. Figs. 1, 2, and 3. Front, back, and side views of *Aphanaia gigantea*, De Kon., one-third nat. size.

Plate X. Figs. 4 and 5. Front and side view of *Aphanaia mitchelli*, De Kon., both half nat. size. Fig. 9. *Sanguinolites tenisoni*, De Kon., nat. size.

On some Mesozoic Fossils from the Palmer River, Queensland.

By the Rev. J. E. Tenison-Woods, F.G.S., F.L.S., Vice-Pres. Linn. Soc., N.S.W.; Hon. Mem. Roy. Soc., N.S.W., &c.

[*Read before the Royal Society of N.S.W., 4 October, 1882.*]

At one time it was believed that there were no mesozoic rocks in Australia, and this, coupled with the existence of many mesozoic forms of animal and vegetable life on our continent, induced many to think that most of its area had existed as dry land since palæozoic times. But as early as 1844 Leichhardt records some mesozoic fossils in Queensland, and Sir Thomas Mitchell, in 1846, found a *Belemnite* at Mount Abundance, in the same Colony.* The Rev. W. B. Clarke also recorded that, between the years 1851 and 1853, he had received a portion of an *Ammonite* from the Clarence River. In 1861 Mr. F. T. Gregory found *Trigoniæ*, *Ammonites*, &c., in strata on the Moresby Range, Western Australia, as mentioned by him in a paper to be cited presently. In the Journal of the Geological Society of London for 1862 (vol. xviii, p. 244) Mr. Clarke published a paper on the occurrence of Mesozoic and Permian Fauna in Eastern Australia, in which he announced the discovery of a large series of fossils of secondary age on the Fitzroy Downs in Queensland.

The first announcement that *Cretaceous* fossils existed in this country was made by Professor M'Coy, of Melbourne, who, in 1865, read a paper before the Royal Society of Victoria on certain organic remains brought down by Messrs. Carson and Sutherland from the western bank of the Flinders River, at the base of Walker's Table Mountain, in latitude 21°13′, longitude 143°. The matrix of these fossils was an olive-coloured marl of lime and clay. The specimens included, besides the vertebræ of a very large teleosteus fish, which was indeterminable, two species of *Inoceramus* with very thick, coarse, fibrous shells, Ammonites, with a few other remains, which taken together enabled Professor M'Coy to announce for the first time with certainty that a cretaceous

* See Proc. of the Roy. Soc., Tasmania, 1878, p. 18, where there is a very interesting paper by R. Etheridge, jun., on the re-discovery of this fossil in the collection of the British Museum.

formation existed in Australia. Previous to this Mr. A. Gregory had, in a paper read before the Geological Society of London,* doubtfully indicated cretaceous fossils in latitude 30°15′.

Other papers announcing further discoveries, written by the same author, will be found in the "Annals of Natural History for 1867," p. 355, and the "Transactions of the Royal Society of Victoria for 1868," p. 41; 1869, part 2, p. 77. In 1870 Mr. Moore read a paper before the Geological Society of London (see vol. xxvi, for 1870, p. 226), on Australian Mesozoic Geology and Palæontology. In this paper many species were described and figured, and it is undoubtedly the most valuable contribution to the palæontology of Australian mesozoic rocks that has yet been made. In 1872 Mr. R. Daintree published in the same Society's Journal, vol. xxvii, p. 271, a very lengthy report on the geology of Queensland. In the appendix to this paper Mr. R. Etheridge described and figured a number of Cretaceous fossils from various parts of the interior of the Colony. In February, 1880, Mr. R. Etheridge, jun., read before the Royal Physical Society of Edinburgh (see Proceedings for that year) a paper on a collection of fossils from North Queensland. In this essay there are full descriptions and figures of many palæozoic fossils, besides figures and description (plate 17, figs. 55 to 58) of a new Cretaceous *Crioceras* (*C. jackii*) which was found by Mr. Jack in the mountain sources of the river Tate, not very far from the Herberton tin-field. In July, 1880, Professor Tate read before the Royal Society of South Australia a description of a new species of *Belemnite* from the mesozoic strata of Central Australia. (See Proc., vol. iii, p. 104.) In the Southern Science Record for 1881 I announced the discovery of a new bed of cretaceous fossils on the Burnett River in Queensland. This list includes all the palæontological literature on the mesozoic rocks known to me.

There is one circumstance connected with most of the fossils described as Cretaceous in the foregoing papers, which is that the beds in which they occur are rarely described. This has arisen partly from the fact that the specimens have been collected by those who knew little of geology, and they have frequently passed through two or three hands before reaching the geologist who described them. But there is another reason for this. In the mountain ranges on the eastern side of the table-land Cretaceous fossils occur in drifted nodules in the beds of the creeks, and entirely unconnected with any beds or strata. This is the case, I believe, with the fossils found in the Tate River. In the case of those now to be described from the Palmer River, about 180 miles north of the Tate, the same thing is observed. In the course of the stream, which runs through granite and palæozoic rocks overlaid by recent trap and Desert Sandstone, large nodules of bluish

* Quart. Jour. Geol. Soc., Lond., vol. xvii, 1861, p. 475.

clay are found. They vary in size and shape, but are generally rounded, and about 6 to 10 inches in diameter. A good many of them are septaria, which, when divided and polished, are of great beauty. Others, when carefully divided, reveal fossils in a more or less perfect state of preservation. I have no doubt we have in these instances the remains of what have been extensive mesozoic beds connected with those in the great mesozoic basin of the interior. They have been broken up at the upheaval of the tableland and denuded away, and these nodules scattered on the watercourses all over the most elevated portions of the plateau testify to their former extent. Possibly, however, undisturbed portions of the strata will still be found. In nearly every case the remains preserved are those of Cephalopoda, the only exception being Mytilidæ, some very imperfectly preserved brachiopoda, which cannot be determined. It is no unusual thing to find fossils of only one or two kinds preserved in strata. Thus, in the eocene rocks of Mount Gambier only brachiopoda, bryozoa, pectens, urchins, with a few of the corals of compact tissue (Oculinaceæ) are found. All other remains have been removed, and show their former presence as casts and cavities in the rocks. The explanation of this has been given by the able researches of Mr. H. C. Sorby, F.R.S., and has been already referred to by me in a former paper. It appears that the carbonate of lime which occurs in shells is in a chemical, not an organic form, and is either aragonite or calcite. The former is an unstable compound, easily decomposed and lost, the stable compound calcite, on the other hand, resisting decomposition. Now it is found that those organisms in which only casts are found belong to genera in which the carbonate of lime exists as aragonite, and therefore easily perishing, while the preserved shells are those in which the carbonate of lime has existed in the form of calcite. But this explanation will not meet the case of the mesozoic fossils preserved in these nodules, because, first, the matrix is bluish clay, and not lime—in fact, there seems to be very little lime in it; secondly, the Cephalopoda are precisely those in which the carbonate of lime exists in the form of aragonite. Possibly these larger shells have in their deposition and consequent decomposition of the animal tissue concreted large masses of clay around, which has better resisted decomposition, and they owe their preservation entirely to their large size. This is borne out by the facts, because only large shells are seen, I am informed, at Hughenden, and those are not restricted to cephalopoda, but include *inoceramus*. The exception to this is a thin bed of limestone, about 4 inches thick, full of *Avicula hughendensis*, Ether. The rest of the fossils were obtained from horizontal calcareo-argillaceous beds. About 20 miles beyond this locality hundreds of belemnites are strewn over the surface of two ridges, but they are rarely found in the soft shales, says Mr. Daintree, which crop up under the Desert Sandstone. Amongst the fossils with which I have to deal are three or perhaps four species of Cephalopoda all from the Palmer River, and found in nodules as described.

The first is the phragmacone of a belemnite which I recognize as very closely resembling one described but not named by Professor John Phillips. In Mr. C. Moore's essay already referred to (p. 258), a note is added by Professor J. Morris on the *Belemnites.* He says :—" Of three species which are in the Australian collection sent me by Mr. C. Moore, the first, a large phragmocone typical of the oolitic system (meaning by this the whole series of beds from the middle lias to the Kimmeridge clay inclusive), is 5·5 inches long, its greatest diameter 1·75; the section nearly circular. Above forty septa can be counted, and the whole number must have been fifty without counting the last chamber. The septa are a little oblique, advancing in the dorsal and retiring a little on the ventral face, with a slight lateral flexure. Depth of the chambers about one-sixth of the diameter. Siphuncle clearly internal, its section rather elliptical. The phragmacone is nearly straight, with an angle of 18°. Of the guard only a slight indication of a subcentral axis can be recorded. I cannot at present assign its distinctive characters." From Wollumbilla. In many particulars our fossil corresponds with the above, but the difference will be seen from the following diagnosis :—

Belemnites selheimi, n.s. Pl. 7, fig. 1. Phragmacone extending at an angle of 17°, circular, broken at each end; 100 millim. long, 45 millim. at broad end and 15 millim. at narrow end. Chambers —twenty-five in number, slightly oblique, advancing a little on the dorsal face, and retiring on the ventral, with slight lateral flexure. An obscure carina on the dorsal face, with a distinct shallow groove for the whole length. Siphuncle partly covered with matrix, and not very visible. The fragment is shorter than that of Professor Phillips, and the chambers are relatively deeper, as there are fewer by fifteen in very nearly the same length. The dorsal keel and obscure shallow groove are also very distinctive features. I have given the species the name of its discoverer, Mr. Selheim, at present acting as Warden and Police Magistrate at Charters Towers. Mr. Selheim has made most valuable observations and collections in geology and zoology on the Palmer River. All my Cretaceous specimens from the Palmer River were obtained from him.

Ammonites olene, n.s. Front view, Pl. 7, fig. 2; side view, Pl. 8, fig. 1.—Fossil much compressed, periphery narrowed to an acute angle, whorls 8½ probably, but the umbilicus, which is apparently narrow, is covered by the matrix; surface crossed by rather broad obtuse sigmoid ribs, which are rather acutely bent in the middle

Some few bifurcate, about from forty to fifty in the last whorl; diameter (taken across from extreme visible edge of last whorl), 103 millim.; thickness, 17 millim.; diam. of flexuous costæ, from 5 to 7; sutures very indistinct, apparently seven, much divided, rounded lobes on each side. The specific name is derived from the elbow-like bend of the ribs.

This ammonite is very near the *A. biflexuosus*, D'Orb., of the Great Oolite, except perhaps that the keel is not so acute, but a very satisfactory comparison cannot be made, in consequence of the extent to which the fossil is covered by matrix. Any attempt to liberate it only imperilled the whole specimen, as it was exceedingly brittle, so I have been obliged to leave many points without a satisfactory solution. The species is, however, easily distinguished from all others described from Australia by (1) its acute periphery, (2) its broad sigmoid ribs. Eight species of ammonites have been described from Australia. Four by Moore, viz.:—*A. aalensis*, var. *moorei*, Lycett.; *A. radians*, Rein; *A. brocchii*, Sow.; *A. macrocephalus*, Schloth. None of these have any resemblance to this species. In all the shell is not acute at the periphery, and the ribs are close and numerous. Three species are described by Etheridge, namely:—*A. beudanti*, Brongn, var. *mitchelli*, Ether.; *A. daintreei*, Ether.; *A. sutherlandi*, Ether. *A. daintreei* has rather a rounded back and the ribs are close. *A. sutherlandi* is closely ribbed and thicker, with no acute keel. *A. beudanti* is the almost smooth shell, with fine striæ, which Mr. Etheridge regarded as represented by a variety (*A. mitchelli*). But this was already described by Professor McCoy under the name of *A. flindersi*, he noting at the same time that he regarded it only as a variety of *A. beudanti*. In reality, then, we have but seven ammonites, only two of which can be claimed as peculiar to the Australian deposits. If the present species is distinct it will make a third, but I hardly think that it is.

Crioceras irregulare, n.s. Pl. 8, fig. 2.—Shell loosely and irregularly coiled, whorls, $1\frac{1}{2}$, quite free, but the distance irregular, much compressed at the sides, tuberculate, in sixteen rows. The first six obsolete, tubercles, three on each side, conical, short, close on the sides, but at an interval on the dorsal edge, then disappearing except that a faint row, seen near the end of the fragment after a long interval. Costæ of two sizes, the tuberculate ones large, and separated from one another by simple, narrow, round, undulating ribs, which vary in number between the tubercles from two to thirteen.

This species differs from the typical form of the genus in the loose irregular coiling, in which it combines something of *Ancyloceras* and *Toxoceras*, the latter especially, as the coils can scarcely be said to be complete. The nucleolar portion of the whorl is quite blunt. M. Astier*, a great authority on the genus, is of opinion that all species of *Crioceras* become *Ancyloceras* in their adult state, and that in the former genus we never find the perfect mouth of the adult shell. Again, Pictet† states with regard to *Toxoceras* that, from certain facts he had observed amongst the fossils of Switzerland and Savoy, he believed that the *Toxoceras* form and *Ancyloceras* form entirely depended on mode of growth. This was even in the same species so variable that one specimen might be referred to a *Toxoceras* and another was so unrolled as to be an *Ancyloceras*. In the present species the first whorl as far as the termination of the tubercular ribs is clearly of the *Toxoceras* form, and if found in that stage of its growth would be referred to that genus. Subsequently, from impressions on the matrix, the shell seems to have straightened out and become an *Ancyloceras*.

Two species of *Crioceras* have been previously recorded from Australia. One is figured and described in Moore's paper already referred to. The other is by R. Etheridge, jun., in the Proc. of the Royal Physical Society of Edinburgh (*loc. cit.*, p. 43). Mr. Moore's species, *C. australe*, will be dealt with presently. *Crioceras jackii*, Ether, is quite a different shell from ours. The whorls are regularly coiled; the smaller ribs are proportionately larger, and the tubercles are in fewer rows, only two at each end, and are blunt or flatly truncate. Professor M'Coy, in the Annals of Natural History, 1867, vol. XIX, p. 356, describes an *Ancyloceras* from the head of the Flinders River, as follows:—"A gigantic species of *Ancyloceras*, exceeding the *A. gigas* of the Isle of Wight in size, and differing by having the transverse ribs larger, forking on the side, and a row of large compressed tubercles on each side of the back. It most resembles the *A. zaberelli* of the French Lower Greensand. I name it *A. flindersii*." I need not point out that this is entirely different from our species.

Crioceras australe, Moore, Pl. 10, figs. 5 and 6.—I believe that the specimen found with the last species is a fragment of the above, which is thus described:—"Shell very large, discoidal, whorls rounded, incurved, the inner whorls rather closely fitting, but separate. In the younger state, as seen in the reduced figure, the shell possesses regular, rounded, slightly curved ribs, with intervening rounded sulci, which increase in width with the age of the shell. In the adult shell the ribs become widely separated, the largest chamber measuring $3\frac{1}{2}$ inches at the back, and they possess very acute ridges, with two depressed bosses on each side, the depressions between the ribs being regularly concave. The block containing the last five chambers of the shell is slightly compressed on the back, and though it is not complete the

* Catal. descrip. des Ancyloceras de l'Etage Néocom. Lyon. 1851.
† Traité de Paléontologie, vol. ii, p. 706.

mouth measures $7\frac{1}{2}$ inches in depth by 7 inches in breadth. The siphuncular tube is small, and situated immediately under the back of the shell. There appears no reason to doubt that the larger chambers belong to the smaller whorls, though the connecting portions are wanting. When complete it is probable the shell attained nearly twice the dimensions of the *C. bowerbankii* of the lower greensand. Its ornamentation is proportionably much smaller than in that species. On the interior of the shell are attached bryozoa, serpulæ, and other remains identical with those on the interior of the *Cytherea clarkei,* previously noticed, from which there appears no doubt that that shell and the *Crioceras* are identical in age, and as no example of *Crioceras* has yet been obtained out of the Neocomian period, it is reasonable to infer that they represent it on the Australian continent. It is from the district of the Upper Maranoa."

My specimen is only a fragment of one of the inner whorls, with indications of the others which show that they were detached, and that the complete shell was of huge size. The siphuncle and ribs correspond with the above description, but there are no traces of the bosses referred to; nevertheless, I believe that the species are the same. There are fragments of what may be another species of *Crioceras* or the above *C. jackii,* Eth., which it resembles in not being compressed, and in the tubercular ribs having only two distant tubercles at the side. But there is only one such rib preserved. Fragments of the inner coil can be seen showing the whorls to be detached, regular, and close, as in the species referred to.

Mytilus inflatus, Moore, Pl. 10, fig. 7.—"Shell smooth, slightly inequivalve, curved, both valves inflated, margins close set, umbones terminal, acute, anterior, hinge-line extended and oblique, posterior margin and front rounded, dorsal surface smooth, with irregular concentric bands of growth. This pretty little shell is to be distinguished by its very inflated appearance, its more extended hinge-line and terminal umbones. Its test still retains some colour. Two examples are in the Australian collection, both of which are from Wollumbilla."

The above diagnosis corresponds very exactly with two specimens I have, which are, however, more than double the size of that figured by Moore, who describes also three other species from the same beds. A large *Mytilus* has also been described by me from somewhere in the neighbourhood of the Barcoo.* This is noted for its large size, and has been named in consequence *M. ingens.* It is evident that some of the fossils here described are identical with Oolitic species, and in the matrix of the *Mytilus*

* See Proceedings Linnæan Society, New South Wales, vol. vii, part 3, September meeting.

the oolitic appearance of the rock is most striking. The marked character of the *Ammonite* is even older. But, on the other hand, the species of *Crioceras*, the shelly matter having nearly disappeared, are fossils of quite another horizon, probably like those of the Flinders River. Neocomian or Lower Cretaceous: The matrix has a different aspect, and the shells are fresh and new-looking. How are we to account for this mixed fauna? If the fossils were associated in the same strata, it would be very puzzling. Seeing, however, that they are found as nodular masses in the beds of creeks, there is no difficulty in explaining their association. Both are derived from beds of different age, which have been broken up and denuded away during the upheaval of the table-land or during its subsequent subaerial history. It is not at all improbable that we shall in the course of time meet with other and more interesting relics. I could have procured many more but for the difficulty of carrying them on horseback over many miles of most difficult country. But the remains are so extensively distributed that large collections will surely soon find their way to our museums and learned Societies.

List of fossils described in this paper :—

1. BELEMNITES SELHEIMI, N.S.
2. AMMONITES OLENE, N.S. vel var.
3. CRIOCERAS IRREGULARE, N.S.
4. C. AUSTRALE (?), Moore.
5. C. JACKII (?), Etheridge.
6. MYTILUS INFLATUS, Moore.

EXPLANATION OF PLATES.

Plate VII. Fig. 1. *Belemnites selheimi.* Phragmacone with matrix formed of nodular clay. Fig. 2. Front view of *Ammonites olene.*

Plate VIII. Fig. 1. *Ammonites olene*, side view. Fig. 2. *Crioceras irregulare.*

Plate X. Figs. 5 and 6. Two views of *Crioceras australe*, with part of the adherent clay matrix of nodule. Fig. 7. *Mytilus inflatus.*

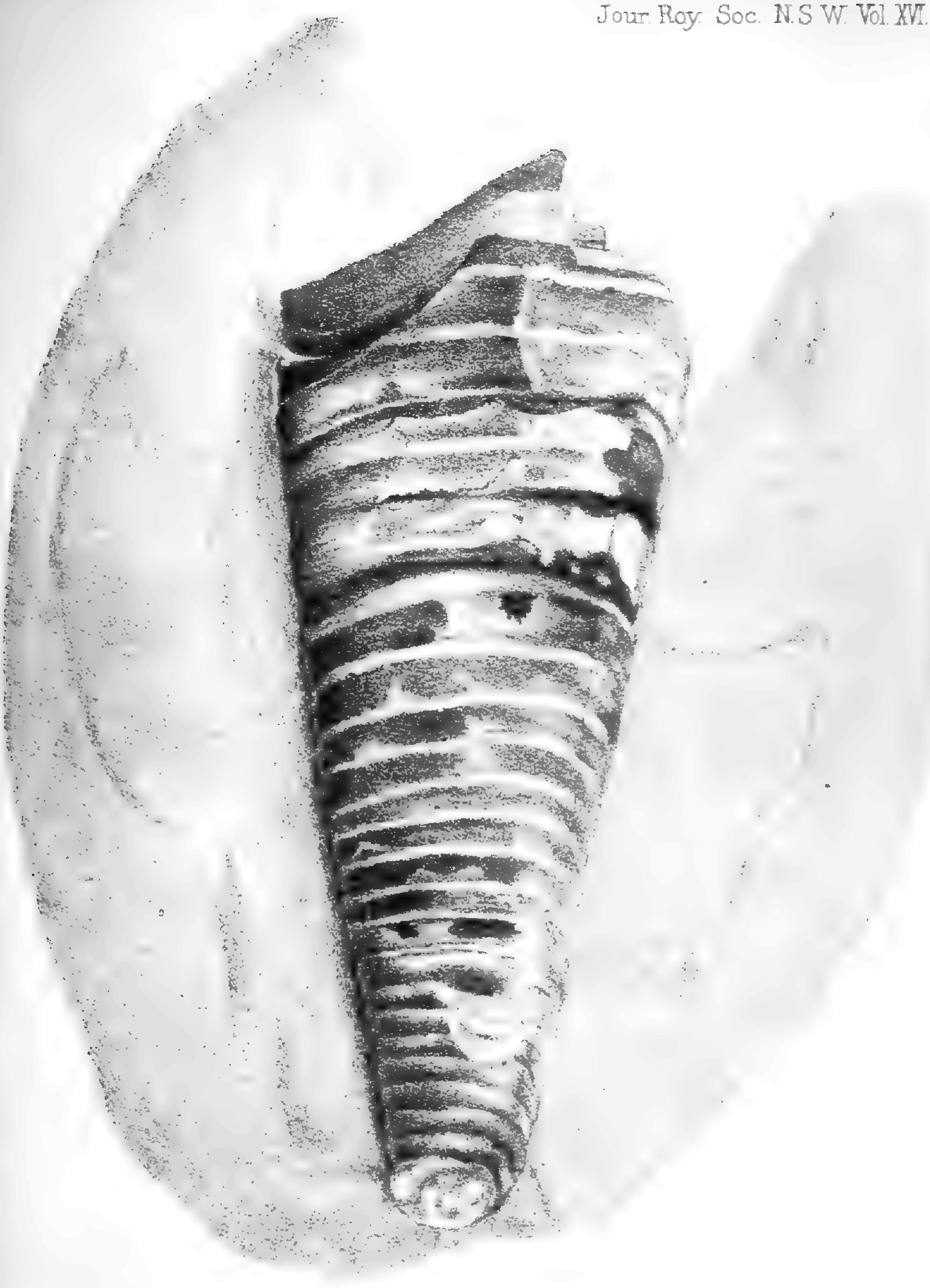


Fig. 1, Belemnites selheimi *(phragmocone in matrix)*

Fig 2, Ammonites olene.
(front view)

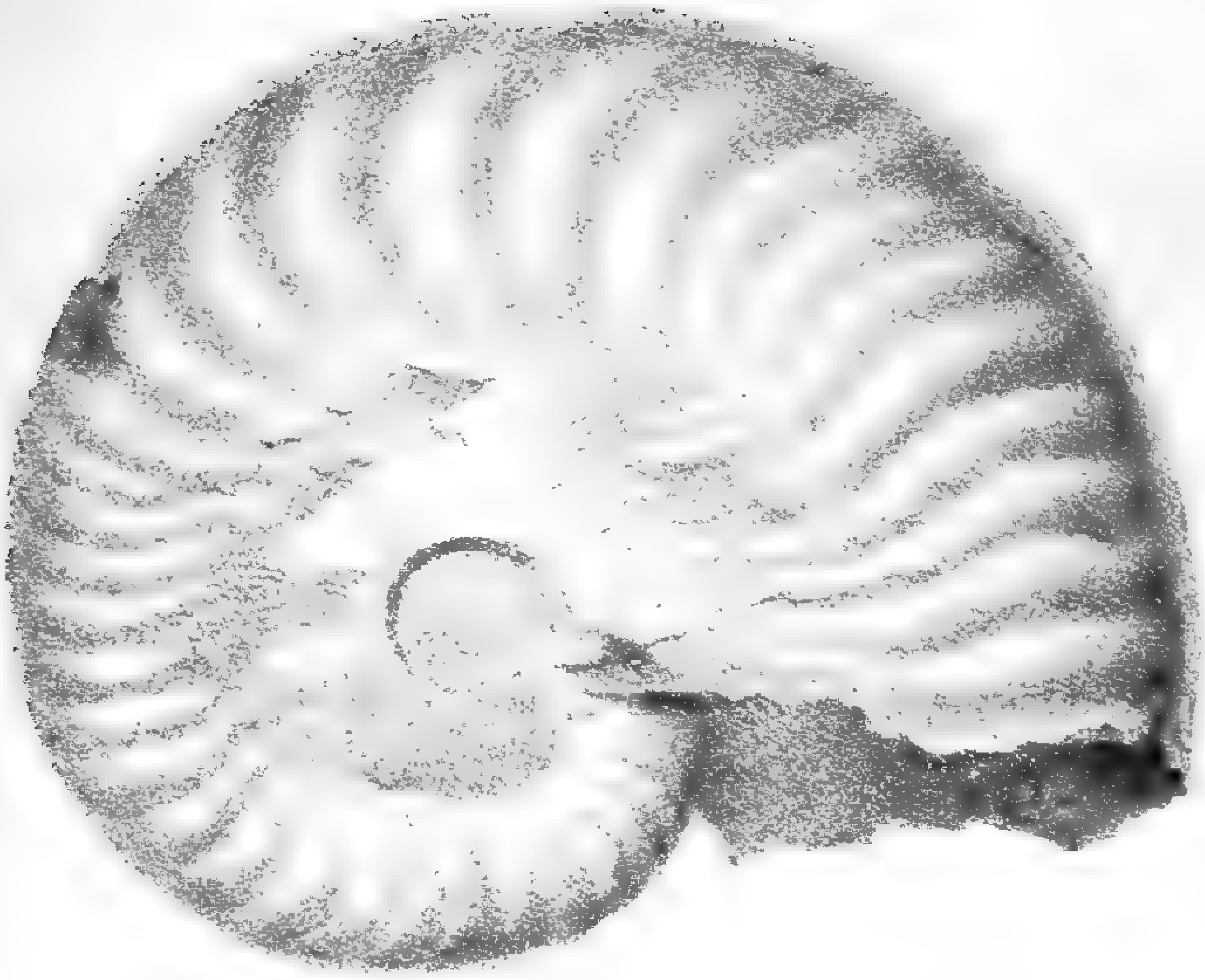


Fig. 1, Ammonites Selene

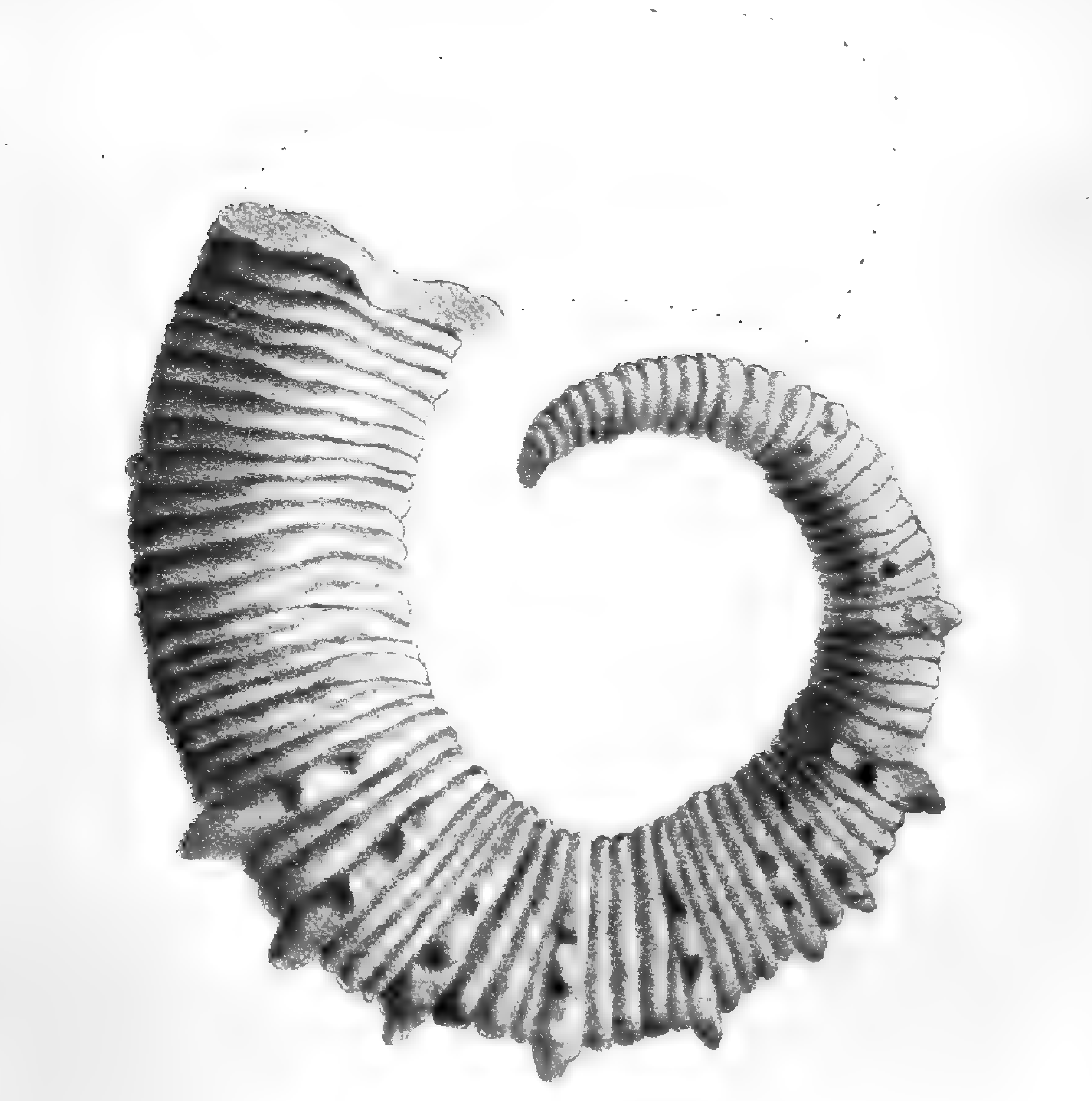
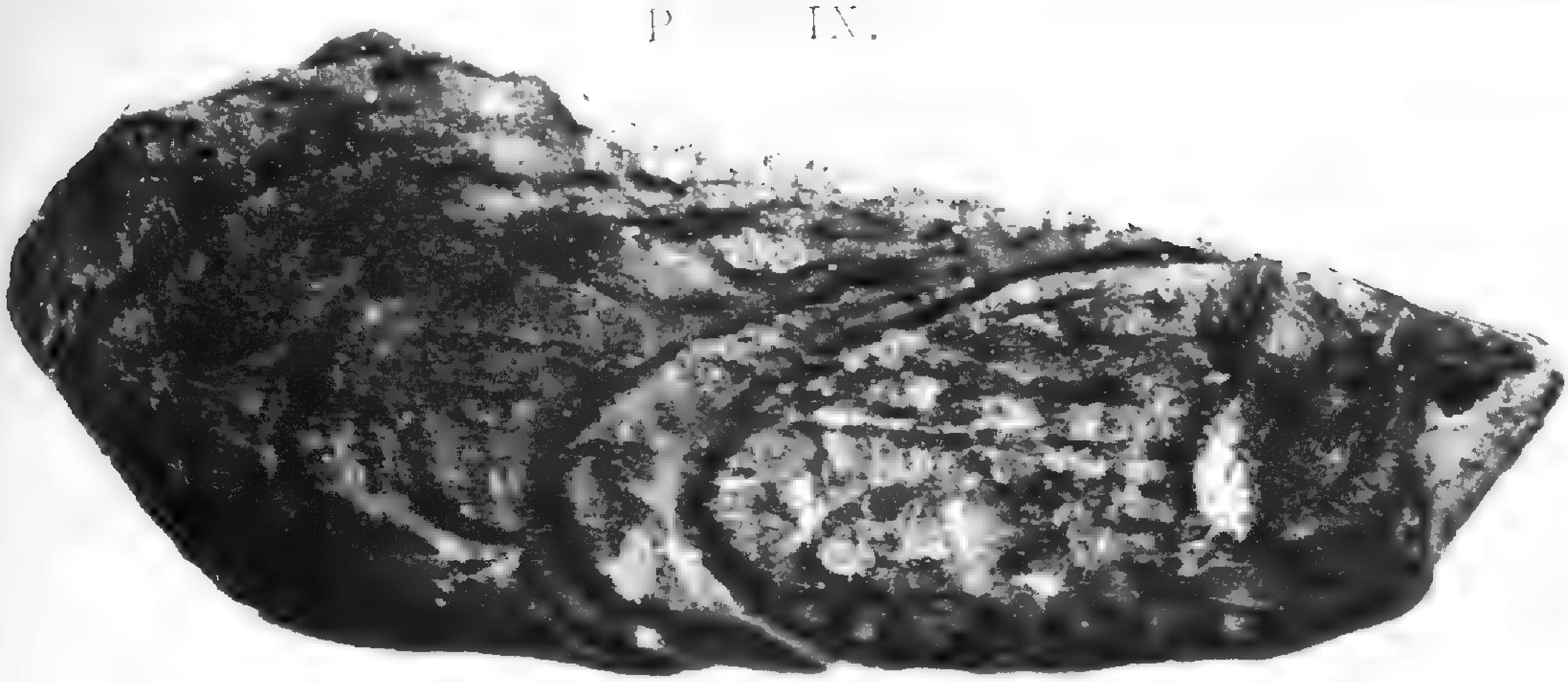


Fig. 2, Crioceras irregulare

J. E. Tenison-Woods, del.

S. T. Leigh & Co. lith. Sydney.

P IX.



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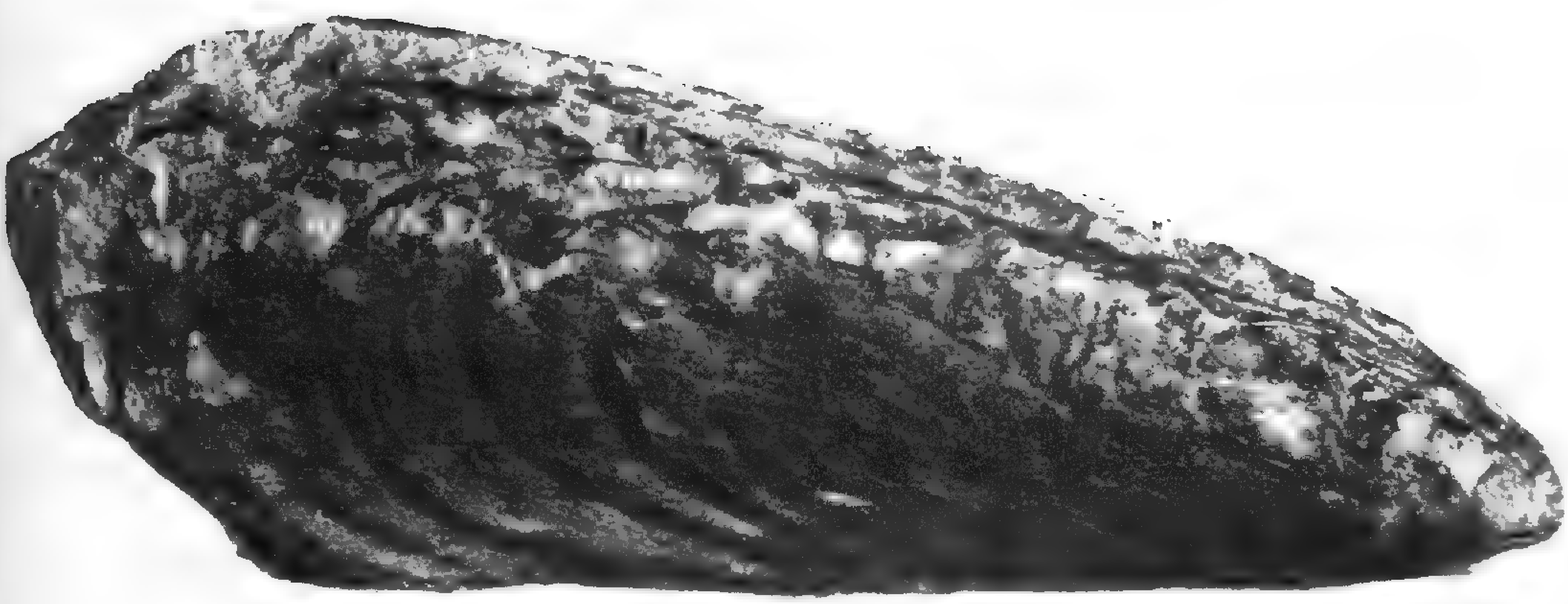

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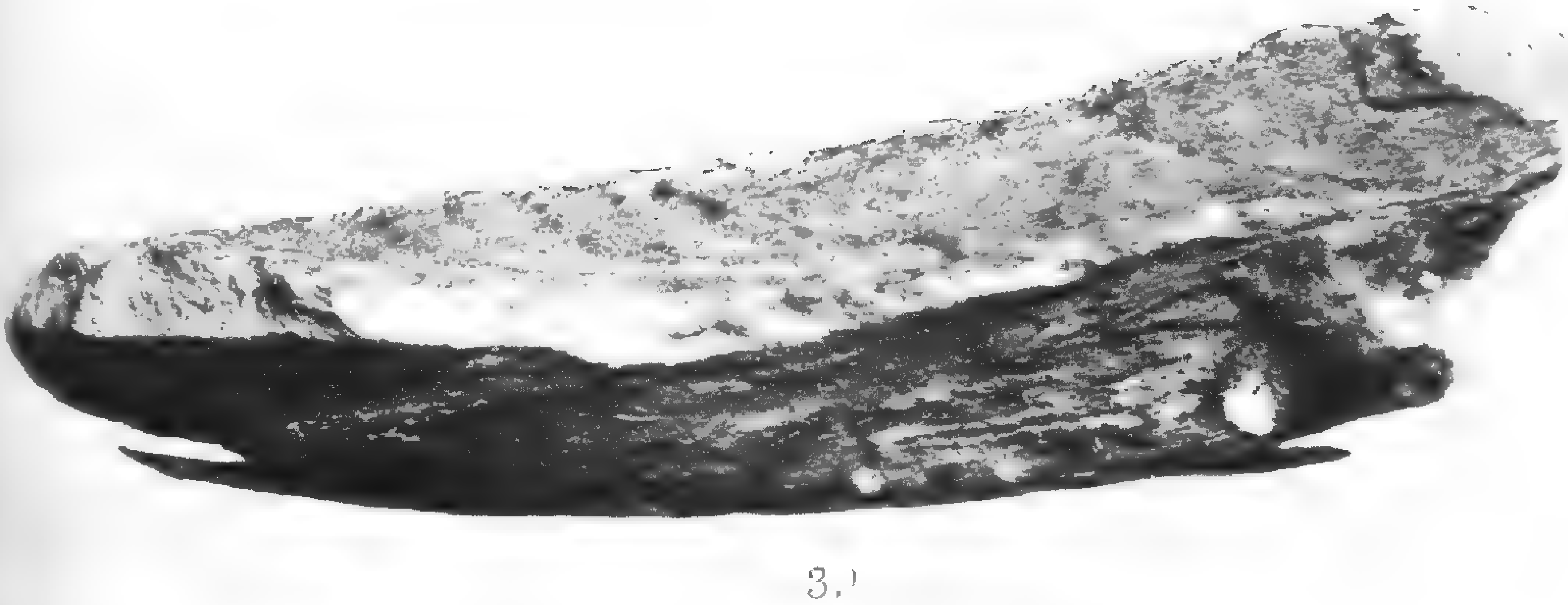


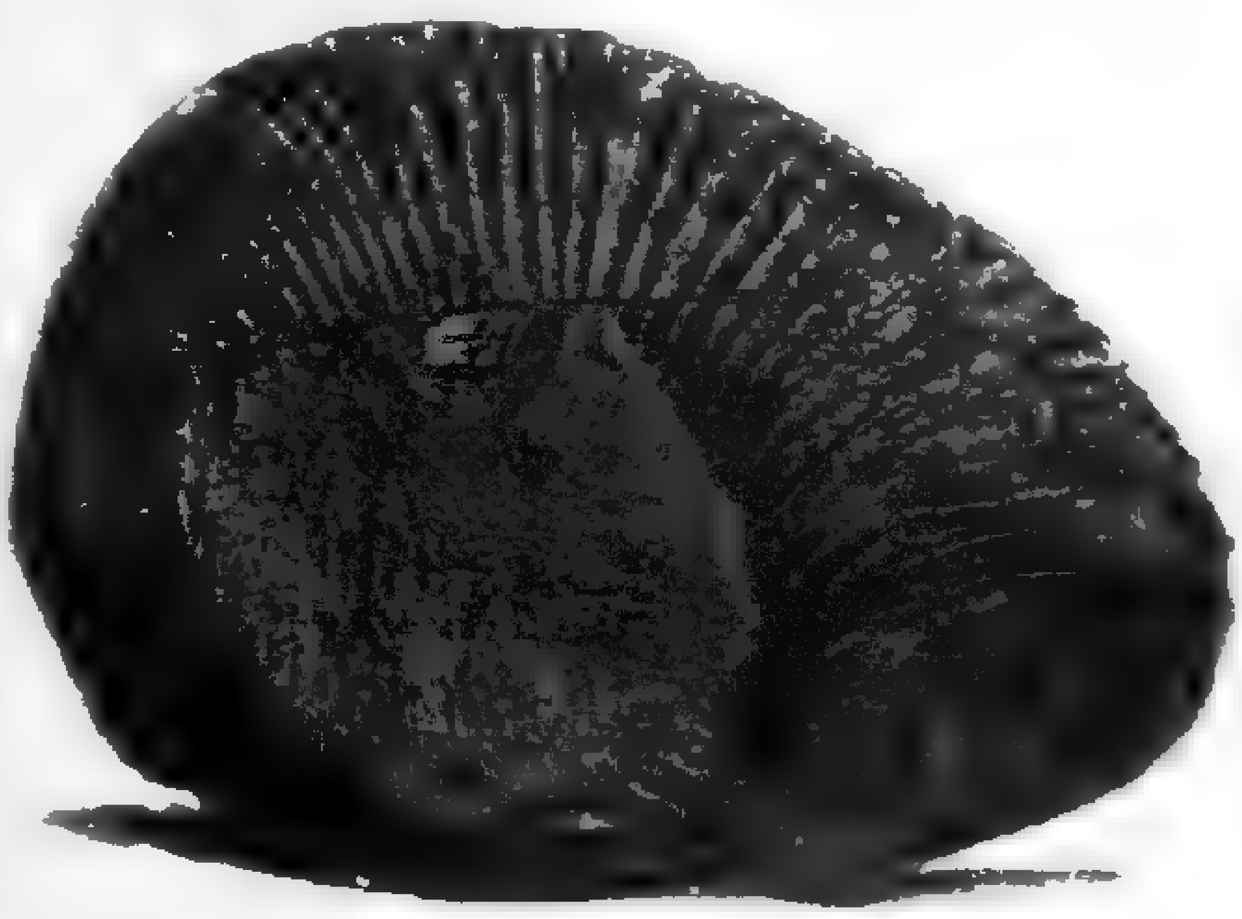
3.

Fig. 1. Aphanaia gigantea—*De Kon.*, front view,
2. Ditto back view.
3. Ditto side view.
All one-third natural size.

PLATE X.

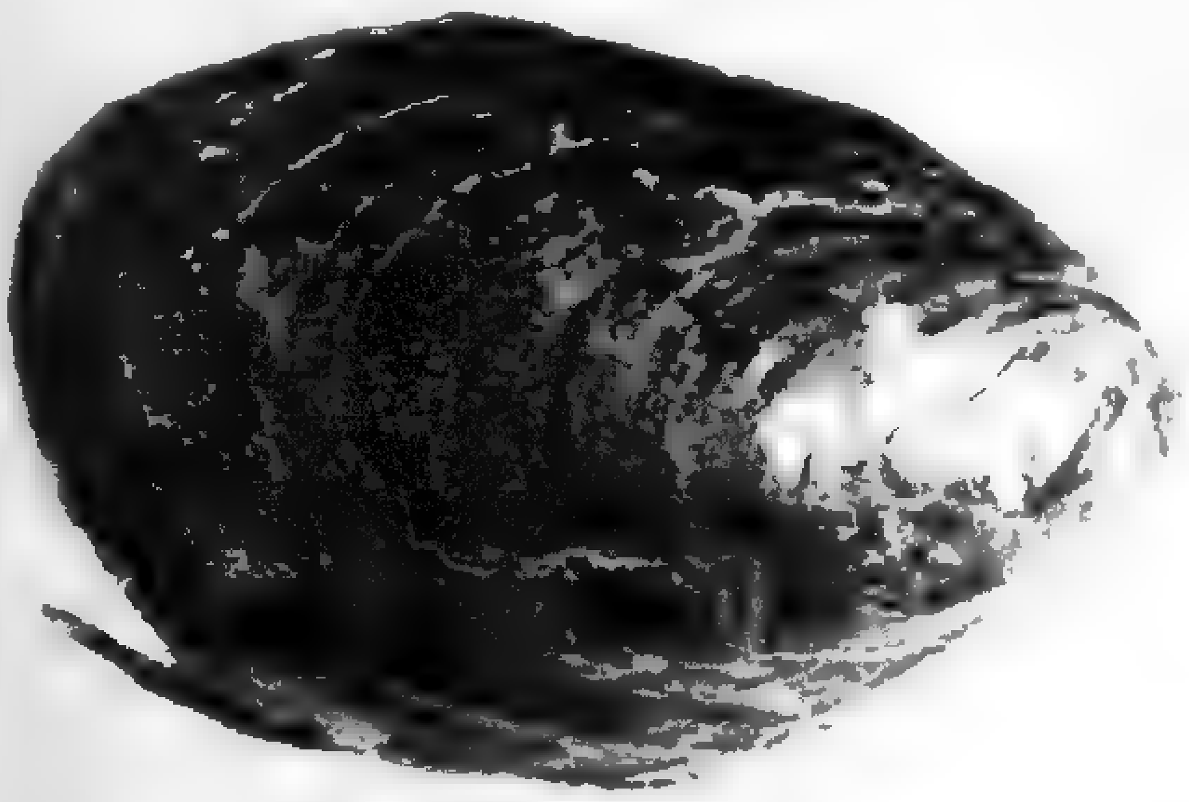
(4.)
Aphanaia mitchelli—*De Kon.*,
half natural size.

(5.)
Ditto, side view.

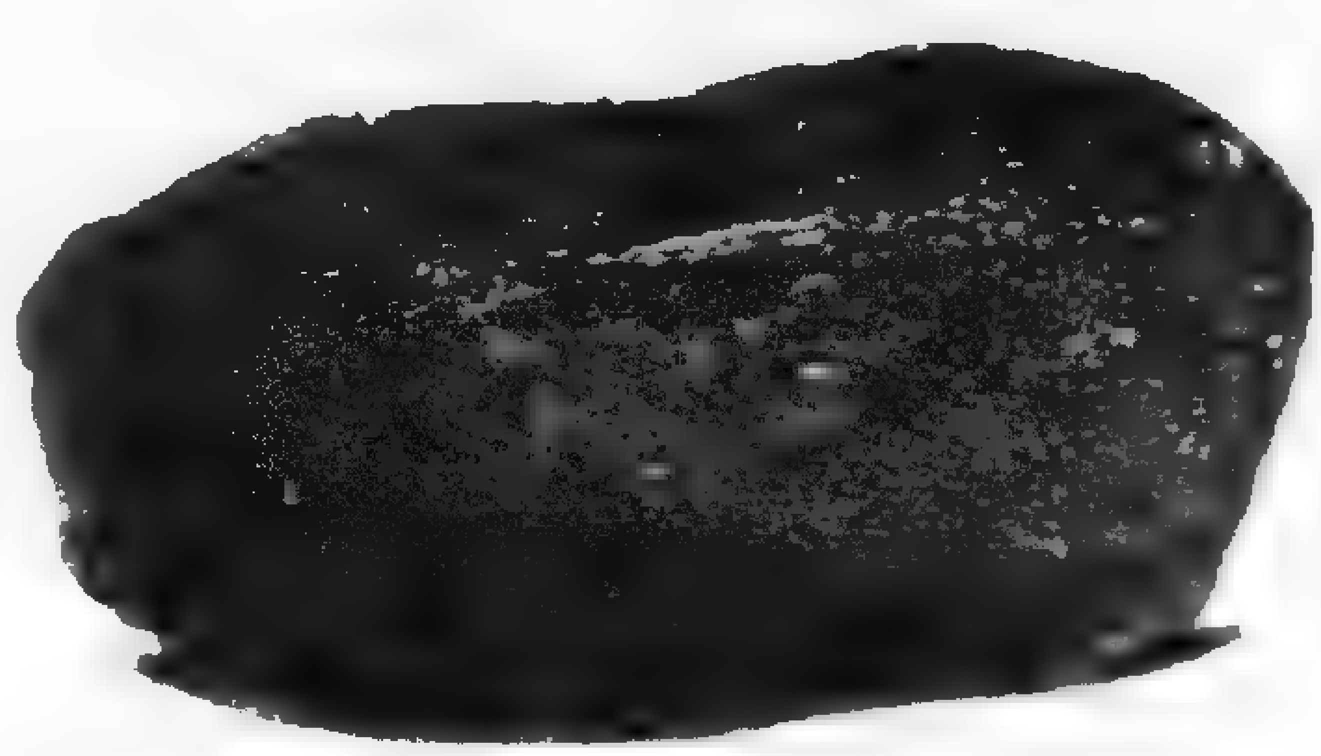


(6.)
Crioceras australe—*Moore*,
front view, one-third natural size.

(7.)
Ditto, back view.



(8.)
Mytilus inflatus—*Moore*,
two-thirds natural size.



(9.)
Sanguinolites tenisoni—*De Kon.*,
natural size.

Notes on the Aborigines of New Holland.

By James Manning.

[*Read before the Royal Society of N.S.W., 1 November, 1882.*]

In 1844 and 1845 I had the privilege of taking some interesting notes from the blacks of this Colony on the subject of their religious belief. Those notes were necessarily and mainly taken from the most intelligent of those natives who frequented the neighbourhood of my own home in the bush in those early days. At and before that time I resided at Cumbamarro, very near the outside boundaries of the then location of settlers to the south, and near the Murrumbidgee River, and for ten years prior to my taking such notes in writing I was a resident of those parts. For the first four or five years or more of that earliest time there was no church south of the little one that was at Bong Bong, near Mittagong. The cities and towns of Goulburn, Yass, Albury, and Melbourne did not exist. It was a common parlance amongst the early settlers, when travelling south, before Goulburn and Yass townships were formed and had churches, to say that "there was no Sunday after crossing Myrtle Creek," which is a stream bordering old Bargo Brush, a little south of Picton, and some 50 miles only from Sydney. No missionaries ever came to the southern district at any time, and it was not until many years later that the missionaries landed in Sydney on their way to Moreton Bay, to attempt, in vain, to christianize the blacks of that locality, before the Queensland separation from this Colony took place.

These facts are advanced in proof that the notes which I took, later on, upon the religious belief of the whole of the aborigines of this continent are perfectly true and consistent with their own traditions. I also desire to say that, since I penned them, in January, 1845, I met with fresh confirmations to the general belief of the blacks in a Supreme Being or Deity in all parts of New South Wales, in Victoria as far west as the Grampian Hills, and in Queensland as far north as Rockhampton. At each such place the God of their faith was in every instance represented to me as having his abode where the sun rises. I may further add my conviction, without having visited the far interior of those parts where Burke and Wills perished, that the blacks are all of the same religious belief as those who have come under my notice and inquiries. This conviction I maintained from the moment that I saw in the *Illustrated London News* of that time the picture of two stalwart natives of that region, who were sketched from nature by one of the parties who went in search of those unhappy explorers. That picture represented those two fine-looking blacks to be minus the front tooth, which I considered had doubtlessly been knocked out under the sacred ceremony of the so-called "Irangung," the nature of which my notes fully explain.

The extraordinary though incongruous parallel between the religious belief of the natives of this country with those of the Hebrews or of Christian nations caused a great deal of doubt to be cast on the originality of the statements made by me. Many of those who read them pooh-poohed the idea of their truthfulness; in some instances I felt myself to have been almost insulted for having propounded what seemed to be evidence of weak credulity on my part. I may mention that almost the first person and friend to whom I showed these notes was Mr. Charles Cowper, afterwards Sir Charles. He saw them when we met in Melbourne, in April, 1845. He expressed himself to be much astonished at the revelations I had thereby made, but could not divest himself of the idea that some missionaries, catechists, priests, or clergymen had been tampering with or schooling my black friends into a crude kind of trinitarian belief; and he expressed his opinion that the notes needed confirmation from other quarters than from the special parts only where I resided in New South Wales, and from whence I obtained my earliest and leading information. That confirmation I have since obtained in various and widely separated places, as before stated. As Sir Charles (then Mr. Cowper) thought of these notes, so did very many; but when I lent them to the late Bishop Broughton to read, in 1851, he was so struck with the statements made, and found them so ably and really logically supported by the singular avowals and remarks of my chief sable informant, that he asked for a copy of them to take with him to England, to have them printed there through one of the religious Societies. I was at that time under a pledge to my black informant not to publish them in Sydney until they had been published in England, for reasons which will appear to be just and warranted when the notes are read and understood. I gave Bishop Broughton a full copy as he was leaving for England in 1852; he died shortly after reaching home, and that copy has never since been heard of. My original paper remained with me for twenty years afterwards; it was lent to various friends, among whom was the late Bishop Barker. At last, and about ten year ago, this original, by passing from friend to friend, also became lost; but fortunately (as the sequel will show), among the many who had had the notes to read was the late Lord Audley, who had them in 1852, just thirty years ago, and whilst he was encamped near my station. By a strange coincidence it was only within the last three months that our worthy President (Mr. C. Rolleston), who had heard me speak of these old and lost notes, remarked, in conversation about them with Mr. John F. Mann, of Sydney, that I had had and had lost such notes. Whereon Mr. John Mann, who was Lord Audley's brother-in-law, immediately exclaimed, "Why, I have them; I took a copy of them into a folio book whilst the notes were with Lord Audley!" Hence, and by this extraordinary coincidence, the notes are restored to me in their original wording, and I have now the pleasure to make them public, there being no longer any reason for caution in making them known, my black friend "Andy," who gave me almost all my information, having passed away, and the whole race of blacks in the civilised parts no longer existing in their primitive state, and having nearly died out, as prophetically decreed.

I wish to add, in confirmation of the originality and truthfulness of these notes, that Black Andy was respected by all the few gentlemen who were in my neighbourhood; and that in my own solitude in those days I appreciated the interchanges of thought with this fine aboriginal, whom I used to regard in the light of a "nature's gentleman," of no mean reflecting and reasoning capacities, and who by his ready acquisition of the English language afforded me singular advantages in gaining the information I did. Mr. John Mann knew this good "blackfellow" very well, and will perhaps support my present attestation of his superiority before I give utterance to notes which will surprise, and will be found to give evidence of the tradition of the blacks on their religious creed much in same way as the Old and New Testaments contain the traditions of the Christians and Hebrews. I may state, under my own familiarity with the subject, that the natives of New Holland are not heathens or pagans, because they worship no idols; and that, so far from their being atheistic in their belief, they are not even deistic, because they not only acknowledge a Supreme Deity, but also believe in his providential supervision of all creation, aided by his Son, "Grogoragally," and by the second mediator, in the supernatural person of their intercessor, "Moodgeegally," and also because they believe in a day of judgment and retribution to each man immediately after death and resurrection, and in a future state of reward and punishment by the *fiat* of their Supreme "Boyma," or God, as will be understood on the reading of my notes.

These notes will also, and unfortunately, show that the originality and seeming implicitness of the religious belief and superstitions of the natives of New Holland are rendered almost nugatory by the extraordinary and debasing ignorance under which they are bound to keep their women, through the supposed stern decree of their great lawgiver, "Moogeegally." They degrade their women worse than the Hindus do theirs.

In conclusion, I wish to say that the singular recovery of these notes is due to the interest which Lord Audley and Mr. John Mann took in them, so much so as to have copied them in detail unknown to myself, and that their resuscitation is due to the interest which Mr. Rolleston expressed about their having existed and been lost. To these gentlemen I wish to tender my thanks. Between us all these notes seem to have been destined not to be irrecoverably lost; and now that I have them again, and that as I have nearly reached the full span of human life, I hope it may be accorded by this meeting that no more time should be lost to place them on permanent record, to which effect I have much pleasure in offering them to this our Sydney Royal Society.

P.S.—The above constitutes my preface to the old notes which I am about to read you; but since I have penned this preface, and, indeed, only this morning, I am placed in possession of still further corroboration of the originality of the subject matter of my notes. I had invited Dean Cowper to come here this evening, and, as an inducement I sent him a press copy of my preface to the notes, which he returned to-day with a very interesting note of his own, part of which, I am sure, he would have no objection to my quoting. After informing me that he regretted that professional duties would prevent him from attending this meeting as a visitor, he gives me the following information, which is most interesting, and gives the strongest confirmation to all I have written and said on the subject. Before quoting his words, I beg to say that I was perfectly ignorant of what he informs me as having come from Archdeacon Gunther and from the Rev. Mr. Ridley, although I knew that they had both written on the subject of the faith of the blacks, years and years since the date of my notes; and as they point to the same traditions, I shall quote them with the greatest satisfaction.

The Dean writes me as follows:—"I do not know whether you are aware that the late Archdeacon Gunther, of Mudgee, prepared a grammar of the aboriginal language, which went home a few years ago, through the Colonial Secretary, to Professor Max Müller. In this grammar there was a special note upon the belief of the aborigines on the being of a Deity, his providence, and the doctrine of rewards and punishments. Mr. Gunther, when a missionary to the aborigines at Wellington Valley, derived his information, he told me, from some of the oldest of the blacks, who, he was satisfied, could not have derived their ideas from white men, as they had not then had intercourse with them. The language, also, was witness of their faith. There was a being to whom they gave the name of Baimè, or Bhaiamè. The word is a noun, from baio or bhaio, which means to cut or make, and signifies maker. They applied this to Him who made all things; they said that He lived far away, and that He would punish bad men and reward good. This news was strongly confirmed by the Rev. Mr. Ridley, who was a missionary for about two years amongst the Kamilaroi tribe of aborigines on the Upper Hunter River. He also compiled a grammar, which I dare say you have seen; and in it he gives the same name for the Deity amongst the aboriginals with whom he had been associated, and whose language he had learned. I had a conversation with him one day, in which he referred me to his grammar, corroborating what I had heard from Archdeacon Gunther."

With such unexpected corroboration of my own words, I end this preface by saying that if scepticism in this matter is still to continue, I think unbelievers would do well to peruse the notes a second time carefully before they pronounce their judgment on the revelations made, which were never dreamt of before I made them public. To such sceptics I will venture the suggestion that they should consider how easy it might be for intelligent men to pass almost a lifetime among the blacks in any quarter of this continent without securing that entire confidence of even the best of the natives around them, through whom they might possibly become entrusted with their religious secrets—secrets which they dare not reveal to their own women at all, nor to their adult youths until the latter have been sworn to reticence under that terrifying ceremony which my notes describe.

I, however, claim to have been specially fortunate in my researches, and therefore, with my confidence in the validity of these statements, I leave it to time and the future inquiries of others to have my notes confirmed in manner I have no doubt they will be.

Notes on the Religious Creed, &c., of the Natives of New Holland.

The aborigines of the southern part of New Holland have a belief in the existence of a Supreme Being; and, from connecting circumstances, I am of opinion that the same creed upon religious subjects exists throughout the whole continent of New Holland. The God of their belief is called "Boyma," who, they say, dwells at an immense distance to the north-east, in a heaven of beautiful and supernatural appearance, where the Almighty is represented by them as seated on a throne of transparent crystal of vast magnitude, which has its base in the great water, and rises to a stupendous height towards the stars. In their notion of God's appearance he is great beyond conception, beautiful to look upon, and immovably fixed in this crystal rock, with only the upper half of a supernatural human body visible. Around Boyma and his throne are countless rays of rainbow colours, which are designated "curanguerang." On each side of the throne are seen a great many beautiful pillars of crystal, handsomely carved, and emitting prismatic colours. These pillars they designate "yamoon." This description of the Godhead bears a striking resemblance to the description in 3rd verse of the 4th chapter of Revelations. They believe in the existence of a Son of God, equal with him in omniscience, and but slightly inferior to his Father in any attribute. Him they call "Grogoragally." His divine office is to watch over the actions of mankind, and to bring to life the dead to appear before the judgment-seat of his Father, who alone pronounces the awful judgment of eternal happiness in heaven, "Ballima," or eternal misery in "Oorooma" (hell), which is a place of everlasting fire (gumby). Their belief in God's creation of His own Son was explained to me thus by the intelligent native from whom I derived my chief information. "Boyma," on his own creation, feeling "lonesome," wished for a son after his own likeness. He observed in the firmament a liquid, resembling blood, which, reaching with his hand, he placed in a crystal oven, and, in a short time, the Son of God was born, a being resembling God and man. Boyma is described as of an incomprehensible greatness in appearance; his Son they compare to the size of a mountain. Grogorogally is the active agent of his Father, who immovably presides over all nature. The Son watches the actions of men, and quickens the dead immediately upon their earthly interment. He acts as mediator for their souls to the great God, to whom the good and bad actions of all are known. The Son's spirit they represent as being in every part of the habitable world, spreading—as was expressed to me—over the supposed distance of England and Sydney. He does not seem in their belief to be co-equal with his Father; he sees and knows all the wicked and good deeds of mankind, but is not judge of their virtues and vices in the day of retribution; his office seems chiefly to be to bring at the close of every day the spirits of the dead from all parts of the world to the judgment-seat of his Father, where alone there is eternal day. There he acts as intercessor for those who have only spent some portion of their lives in wickedness. Boyma, listening to the mediation of his Son, allows Grogorogally to admit some such into Ballima.

There is a third person in their belief, who is of a semi-divine, semi-human nature, the great lawgiver to the human race. Him they call "Moodgeegally." He was the first man created, and being of the special formation of the Supreme Being, he is said to be immortal, removed from this to an indefinite distance in a happy region of his own, situated at the confines of the world, and in the immediate neighbourhood of the supposed heaven of Boyma. He, too, is perfectly cognizant of all events, and is revered by all for his virtues. He is the avowed enemy of all wicked men; misdeeds of such are transmitted by him to Grogorogally, and by the latter again to the supreme Boyma. Notwithstanding that both Father and Son are omniscient, Moodgeegally, alone of mankind, and himself living immortal in his own paradise on earth, has the power of visiting the heaven of Boyma. The happy land of Moodgeegally is supposed to be within three days' journey ("nangery") of Ballima. Beautiful plains, with numberless and wonderful featherless emus, afford him eternal happiness in his human occupation when not engaged in his divine mission to the abode of God, and from thence again to the confines of this world, which he seems to be unremittingly doing. From this blissful region, far away to the north-east, and where land terminates, he ascends to heaven by a high and precipitous mountain, covered with beautiful trees. His ascent on foot is rendered easy by a path winding round the mountain, called "Dallambangel," which he ascends in a three days' journey. A ladder or flight of steps from the top of this mountain leads him to the entrance of heaven, where he arrives in the presence of God to execute his mission to the Father and Son; and receiving from them such laws as may seem fit to the Almighty to transmit to the human race, especially such as relate to the changing ordinances of the sacred "corroberee." Moodgeegally then descends again to the earth, and publishes the will and laws of Boyma to the northernmost tribes, and from them all others by degrees obtain the laws.

This description of Moodgeegally on Mount "Dallambangel" cannot fail to strike every reader of these notes as showing a strange similarity to Moses on Mount Sinai receiving the commandments from God, for transmission through him to the Israelites. (See Exodus, chap. 19). Ballima (heaven) is represented as being a most blissful abode for the good who have inherited eternal happiness. The rejoicings of the blessed, I was told, might be heard at a distance as far apart as "Sydney to Port Phillip." Their existence in heaven is of a spiritual nature, with their forms as human beings, receiving and requiring no nourishment, their enjoyments constant dancing and blissful shoutings. Grogorogally frequently visits them, and joins in the incessant happy jubilee. He is represented to wear a brilliant belt ("gurungerong") of rainbow colours, worn across the shoulder to the side. This is of a crystal nature; from the belt is suspended a beautiful crystal sword or wand called "gundungbillong," and which his Father made and gave him as a sign of his divine authority. Hence probably the use of and veneration for the small rock crystals which descend from father to son as amulets of supposed semi-divine authority to act as doctors and priests. Andy possessed one as a "doctor"—he specially prized and protected it.

The wicked Boyma condemns to eternal fire in Oorooma. Grogorogally then hands them over to the devils outside of heaven, which are called "Wawamolong." These evil spirits are described as being of most hideous forms, and emitting flames of fire from the elbows, the knees, and the knuckles of the hand. These convey the damned down to Oorooma, where may be heard the frightful yells of the wicked; they are then given in charge of lesser devils, and committed to the eternal "Gumby" fire. These devils are described as only half human in appearance; they have long claws to their hands, with which they seize the unhappy wretches committed to their care. They are monsters, having ugly "heads as big as a bullock." The miseries of those suffering eternal fire were represented to me by my informant by mock writhings of his body. * * * This severe description of eternal punishment by hell-fire is inconsistent with their other belief, that Boyma is never considered by them otherwise than as a benevolent, though dreaded, being. The dread of eternal punishment acts forcibly as a restriction upon their conduct in life, and restrains them from murder among themselves, or from slaughtering of their own race, unless in the spirit of united and justified revenge, which is not punished by "Gumby." No crimes, they believe, are so punishable but murder, falsehood, and adultery when committed by married men. The act of thieving among themselves is wholly unknown, swearing is also unknown to them in their own language. Such blasphemies as are heard from them are entirely such as they have acquired by their intercourse with Europeans. They admit they rob the whites sometimes, but do not esteem this act punishable with fire. I remarked to Andy that if I told the whites all he informed me of they would laugh and say "the blacks have been told all this from the whites," to which he hastily and shrewdly remarked, "Why, whitefellow no call budgery place 'Ballima,' (nice place heaven), or other place 'Oorooma' (hell), nor God 'Boyma,' nor son 'Grogorogally,' only we blackfellow think and call them that way in our own language before whitefellow came into the country." He seemed quite amazed that whites might attempt to disbelieve their statement on that ground. Their women do not go to heaven. The men have an imperfect consciousness that there is another world for them, but not in Ballima. The strange reason assigned for this is, that Boyma and Grogorogally, having no wife and no mother, will not admit the female sex into heaven, whether they be good or evil.

I was asked by Andy if we white people thought white women went to heaven. On my expressing my assurance of it, he expressed his surprise at our strange belief in entertaining such an idea, Boyma having neither mother nor wife. "But we'll see when we die," was his final remark to this as to several other points in dispute. To women the grand secrets of their religious belief are wholly unknown. They are regarded as inferior beings, and that there is a law given them by Moodgeegally that they should always be kept ignorant of these mysteries; for that, immediately upon the women becoming informed of them, there must be an immediate end put to the whole of their race by a general massacre, first of the women, and then each to sacrifice the other until the last man survives to sacrifice himself. So rigid are the men in the observance of this supposed divine law, that in no instance has a living woman been known to have an idea of their religious belief.

It is the dread of this necessary destruction of the whole race that has in a great measure precluded the whites from obtaining information on the subject. I had in the first instance the greatest difficulty to induce the men to speak to me on these points; they required such secrecy on my part, and seemed so afraid of being overheard even in the most secret places, that in one or two instances I have seen them almost trembling whilst speaking. In one case I examined a native, and for the sake of secrecy made him come into the house. He appeared willing to afford me information; but he went two or three times to the door and window to see if any being, black or white, might by possibility overhear him, although in this respect he was perfectly safe, yet for further security he stood in the wooden fireplace, and spoke in a tone a little above a whisper, and confirmed what I had before heard. Another cautioned me to be very secret lest the station servants might hear of it, and ask his gin (wife) something about it. This particular man was the most intelligent of those I obtained information from. He asked if I would publish my notes in England, as he seemed proud to think it should be done, and did not fear mischief through that course. He said if his wife were to hear of it and ask him a question about it, he should immediately kill her to save himself and the whole race, as ordered by Moodgeegally.

Having examined a civilized native from the Lower Lachlan River, who came from a distance of 300 miles, and was living with a gentleman in the neighbourhood as servant, I had the opportunity of questioning him in the presence of my black interpreter, who explained all I could not understand. The Lachlan native's statements agree fully with all the others, excepting that he designated Grogoragally by the name of "Boymagela," which he told me meant Son of God or young god—a name as applied to Grogoragally that Andy had never heard before. The other, or Lachlan black, was aware of the name of Grogoragally, though not usually adopted in his country. The Port Phillip and the Murray natives have another name for him, which I do not remember. The souls of the dead rise again soon after interment, by the agency of the spirit of Grogoragally, who they say administers "water" to the relicts of the deceased men, which water of life being sent from the great Boyma instils fresh life into the remains; and when these are brought before the throne of Boyma, they instantly fall before his presence, when their spirits die a second death, as if to become abased before God and to throw off their mortal nature. Half an hour after this they suppose the souls to rise again in a wholly new and regenerate state; or, to use Andy's expression in his broken English, "They no good first time when come before Boyma—only all wild fellow and bail budgery (no good), and very miserable." After this new birth they become immortal. At this period it is that judgment of God is pronounced in command to his son Grogoragally. To those he has judged to be good, he orders the Son to put them into heaven—"Ballima warrior bungandinge." For those he judges to be wicked he pronounces the judgment "Gumly ganoo niagroo" ("Let him burn"). These awards to Grogoragally are the only ones supposed to have been uttered by God in the presence of resuscitated mortals.

The only prayer used is that at the interment of men, when all the adult males of the tribe assemble, and having buried their deceased friend (ordinary men in the ground, and those who possessed authority in hollow trees), they all retire irregularly at a distance from the grave, and all kneeling together clasp their hands behind their backs, and all simultaneously utter a lamenting prayer respecting the praises and good deeds of their friend, and imploring Grogoragally to intercede for his soul that it may be admitted into Ballima. After this prayer (which was represented to me), or just at its close, they have a strange superstition that always at this moment the dead man is heard to kick in his grave, which is the signal that his soul has just taken its departure to heaven. The poor women never kick in their grave nor rise to heaven—no prayer is offered for them. The custom of daily prayer to God is thought absurd; it is supposed to be only resorted to by those who have sinned and wish to escape punishment. As good men cannot have occasion for such supplication, and as they say bad men cannot profit by it, it is altogether omitted. The use of prayer among whites is ridiculed on this ground, that men pray to Boyma and praise him, and rise from their knees and curse and swear and commit rogueries. Andy's curiosity had once or twice induced him to visit the Yass church recently, when he formed this opinion of the lower orders particularly; but he thought "real gentlemen" seemed to profit by the habit of attending churches, as he seldom heard them swear, and he seemed to entertain a much higher opinion of their moral conduct. Wicked men, though sometimes unknown to men to be wicked, cannot screen themselves from the searching eye of Boyma. They, in common with other offenders, are supposed to have a mark set on them, such as small-pox, coughs &c., which, if they persist in sin, infallibly produces death. These after death are conveyed by Grogoragally to Boyma, who pronounces the judgment on them before mentioned, and then they are handed over to Wawamolongs, to remain in eternal torture in Oorooma.

Thunder and lightning are regarded as the expression of Boyma's wrath at some wicked deed perpetrated or being perpetrated by a man. It is regarded with great awe by them as by all savages, or indeed by all men who are wholly ignorant of the cause and effect. These natives do not think that some malignant being is the cause, as most other savages do; they regard it (that is the men) as a powerful sound, proceeding from an angry God, who is never considered by them otherwise than as a benevolent though dreaded being. When any recover from sickness or other calamity, it is supposed their guilt has not been too great for pardon, and Boyma accordingly restores them to health and vigour after their temporary punishment. Early death is supposed to be a sign of Boyma's wrath, for in the beginning, they say, all men were gifted with longevity, but that sin cuts them off in their prime. Old men must be good men, as Boyma would otherwise have shortened their days. When the good old men become by their nature infirm and incapable of enjoyment, Boyma releases them from the world in compassion, and immediately they are transferred to the abode of the happy in Ballima.

The religious mysteries are not divulged to boys until they arrive at the years of puberty, and not until the ceremony of "Irangung" has been performed upon them, a practice which may be regarded as a kind of adult baptism, as the boys are then taught to know and believe in the mysteries of the religion of their forefathers, the nature of the creation of the world and of all things, and to believe in a future state of immortality and of rewards and punishments. The age of puberty is adopted for the ceremony evidently from expediency, and from a care not to trust younger boys with those secrets which their carelessness or their ignorance of the nature of a vow or moral obligation might lead them to reveal. The age of the boys on whom the Irangung is performed is about fourteen years. The blacks consider this ceremony sacred, and to be especially sent from Boyma through Moodgeegally. The forms of ceremony involve the necessity of having the front tooth knocked out with sharp stone tools. At this ceremony all the neighbouring tribes for perhaps one hundred miles around assemble together in a secret place. The men select from the whole body of blacks such young men as they deem fit to be iranganged. They may find from twenty to thirty fit for the ceremony, in proportion to the total number congregated and to the length of time elapsed since the last similar occasion, which only occurs at periods varying from one to three years. These youths being selected by the older men, are painted all over with red ochre and then formed into a ring. This being done, all the women and all the children over two years of age are ordered to lie down and to conceal themselves under their opossum cloaks, which they must do at the peril of their lives. The men then heap upon them light leafy boughs of trees, to insure their safer concealment. Upon this being done—and no white man dare be admitted to witness the ceremony—the grown and selected boys are, by a signal of one specially authorized, ordered to go off into the "bush" in a certain direction, and are accompanied by all the men, excepting one, who remains, spear in hand, as a guard over the women and children, and who is the one they say is gifted with sacred authority from Moodgeegally. Him they call a "Yaweyewa," and Andy compares his office to that of our priests or parsons. This Yaweyewa, soon after the other party is out of sight, tells the women to rise, and directing them a contrary course to that taken by the men and youths, accompanies them and remains on guard all the ensuing night. The same ceremony exists among the Darling River and Queensland blacks, where it is called the "Boree," for making youths men.

At this time all the grown boys are conducted by the men to a most secret spot, where the ceremony of the irangung is completed. The front tooth of each is knocked out, some ten or twenty men standing over each youth, pointing their spears in a menacing manner close to his person, and others holding his hair tight, make him swear most solemnly never to divulge to the women and children those sacred secrets about to be told him. To this the affrighted lad is forced to consent upon pain of his being instantly speared and cut to pieces. The solemn oath being thus administered to each youth, the authorized priests divulge to the youths their religious creed, and when the terrifying ceremony is completed, they are taught a sacred song sent by Boyma through his Son Grogeragally and Moodgeegally. This song is held in such solemn reverence, and known under such severe secrecy, that I found it quite impossible to make my informant reveal it to me. My pressing him only seemed to make him impatient and angry, and as he said he dared not do so because it was against the laws received from Moodgeegally, I desisted from any further attempt. He then said he was sure that I already knew more of their *secrets than any other white man did, and that he was satisfied that no others supposed his countrymen entertained any such religious belief as he and others had revealed to me.* Youths cannot marry until they have gone through the ceremony of irangung, and any boy dying before this kind of baptism does not go to Ballima, but shares the same fate as the luckless women. On the death of a husband the survivor is forbidden by Moodgeegally's law to marry for a long while. Should this law be broken, both parties are killed as soon as discovered, as it is thought their conversation on the deceased man must be prejudicial to him and would displease him.

The term corrobery is generally understood to signify a dance, whereas it is a changing ordinance of Moodgeegally, and is supposed to be transmitted from tribe to tribe from the far northeast. I cannot clearly understand this strange mystery, but I am aware that the ceremony is a very solemn one among the adults when it does take place. It has for its form the most curious painting upon a sheet of bark, done in various colours of red, yellow, and white ochre, which is exhibited by the "Yaweyewa" before mentioned, who is appointed by descent from Moodgeegally. This sacred ceremony is as secretly conducted as the "Irangung" or Boree of the north. A gentleman of my acquaintance chanced to come on a tribe whilst this ceremony was going on in a deep gully in the ranges. He had reason to apprehend that some violence would be done to him for his intrusion, but was saved by the intercession of one or two who knew him well. He saw the sheet of bark, and represented it to me as being most singularly painted, and was done so neatly as to resemble figured oilcloth. It is consequent on these sacred occasions that they meet and have those night dances which are ordinarily called "corrobery."

To Boyma is ascribed the creation of all the heavenly bodies. They believe the earth to be an immense plane, and fixed, the sun, moon, and stars revolving round it to give it light. On my representing the fixed position of the sun, the rotundity of this world, and its own diurnal and annual motions, he was quite amused at our strange belief, and endeavoured to convince me we must be wrong. This he did, not on the similar and false showing of Tycho Brahe to the same effect, nor against the true system of Copernicus, Galileo, Kepler, Newton, and others, but *a fortiori* by his assigning his own singular reasoning, that "if the sun never moves whereabouts is Boyma's Ballima?" This I could not understand until it was explained that the sun came from the neighbourhood of God's heaven every morning, and, after running its daily course to give them light, passed under the earth, and returned to Ballima for the night, causing eternal day in God's heaven. Nothing could induce him to regard my statement with anything but ridicule, saying, "I would not believe that if everybody said so, but we will see when we die, but not before." Knowing that the blacks assert that Ballima is fixed in the north-east, that it stands distinct, and that connection with the world is by their very high "Dallambingal" mountain, on the top of which is a step-ladder uniting earth with heaven, I felt that this *argumentum ad hominem* was too much for my logic, and consequently I beat an honorable retreat, on which my opponent gloried very much.

I thought afterwards that Andy might, by his own reasoning, have asked what would become of the step-ladder which connects heaven and earth at the top of Mount Dallambangil if the sun was fixed and the earth revolved as I stated. To Boyma is ascribed the creation of the whole universe; therefore they believe him to be self-created, and that he formed everything out of nothing. Upon this peculiar point I asked Andy how he accounted for God's own creation? He replied that he arose out of the glassy mountain which forms his throne, and to which he is supposed to be immovably fixed. I then asked him how came the creation of the primitive crystal mountain in Ballima. He replied that "it rose out of the great water and clouds"; but on being again asked to account for the creation of the great water and clouds, he replied that "Boyma made it, he believed," adding significantly, and looking fixedly at me, that "he could not tell, nor any one else—('Bail me know')—do you?" The sun, they believe is only the orb of light, and not the means of producing heat, or by the greater or lesser ecliptical altitude of the earth producing the change of seasons. In endeavouring to undeceive my sable friend in this, too, I had the same difficulty as in the other instance of the earth's and sun's motions. In again ridiculing our assertions that the sun was the cause of all heat, he remarked that "if the sun makes the warm weather come in summer-time, what for not make the winter warm as it is seen every day?" The influence which produces heat, in their belief, accompanies the Pleiades (mangudia). When the mangudia are visible at a certain altitude above the horizon it is spring (begagewog). When it rises to its highest altitude, it is summer, "winuga," and upon this cluster of stars sinking again towards the horizon in autumn, it is "domda." In winter when the Pleiades are barely visible or lost to view altogether, it is then winter (magur) and cold. The ordinary stars (miunga) have no kind of influence on the seasons, but simply the Pleiades. The constellation Mungudia is retained by Boyma near Ballima during winter, in the same way that they believe that the sun (Bungal) is retained by God during the night, and both are sent to give light and heat during their respective seasons. The clouds that obscure the sun in all seasons equally obscure the influence of heat from the Pleiades, and therefore they have no belief in the power of the sun's rays to produce heat, but only light. [The ancient Greeks determined their seed-time and harvest by the position of the Pleiades.] The Latins designated them vergiliæ, from their being first visible in the spring, "ver."

The above notes comprise all that is most interesting of what I have gathered from time to time. On further opportunities presenting themselves I may gain more information. The sense of Deity, like many other delicate senses, being in all savages faint and obscure, it is not easy to obtain information on these points without a great deal of premeditated questioning. These notes are, however, sufficient to prove that, however faint and obscure the religion and moral sense of the aborigines of this country are as compared with that of enlightened nations, enough is shown that, although very humble as the natives of New Holland are in the scale of human nature, they are not without a very high sense of the supreme Godhead, and of a moral conception of what is right and wrong; that their religious creed is far less erroneous and extravagant than that of most other savages, and that above all, their belief bears a most singular and striking analogy, excepting in its crudities, to the Christian and Jewish faiths. However, notwithstanding my own improved opinion of the character of our aborigines, I do not think it possible or perhaps desirable to confuse their faith by any attempt to enlighten them in the Christian belief. I do not think them capable of understanding such truths, or of being brought to believe in any other creed than in that which was born with them and their forefathers; and if this difficulty were not enough, there would, I think, be an insuperable one in consequence of those supposed divine laws which so strictly enjoin secrecy on these subjects towards women and children. I apprehend, therefore, that any pious attempt of any class of missionaries will never prove otherwise than abortive, unless perhaps to the extent of gaining the natives to utter parrot-like and unmeaning mockeries of hymns and prayers of no lasting moral or religious value and effect. The natives of New Holland must, it is to be feared, continue in their ignorance; and those good men who might wish to reclaim them to the Christian faith will, I think, have to content themselves with a consciousness that those blacks have a religion implanted in them which exercises a beneficial effect upon their moral intercourse with each other; and that the hope that if they obey the Divine laws of their God as given to them by his Son "Grogoragally," through "Moodgeegally," their great lawgiver, on Mount "Dallambangel," they will inherit eternal life and happiness in Ballima or heaven. This latter remark, unfortunately only applies to the men and adult youths. It would be well if their women rejoiced in the same belief, and were not kept under such strange, debasing, and superstitious ignorance. It must be palpable to any one who has seen much of the natives of this country how very inferior the women are to the men in intellect,— an effect which can readily be traced to the cause of their not sharing with the men the beneficial influence of a religion which, however strange and absurd in some respects, works for good in the development of the men, by producing on their savage minds a superstitious awe and reverence towards their ideal God and the God of their forefathers.

Cumbamuzzo, Jugyong Creek, January, 1848.

Discussion.

In answer to a question from the President, Mr. Manning related an interview he had with Goethe, the great German poet, poet, fifty-one years ago, and just eight months before he died, at the age of eighty-five. At that interview the question of foreign missions had been brought up, in which Goethe showed himself well informed, but concerning which his guest had but little knowledge. The conversation made an impression upon Mr. Manning, and it was in some measure due to it that he set to work in after-life to gather information concerning the religious belief of the aborigines of New Holland.

Mr. J. F. Mann gave very interesting reminiscences of his intercourse with native tribes in the Colony, he having spent about thirty years of his life in the bush. He had taken a great interest in their customs and mode of life, but he had never met one aborigine, notwithstanding the paper read, who had any true belief in a Supreme Being. They sometimes spoke of a god, but upon cross-examination admitted that what they told the auditor they had learned from a missionary or some resident in the district. With all uncivilised tribes, as it is with not a few members of civilised communities, curiosity is a leading trait. When the blacks were numerous and the whites few the greatest possible curiosity was shown by the former in the movements and actions of their "pale-faced brothers," and gathering scraps of information from them they carried the news from tribe to tribe, and some of the gossips having fully developed imaginative powers, the stories lost nothing in the telling. From missionaries and residents they obtained a dim insight into the Christian religion, and by this fact some of those who had associated with the tribes and had been admitted to the confidence of many of their members, accounted for the wonderful revelations made by some of the blacks with regard to their religion, which, as described by Mr. Manning in his very interesting "notes," has a strange relationship to that of Christians in the belief in a Divine Being, a Son of God, a future heaven and a hell. Messengers were occasionally sent from tribe to tribe. One of these couriers would often travel through the bush a distance of 100 miles. On the arrival of one of these messengers at a camp the talking at once ceased, and one of the tribe nodded in the direction of a certain portion of the bush. Looking in that direction I saw a blackfellow coming slowly through the forest. He gradually advanced to the camp and sat down about 50 yards distant from it. He appeared to pay no attention at all to those in the camp. He held a sprig of a branch in his hand. Then one of the tribe advanced, and taking up a twig lit it at the fire and held it up as a token of friendship. The messenger then came forward, and was warmly greeted. On his journey he had doubtless picked up many odds and ends of news, and listening to his story the tribe sat round the fire all night, and no doubt wove into fictitious traditions many a story to be told in the future to the white man. There would appear to have been among the tribes a national or religious custom of burying the members after death on the spot where they had been born. In one case a dying boy had been carried on the shoulders of his father, and accompanied by the tribe, a distance of about 40 miles to the bank of the Hunter River, where he died about twenty-four hours afterwards. A deep hole was dug and lined with grass, the boy was rolled in a blanket, and placed in the grave. Then the gins cut their heads with tomahawks in token of their grief, and the men and women dividing, the one class went in one direction, the other on the opposite, and, rubbing their hands, raised a mournful song. On one occasion a gentleman was dining at the house of a friend, residing near the M'Gregor River, when the cook ran into the room and said that there was a black man outside, who insisted on cutting down one of the posts of the kitchen door. Going out to expostulate with the man, they found him very obstinate, and it was not till the friendly medium of a bottle of rum had been produced that he could be persuaded to desist from his attack. Afterwards he selected a spot not far distant from the kitchen, where he commenced digging operations, and they learned then that at that spot had been born one of the tribe who had died, and whom his countrymen wished to bury there. Women had also been seen carrying about the skeletons of men wrapped in hides, and seeking a place of burial for them. In Queensland, upon the death of her husband, a gin had to go in mourning sometimes for the space of two years. During this time she was interdicted from eating certain kinds of food—for example, anything that climbed upon trees—and on no account could she be again married till the time of mourning had expired. She plastered clay on her face and mingled it with her hair. A general impression prevailed that thunder and lightning came from the evil spirit or "devil-devil," and during the continuance of a storm great respect was paid to the manifested power of the "bad fellow." Once during a storm a white man, who was assisted at his work by an aborigine, told his fellow-worker in a loud voice to put the saw he was using under a log, and to go under shelter. He found that the saw had been put away and the blackfellow who had got under cover was very indignant at his master having spoken as he had. "What for speak so loud?" said he, "now um thunder hear and know where um saw is," and he went out and shifted the saw to a new hiding-place. Between the missionaries and the rum the unfortunate blackfellows occasionally got very mixed in their newly acquired theological doctrines. A blackfellow went up to a gentleman on a visit to a homestead, and remarked to him, with an air of conciliation and friendship, "White one steal peach." The gentleman, knowing that there was a large orchard near to the homestead, thought some of the men had been pilfering; but upon making further inquiry from his informant he was told, "No, no; first fellow steal peach." The little transaction referred to was that between Adam and Eve. The account of Noah's Ark was a very general cause of confusion. As a rule, the aborigines were totally incapable of remembering quantity, number, time, or space. A pleasant little ceremony was the admission of the youth of a tribe, on coming of age, into the participation of certain secrets and privileges. For some time previous to the initiation, about six months, the boys were starved down, and on the day appointed the tribe assembled and the chief elder of the number knocked out the front tooth of each with a stone hatchet. The secrets of the tribe were then told them apart from the women, and they were compelled to sleep for the night on the graves of the departed patriarchs of their families, they being thus supposed to absorb the virtues of the deceased. One lad who related the story of his initiation stated to the narrator that he had trembled with fear and the perspiration had poured from him whilst he was taking in the essence of his deceased great-great-grandfather. The old gentleman had been a celebrated fisherman, and it was hoped his great-great-grandson would follow in his footsteps. Certain men who held the rank of doctors in their tribes always carried with them a crystal, which was supposed to be possessed of some supernatural power. A blackfellow, in whom he had the greatest confidence, once took him aside in a most mysterious manner. The black man led him to an inner room of the house, and after looking carefully around that no prying eyes should watch their movements or listening ear hear their words, he said he would show the white man his crystal, he being a doctor in his tribe. The man was divested of all clothing except his loin cloth. He saw the man lift his head, and then there gradually rose in his throat a little lump which ascended slowly to the man's mouth. He opened his mouth and spat out a crystal amulet. He opened his mouth again, replaced the "fetish," and the crystal returned down the throat. Mr. Mann assured his auditors that he in person had seen what he related, and incredible as it might appear, it was nevertheless true, and if the possessor had not transferred the amulet he had no doubt it was now in the grave in the stomach of its owner. These crystal charms were supposed to render their owners invulnerable. The aborigines possessed a very extensive knowledge of the properties and uses of plants, and they were ready in concocting stories which afterwards they told to white men as traditions of their tribes, whereas in truth they were but fictions founded on scraps of information they had picked up from associating with the whites.

This is the photograph of "ANDY," the aboriginal, who gave nearly all the information contained in Mr. James Manning's paper to the Royal Society, on the subject of the religious creed and superstitions of the natives of New Holland. The photograph was taken at Yass, nearly twenty years ago, and some twenty years after the date of the Notes of 1845.

Mr. Palmer said that his experience of the aborigines of Northern Queensland supported what had been stated in Mr. Manning's notes. He was quite convinced that there existed among them a belief in a Supreme Being. He offered to, at some future time, embody his notes in a paper to be read before the Society.

Other members referred to the customs of the aborigines and their religious observances.

A suggestion was made at the meeting that as it would soon be very difficult to collect any information from the blacks, who were so rapidly dying out that they would soon be extinct, it would be wise to collect all the notes in the possession of those white residents who had had intercourse and constant conversation with the aborigines in the early days of the Colony, in order that some record of their manners and customs might be preserved.

Mr. Manning, in reply, again expressed his full belief in the authenticity of the information he had received from Andy, his aboriginal informant.

On the Ashes of some Epiphytic Orchids.

By W. A. Dixon, F.I.C., F.C.S., Lecturer on Chemistry, Technical College, School of Arts, Sydney.

[*Read before the Royal Society of N.S.W., 6 December, 1882.*]

Last year I submitted to the Society analyses of the inorganic constituents of some epiphytic ferns (Journ. Royal Society of N.S.W., XV, 173), and the present communication is a continuation of the same work on other aerial-growing plants. As there are considerable difficulties in the way of a resident of Sydney obtaining a supply of these plants, I have but few results to place before you—too few indeed to allow of much discussion, but I venture to publish such as I have, as the subject opens a new field in phyto-chemistry.

As in the case of the ferns referred to, it was evident that in these plants the ash constituents, which are present in considerable quantity, are obtained from dust, as some was found in the axils of the leaves. This dust was removed as far as possible before incineration, but it was impossible to do so completely without cutting up the plants and washing them, which, from their succulent character was inadmissible. From this cause the crude ashes were found to contain from one and a quarter to nearly thirty per cent. of sand and silicates, undecomposable by a short treatment with hydrochloric acid. This has been deducted from the analyses, with the carbon dioxide and residual carbon, which has not been done with the soluble alumina, as there was no observable ratio between the sand and it in the different plants. Such a ratio would probably have been found to exist had both been derived from adherent dust, as all the specimens were obtained from the "brushes" on the alluvial soil of the Clarence River. I would not, however, venture to say definitely that alumina is a necessary ash constituent, without a further careful examination of other specimens of the plants. The plants were charred at a dull red heat, and the combustion of the carbon effected at as low a temperature as possible; the latter process not being carried very far, not only to prevent loss of alkalies by volatilization, but also to prevent as far as possible their action on the silica.

Sturmia reflexa.

Potash	24·81
Soda	5·21
Chloride of sodium	5·23
Lime	24·37
Magnesia	4·60
Ferric oxide	5·06
Alumina	18·37
Phosphoric oxide	1·76
Sulphuric "	1·80
Soluble silica	8·25
	99·46
Ash of the composition given	8·16 per cent.

Dendrobium Hillii.

This was a large specimen, the pseudo-bulbs being about 14 inches long, and in it the actively-growing bulbs with their adherent leaves, and the roots and dead parts were examined separately, those parts which were merely withered being rejected.

	Live parts.	Dead & roots.
Potash	36·04	......
Soda	3·31	......
Chloride of sodium	8·76	8·92
Lime	30·60	17·58
Magnesia	11·41	2·50
Ferric oxide	1·37	14·08
Alumina	4·36	26·79
Phosphoric oxide	2·36	7.17
Sulphuric "	·31	5·13
Soluble silica	1·52	18·08
	100·04	100·25
Ash of the composition given	6·68	2·33 per cent.

In the crude ashes the live frond parts contained 4·44 per cent., whilst the roots, &c., contained 78·85 per cent. of sand, although the plant had grown on a tree. The second analysis shows a great removal of ash, two-thirds of the entire quantity, including all the potash, having been apparently appropriated by the growing parts.

D. Kingianum.

Potash	22·60
Soda	1·99
Chloride of sodium	17·20
Lime	24·00
Magnesia	7·54
Ferric oxide, Alumina	12·78
Phosphoric oxide	7·37
Sulphuric "	2·34
Soluble silica	3·68
	99·50
Ash of the composition given	2·13 per cent.

D. Linguaforme.

Potash	17·11
Soda	18·21
Chloride of sodium	1·92
Lime	38·98
Magnesia	10·93
Ferric oxide	traces
Alumina	8·12
Phosphoric oxide	·14
Sulphuric "	3·22
Soluble silica	1·78
	100·48

Ash of the composition given ... ... 4·56 per cent.

The small quantity of phosphoric oxide in this ash is peculiar, as is also the large quantity of soda; but second determinations being made by my assistant quite independently, I have no doubt as to the accuracy of the numbers.

A Fossil Plant Formation in Central Queensland.

By the Rev. J. E. TENISON-WOODS, F.G.S., F.L.S., Vice-President Linn. Soc. N.S.W.; Hon. Mem. Roy. Soc. N.S.W., &c.

[*Read before the Royal Society of N.S.W., 6 December, 1882.*]

I WISH to bring under the notice of the Society a fossiliferous formation in Central Queensland, which has recently yielded plant remains which are new to Australia. It is situated on the central line of railway, which runs westward from Rockhampton to the Drummond Range, a distance of about 230 miles from the farthest navigable point of the Fitzroy River, and nearly 300 miles from the sea. It is intended to carry the line far into the plains of the western watershed, but as yet it has not crossed the divide. It is necessary to bear this in mind in considering the relations of the rocks exposed in the railway cuttings. There is no part of the continent where the Dividing Range makes so far a curve inland from the sea. Even when the Drummond Range is cut through, the railway will not be found upon western waters. The valley of the Belyando will be reached, which is a tributary of the Burdekin River. On the further side of this valley will be the real divide. I shall have occasion to refer to this more particularly in the latter part of this paper. In the Drummond Range occurs the fossiliferous formation whose plant remains I am about to describe. Its highest point where the railway crosses is 1,840 feet above the sea-level, at 235 miles from Rockhampton.

After crossing the basaltic plains west of Emerald, with their immense tracts of brigalow scrub, a remarkable change occurs in the geology of the country, at a place called Zamia Range, 1,180 feet above the sea, at the railway cutting 213 miles from Rockhampton. The soil is sandy, supporting an open forest of *Eucalyptus melanophloia*. The railway cuttings expose one or two igneous dykes, and some granite, or metamorphic rock of some kind, which is not exposed beyond the weathered portions, and therefore its true character is difficult to determine. It is mingled with a stratified rock, in which no fossils could be detected, but in appearance it was like some of the oldest mesozoic rocks in Victoria; it overlies, as it seemed to me, certain dark brown sandstones, which soon rise to the surface and occupy the whole extent of the country around. The rock forms low outliers from the Drummond Range, giving an undulating but not rugged outline to the country. The dip is very regular to the eastward, but the inclination is slight, hardly more than 10 degrees. At about 10 miles from the range an anticlinal axis is crossed about 1,200 feet above the sea-level, and then the dip is regularly to the westward, with the same or a less inclination. As the chain of mountains is approached, it is seen to consist of a series of terraces or escarpments facing to the eastward. The lines of bedding are very visible on all the sides of the valleys, and give the scene a remarkable and characteristic aspect. The sandstone is now and then interrupted by beds of shale of a dark and earthy composition. It weathers into a fair soil in some places, but is generally poor and sandy.

A little beyond Bobuntungen, which is the last station on the railway, there is a heavy embankment, and the stones composing it are entirely derived from the sandstone range. At the first glance I was struck with the number of plant impressions they contained, none of them being sufficiently well preserved to admit of their identification. There were some long, linear, narrow, ligulate leaves which strongly resemble the *Cordaites australis* of McCoy, to which reference will be made presently. It was found afterwards that these leaf-like impressions were in reality stems of *Calamites.* The discovery of this much, however, encouraged me to a closer and more extended exploration of the rocks around, and soon an immense number of fragments of stems of *Lepidodendron* and *Stigmaria,* with *Calamites,* were obtained. I spent in all a week at Bobuntungen, yet being occupied in other ways I could not give to the formation all the attention I desired; but I found an active co-operator in Mr. Phillips, the Station-master, who, since my departure, has been indefatigable in seeking for well-preserved specimens from the abundance of fossils in the locality. I have lately received from him a small box of fossils which are of the highest interest, and which, together with my own collections, will form the subject of this evening's paper.

Before entering into a description of the species, it may be well to give a retrospect of what has been done hitherto by geologists in illustrating the paleozoic plant remains of Queensland. In 1861, the Rev. W. B. Clarke, F.R.S., in a paper read before the Geological Society of London (see vol. xvii, p. 354), speaks of the occurrence of shales and grits charged with plants in Queensland, associated with calcareous beds holding abundance of Carboniferous and Devonian zoological forms. These referred to the Bowen River and other coal-fields. In 1872 Mr. Daintree gave to the same Society a sketch of the geology of Queensland (see vol. xxiii, p. 271), in which were fuller details. He says, at p. 288:— "*Devonian.*—From the southern boundary of Queensland up to lat. 18 degrees south, a series of slates, sandstones, coral limestones, and conglomerates extend to a distance of 200 miles inland. These are sometimes overlaid by coal measures, sometimes by volcanic rocks, and consequently do not crop out on the surface over such districts * * * In the higher members of this group, which from their general analogy to the English group of that name we will term Devonian, specimens of fossil plants are abundantly met with." Mr. Carruthers, F.R.S., has described and named those from three widely separated localities—Mount Wyatt, Canoona, and the Broken River—and refers them all to one form, *Lepidodendron nothum*, Unger (not Salter's species of that name). To the same paper Mr. Carruthers added an appendix in which the fullest details of the plant were given. He states that the collections of Mr. Daintree were so full and complete, and so much more perfect than any previously at the disposal of palæontologists, that he was able to give a description of the whole plant and clear up every doubtful point of its structure.

Before giving details of the species I have recognized, it may perhaps be as well to remind the members of the Society who may not have access to all the literature of the subject, of the progress that has been made in this portion of palæontology. The plants of the early geological periods differ so completely from anything existing at the present day that they presented very puzzling problems to palæontologists. This is not a matter of wonder when we remember how fragmentary were the specimens submitted to their examination, and how rare it was to find stem, leaves, roots, flowers, and fruits so associated together that they could be recognized as belonging to one plant. To add to the difficulty of the problem, it has been found that in these extinct forms of vegetation the various parts of the plant were more differentiated and specialized than they are now. Thus roots of plants in the present day are very uniform and simple organs; in fact, so uniform that only slight difference or no difference can be traced between those of shrubs or trees widely separated in every other respect. But the roots of coal plants seem to have been very different structures. *Stigmaria*, for instance, is now known to be the root of trees resembling our club mosses, called *Sigillaria*. But these roots were arranged in a regular spiral series. They were swollen fleshy tubers, articulating by a joint to the rhizome, having peculiar scars in the bark outside and in the woody tissue underneath. Furthermore, they are forked or divided, and terminate in an obtuse apex. No wonder that Sternberg, when he found these rootlets by themselves, compared them to arborescent euphorbiaceous plants. Von Martius referred them to a fleshy composite (*Cacalia*) or a fig-tree. Brongniart classed them with the Lycopods, but later as roots of such peculiar conifers as in his view *Stigmaria* were. Corda regarded them as plants uniting the characters of houseleek, euphorbias, *Cactus* and *Zamia*. Lindley and Hutton took them for the fleshy leaves of some horizontal subterranean tree entirely different from anything at present known. In the course of time the discovery of true Lepidodendroid trees with upright stems and with roots (*Stigmaria*) in the ground has manifested the true character of these remains.

In like manner, different portions of the same plants have been subjects of doubt and controversy until their nature and office was known. The cones, or fruit spikes, of *Lepidodendron* were called *Lepidostrobus*; *Cyperites* was the name given to the leaves, *Sternbergia* to the pith, and *Knorria* to the internal casts of the trunk.* Other specific and generic distinctions were built upon the mode of preservation, which was subject to great variation, for the stems of these trees were soft and hollow, or at any rate filled with a soft yielding pith; then, when the entombing rock pressed upon them in the course of time, they became flattened, and the sections of round stems, or the cast of the interior, were thinned at each end, so that the section became like the section of a lentil.

All these remarks are necessary to understand the character of the fossils which I exhibit this evening. They have been subjected to great pressure, and there are fragments of all the different portions of the plant. I will begin by describing the species to which most of them must be referred.

Lepidodendron Veltheimianum.

Sternberg—Flor. d. Vorw. I, part 12, pl. 52, fig. 2. See also Schimper, "Paléontologie Végétale," vol. ii, p. 29, atlas, pl. 59, figs. 6, 7, 8. Schimper gives a large list of references and synonyms, which I need not quote here. See also Feistmantel "Paleozoische and Mesozoische Flora des öestlichen Australiens"—Cassel, 1878 and 1879, p. 151, pl. 5, figs 2 and 3 (though doubtfully referred to this species); pl. 7, fig. 2; pl. 23, figs. 2 and 3.

Apparently a moderate-sized tree, with dichotomous branches, covered with a network of very narrow leaf-scars; leaves narrowly lanceolate, spreading, slightly incurved; scars of the branches erect, rhomboid, close, with an obovate cushion accuminate at the base, keeled, furnished with a transverse rhomboid cicatrix; scars of the trunk oblong-rhomboid, apex and base long and acuminate, subinflexed, and after the disappearance of the little cushion, fusiform.

This plant is characteristic in Europe of the lower coal formations, corresponding to the carboniferous limestone. It has been found in many places in Silesia, in the *Posidonomya* schists at Magdeburg, in the Hartz Mountains, at Nassau, in the valleys of Thann and Niedurburdach; in France, in the Upper Vosges, and in the coal-seams of the Black Forest. This fossil is also, according to M. Geinitz, the same as *Ulodendron ornatissimum*.

* But the name *Knorria* is now generally applied to a genus of plants like *Lepidodendron*, but with peculiar fleshy leaves.

In the 3rd edition of the late Rev. W. B. Clarke's "Sedimentary Formations of New South Wales" (1875), at p. 17, mention is made of a species named *Lepidodendron rimosum*, of which in 1878 Feistmantel gave a fig. (*loc. cit.*), remarking that it seemed more to resemble *L. veltheimianum*. Before this, in 1876, as I shall state subsequently, Professor de Koninck had submitted about twenty plant specimens sent to him by the Rev. W. B. Clarke to the eminent Belgian palæontologist, M. Crepin, of the Brussels Museum. Though the specimens were in a very bad state of preservation, he was able to recognize *L. veltheimianum*, besides *Calamites radiatus* and *C. varians*, all of which we shall see are found in the Drummond Range. Dr. Feistmantel was not aware of Mons. Crepin's determinations at the time he pronounced upon his specimens, so that the independent testimony of two such eminent and experienced authorities gives additional weight to the identification. Mr. Clarke's fossils are quoted by De Koninck as from the quarries of Murree, Russell's Shaft, Glen William, Burragood, and the Ichthyodorulite Range. Dr. Feistmantel's examples came from the strata of Smith's Creek, near Stroud, and the Rouchel River.

Amongst the numerous examples found in the Drummond Range, there are many compressed branches which have formerly been cylindrical, and instead of having the lozenge-shaped depressed leaf-scars with a raised margin, are marked with impressions of distant narrow-pointed leaf-like scales. They exactly correspond with the figure given by Feismantel in the above work, at plate 23, figs. 2 and 3, and which are lettered *Knorriastadium* (?) of *Lepidodendron veltheimianum* (?), the doubtful note in both cases being that of Dr. F. They came from Smith's Creek, New South Wales. I think there can be but little doubt, from the mode in which they are associated, that they belong to the same plant. There are also smaller stems, of which I figure one example, which seems to me like the internal casts of the smaller branchlets. The surface is covered with raised cushions, which are closely quincuncial. The cushions rise gradually towards the apex, and have an imbricated appearance. In the larger examples the cushions are longer and very much narrowed. I think we have in these, internal casts of the branches. If we suppose the external scars to be raised in such a way as to give rise to a corresponding depression in the internal cylinder, then the casts would present the appearance noticed above. Moreover, they are ill-defined, and without any leaf impressions, just as internal depressions would be. The stone is quite fine enough to retain the most delicate marks where they exist. The shape of these casts also confirms this explanation, for they are always more or less cylindrical, or the casts of cylinders which have been compressed. Whenever the exterior of the branches is exhibited, it is on the surface of concave casts.

CYCLOSTIGMA. Haughton.

The plants thus distinguished were first brought to the notice of science by Dr. Haughton, in a paper published in the Annals of Nat. History for 1860 (3rd ser., vol v., p. 444), entitled "On Cyclostigma: a new genus of fossil plants from the old red sandstone of Kiltorkan." *

CYCLOSTIGMA AUSTRALE.

Feistmantel, *loc. cit.* p. 76. A tree trunk with slender terete branches, cushions or raised scars subglobose, pitted, approximate, spirally disposed, impressions oblong oval, rather deep, situate in the upper portion of the oblong ovate tubercle. The species was found in two places in New South Wales, according to Dr. Feistmantel, namely Goonoo Goonoo Creek, near Tamworth, and at Smith's Creek. Dr. Feistmantel was of opinion that the species was so near *C. Kiltorkense* that he could see little difference, but lest he should make a false identification in a plant where the details are so few and simple, he preferred to give it another name. He gives figures of a few specimens at pl. i, fig. 6, a doubtful identification, pl. iv., fig. 3, pl. v, fig. 1, pl. xxii, fig. 1. Amongst the Drummond Range specimens I have only one which can be referred with any probability to this species, and in this case the impressions are so faint and worn that I describe it as a *Stigmaria (Cyclostigma ?)*. I quote from the Rev. Dr. Haughton's paper somewhat fully, because his description corresponds so well with the strata of the Drummond Range that lithologically they may certainly be said to belong to one formation. The rose pink sandstone in which some of the fossils are embedded, and the golden yellow colour of others, is especially remarkable.

"The fossil plants of the yellow sandstone of the county Kilkenny occur, as they do in other parts of Ireland, in the sandstone lying immediately under the great mass of the carboniferous limestone, which constitutes the most important member of our Irish fossiliferous rocks. They are found at Jerpoint, about a mile and a half south of the Abbey, on the roadside near the corn-mill, on the road to Ballyhale, about 90 feet below the lowest bed of limestone, in rocks composed of red, whit , and blue limestone, with triboliths formed of pink quartz, rounded pebbles grooving the hone stone ; and above the plant beds a remarkable white grit conglomerate is found. The plant-beds, on the same geological horizon, are also found in the railway cuttings at Ballyhale. They are found, however, in the greatest abundance, and in

* Other species have since been described by Heer. Fossil Flora de Burren Insel, p. 43, pl. xi ; by Lesquereux, Geol. Survey of Arkansas, p. 311, pl. iii, fig. 3 ; and Dawson, Fossil Plants, Geol. Survey of Canada, p. 43, pl. xiii, figs. 92 to 96.

the best state of preservation, on the top of the Kiltorkan Hill, near the railway station of Ballyhale. I believe the plant-beds on the summit of this to form an 'outlier,' and to occupy the same geological position with respect to the limestone as the beds at Jerpoint and those of the railway cutting. The fossil plants here found have never been described except casually. They consist of remains of a large fern, called *Cyclopteris hibernica*, by Professor Forbes, associated with a large bivalve, named by him *Anodon jukesii;* of undescribed dermal plates of a cartilaginous fish, probably a species of *Coccosteus;* and of numerous unknown plants closely allied to *Lepidodendron*, and so named by Professor Forbes and M. Brongniart, the latter of whom has named a remarkable species, preserved in the Museum of the Royal Dublin Society, *Lepidodendron griffithsii.* Others of these fossil plants have been named *Knorria;* and a large undescribed group remains, to which I propose to give the name *Cyclostigma.*"

CYCLOSTIGMACÆ.

A natural order of fossil plants found in the lowest beds of the carboniferous system, part of the oldest flora known to have existed on the globe, probably closely allied to the orders described as *Knorria*, *Lepidodendron*, and *Sigillaria*, known only by their leaf-scars and leaves, which were arranged in alternate whorls, plants not jointed at the whorls, the leaf-scars perfectly circular, showing in many cases a minute and well-marked dot in the centre, probably coinciding with a central bundle of woody tissue. Many of the larger plants show traces of a thick central woody axis, like that found in *Stigmaria;* stems much crushed and flattened, as if they were not woody throughout. They approach nearest to *Stigmariaceæ*, from which they differ in the leaf-whorls being further apart and more distinct. There are many varieties of this remarkable fossil, showing the alternate whorled arrangement of leaf-scars. None of them are perfect stems, but appear to be torn portions of the rind of large plants which have been macerated by floating for a long time in water. In the quarry of Kiltorkan the *Cyclostigma* is found in layers different from those in which the *Cyclopteris hibernica* occurs. In some specimens of *Cyclostigma* the leaf-scars are closer together than in the last, and are somewhat oblique to the transverse line of the stem—this obliquity being due to distortion caused by lateral pressure of the mudstone in which the fossils occur. The whorled arrangement of the leaves, each whorl being alternate to that above and below it, is frequently well shown.

Mr. Carruthers, in his appendix on the fossil plants (see Daintree on the Geology of Queensland, *loc. cit.*), says:—" Among the Devonian fossils presented by the Rev. W. B. Clarke to the Society's museum there is a fragment of a lepidodendroid plant which I cannot separate from that found at Kiltorkan, to which Dr. Haughton gave the name of *Sigillaria dichotoma*, and afterwards of *Cyclostigma kiltorkense*, and which, after receiving many other aliases, should be named, I believe, *Syringodèndron dichotomum*, as being a species of that genus as amended by Brongniart in his 'Histoire,' and again in his 'Tableau.'"

Order CALAMITEÆ. Brongniart.

(See Schimper, *op, cit.* vol. i, p. 291.) For the convenience of students in Australia, where the works of Schimper, Brongniart, Ettingshausen, &c., are so difficult of access, I give an abridged notice of the literature of the order, and fuller descriptions of its character. This order is distinguished from the *Equisetaceæ* or horse-tails, to which also belongs our fossil *Phyllotheca*, by the verticillate leaves, which are entirely free or confluent at their base, and by the sporangiferous spikes being axillary like those of Lycopods. Some of the genera of this order have been named and classified in the early history of palæontology from fragmentary fossils, and, as investigation has gone on, and better and more numerous specimens were discovered, just as in the case of the different portions of the *Lepidodendron* family, they have proved to be different portions of the same plants. Thus Ettingshausen has proved that *Asterophyllites* are the branches and branchlets of Calamites, and the spikes known under the name of *Volkmanniæ* are the fruit-bearing portions of the same genus. It is to Mr. Binney, of Manchester, that we owe the knowledge that the capsules enclosed in the spikes are not anthers but sporangia.

CALAMITES. Suckow.

Including *Calamites*, *Equisetites* (in part), *Asterophyllites*, *Volkmannia*, *Beehera*, *Bruckmannia*, *Bornia*, of Sternberg and Goeppart, and the *Calamites*, *Equisetites* (part), *Calamodendron*, *Asterophyllites*, of Brongniart, Bunbury, Binney, Dawson, and others. Tree-like plants, rising from subterranean rhizomæ, stem simple, somewhat conical, jointed and gradually narrowed, branches in whorls, with forked branchlets. Bark smooth, or more or less distinctly sulcate, internodes of varying length, but generally shorter as they descend. Inner lining always sulcate and constricted at the joints. Internal structure similar to *Equisetum*. Cauline leaves extremely fugacious, wholly unknown but in their place, usually represented by minute, convex, ovate scars on the inner wood. Branch leaves longer and more numerous than the cauline, of equal length, free or confluent at the base, linear or narrowed or slightly dilated above, acuminate, ribbed, entire, suberect or reflexed. Sporangiferous spikes verticillate from the axils of the leaves, disposed in corymbs along the branches or at their extremities, oblong or elongately cylindrical, small for the size of the plant. Bracts, alternating with the sporangia, verticillate, lanceolate, erect above, below uniting into a disc. Sporangia bearing stalks, peltate, and arranged in whorls of six; sporangia, four to each stalk, borne on the under side of the peltate leaves; spore cases, with cellular walls; spores spherical, with thread-like elaters. The fruit-spike or cone bears a very strong resemblance to *Equisetum*, but in the latter all the leaves of the cone are fruit-bearing, while in *Calamites* some are fruitful and others are like the ordinary leaves of the plant.

Calamites abound in the carboniferous rocks, and no doubt the great mass of the coal was formed by them. They may be said to have died out at the close of the palæozoic period; though some are still found amongst the lower members of the mesozoic strata. We have only two quoted from Australia, and those are from the lowest group of our coal strata. Smith's Creek, near Stroud.

CALAMITES (BORNIA) RADIATUS.

Brongniart, Histoire des Végétaux Fossiles, i, p. 122 (quoted by Schimper as *Bornia*, vol. i, p. 335). Paris, 1828. This species belongs to the subdivision *Bornia*, distinguished amongst *Calamites* by its interrupted, non-alternating ribs, its free leaves, which on the branches are once or twice-forked, divided above, ovoid elliptic spikes, scutellæ with a scar on the centre of the external face. It is thus characterized :—Leaves of branches very long, linear free, often forked. Cauline leaves much shorter. The fossil is very wide-spread, being found in the lower coal and Devonian rocks of Europe and those of America. (See Dawson's Devonian Plants, Quart. Jour. Geol. Soc., vol. xviii, p. 309; also Schimper, atlas, pl. xxiv, where many figures are given of stem, leaves, and fruit.) In Feistmantel's Nachtrag zur Fossilien Flora Australien, already quoted (Paleontographia, *loc. cit.*, plates vi, vii, xxiv, xxv) there are three figures given of this fossil, representing some leaves and certain portions of the stem. It should be mentioned that, except to an experienced eye, or without some fruit-cones, these fossils might easily be mistaken for *Phyllotheca australis*. It belongs, however, to a much lower horizon, and the leaves will be found to be dichotomous, which is never the case in *Phyllotheca*. *Calamites varians* is quoted by Feistmantel (*loc. cit.*, p. 145) on the authority of De Koninck. The passage referred to is as follows :—*

"Before commencing the study of the numerous animal forms belonging to the carboniferous period, I will glance on some contemporary plant remains received at the same time and also often

* (Recherches sur les Foss. Paléoz. Nouv. Galles de Sud. Australie, part 3, p. 142).

in the same rocks from the Rev. W. B. Clarke. I should state, previously, that the specimens sent to me (not above twenty in number) were in such a bad state of preservation that, notwithstanding the immense experience of M. Crepin, who was kind enough to examine them, or the abundant materials for comparison which he had at his disposal in the Brussels Museum, he was unable to determine any specimens with certainty. According to him, nevertheless, some specimens came very near to *Lepidodendron veltheimianum*, Sternberg; others to *Bornia radiata*, A. Brog; and others to *Calamites varians*, Germar, and constitute the dominant forms. All these plants are contained either in a hard and compact greyish yellow or greenish limestone, the other in friable, easily powdered, grey or brownish sandstone. Many are associated with marine animal remains such as stems of *Crinoids*, *Productus*, *Cornularia*, &c. By their characteristics they cannot be said to belong to the carboniferous formation properly speaking, but to the period which preceded it, being preserved in the rocks on which the carboniferous rocks rest. The principal localities in which these different fragments have been collected are the Murree quarries (Loder's Creek), Russell's Shaft, Glen William, and Burragood."

Calamites varians.

Schloth, Petrefac, p. 399, pl. xx, fig. 2. Artis, Antedeluv. Phytology, pl. 4.

This species is distinguished by the very short intervals in the basal part of the trunk becoming suddenly elongated in the upper part. The shoots of the basilar portion were rather stout, and disposed quincunically. The scars are large and round, and the ribs near them converge towards them with their upper and lower extremities. The same thing is seen in the leaf-scars, but then the converging ribs are less numerous, and there are never more than three. From the Drummond Range I have a very fine series of these plants, as will be seen from the accompanying specimens and figures, which place the nature of the fossils beyond any doubt. It is the first time that we have any record from Australia of the roots and stems of this characteristic palæozoic coal fossil. They abound in the strata, and there are some portions of the stone which seem to be made up entirely from the stems. Nevertheless, leaves are rarely found associated with them; in fact, none of the more tender plants—such as ferns, or organs of plants—are found in these strata where *Lepidodendron* abounds. In the neighbourhood of the shales, leaf impressions and those of ferns may be found; but these I have not as yet been able to examine.

It remains to say a word as to the age of these beds. There can be but little doubt that they agree in the fossils with the

Smith's Creek beds and those of Goonoo Goonoo. These, again, are identical with the plant remains of the lower coal formation of Europe. These Australian formations, for which I propose the name of Bobuntungen beds, because they are best represented at that place, are distinctly separated in their fossils from the Devonian beds of Gippsland and Queensland, with *Lepidodendron nothum*, *L. australe* (M'Coy), *Sphenopteris iguanensis* (M'Coy), and *Archæopteris howitti* (M'Coy). They are equally distinguished from the Newcastle beds with *Glossopteris*, *Phyllotheca australis* (M'Coy), and the well-known flora of our New South Wales coal measures. I think we may also safely say that the Bobuntungen beds should be intercalated between them, which will give one more link in the series which gradually unfolds itself of our Australian coal-bearing strata.

Without venturing to decide finally as to the horizons or periods which I here give only provisionally to the formations cited, I think the time has come when we may very safely rely upon the following order in which they are placed, as marking the relative age of their distinct and well-marked flora:—

1. Devonian rocks, with *Lepidodendron australe*, *L. nothum*, *Cordaites australis*, *Sigillaria*, *Stigmaria*, *Archæopteris howitti*, *Sphenopteris iguanensis*. Victoria: Iguana Creek, Gippsland. New South Wales: Capertee? Mt. Lambie, Nyrang Creek (near Canowindra). Queensland: Mt. Wyatt, Canoona, Broken River, and Gympie.

2. Lower carboniferous, with *Lepidodendron veltheimianum*, *Calamites radiatus*, *Rhacopteris inæquilatera*, *Cyclostigma australis*. Victoria: Not known. New South Wales: Smith's Creek, Goonoo Goonoo Creek, Liverpool Plains, Rouchel River, County Durham. Queensland: Bobuntungen.

3. Upper Palæozoic (according to most authors), with *Glossopteris* (several species), *Phyllotheca australis*, *Vertebraria australis*, *Gangamopteris angustifolia*, *Noggerathiopsis spathulata*. Victoria: Bacchus Marsh. New South Wales: Newcastle, Greta, Raymond Terrace, Blackman's Swamp, Bowenfels, Mudgee, Illawarra, &c. Queensland: Mackenzie and Dawson Rivers, Bowen River, Pelican Creek (all within the tropics). Tasmania: Don River, Mersey River.

4. Mesozoic Beds. *Zamites*, *Alethopteris australis*, *Equisetum*, *Thinnfeldia odontopteroides*, *Tæniopteris daintreeii*. *Palissya* species, and probably *Thinnfeldia indica*, with a *Brachyphyllum* closely resembling *B. mamillare*, which would all indicate an oolitic flora, as Professor M'Coy has long since pointed out. The discovery of so well-marked an oolitic form as this *Brachyphyllum* has been quite recently made by me. *Thinnfeldia indica* (Feistm.), or a closely allied form to what is a characteristic Indian fossil, has been recognized amongst some plant remains

sent to me by the Rev. J. Milne Curran, from Dubbo, where it was found associated with *T. odontopteroides.* Victoria: Bellerine, Cape Paterson, Wannon River. New South Wales: Mount Victoria, Dubbo. Queensland: Ipswich, Tivoli, Burrum River (near Maryborough), Burnett River (near Bundaberg), Clifton (?) on the Darling Downs. Tasmania: Jerusalem Basin. I must add that I do not think that the identification of the Victorian with the Queensland beds has been satisfactorily worked out.

5. Plant beds of uncertain position but probably mesozoic. (1.) Rosewood, 24 miles west of Rockhampton, with large *Equisetum*, *Ptilophyllum oligoneurum* (n. s. nobis. MS.), a coniferous plant like *Sequoia* (*Voltzia ?*) (2.) Ballinore, near Dubbo, with *Arucarites australe* (nobis MS.), *Thinnfeldia?* *Sphenopteris.* (3.) Cooktown, North Australia. Plants not identified.

I may further state that no coal has been found in connection with No. 2, at Smith's Creek. There are beds of impure earthy shale, which will not burn. The same kind of shale I noticed at some of the outcrops at Bobuntungen, but no further examination has been made.

It will be necessary to make some alterations with reference to these beds in the geological sketch map of Mr. Daintree and my own, as published by Messrs. Gordon & Gotch, in "The Australian Handbook." In Daintree's map, the portion of Drummond's Range here referred to is coloured as metamorphic, bordering on the edge of carbonaceous rocks to the eastward. In my map it appears as a granitic axis flanked by earlier palæozoic rocks, such as Cambrian and Silurian. It must now be coloured as a granite axis, and in this locality flanked by carboniferous rocks.

It is stated in the earlier part of this paper that the dividing range here makes a curve to the westward, leaving a larger area between it and the eastern sea than is found at any other portion of its course. The distance of the divide from the sea is at this point nearly 300 miles. From Rockhampton the railway passes along a gently sloping open forest, with occasional scrub to Westwood, 30 miles, where it cuts through the Goganjo Range at 600 feet. The cuttings display much older hornblendic trap rock, with palæozoic (Cambrian ?) slates, folded and highly inclined, also quartz reefs and a little gold. This range and its spurs being crossed, there is a fall for about 10 miles to the basin of the Dawson River, which is not quite 280 feet above the sea; from this point there is a gradual rise to the foot of Expedition Range, which at 110 miles from Rockhampton is 800 feet above the sea-level. Then succeeds a table-land, undulating between 650 and 800 feet, falling to 520 feet in the basin of the Comet River at 140 miles. Another table-land, of about 700 feet elevation, succeeds with the basin of the Nogoa at Emerald at 620 feet, distance 164 miles. All the table-lands are clothed with brigalow scrub; but where they are basaltic, which they are in most cases, the soil is very rich. Beyond Emerald a basaltic terrace raises the table-land to 800 feet, and at 175 miles St. Helen's Range is crossed, at 900 feet elevation. This height is kept on an undulating plateau to 195 miles, where a sandstone or quartzite terrace raises it to 1,000 feet. The terrace bears the name of Anakie Range. Basaltic rocks of a modern aspect succeed. At Blackfellows Creek, 205 miles, the basin is below 900 feet, but 8 miles further the elevation of Woodbine Creek is 950 feet. Zamia Range is crossed at 217 miles (1,180 feet). The Medway Creek, 228 miles, is 1,220 feet above the sea-level, and then the rise is abrupt by escarpments of carboniferous rocks to the Drummond Range, which probably average 2,000 feet above the sea.

In more than one place in all this distance lower carboniferous marine fossils are found, many of the species being identical with those found in the equivalent beds of Europe. At about 10 miles from Rockhampton, in what is called the agricultural area, careful collections were made by Mr. Charles de Vis, B.A., Curator of the Brisbane Museum. The locality is extremely rich in fossils, and the zeal and industry of the gentleman named were such that a complete series were obtained in excellent preservation. Many of these were kindly submitted to me for examination, and I propose, as soon as my other engagements will permit, to publish the results. I am not as yet able to state the relative positions of these marine fossils and plant-bearing beds. Between them there occurs the Boomer Range, with palæozoic rocks, highly inclined, and of probably Cambrian age. West of this is the basin of the upper tributaries of the Fitzroy, in which newer coal deposits occur. These are the equivalents of the Newcastle beds. They are so overlaid by recent volcanic rocks that it is hopeless to expect to find the relations between them and the strata of the Drummond Range.

Discussion.

Mr. Wilkinson, the Government Geologist, remarked that the fossils were exactly like those found at the Lachlan, in the Forbes district, and the occurrence of this formation in the locality described by Mr. Tenison-Woods was of especial interest, as showing the wide-spread extent of the lower carboniferous formation. It was found in Smith's Creek and in the Upper Hunter, also west of the dividing range and elsewhere; and the beds were associated with purple, pink, and yellow-coloured sandstone, as described by Mr. Tenison-Woods. It was important when these rocks were met with, because they were an indication of the formation referred to, in which coal exists in other parts of the world.

Some of these were to be seen near Narranderra and Moun Brown. They all, as it were, represented islets of the same formation, the intermediate country being filled up by a newer formation. At Smith's Creek, in the locality of these rocks, coal-beds had been seen, but they had proved to be of very little value; still in some of these localities workable and valuable coal might be found, and therefore this subject became one of great importance as the railways extended into the interior of the country.

EXPLANATION OF PLATES.

Plate XI.

Fig. 1. Portions of branches of *Lepidodendron veltheimianum*, half natural size. These exhibit the impressions of peculiar scale-like leaves tapering sharply to a point.

Fig. 2. Cast of exterior of same enlarged, showing the leaf-scars.

Fig. 3. Branch of same internal cast. The reniform tubercles are succeeded by an elongated leaf impression; still this may not belong to the same plant.

Fig. 4. This was seen to be (from the lower portion which has been destroyed in getting out the fossil) a large Calamite root.

Fig. 5. Better preserved portion of root end of *Calamites radiatus*. In this specimen the scars of rootlets are well seen at the septa.

Fig. 6. Internal cast of trunk of *Lepidodendron veltheimianum*, half natural size. This was seen to belong to the same species, as it formed part of a tree-stem which had well defined leaf-scars.

Plate XII.

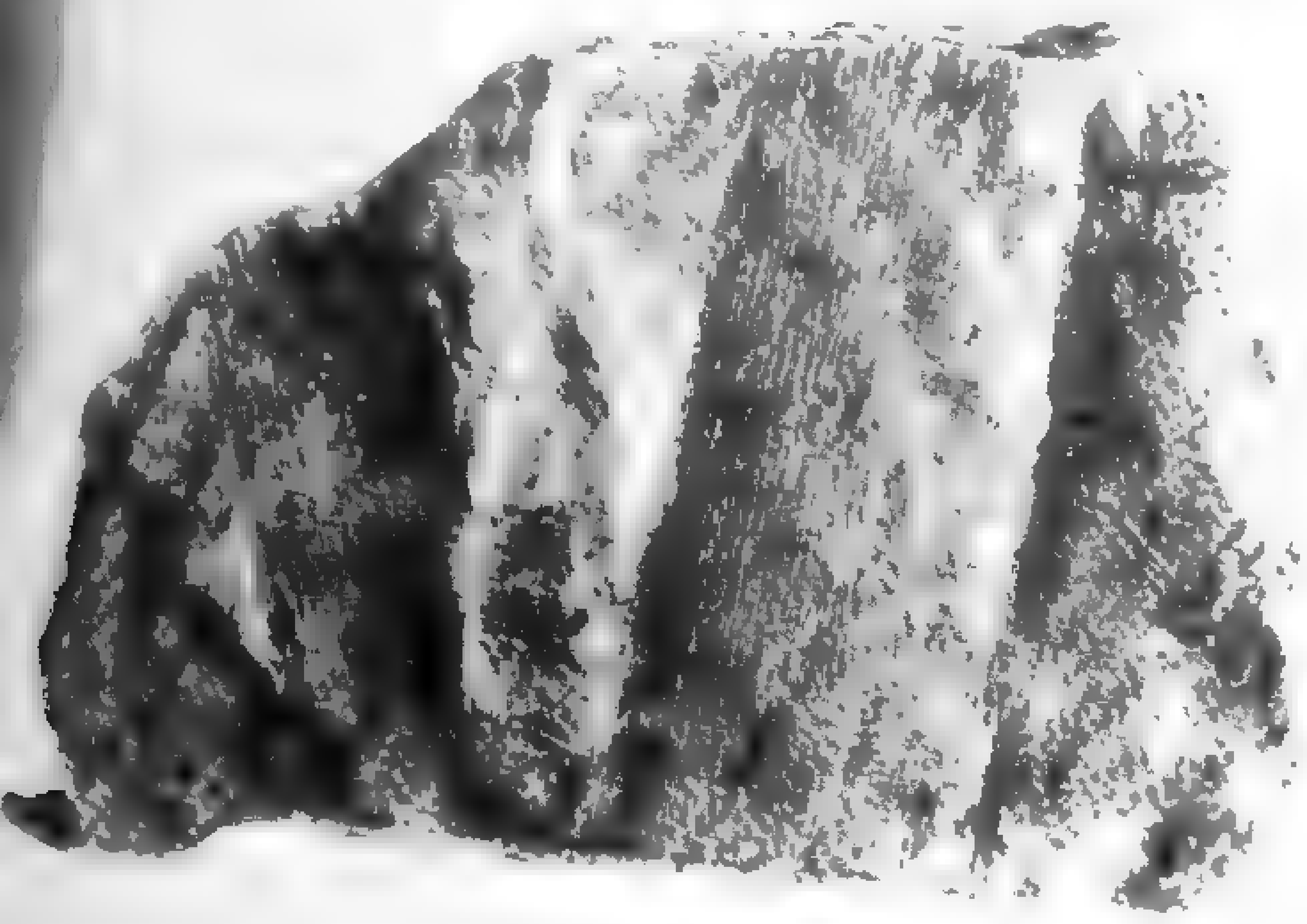
Fig. 7. *Calamites radiatus*. Stem natural size, showing septa and continuity of the ribs.

Fig. 8. Cast of small trunk of *Lepidodendron veltheimianum*. I am inclined to regard this as an internal cast, nevertheless it may be an external surface with faint impressions of leaf-scars.

Stigmaria. Two-thirds natural size. This fragment lay in the position of a root in the rock, subtending a stem, probably of *L. veltheimianum*. It was three times the length of the portion figured.

Fig. 10. Stem of *Calamites radiatus*, half natural size. This must have been an upper portion of a branch, as seen by the great distance between the septa, and therefore was a large tree.

Plate XI.



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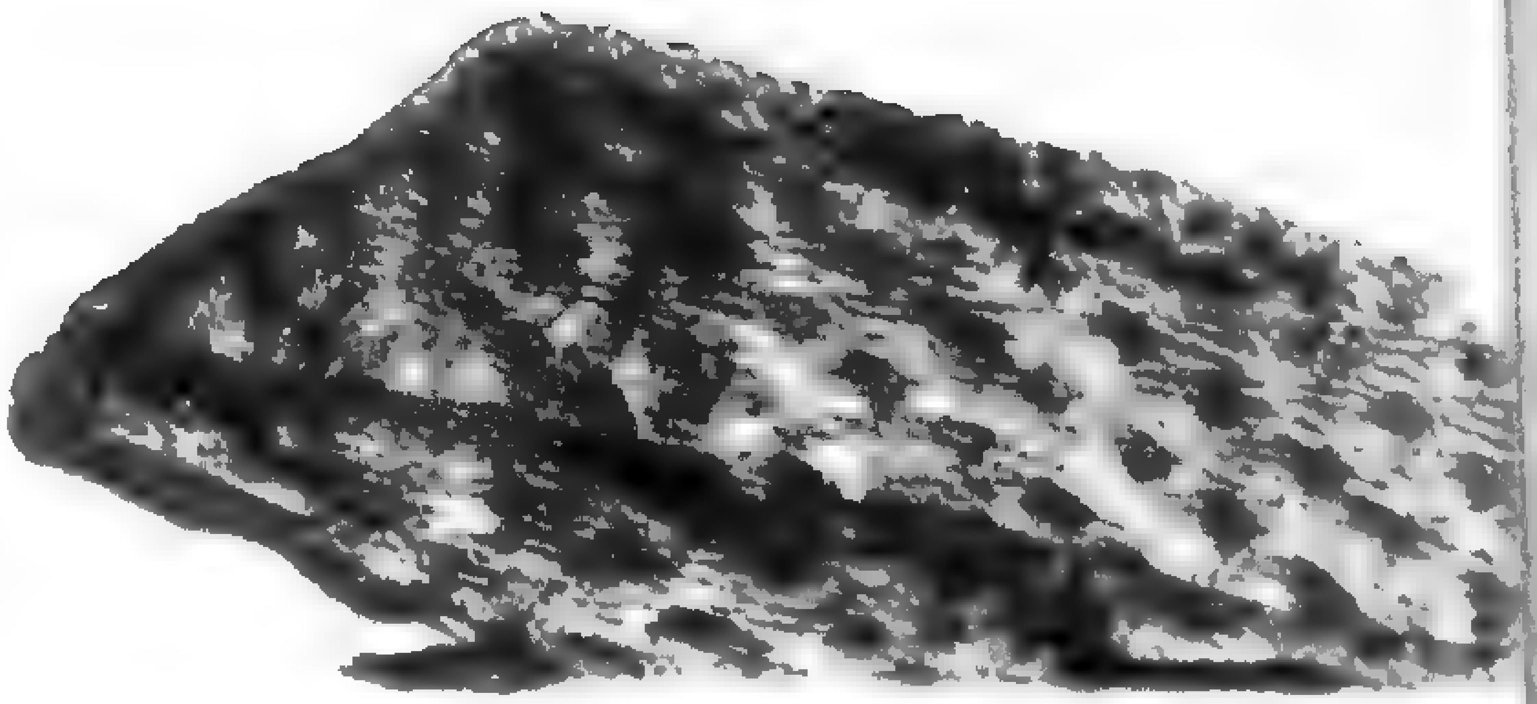

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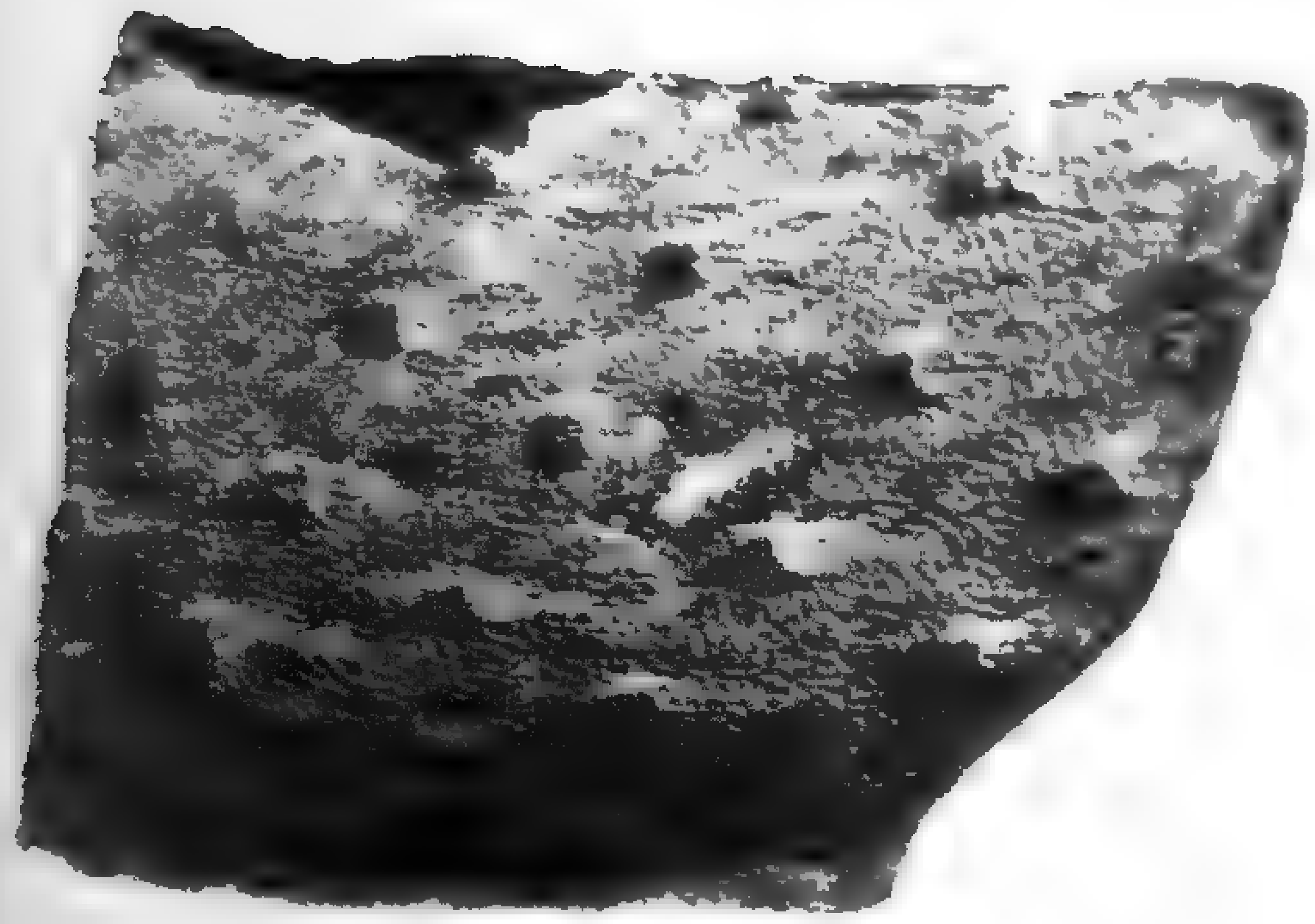
CARBONIFEROUS FOSSILS.



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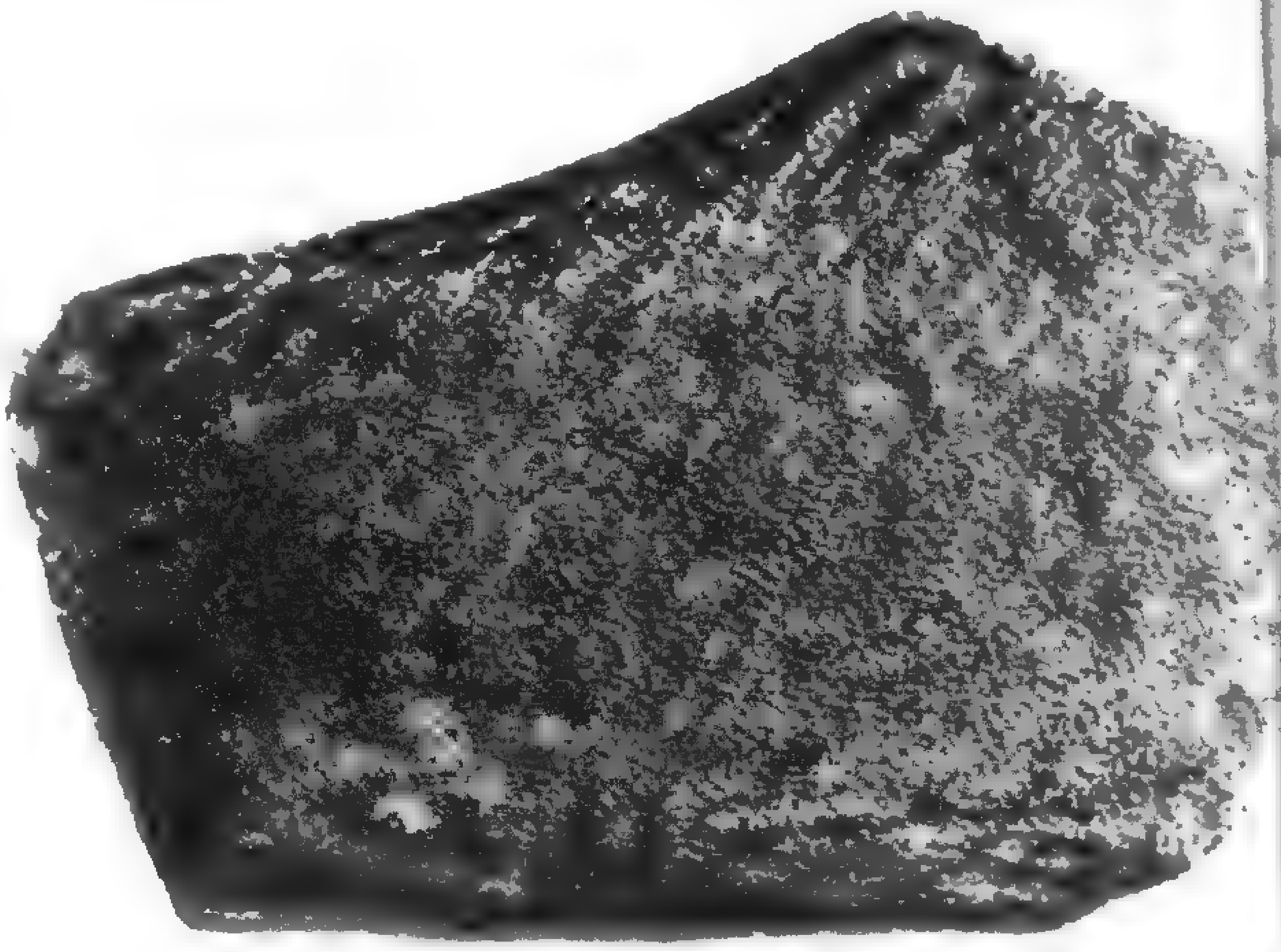

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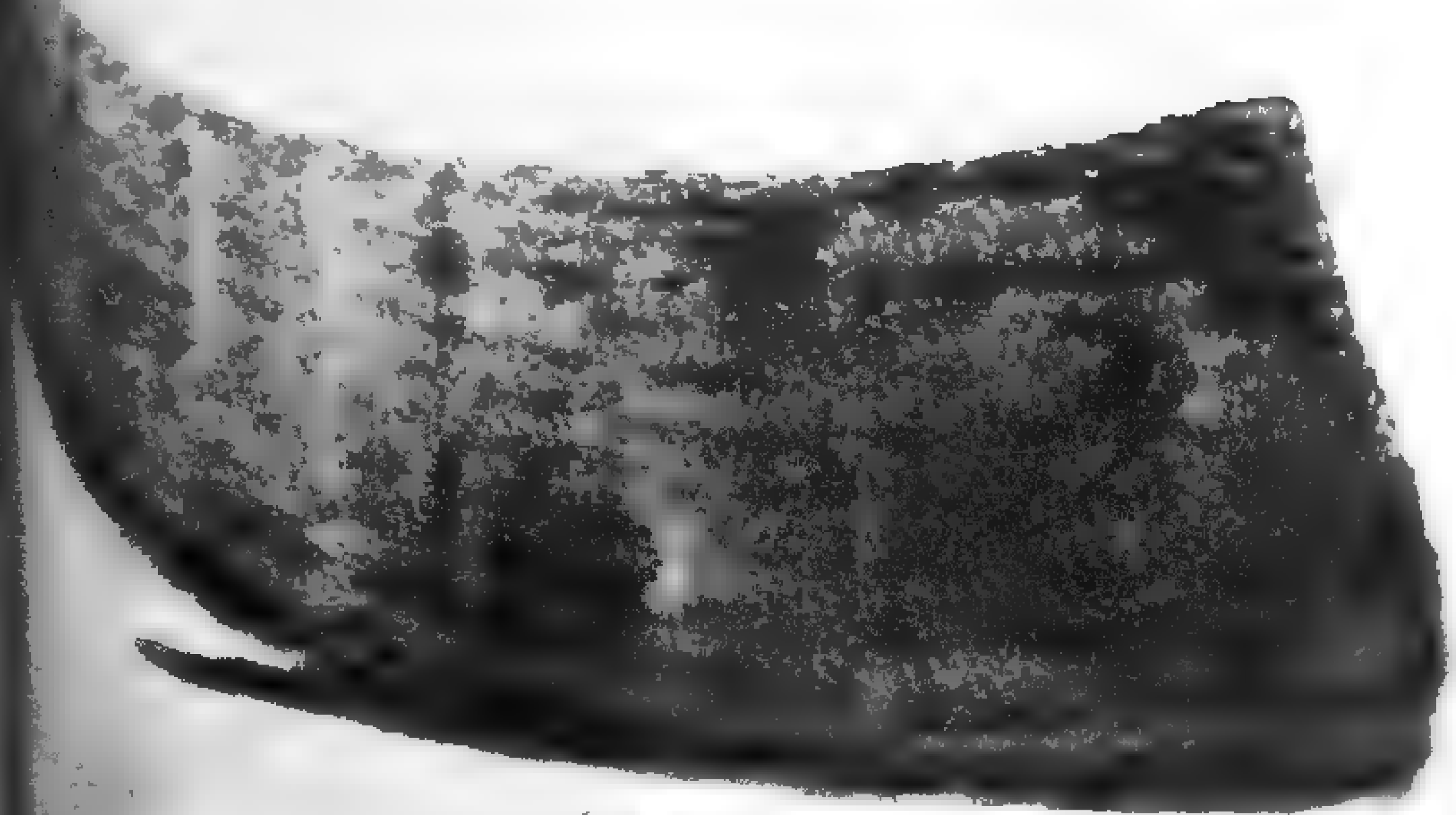

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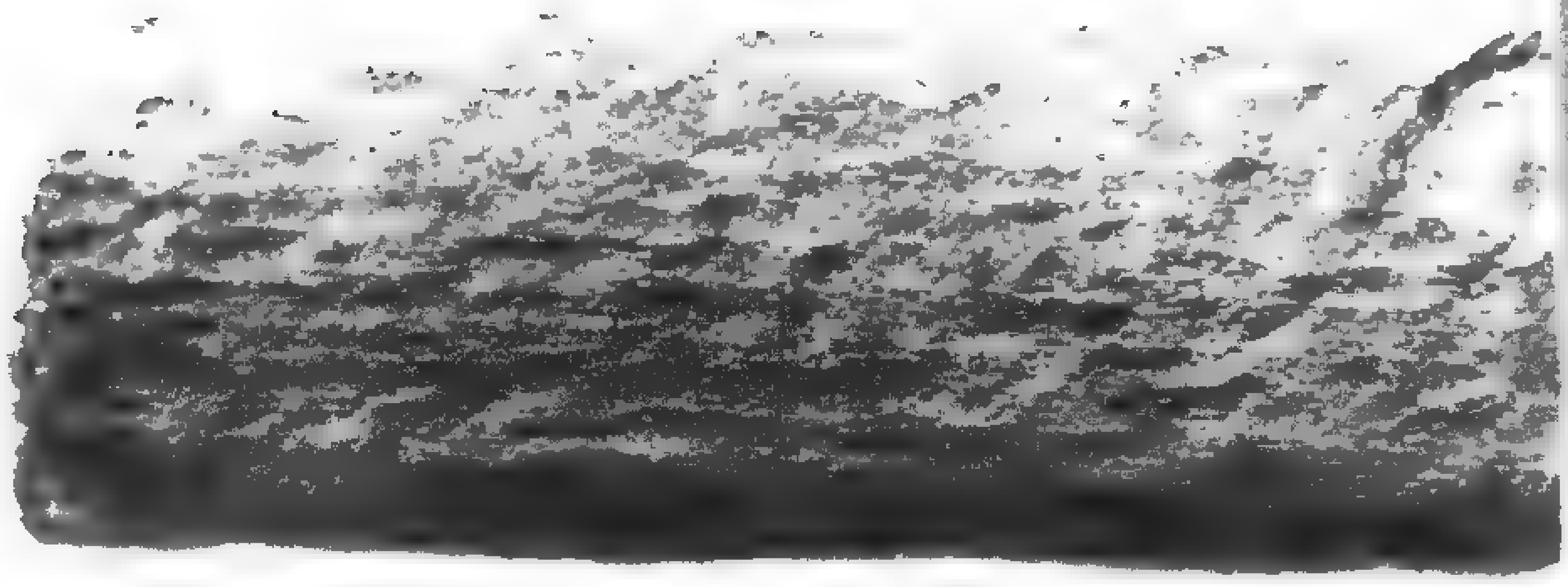


(6.)

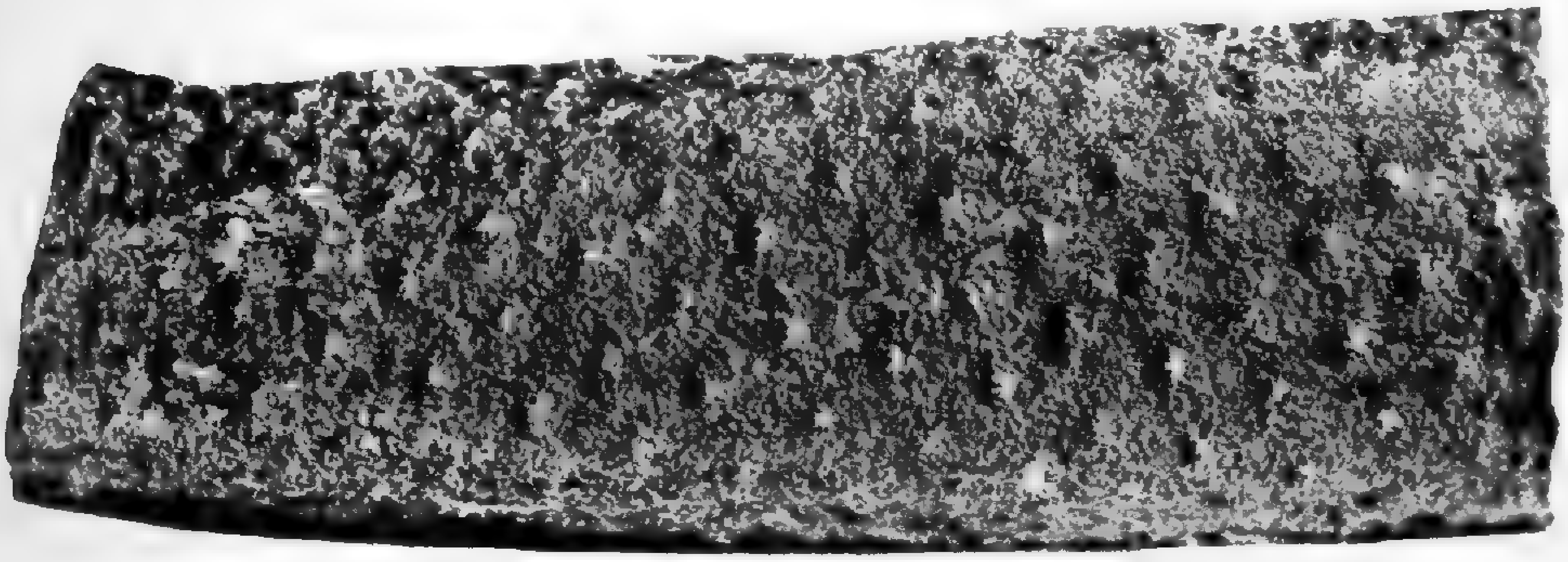
1. Portions of branches of *Lepidodendron veltheimianum*, half natural size.
2. Cast of exterior of same, enlarged.
3. Branch of same, internal cast, natural size.
4. Internal portion of root, large *Calamites*, two-thirds natural size.
5. Root end of *Calamites radiatus*, two-thirds natural size.
6. Internal cast of *Lepidodendron veltheimianum*, half natural size.

PLATE XII.

(7.)

(8.)

CARBONIFEROUS FOSSILS.



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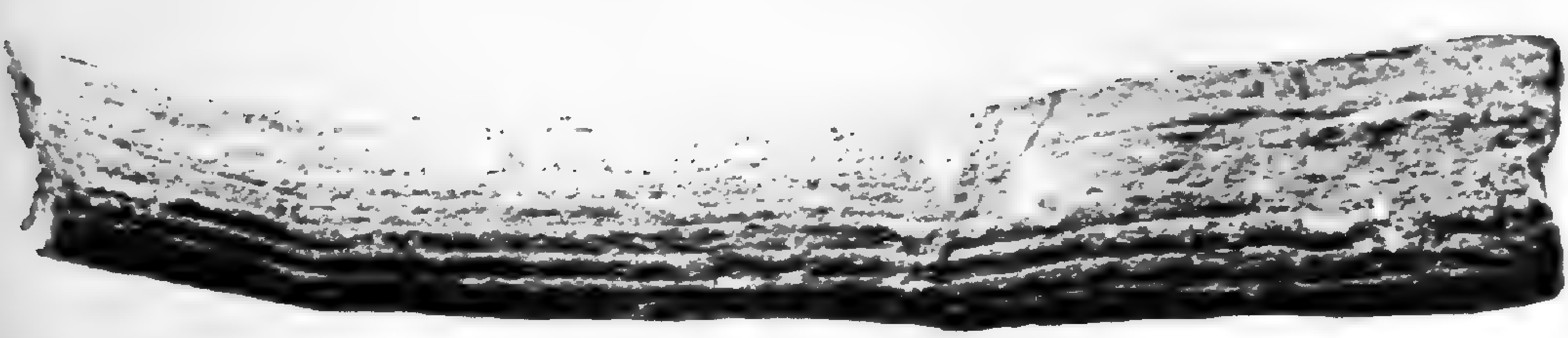

(10.)

7. *Calamites radiatus*, stem natural size.
8. Internal cast of *Lepidodendron veltheimianum*, natural size.
9. *Stigmaria*, two-thirds natural size.
10. Stem of *Calamites radiatus*, half natural size.

The Aborigines of New South Wales.

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THE negro has suffered much at the hands of his fellow-man. The curse is upon him—"A servant of servants shall he be unto his brethren." Yet he is our brother, for his ancestry is the same. Let me, therefore, introduce my subject by endeavouring to show, historically, the relations of the Austral-negro race to the others.

In the far past, one man and his wife, his three sons and their wives, were the only surviving representatives of mankind; the patriarchal home was in Armenia, under the shadow of Ararat; but soon the family peace was broken, and a son went forth, an outcast and a fugitive, carrying with him a heavy burden of guilt and a father's curse. Gathering together their wives and little ones, their flocks and their herds, Ham and his son Canaan seem to me to have passed through the gorges of snowy Niphates and to have proceeded southwards along the course of the Euphrates, planting themselves first in the highlands of Upper Mesopotamia; then when, in the course of time, their families and goods had increased, they occupied fresh territory further to the south, still between the two rivers, a prolific region. Here, I imagine, they lived long in peace, the sole possessors of the riches of the land, till they were dislodged by fresh bands issuing too from Armenia, that *officina gentium*, where surrounding circumstances were unfavourable to permanent occupation by these infant races. The new-comers were the Shemites, descending through the northern passes, and the Turanian Scyths, probably from the north-east by the way of Mount Zagrus and the Tigris. Finding the way barred by the Hamites already in possession of all the country between the two rivers, the Shemites and the Scyths hurled themselves upon them from above, and scattered them in fragments to the east and the south and the west. Accordingly, the position of the Hamite or black races at the opening of history is, in Genesis x. 6, indicated ethnically by the names Kush and Mizraim and Phut and Canaan, which geographically are the countries we call Ethiopia and Egypt and Nubia and Palestine. The Kushites, however, were not confined to Africa, but were spread in force along the whole northern shores of the Arabian sea: they were specially numerous on the lower courses of the Euphrates and Tigris, their original seats, and there formed the first germ whence came the great empire of Babylonia. In this sense the later Greek tradition (Odyssey I—23-24) speaks of both an eastern and a western nation of Ethiopians, because the black races, many centuries before the Trojan war, had spread themselves from the banks of the Indus on the east right across to the shores of the Mediterranean, while towards the south-west they occupied the whole of Egypt and the Abyssinian highlands. Thus they held two noble coigns of vantage, likely to give them a commanding influence in the making of the history of mankind—the valley of the Nile, which, through all these ages to the present hour, has never lost its importance—and the luxuriant flat lands of Mesopotamia. A mighty destiny seemed to await them, and already it had begun to show itself, for the Kushites not only made the earliest advances towards civilization, but under Nimrod, that mighty hunter, smitten with the love of dominion, they threatened at one time to establish a universal empire with Babel as its chief seat. And not without reason; for the Kushite tribes were stalwart in stature and physique, in disposition vigorous and energetic, eager for war and conquest. But a time of disaster came which carried them into the remotest parts of the earth—into Central Africa, into the mountains of Southern India, whence, after a while, another impulse sent them onwards towards our own island-continent; hither they came, as I think, many centuries before the Christian era, pressed on and on from their original seats by the waves of tribal migration which were so common in those early days. Similar was the experience of the Celts, a very ancient tribe; soon after their first arrival in Europe we find them occupying Thrace and the countries about the mouth of the Danube; but fresh immigration from the Caucasus plateau pushed them up the Danube, then into Belgium and France, thence into Britain, and last of all the invading Saxons drove them westwards into Ireland, and into the mountains of Wales and Scotland. So the successive steps of the Kushite displacement, in my opinion, were these:—First into the valley of the Ganges, where they were the original inhabitants, then into the Deccan and into Further India, then into Ceylon, the Andaman Islands and the Sunda Islands, and thence into Australia. These stages I will examine presently more in detail.

But, meanwhile, let us look at the old Babylonian kingdom. Its ethnic basis was Kushite; its ruling dynasty continued to be Kushite probably down to the time of the birth of Abraham, B.C. 1996. But before that date, the Babylonian population had been materially changed. Nimrod had conquered Erech and Accad and Calneh in the land of Shinar; an Akkadian or Turanian element was thus incorporated with his empire; he had built Nineveh and Rehoboth and Calah and Resen (Genesis x. 11); a Shemite element was thus or in some other way superadded; other Turanians and Shemites and Japhetian Aryans too, perhaps attracted by the easy luxuriance of life on these fertile plains, had all assembled in Chaldæa and Babylonia. In consequence, we find that about twenty centuries B.C. the Kushite kingdom had become a mixed conglomerate of four essentially different races—Hamites, Turanian, Shemite, and Japhetian—which on the inscriptions are called *Kiprat-arbat* "the four tongues." Then, as the Babylonian worship of Mulitta demanded free intercourse as a religious duty, a strange mixture of physical types must have been developed among the children of these races, the Ethiopian, Scythic, Shemitic, and Aryan all blending—a rare study to the eye of a physiologist, who would have seen sometimes the one type sometimes the other predominating in the child. This Chaldæan monarchy—the first of the five great monarchies of ancient history—was overthrown by an irruption of Arab (Shemitic) tribes about the year 1500 B.C. And now, as I think, another wave of population began to move towards our shores, for these Arabs were pure monotheists, and in their religious zeal must have dashed to pieces the polytheistic and sensual fabric which the Babylonian conquests had extended from the confines of India westwards to the Mediterranean (cf. Chedorlaomer's expedition, Genesis XIV. 9). Those portions of the Chaldæo-Babylonian people that were unable to escape from the dominion of the Arabs were absorbed in the new empire, just as many of the Celtic Britons were in the sixth and seventh centuries merged in the newly formed Saxon kingdoms. But the rupture of the Babylonian State and the proscription of its worship must have heen so complete as to drive forth from their native seats thousands of the people of the "four tongues" and force them westwards into Africa, or eastwards through the mountain passes into the table-land of the Punjaub, and thence into the Gangetic Plains. Here, I imagine, were already located the pure Hamites of the Dispersion; but finding these to be guilty of a skin not exactly coloured like their own,* and not understanding their language, these later Kushites of mixed extraction regarded them as enemies and drove them before them into the mountains of the Deccan, where, to this hour, the Dravidians and Kolarians are black-skinned and savage races. Ere long, these Babylonian Kushites were themselves displaced and ejected from the Ganges valley by a fair-skinned race, the Aryans, another and the last ethnic stream of invaders from the north-west. These Aryans, in religion and habits irreconcilably opposed to the earlier races of India, waged on them a relentless war. Hemmed up in the triangle of southern India, the earlier Hamites could escape only by sea; the Babylonian Kushites, on the other hand, could not seek safety in the mountains of the Deccan, as these were already occupied; they must

* Occasionally a copper-coloured man has been found among the native tribes in Australia. One such was exhibited in Sydney many years ago. Another was found in the Gringai tribe, near Dungog. An aboriginal, who shared his *gunyah*, watched one night till he was asleep, and cut off his head!

therefore have been pushed down the Ganges into Further India and the Malayan peninsula; thence they passed at a later time into Borneo, and the Sunda Islands and Papua, and afterwards across the sea of Timor into Australia, or eastwards into Melanesia, driven onwards now by the Turanian tribes, which had come down from Central Asia into China and the Peninsula and islands of the East Indies.

Thus, in my view, our island first received its native population, in two different streams, the one from the north, and the other from the north-west.

Many known facts favour this view :—

(1.) Ethnologists recognize *two* pre-Aryan races in India. The earlier had not attained to the use of metals and used only polished flint axes and implements of stone; the later had no written records, and made grave mounds over their dead. The Vedas call them "noseless," gross feeders on flesh, "raw eaters," "not sacrificing," "without gods," "without rites"*; they adorned the bodies of the dead with gifts and raiment and ornaments. All this suits our aboriginals; they are noseless, for they have very flat and depressed noses, as contrasted with the straight and prominent noses of the Vedic Aryans; they have no gods and no religious rites such as the Vedas demand. The Nairs in the south-west of India practice polyandry; so do our aboriginals in certain circumstances.

(2.) The Kolarian and Dravidian languages have inclusive and exclusive forms for the plural of the first person. So also have many of the languages of Melanesia and Polynesia. Probably also the dialects of the north-western coast of Australia have this peculiarity, but I have no information about them.

(3.) The aborigines on the south and west of Australia use the same words for *I*, *thou*, *he*, *we*, *you* as the natives of the Madras coasts of India.

(4.) The native boomerang of Australia is used on the south-east of India, and can be traced to Egypt—both of them Hamite regions.

(5.) Among the red races of America—who are Turanian—four is a sacred number, having a reference to the cardinal points. In Egypt the pyramids have square bases, and the Great Pyramid is found to have its angles pointing exactly to the four cardinal points. The Chaldæans also built their temple-towers as pyramids, and

* The Akkadian religion of Babylonia had no temples, and no fixed public worship.

their partiality to the number four is seen in their four-fold arrangement of cities, &c. Their "tongues" were four. The castes of India are four, possibly an arrangement adopted by the Aryans from the earlier Kushite inhabitants of India. With all this, I compare the universal division of the native tribes of Australia into four intermarrying classes.

(6.) These class names form their feminines in *tha*, as Ipai (masc.), Ipa-tha (fem). This is a peculiarly Shemitic inflexion. So also in Hamitic Babylonian, we have Mul (masc.), Muli-tta (fem.); Enu (masc.), Enu-ta (fem). This seems to indicate that among our native tribes there exist the same mixed elements as in the old Babylonian empire.*

(7.) So also does the fact that several tribes practise circumcision, that one tribe in Queensland has distinctly Shemite features, and that there are among the tribes so many varying types of men. Some are Hamite negroes in colour and cranial shape; others are evidently mixed Kushites; and others again seem to be pure Turanians.

(8.) In some parts of Australia, as at Tenterfield, our natives erect stages—the Parsee "towers of silence"—on which to place the bodies of their dead, a custom which their ancestors, I believe, brought from Asia. In other parts of New South Wales they do not bury the body, but place it in a hollow tree, and, even where they do dig a grave, the body is so wrapped in bark and so tied up that the earth does not touch it. In South Australia the body is desiccated by fire and smoke, then carried about for a while, and finally exposed on a stage. All this corresponds with the Persian religious belief in the sacredness of the earth, which must not be contaminated by so foul a thing as a putrefying human body. In Chaldæa also, the same ideas prevailed; for the dead were not interred; they were laid (1) on mats in a brick vault, or (2) on a platform of sun-dried bricks, and over this a huge earthenware dish-cover, or (3) in a long earthen jar in two pieces fitting into each other; the body did not touch the earth.

(9.) There is nothing improbable in the supposition that the first inhabitants of Australia came from the north-west, that is, from Hindostan or Further India. The native traditions of the Polynesians all point to the west or north-west as the quarter from which their ancestors

* Two of the Australian classes are called (in Kamilaroi) Kum-bo and Kub-bi. I think I find these names in Kam (black), the inscriptiona nam for the land of Egypt, and in Ai-gup-t-os, E-*gyp*-t.

came. So also the Indias are to the north-west of our island. The distance from Madras to Sumatra is about 1,200 miles, and from Sumatra to the coast of Australia about 1,400 miles. Such a distance is not impracticable to a savage; for in January 1858, a boat, with a numerous family on board, was driven by the westerly winds from the Union Group in Polynesia to Mangaia, a distance of 1,250 miles, in a south-easterly direction, and other similar instances of involuntary emigration have occurred. In some such way, perhaps fleeing from the conquering Aryans, some of the early Kushites of Southern India may have come to Sumatra, and thence also to our shores. In the woods and mountains of that island there are still two aboriginal races (the Malays occupying the coasts), and one of these is called Kuba, a name identical with our tribal class Kubbi. The interior of Borneo is also the refuge of three native black races, and one of these is very like that in the interior of Sumatra. Of these Sir James Brooke says: "These people are mild, industrious, and so scrupulously honest that not a single case of theft has come under my notice; in their domestic lives they are amiable, without white vices; they marry but one wife, and their women are always quoted for chastity." I may add as a coincidence, that the native name for Borneo is Bruné, and that Bruné is also the name of a large island in Storm Bay, near Hobart.

It thus appears that the islands of the East Indian Archipelago were at first inhabited by aboriginal black races, which had come from the adjoining continent. When the Malays entered, these blacks either fled into the interior or left the islands; and, as Java and Timor especially are near Australia, a large portion of our native population must have come hither by that route.

(10.) The languages spoken by non-Aryan races on the south-east of Hindustan along the Coromandel coast are the Tamil and the Telugu; the system of kinship among these races is the same essentially as among the Australian tribes.

(11.) Identity of language is a strong evidence of identity of origin; thus, I take the Australian tribes to be homogeneous, for some words of theirs are found distributed over the whole continent; for instance, the word *dinna* "foot," with only slight phonetic changes, exists in the native languages from Cape York all over Queensland, New South Wales, Victoria, and South Australia. The word *mil*, "eye," is also widely distributed. In the names for the numeral "one," there is great diversity, as in the Aryan languages, but *bular*, "two," extends from Cape River (Queensland) into New South Wales, Victoria, South Australia, and even as far south as Bruné Island near Hobart. This last fact is rather remarkable, for, although I endeavoured for more than a year to trace a connection between the dialects of Tasmania and those of Victoria and New South Wales, I had failed until, quite recently, I have found in Tasmania some remarkable correspondences with the Gringai language of New South Wales; for instance, "ear," *mung-enna* (Tasmania), *mug-u* (Gringai); "foot," *lugg-ana** (Tasmania), *tung-anai* (Gringai); also *wee*, "fire" (Kamilaroi), *wee-al-utta*, "red hot embers" (Tasmania), *wee-na-leah*, "fire" (W. Tasmania); *rim-utta*, "hand" (Tasmania), *rima* (Polynesia), *'ima* (New Guinea).

These eleven points are the main features of an argument by which I would maintain that our black people came originally from the shores of the Persian Gulf, and that they came to us through India.

But I pass on to the proper subject of this essay—the aboriginal tribes of New South Wales. And now my narrative is founded on statements either made to me personally by the blacks with whom I have conversed, or communicated to me orally or in writing by friends† who have long been familiar with the habits and condition of our native races. In order to proceed methodically, I shall first give a sketch of the tribal arrangements which affect the three periods of life,—(1) YOUTH, (2) MANHOOD, (3) OLD AGE; and to avoid needless repetition, which must present itself if I were to describe the customs of each tribe separately, I will frame a narrative applicable to all; but, wherever any material difference of usage exists in any particular among the tribes, this difference will be noted. I expect thus to give an intelligible view of aboriginal life in general, without specifying the locality where each individual feature of the description is to be found. All that follows is the product of original research, but if in any instance I refer to the printed statements of others, I shall name the authors whom I quote. The tribes with which I am acquainted are chiefly those of the northern half of our territory,

* *d* or *t* and *l* are interchangeable; as in Latin odor, olor; dedicare, delicare; lingua (dingua), E. tongue.

† I owe special acknowledgments to Mr. C. Naseby, Maitland (for the Kamilaroi tribe), and Mr. J. W. Boydell, Camyrallyn, Gresford (for the Gringai tribe). Both of these gentlemen have had an intimate acquaintance with these tribes for more than thirty years.

the Gringai, the Kamilaroi, and the Ooalaroi, and to these I add a slight knowledge of the Wiradjery and Yūin tribes. As it is impossible within the limits of an essay to discuss fully so large a subject as this, I will dwell upon those points which seem to admit of original investigation, and will omit altogether or touch lightly upon those features of my subject which are generally known.

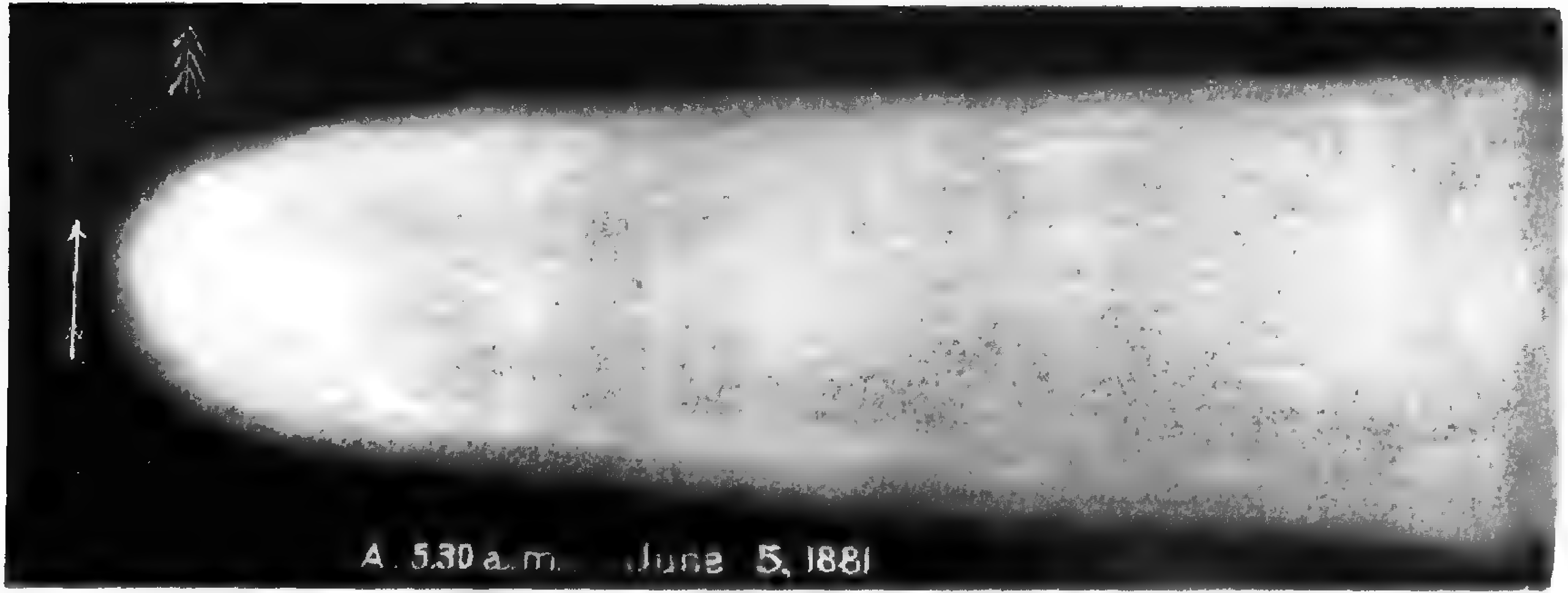
I.—Youth.

An aboriginal child is heir to a tawny skin, "the vellum of the pedigree they claim," and exposure to the air soon deepens the swarthiness. The depth of colour varies in different tribes, for some of them, according to my hypothesis, are more purely Nigritian in their origin, while others are from the mixed Kushite race; and tribes that have long dwelt in swampy regions are darker, while those occupying the uplands are lighter in colour than others.

The advent of the baby is not always a source of joy to the parents. The mother, in parturition, is left to the assistance of one or two female friends, often left entirely alone, at a little distance from the main camp, and ere long she joins her husband with or without the baby. If the season has been hard and there is a scarcity of food, or if the mother is already burdened with many children or with heavy labour for her lord, the little one is left to perish. A native woman at Goodooga thus abandoned several of her children in succession, and then, after an interval of seven or eight years, suckled and reared another, which is now alive. We condemn this inhuman practice of infanticide among the black races; but what shall we say of the intellectual and polished Athenians who, by law, allowed a father to order any one of his infant children to be exposed to death? Our blacks in the Ooalaroi country, soon after the arrival of the white man in that district, spared the females at their birth, but left all the males to perish; they feared that these half-caste males, if they grew to be men, would have the qualities of a superior race and would be too intelligent, too strong, too dangerous for the tribe, and so they suffered none of them to live.

If a child should die, the parents and even the neighbours make great lamentation over it, weeping bitterly; when they have buried the body, they forthwith shift their camp. They have an idea that an evil spirit, the Krooben, haunts the graves, and they fear to be near him. At Kunopia, when an infant dies, they roll the corpse in a thin sheet of bark and keep it over the smoke of a fire for about a fortnight; the smoke-dried corpse is carried about till twelve months after the birth; it is then buried.

Mothers are very attentive to their children; they nurse them carefully and continue to show them every token of affection. They carry them on their backs, wrapped in a rug or blanket. As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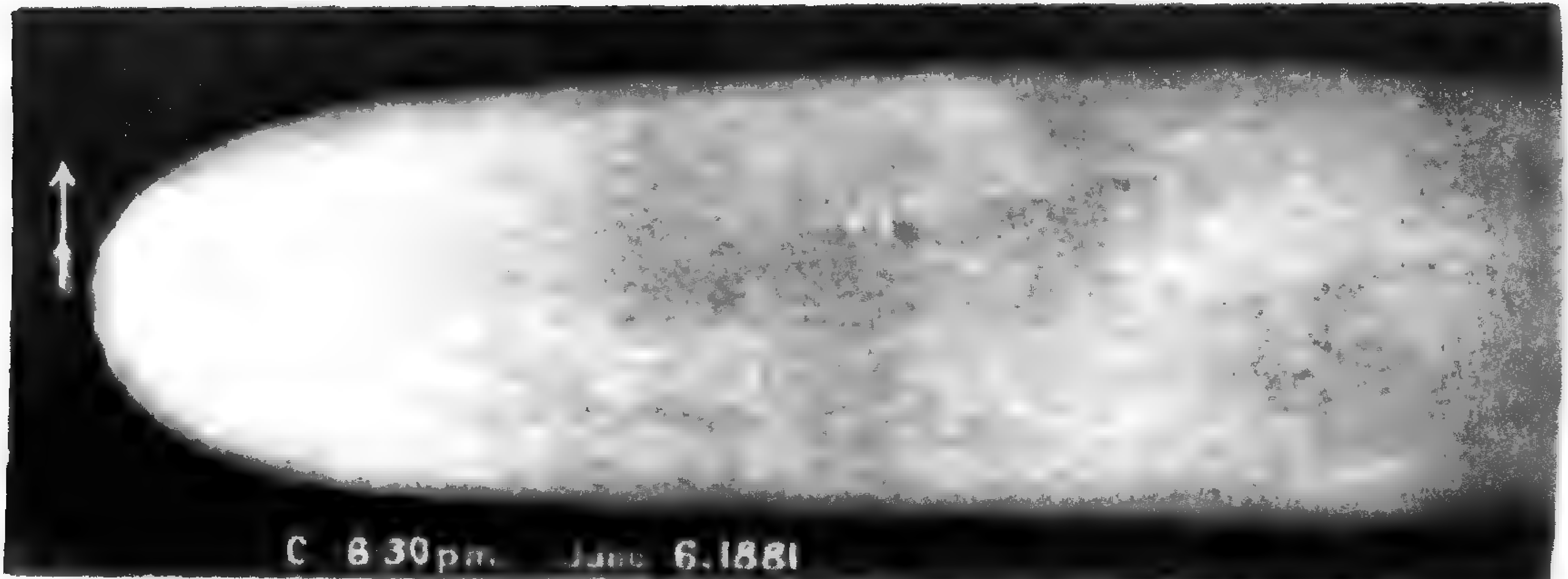
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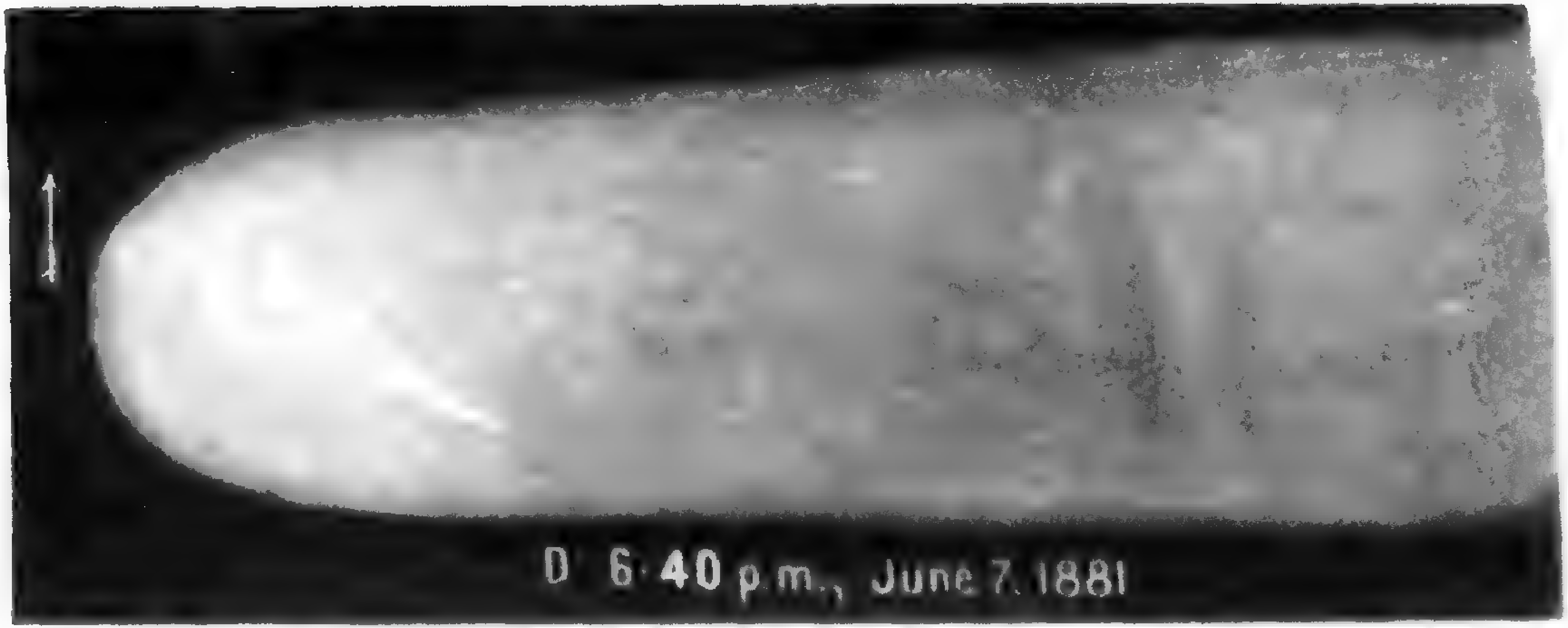

COMET *b*, 1881, as seen at Sydney.

COMET *b*, 1881, as seen at Sydney.

Please insert enclosed Drawings of Comet of 1881 after page 86 in Journal Royal Society for 1881, Vol. XV.

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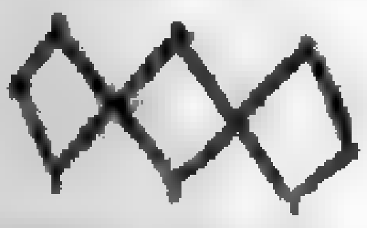
Page 90, last line. After June 8, *insert* June 11.

soon as the boy is able to walk, his father and his elder brothers delight to teach him the elements of all manly accomplishments—to swim, to throw the boomerang and spear; from his mother he learns to dig up roots, to gather edible sedges from the margin of the lagoon, and to become expert in other useful arts. Dawson says that even at the early age of one or two years, but often later, the Gringai tribe mark parts of the body of the child with scars in the form of some simple device, using for the purpose the sharp edges of shells. I know that this practice exists in Queensland and in New South Wales; in the Kamilaroi tribe it is called the man's *mombarai* or "drawing," and assumes such forms as  or  or  or , and in Queensland . These marks are placed on the upper front of the arm near the shoulder, or on the chest on each side of the breast bone, or on the back. A white man, who had been bled by cupping on the back, and who, consequently, bore the marks of it, was believed by the blacks, who saw him bathing, to have been formerly one of their race, from the resemblance which the scars had to their *mombarai*. I think it likely, although I have not been able to obtain satisfactory evidence on this point, that each family had its own *mombarai*, or at least a peculiar modification of the *mombarai* which, I suppose, belongs to each clan in the tribe, for a friend tells me that on one occasion he had an opossum cloak made for him by a man of the Kamilaroi tribe, who marked it with his own *mombarai*; when this cloak was shown to another black man some time after, he at once exclaimed, "I know who made this, here is his *mombarai*." * These markings are not so elaborate as the tattoo of the Maori, or so neat as the similar arm brands of the Papuans; they can scarcely be intended as ornaments, but they may have been adopted for the purpose of identification in battle or otherwise.

Meanwhile the training of the boy proceeds. As soon as he is old enough, perhaps seven or eight years old, he goes forth with his father to the chase, and learns to stalk the kangaroo, to recognize on a tree the mark of an opossum's recent ascent, to knock down the pigeon from its branch, to follow the honey-bee to its nest, to dive under water and spear the fish in their resting-places, and all other accomplishments, which in old England would have been included under the name of "woodcraft." He is early taught also to exercise his faculty of observation, and he becomes quick of eye and acute in understanding all natural phenomena, and in detecting the disturbances which the foot of man or of beast has worked in the aspect of nature around him. Thus at a tender age

* Most of my experts assure me that the *mombarai* is merely an arbitrary brand.

he can tell by the faintest tread on the grass or on the bare soil, by the stones upturned by the foot, or the pieces of dry wood broken on the rocky ground, how many men have passed that way and how long before; if he sees a native bee he catches it, fixes a little bit of white down on its body, then sets it free and follows it with his eye, running hard until he knows where its nest is; his reward is a feast of honey. If he sees a pigeon perched on the limb of a tree and wishes to have it, he makes a great circuit until he is behind the tree, so that the trunk hides him from the eye of the bird, he then moves forward very stealthily until a blow from his stick secures the prize. Perhaps he assists in hunting the kangaroo. When the men see one quietly grazing, they spread themselves in a circle, such as in the hunts of Celtic Scotland is called a *tiomchioll*, round about and at some distance, each carrying a leafy branch of a tree before him; with these they cautiously advance, halting and assuming the appearance of rooted saplings whenever the kangaroo looks up alarmed; at last the circle has so closed in, that when the quarry does at last detect the enemy and begins to hop away he finds a spear or a club everywhere near enough to give him his death blow. In the rivers where large fish are to be found the black boy learns to dive and remain for a time under water;* walking on the bed of the river, with his eyes open, he dislodges from their lairs the lazy fish and kills them, or spears the smaller ones as they hurry past him. In this practice the blacks show wonderful precision and dexterity.

When game is scarce, the black man must subsist on fish or roots. At Brewarrina, on the lower Barwon, there is or was an ingenious fish cage, constructed in the river by the blacks, and called by the settlers the "Fishery." The cod-fish come up here from the Darling of all sizes, from 4 to 40 lbs. weight. Here they lodge in the deep waterholes, and, feeding on mussels and smaller fish of their own and other kinds, they attain to a huge size, their body sometimes weighing from 120 to 150 lbs. To catch these fish of the smaller size the blacks took advantage of a "falls" or shelving part of the river, just below the crossing-place, and placed in the river, from bank to bank, a solid wall of stones, each about as large as two men could carry. Below this solid wall they laid in the river other stone walls at right angles to each other, much like the dividing lines of a chequer board, thereby forming open spaces, each 8 feet square and about 3 feet 6 inches deep. In these walls, which cross each other, they left small slits open from top to bottom and about 15 inches wide, thus large enough to let a fish of 40 lbs. pass through. The uppermost

*In hot weather the boys and girls are very fond of swimming and diving in the river; they throw themselves in doubled up, and thus make a great splashing noise.

wall next the crossing place was made the most substantial of all, to resist the force of the current in the river. It also rose higher out of the water, the others being just so much lower as to cause a slight ripple over them. This fish trap was used in flood-time, and the builders of it, knowing the habits of the cod-fish, which abound here, have so arranged the slits in the lower walls that the fish in going upwards can proceed only in a zigzag direction, and, as they never try to turn back, they at last collect in great numbers in all the squares, but especially in the uppermost ones, from which there is no exit, as the wall is solid throughout. Meanwhile our tyro is getting experience in fish-spear practice, for the blackfellows stand in the squares and ply their spears with such effect that tons of fish are landed on the bank. The river is here about 800 yards wide.

Our young boy also assists in an important operation, that of axe-sharpening. One of the earliest developments of civilization is the stone axe, but the axe to be useful to the savage must be kept sharp, and this he can accomplish only by rubbing. Near Yaggabi, on the Gwydir, there is a great rubbing place, which must have been used by the tribes around for many generations. It is an extensive deposit of sandstone of a gritty nature, fit for grindstones. The rock rises out of a deep reach of the river, and slopes backwards for about 30 feet, and then terminates in a flat top, much of which is now covered with grass. Yet over at least 2 acres of this top there may be seen innumerable hollows made in the stone by the blackfellow when sharpening his axe; for as soon as one groove became too deep he would begin another beside it. Not only on the top but also on the sloping side these marks are seen down to the water's edge, and below it as far as the eye can penetrate. In 1841 there was a great drought in these parts, so severe that the large timber on the black ridges and elsewhere all died over an extent of 10 or 12 miles. At that time the water in the river at the rubbing-place was very low, and yet the rub-marks could still be seen far below the surface of the water. How many generations of Kamilaroi blacks had encamped there we cannot tell, but the rocks still testify why they came there and how laboriously they had toiled.*

Although these are the labours in which the native boy is required to join, yet it must not be supposed that his life is solely or chiefly one of toil. When the pressure of hunger—his greatest physical enemy—is relieved, the black man, feeling comfortable within, is disposed to be pleased with himself and with all around him. Then they lounge on the ground in groups,

* Here is an instance of their perseverance in rubbing. Many years ago a party of surveyors was killed on the Gwydir. The blacks broke the tires of the dray wheels into small pieces and made them into tomahawks by rubbing!

and tell each other stories or recollections of former times, at which they laugh heartily. The young people amuse themselves in various ways; sometimes they propound riddles to one another. Here is one of their riddles: A long time ago, there lived an old woman of our tribe, who was so strong that she could overpower any of the men; so she used to catch young fellows and eat them. One day she caught a young man and left him bound in her *gunyah** while she went to a distance to cut some sheets of bark to wrap the body in, before she laid it in the fire where it was to be cooked. While she was away, two young women, who had observed her doings, slipped into the hut and released the prisoner; they then hurried to the river and, first knocking some holes in the bottom of the old woman's canoe to hinder her pursuit, they all escaped safe to the other side in another canoe. Meanwhile the old dame returned and saw her victim was gone; she hastily repaired the damaged canoe and crossed, but only to find the young man surrounded by his friends ready to defend him with their spears. She boldly advanced, heeding not the spears thrown at her, although they were sticking in her body everywhere; she had seized the young man, and was making off with him again, when the great wizard of the tribe opportunely arrived, and, giving magical power to the blow, thrust her through and through with his spear. Thus the young man was safe. Who was this old woman? Do you give it up? It was a *porcupine.*

Now, although there is not much ingenuity in this riddle, yet it reveals two things:—(1) the existence of cannibalism, and (2) the belief that a wizard's magic can overpower all natural strength and every opposing influence.

Until his formal reception into the tribe through the Bora, the boy is *wonnal* and must eat only the females of the animals which he catches; the males he brings to the camp and gives them to the aged and infirm and those who have large families.

II.—Manhood.

(A.) *Initiation.*

When a boy approaches the age of puberty, a feeling of restless anticipation spreads over his mind, for he knows that his opening manhood has brought him to the threshold of ceremonies of mysterious import through which he is to be formally received into the tribe and thereby acquire the dignity of a man. The rites of initiation are important, numerous, and prolonged, and as his admission does not concern himself or his family merely but the whole tribe, these observances call together large assemblages and are the occasion of general rejoicing. This assembly—the most solemn and unique in the tribal life—is called the Bora and sometimes the

* A tent or hut formed of the branches and the bark of trees.

Kobbora. I take *Bora* to be only a shorter form of Kobbora—a name which seems to me to be identical with *Cobra,* meaning in the Ooalaroi and Gringai dialects a head; thus the Bora is the "head" or chief of all the meetings of the tribe.*

The whole proceedings are interesting; they are essentially the same everywhere in their general features and teachings, but the details vary among the different tribes. Therefore, instead of a separate narrative for each tribe, I will endeavour to present a full view of the Bora, taking the Gringai mode as the basis of my description, but introducing, from the other tribes, such features as appear to me to be necessary to complete the significance of the ceremonies.†

The chiefs of the tribe know that some boys are about twelve or thirteen years of age and therefore ready for initiation; they accordingly summon their *marbull* or "public messenger" and bid him inform the tribe that a Bora will be held at a certain time and place, the time being near full moon and the place being usually a well known Bora-ground; they also send him away to invite the neighbouring tribes to attend; this invitation is readily accepted, for, although the tribes may be at variance with each other, universal brotherhood prevails among the blacks at such a time as this. The day appointed for the gathering is perhaps a week or two distant, and the intervening time is filled with busy preparations by the leading men of the novice's tribe. They select a suitable piece of ground, usually near water and level for convenience in sitting or lying on, and form and clear two circular enclosures—a larger and a smaller, about a quarter of a mile from each other with a straight track connecting them; the trees that grow around the smaller circle they carve at about the height of a man, often much higher, with curious emblematical devices and figures; the circuit of these two rings is defined by boughs of trees laid around, and in the centre of the larger one they fix a short pole with a bunch of emus' feathers on the top of it.‡ Everything is now ready for the rites of initiation, and there is a large concourse; the men stand by with their bodies painted in stripes of colour, chiefly red and white;

* This derivation is only a conjecture.

† The description of the Gringai Bora here given was communicated direct to a friend of mine by a young black who had recently been initiated. I have the utmost confidence that it is circumstantially correct, for I have tested it by inquiries made elsewhere. The facts about the Yüin Bora were similarly obtained by my friend, Mr. Howitt (see page 14), who also purposes to verify them personally. It is every year becoming more difficult to obtain reliable information about the Bora, for it is falling into disuse, the younger men refusing to pass through the ceremonies, and the older men are usually reticent and refuse to tell.

‡ Two such poles, painted red, adorned atop with the white down from the cockatoo, were placed recently at the grave of the king of a tribe near Roma, Queensland.

the women, who are permitted to be present at the opening ceremony only, are lying on the ground all round the larger ring with their faces covered. The boy* is brought forward, made to lie down in the middle of it, and covered with an opossum rug; such of the old men as have been appointed masters of the ceremonies now begin to throw him into a state of fear and awe by sounding an instrument called *tirricoty*, similar to what an English boy calls a "bull-roarer."† The men use this on all occasions when they wish to frighten the women and the boys, who cower with fear whenever they hear it. It is made of a piece of thin wood or bark; it is about 9 inches long, and is sometimes shaped like a fish. The roaring sound is supposed to be the voice of a dreaded evil spirit,‡ who prowls about the camp, especially at night, and carries off, tears, and devours those he can seize. The Kamilaroi tribe call him the Krooben. When the performers think that the *boombat* (so they call the novice) has been sufficiently impressed, *tirricoty* ceases to speak; they then raise the boy from the ground and set him in the ring so that his face is turned towards the cleared track which leads to the circle of imagery; they paint him red all over; then an old man comes forward, breathes strongly in his face and makes him cast his eyes upon the ground, for in this humble attitude he must continue for some days.

Two other old men next take the boy by the arms, and lead him along the track to the other enclosure and set him in the middle of it. (As soon as this is done, the women rise from their prostrate position and begin to dance and sing; after this they go away to a distance, for they are not to see any more of the ceremony at present.) The Yūin tribe,§ on our S.E. coast, place along this path figures, moulded in earth, of various animals (the *totems*), and one of Daramūlun, a spirit-god whom they fear. Before each of these figures, the devotees have a dance, and a Koradjie ("doctor") brings up out of his inside, by his mouth the *jo-e-a* ("magic") of the *totem* before which he stands; for the porcupine he shows stuff like chalk, for the kangaroo stuff like glass, and so on. Meanwhile the boy has been sitting in the smaller circle with downcast eyes; he is told to rise and is led to the foot of each of the carved trees in succession, and is made to look up for a moment at the carvings on them, and while he does so the old men raise a shout

* For convenience, I speak of the boy in the singular number, but there are usually several boys initiated at once.

† This instrument is variously named by different tribes: as *turndun* (in Victoria), and in N.S. Wales *wundaba*, or *goonunganiga*, or *goonung tuckia* = *stercus humanum edens*.

‡ I had one of these "roarers" made and sounded it the other day in the presence of a blackfellow who visits me. He shrunk from it and exclaimed "Bail (=no) me like that."

§ The more correct designation for this tribe would be the *Murring* (from the Shoalhaven River to Cape Howe); the Yūin is a sub-tribe.

They now give him a new name,* which must not be revealed to the uninitiated, and they hand to him a little bag of stringy-bark containing one or more small white stones of crystal quartz; this bag he will always carry about his person, and the stones must not be shown to the uninitiated on pain of death.† This concludes the first part of the performance.

The *boombat* is next conveyed, blindfolded, to a large camp at a distance of several miles, no woman being near, and food is given to him, which he eats still with eyes cast down; here they keep him for eight or ten days and teach him the tribal lore by showing him their dances and their songs; these he learns, especially one song of which I can tell nothing further than that it is important for the boy to know it. These songs they say, were given them by Baiamai, the great Creator.‡ At night, during this period, the *boombat* is set by himself in secluded and darksome places, and, all around, the men make hideous noises, at which he must not betray the least sign of fear. At some part of the ceremony he is shown a sacred wand; of this Ridley says—"This old man Billy told me, as a great favour, what other blacks had withheld as a mystery too sacred to be disclosed to a white man, that '*dhūrumbulum*,' a stick or wand, is

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* As to the new name, "My father," says a correspondent, "sometimes found out what the name was, and would tease the men by pretending to reveal it to the women; when he did this they would get angry and chase him away."

† The tribal laws against the revealer of the mysteries were strictly enforced. Many years ago, some shepherds on the Upper Williams had obtained a few of these crystals and had shown them to the gins. When this became known to the chiefs of the tribe, they assembled in council to consider what should be done; one old man, a great orator, made an inflammatory speech, declaring that the white men should be put to death and not the gins. Accordingly the blacks watched their opportunity, killed the shepherds separately, and feasted on their bodies—a well authenticated case of cannibalism in the Gringai tribe. One old gin long carried about with her in her shoulder-net a hand of one of these shepherds; she would bring it out at times, and pulling the sinews make the fingers move, and say "Bail (no) you make doughboy any more." For this murder one of the blacks was afterwards hanged at Dungog. At the execution many of his comrades were clustered on the trees near by, eager to witness this novel form of the white man's retribution.

Another instance of the women's dread of the white crystals comes from the same locality. Near the Barrington a gin was digging out a *tarak* root, when she turned up a round lump of yellow metal, heavy and smooth. She took it to the camp; the wise men smelled it and felt it and bit it, but to no purpose; then they struck it hard, and finding it yield to their blows, they flattened it and cut it up into small pieces and used them as slugs for their muskets to shoot kangaroos. Some white men saw the pieces and knew them to be gold, but the gin could not be persuaded to go with them and show them the spot; she was afraid, she said, for there were too many white crystals there. So the Barrington or North Copeland Diggings were not discovered till many years afterwards.

‡ The Akkadian root *ba* means "to create," in Kamilaroi *baia* means to shape, make."

exhibited at the Bora, and that the sight of it inspires the initiated with manhood. This sacred wand was the gift of *Baiamai*. The ground on which the Bora is celebrated is *Baiamai's* ground. Billy believes the Bora will be kept up always all over the country,—such was the command of *Baiamai*."

These formalities being completed, the *boombat's* probation is at an end. They now proceed, all of them together, to some large water-hole, and jumping in, men and boy, they wash off the colouring matter from their bodies, amid much glee and noisy merriment; when they have come out of the water they paint themselves white.

Meanwhile the women, who have been called to resume their attendance, have kindled a large fire not far off, and are lying around it with their faces covered as before; the two old men who were the first initiators bring the boy at a run towards the fire, followed by all the others, with voices silent but making a noise by beating their boomerangs together; the men join hands and form a ring round the fire, and one old man runs round the inside of the ring beating a *heelaman* or shield. A woman, usually the boy's own mother, then steps within the ring, and, catching him under the arms, lifts him from the ground once, sets him down, and then retires; everybody, the boy included, now jumps upon the decaying red embers, until the fire is extinguished.

Thus ends the Bora, for the youth is now a man; he is a member of the tribe, undertakes all the duties of membership, and has a right to all its privileges, but may not take a wife for some time yet; the restrictions as to food, however, are now removed, and he may eat anything he can find.

Although these are the formalities observed in admitting a youth into the tribe, yet in the Bora, as in Freemasonry, the novice does not become a full member all at once, but must pass through several grades, and these are obtained by a certain number of Boras; thus the process of qualifying for full membership may extend over two or three years. In his tender years the boy has been taught that he must eat only the female of the opossum or bandicoot, or other animals; all others that he gets must be brought to the camp and given to the aged and those who have large families; when he has attended one Bora he receives permission to eat the male, say, of the paddymelon; after another Bora he may eat the "sugar-bag," that is, the honey, of the native bee; a step higher and he may eat the male of the opossum, and so on until his initiation and instruction are complete and then he may eat anything.*

*Some instances may here be given to illustrate these rules. On a certain occasion, perhaps forty years ago, a dray was travelling on the Great Northern Road, and as the driver was rather short of provisions he said to his black boy, "Georgie, go and catch an opossum; we have no beef."

Another conspicuous part of the inner Bora customs is the knocking out of one of the upper front teeth of the *boombat*. This does not seem to have ever been practised by the Kamilaroi tribe, although it prevailed among the coast tribes, both here and in Queensland, but among them also it is falling into disuse.* One of my correspondents says: "One of the older fellows places his bottom teeth against the *boombat's* upper teeth, and gives a sudden jerk in such a way as to snap the lad's tooth. On one occasion when one of the black boys had been initiated, I noticed his teeth or tooth was not broken. In explanation he said, "Old Bony nearly broke his own teeth in trying; he tried only three times."

Another correspondent says with regard to the Yūin tribe, who occupy our S.E. seaboard: "The tooth after being knocked out was conveyed by the head *gommera* of the tribe to the head *gommera* of the next tribe at Wollongong; thence, I am told, it was carried up as far as Newcastle, thence round by Lake Bathurst to Yass and Gundagai and round by way of Cooma to the Yūin country, where the head *gommera* either kept it or gave it to its owner. It is said that an ancient shield (cf. the sacred

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Georgie soon caught an opossum and brought it to the camping ground, but threw it down beside the fire. His master said "Why don't you skin it and roast it and eat it?" Georgie replied, "Bail (no), massa; you know me must not eat male 'possum." "But, Georgie, nobody will know, nobody will see you." "The Krooben, he see me, he come and take me; that fellow see everything." "Nonsense," said his master, "Tell him I bade you; you eat." "Well, you are my massa; you bid me eat and I eat." And Georgie did eat at his master's bidding, and so escaped the Krooben!

Some years after, when this black boy was about thirteen or fourteen years of age, the dray was down in Maitland for station supplies. His master observed that Georgie was very restless and anxious to go off into the bush; divining the cause, he said to him, "You wait, Georgie, till we are up the country again and you have a gin from your own tribe." So when they reached home, Georgie went to the native camp and took a gin. In a few weeks they started again for Maitland, master, black boy, and his gin. They had not proceeded far on their journey when the master noticed that they were followed from day to day by a party of black men, armed with spears, who concealed their movements as much as possible by keeping off the main road and skulking among the trees. Suspecting something wrong, he one day, when they were near, stopped his dray and hailed them. They came to a parley, and when questioned informed him that they were sent to kill Georgie for breaking their law; he had not attended enough of Boras to entitle him to take a wife. The master explained that Georgie had done this by his orders, and therefore was not to be blamed. After some further conciliatory talk, the blacks departed, fully satisfied.

A mysterious virtue also resides in the Bora. A black boy at Goodooga could not be persuaded to try to make fire in the usual way by friction, for, he said, he had not been to Bora, and it was of no use to try!

* Indeed in various directions the aborigines have left off many of their native customs in consequence of their contact with white men, and it is only by converse with those who knew them long ago that one can obtain a faithful picture of their undiluted state.

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Ancilia in Rome) handed down from past ages in the Yūin tribe—regarded as almost equal to *Daramūlun* himself—accompanied the tooth."

These, then, are the ceremonies of the Bora; but, before proceeding, I wish to draw attention to the fact that the Hamite negroes of Upper Guinea had seventy years ago—long before ethnography became a science—certain religious mysteries singularly like those of our Bora, and I suppose they have them still. These, like the Bora, are ceremonies of initiation, and not only bring a youth to a knowledge of his country's gods, but qualify him to have intercourse with spirits and to hold civil power and authority in the State; all the uninitiated are to him a *prŏfanum vulgus*, who, on the least transgression of orders, are hurried away into the woods, there to be destroyed by the evil spirits which the magical power of the initiated can control. As this assembly is convened but four or five times in a century, and occupies a period of five years, only a small portion of the male population can acquire the qualification necessary for power in the State. The king issues, when he pleases, an order for the holding of this assembly. The preparations are committed to the care of the old men, known to be best acquainted with the mysteries. These choose suitable places in the woods, and make ready there every appliance which can produce surprise, awe, and chilling fear on the minds of the novices. All women, children, and strangers are warned from the spot, and the novice believes that if he reveals any of the secrets of the grove, the spirits, knowing his faithlessness and profanity, will in one way or other bring destruction upon him. The country three or four miles around is sacred and inviolable, and the evil spirits will carry off those who intrude.

The essential idea prominent in this negro ceremony of initiation is that of a death and of a new birth,—a regeneration. Hence the catechumen, before he proceeds to the groves, gives away all his property and effects, as if about to die to the world, and on the completion of his novitiate, when he returns to his kindred, he pretends to forgot all his past life and to know neither father nor mother nor relations nor former friends—his is a new life—his whole aspect is that of a new man, for he now wears on his head a cap made of the bark of a tree, he is adorned with feathers, and as a badge of his new rank he wears a collar of leopards' teeth round his neck. During the five years of his training, the probationer is attended by some old and experienced devotees who act as his instructors; they teach him all the ritual of their religion, various songs and pieces of poetry, mostly in praise of their chief god, and in particular he learns from them a dance of a frenzied kind. While this course of education is proceeding, the king frequently visits the groves and examines the candidates. When their training is sufficiently advanced, they receive each a new name, and, as a token of their regeneration, several long wounds which afterwards become permanent scars, are made on their neck and shoulders. They are now conducted to some retired place at a distance, where women may attend them. Here, their religious education being already complete, they are instructed in those principles of morals and politics which will make them useful as members of the State and fit to act as judges in civil and criminal causes. This done, they leave the groves and their tutors, and, with their new badges of perfection upon them, they exhibit their magical powers in public by means of a stick driven into the ground with a bundle of reeds at its top, or they repair to the public assemblies and join in the solemn dances of the wise men, or in the duties of civic rulers.*

Now, when I cast my eye over the Bora and its regulated forms, I feel myself constrained to ask "What does all this mean?" I, for one, do not accept the "autochthony of the Australian aborigines," nor can I believe that the Bora with all its solemnities (for the rites were sacred, and the initiated were bound not to divulge what they had seen and done) is a meaningless self-developed autochthonous thing, still less that the same thing can be autochthonous in Australia and in farthest Africa; I prefer to see in it a symbolism covering ancestral beliefs—a symbolism intelligible enough to the Kushite race at first, but now little understood but yet superstitiously observed by their Australian descendants.

Looking at the ceremonies, I notice that in many respects the Bora observances resemble those of the religions of the ancient world.

(*A*) There are two circles; the one is less sacred, for the women may be present there, although only on the outskirts; in it certain preparatory things are done in order to bring the *boombat's* mind into a fit state of reverential awe for the reception of the teaching in the other circle,—the *adytum*, the *penetralia*—where the images of the gods are to be seen; the women and the uninitiated must not approach this inner circle, for it is thrice holy; "*procul este profani.*"

(*a*) In the earliest religions, the circle is an invariable symbol of the sun, the bright and pure one, from whose presence darkness and every evil thing must flee away (cf. the disk as a symbol of the sun-god in Egypt, Chaldæa, Assyria, Persia, India, China). This fact is so well known that it is needless to multiply examples. Those who are within the circle are safe from the powers of

* Re-arranged and condensed from Hurd's "Rites and Ceremonies," Newcastle-upon-Tyne, 1811.

evil. The sacredness of the circle in those early ages is seen in the Chaldæan name (Genesis xxxi. 47) *jegar sahadutha,* "the circle of witness"—a name that bore witness to a solemn compact of friendship. In Persia to this day, in the southern parts of it, which were originally inhabited by a Hamite race of an almost purely negroid type, there are to be seen on the road-sides large circles of stones which the tradition of the country regards as set there by the Caous, a race of giants, that is, of aboriginals. Their name closely resembles the name Kush, as does also Cutch, near the mouth of the Indus, and other geographical names along the Arabian seas. Then in the classic nations, both in Greece and in Italy, some of the most famous temples were circular in form, especially the Pantheon at Athens, and at Rome the temple of Vesta, the goddess of the eternal fire. At Rome also, for 100 years after the foundation of the city, the worship of the gods was celebrated in the open air (cf. the Bora), often in sacred groves, and there also the temple of Janus, the oldest and most venerated of the Roman gods, was merely a sacred enclosure on which no building stood till the time of the first Punic War. The *pomoerium*, or circuit of the walls of Rome, was a sacred ring, and the Circus was consecrated to the sun and was open to the sky. In Britain too, the fire-worship of the Druids led them to construct ring-temples in various parts, and especially at Stonehenge, where there are two rings as in the Bora, but concentric. Even the rude Laplanders, who are sprung from the same Turanian race that we found to be one of the earliest elements in the population of Babylonia, make two circles when they sacrifice to the sun, and surround them with willows; they also draw a white thread through the ear of the animal to be sacrificed.

(*B*) In the Bora, the two rings, both of them sacred, communicate with each other by means of a narrow passage, in which are earthen representations of certain objects of worship. The inner contains the images or symbols of the gods, carved on trees, and the novice is so placed in the outer ring that he faces the passage and the shrine of the gods.

(*b*) The inner shrine is an arrangement common to all religions. At Babylon, in the temple of Belus, which was built in stages, the worshipper had to pass through seven stages of Sabaeism before he reached the shrine; this was the topmost of all and contained a golden image of the god; each of these stages was devoted to the worship of one of the Babylonian gods. In Greece and in Rome, the roofed temples were commonly arranged in two parts, an inner and an outer, and the statue of the god was so placed that a worshipper, entering by the external door, saw it right before him. At the very ancient temple of Dodonaean Zeus, in Greece, the god was supposed to reside in an oak-tree, and there is good reason for believing that the *Xoanon* or wooden image of the god was here and in other grove worships merely a carved piece of bark. The student of Biblical archæology will also remember the Asherah of the Hebrew idolaters, a wooden pillar or statue of the goddess which could be cut down and burned (2 Kings, xxiii, 6.)

As to the images in the passage to the inner circle, something analogous exists in Hinduism, for, on the birthday of Ganesa, the lord of evil spirits, clay images of him are made and worshipped for several days and then thrown into water.

(C) In the Bora, the novice in the outer circle has his body all painted over with red, but at the close of his novitiate he washes in a pool, is thereby cleansed, and then paints himself all white. The other members of the tribe, who have previously been initiated, paint themselves red and white for the ceremony; they too, at the close, wash in the pool and retire white like the *boombat*. This transformation is to them a source of much rejoicing.

(c) Among the black races the colour red was the symbol of evil, and so Plutarch tells us that the Egyptians sacrificed only red bullocks to Typhon, and that the animal was reckoned unfit for this sacrifice if a single white or black hair could be found on it; in certain of their festivals, the Egyptians assailed with insults and revilings any among them who happened to have red hair, and the people of Coptos had the custom of throwing an ass down a precipice because of its red colour. The god Typhon was to the Egyptians the embodied cause of everything evil, malignant, destructive, man-hating in the economy of nature, just as Osiris, the bright and beneficent sun, was an emblem of all that was good. Set or Sutekh, that is, Typhon, hates his brother Osiris, and every evening murders him, the darkness kills the light, the evil slays the good. In Numbers XIX. 2, the red heifer is a sin-offering for the Israelites, probably with some reference to the Egyptian ideas about this colour. In India, Ganesa, the lord of all mischievous and malignant spirits, is symbolized by red stones,* and the Cingalese when they are sick offer a red cock to the evil spirit that has caused the sickness. The blacks of Congo wash and anoint a corpse and then paint it red,† and their black brethren of Madagascar, when they are celebrating the rite of circumcision, never wear anything red about them lest the child should bleed to death. The negroes of Upper Guinea—far enough removed from our Australian Boras to prevent even a suspicion of borrowing—make a similar use of the colours red and white; for in Benin, when a woman is first initiated in the rites which the Babylonians sanctioned in honor of their goddess Mulitta, she seats herself on a mat in a public place and covers her head, shoulders, and arms with the blood of a fowl; she then retires for her devotions, and these being finished she washes herself, returns, and is rubbed all over with white chalk where the blood had been.

The young ladies of Congo—also a black country—have a similar custom, but they besmear their faces and necks with red paint.

Those who pass through the Bora paint themselves *white* at its close. It is well known that in the ancient rituals white was the colour sacred to the Sun, the benign god, before whom darkness flies away; evil spirits must depart at the the crowing of the cock, the harbinger of the dawn.

> "I have heard
> The cock, that is the trumpet to the morn,
> Doth with his lofty and shrill-sounding throat
> Awake the god of day; and, at his warning,
> Whether in sea or fire, in earth or air,
> The extravagant and erring spirit hies
> To his confine."

In India *white* agates represent Siva, the eternal cause of all blessings; in Persia *white* horses were sacred to the Sun; in Celtic Britain, some of the Welsh people even now *whiten* their houses to keep away devils; and so with many other examples.

In these senses the *boombat* enters the Bora, with the brand of Typhon upon him, exposed to all evil influences, to disease and death from animals, men, and spirits, but after he has made the acquaintance of his fathers' gods and has learned the sacred songs and dances of his tribe, he comes forth another man; he

* Ganesa must have been originally a deity of the native black races, not of the white Aryan conquerors. So also Krishna.

† See note, p. 13.

washes away the badge of darkness and evil and assumes the livery of the children of light. The other men, whose mottled colour is a confession of mingled good and evil in their lives, also emerge new men once more, purified and devoted anew to the service of the good, and freed from the power of the evil.

This felt subjection to unseen evil and aspiration for deliverance from it, in the minds of our native races, is not only natural to man everywhere, but was a marked feature in the whole system of Akkadian magic; for these old Chaldæans believed that innumerable spirits, each with a personality, were distributed throughout nature, sometimes in union with animate objects and sometimes separately. Existing everywhere they had each both an evil and a good aspect, at one time favourable, at another unfavourable, controlling birth, life, and death, regulating all the phenomena, beneficial or destructive, of air, earth, fire, water. A dual spirit, bad and good, was attached to each of the celestial bodies, and each living being; a constant warfare existed and was maintained between the bad and the good, and, according as the one principle or the other held sway, so did blessings or disasters descend upon nature and upon man. Hence the value of religious rites such as the Bora: for, the due observance of these, repeated from time to time, gave, for a while at least, the victory to the good spirits and brought blessings to the faithful. Thus, then, I explain the red colour of the novice at the Bora, the red and white of the celebrants, and the white colour of the whole when the service was completed.

(D) Ridley says that the Bora is Baiamai's ground. He adds "Baiamai sees all; he knows all, if not directly, yet through Turramulan, a subordinate deity. Turramulan is mediator for all the operations of Baiamai to man, and from man to Baiamai." "Women must not see Turramulan on pain of death. And even when mention is made of Turramulan or of the Bora, at which he presides, the women slink away, knowing that it is unlawful for them so much as to hear anything about such matters."

(d) We have also seen that the Yūin tribe make an image of Daramulun and set it up at their Boras. In the Gringai tribe, the bull-roaring instrument, whose voice begins the ceremony of the Bora and warns the women not to look, is called *Tirricoty*, and is often made in the shape of a fish; the magic wand that Ridley mentions is *durumbulum*; and the great ancestoral Bora ground of the Kamilaroi tribe is at *Tirri-hai-hai*. In Victoria this same instrument, a correspondent tells me, is called *turndun*, a name which I think should be written *durum-dun*. All these names are identical, and only modifications of *dara-mūl-un*, the original form; thus with a slight alteration of the spelling we have *dara*-mūl-un, *turra*-mūl-un, *durru*-m-dun, *dūrru*-mbulum, *tirri*-coty, *tirri*-haihai. The root of all these forms is *dara*, *dar*, Sanskrit *dri*, meaning to "protect," a root found in all the great branches of human speech and furnishing derivatives which mean "a prince," "a governor," "a lord," a "supreme ruler." Of the other portions of these names I cannot at present give any satisfactory account. But I take the name Daramulun to mean something like "Lord of the mysteries," for it is evident that he presides at the Bora, and is the source of the blessings therein communicated. The use of a fish-shaped roarer to indicate his presence leads me to compare him with the Chaldæan god, Hoa, Hea, half man half fish, who, in the Chaldæo-Babylonian religion, was reverenced as the revealer of all religious and social knowledge. His abode was the sea, the Persian Gulf, where he passed the night, but by day he remained among men to instruct them; thus he became a legislator and protector. Hea, as a god, "sees that all is in order," and, being acquainted with all sciences, he can baffle the powers of evil by his magic arts. (Cf. the "magic" shown by the Koradjie in the Bora in the presence of Daramulun's image.) The Akkadians, and from them the Babylonians, invoked the aid of Hea, when spells and enchantments were found unavailing against the power of demons. So, in the Bora passage, when Daramulun had been duly honoured and magic influence conjured up for the driving away of all adverse spirits, the lad is taken into the inner circle and sees the gods of his fathers, and learns to know them and their attributes, just as in the greater Eleusinia of Greece the duly qualified were, after a course of previous preparation, led into the inner sanctuary in the darkness of night, and there by a dim light allowed to see and know the holy things.

The Indian Ganesa seems to correspond with Hea and Daramulun, for the rite of marriage and other undertakings are commenced by the worship of Ganesa, who drives away the malign effects of the malice of the evil demons. He, too, must have come from the sea, for the clay images which have been set up on his birthday festival are afterwards thrown into water, as it were his native element.

(*E*) The next step in the process of initiation is interesting; the *boombat* is shown a sacred wand, he gets a new name, and certain white stones are given to him.

(*e*) (1.) The wand. In this there is the notion of consecration and sacredness, for, on the Egyptian monuments, the deities are constantly represented as holding in one hand a long rod or wand with a crook on the upper end of it. The king also, and some of the highest officers of state, carry this "crook." In India, we find Yama, the regent of the south, has a name from a sacred staff or rod, and some religious impostors wear as badges of sanctity a "staff" and a deer's skin. The Magi of Persia carried the *Bareçma* or *barsom*, a divining wand, as one of the badges of their ministry, and the magicians of Egypt similarly had rods in their hands when they stood in the presence of Pharaoh (Exodus vii. 12). The traditions of Peru speak of a sacred golden wand borne by the son and daughter of the Sun. These are analogies, but the nearest approach to the use of the wand in the Bora is, I think, to be found in the Finnish Kalevala, where there is reference to a "celestial wand" (evidently as in Peru a sun-wand), which protects its possessor from all spells and enchantments. Even the gods are glad to use it against the powers of evil. (2.) A new name. Having now acquired a knowledge of sacred things, the initiated is a new man, he is "twice born," and like his kinsman in Upper Guinea, already described, he will come forth to the world under a new character, renouncing his former estate. In India, a youth becomes one of the "twice born" by investiture with the sacred cord, receiving thus a spiritual birth; thereafter like our *boombat*, he passes into the hands of religious preceptors who teach him the sacred prayers, mystic words, and devotional ceremonies. In more modern times, when a monastic house or a nunnery received, from the world without, one more recluse, a new name was given by which he or she might thenceforward be known in religion. The underlying idea in all these instances is that a religious profession gives one a new character and a new relation to the rest of the world. And who will deny that this is true, whether the professor be black or white? (3.) The white stones. I am inclined to think that the *boombat* receives only one of these at a time, and that the number of them increases according to the number of Boras he attends, until he becomes a full and accepted master of the craft.* In any case they are used as talismans, and are carried in the belt for life. They are merely small pieces of quartz crystals, but are so sacred that they must not be shown to the women. (See page 15.) The negroes of Guinea use small stones as fetishes, which they carry about their necks or under their armpits. These the priests sell after a formal consecration. The white colour is a sun-colour and is beneficent, as already shown; hence the Hindus dedicated white stones to Siva, the eternally blessed one.

Under this head may I venture to quote the solemn and sacred words:—"I will give him a white stone, and in the stone a new name written which no man knoweth saving he that receiveth it."

(*F*) The initiated lad is next led to a camp at a distance; he is kept there for eight or ten days, receiving instruction specially in songs and dances; he also eats here, and his confidence in divine protection is tested by hideous noises during the darkness of the night.

(*f*) It is rather singular as a coincidence that the Dionysia and the greater Eleusinia of Greece also lasted nine or ten days, and that part of them was a solemn meal and a solemn bathing or purification by water; thereafter instruction was given. So also a Brahman must reside with his preceptor for some time until he has gained a thorough knowledge of the holy books; he must pass through certain purificatory rites which remove the taint of original sin; one of these is the cutting off of the hair, and with this seems to correspond the knocking out of a front tooth practised by so many of our native tribes.

The singing and the dancing are everywhere essential parts of negro worship, and the dance is in its origin religious.

Would that some one could gather together these songs of our aboriginals as used in the Bora ere our native races become extinct! I believe that in these songs we should find their religion and their mythology, at present so little known.

* I am confirmed in this view by a conversation which I had the other day with a black of the Gringai tribe, who comes from the Manning River. He says that Boras are not often held now, but that two years ago they had a Bora there at which eight were initiated, some of them big young men. A boy begins to attend the Bora when nine or ten years of age, and receives a white stone each time until he has six; he is then a man and may take a gin.

(*f*) Then come the washing and the purification, which I have already explained, but after that they join hands all round, dance round the fire, and then jump into it and through it.

(*g*) To illustrate this I give a few quotations from Napier's "Folk Lore." "On May Day the Druids used to light large fires on the summits of the highest hills, into which they drove four-footed beasts, using certain ceremonies to expiate for the sins of the people. The Pagan ceremony of lighting these fires in honor of the Asiatic God Belus gave its name to the entire month of May." "Until very lately in different parts of Ireland, it was the common practice to kindle fires in milking yards on the first day of May, and then many women and children leaped through them, and the cattle were driven through in order to avert evil influences." In Rome, on the feast of Pales, in April, the same forms of purification and dedication were observed. The Medes and Persians were fire-worshippers in the very region from which our Kushites came, and even the Hottentots of the present day retain the old customs, for they make their cattle pass through the fire as a preservative against the attacks of wild dogs. These observances came from the far East, and are widely spread there; we may not wonder, then, that our Australian blackfellows, if, as I believe, they came from Babylonian lands, have not forgotten them, and still trust in the protection of the fire-god! If a blackfellow is going to the river for water at a spot to which his superstitious fears have given a bad name, he takes a fire-stick in his hand to drive away the Krooben (an evil spirit), and, if he thinks that the place where he is camped at night is haunted, he kindles a fire there and removes a little distance off, safe in the protection of the fire.

In India, the youth, when about to be invested with the sacred thread, stands opposite the sun and walks thrice round a fire, and in the marriage ceremony the bride is led thrice round the sacred fire. An incantation used by the Chaldæan sorcerers has these words:—"May the god Fire, the hero, dispel their enchantments" or spells for the injury of others.

I have thus considered at some length the institution of the Bora, because it is the most important of all the social regulations of the aboriginal tribes, and because its universal distribution, although with slight local differences in the manner of its celebration, seems to me a strong proof that our black tribes are homogeneous, of common origin, and not autochthonous, as some allege.

Is it possible that so many tribes differing in language and confined by their laws and habits each to its own hunting-ground, should have evolved from their own consciousness ceremonies so similar, and which, when examined, correspond in so many points with the religiousness of the ancient world? How is it that the blacks of Australia and the blacks of Guinea have similar ceremonies of initiation? Is it not because they have come from the same ethnic source, and have thus a common ancestry and common traditions?

(B.) *Marriage.*

But let us now proceed with our subject. The last of the twelve Sanskāras or purifications through which the young Brāhman has to pass is *Vivāha*, marriage, and this completes his equipment as one of the "twice-born." Our *boombat*, likewise, as soon as his course of Boras is complete, is allowed to take a *gin*. And here again there meets us a very interesting field of inquiry—the marriage laws of the aborigines—but as the whole subject has been fully discussed by Messrs. Fison and Howitt, in their book on the "Kamilaroi and Kurnai" systems,* there is little room for original research here, and I shall therefore content myself with stating a few facts known to me, and a few conclusions therefrom.

Our Australian aborigines know nothing of those romantic preliminaries to marriage, love and courtship, which the higher and more civilized forms of life have established in society. They marry, it is true, and are given in marriage, but not on terms of equality or mutual esteem; for the woman becomes the property of her husband, is treated as his drudge, and often receives cruel usage at his hands; her position is that of an inferior; when he walks abroad, she follows, as a lackey does his master, two or three yards behind, and if he speaks to her, or she to him as they walk, he does not stop or turn round to converse, but goes right on with an air of native dignity and conscious superiority, talking all the while. In forming this relation of marriage, the woman has no choice, unless indeed, when she elopes with some young man; but this is hazardous to both, for the male relatives of the woman pursue, and, if they overtake the fugitives, the man has to defend himself against their attacks; if he displays superior prowess and beats off his assailants, he keeps the woman, but, if he has to surrender or is killed, the woman is taken back to her parents; if they manage to escape pursuit for a time, they are safe.

An aboriginal community is divided into four intermarrying classes, which in the Kamilaroi tribe—one of the best known—are called—

	1	2	3	4
Male	Ipai	Kumbo	Murri	Kubbi
Female	Ipatha	Butha	Matha	Kubbitha

* *Kamilaroi and Kurnai* by Fison & Howitt. *Geo. Robertson*, Melbourne.

The first and second of these classes have each the same subdivisions, named after native animals, which they take as their *totems*, viz., Emu, Bandicoot, Black Snake, while the third and fourth take Kangaroo, Opossum, Iguana. The Gringai tribe has the same class divisions, except that Murri is with them called Biah, and their subdivisions are Black Snake, Bandicoot, Eaglehawk, Black Crow, and Stingaree. Other tribes elsewhere have still the four classes, but under different names and with different sub-classes. The law of intermarriage is such that there is no marrying between members of the same class, but an Ipai must marry a Kubbitha, a Murri a Butha, and so on. The rule of descent, as given by authors who have written on this subject, is this:—"*Descent is reckoned through the mother.*" To this rule, however, there are exceptions, where the children follow the *father's* classification. I am therefore disposed to offer this as a more generally applicable rule:—"*Children take the class and totem of their grandparents*," and this rule, so far as I can see, admits of no exceptions in the tribes which I have examined. It corresponds also with a natural impulse among ourselves in the naming of our children. I tabulate my view thus:—

Laws of Descent among the Aborigines.

Rule:—"*Children take the classification of their grandparents.*"

FOR MALES.

Murri (kangaroo) is the son of Ipai (emu): therefore his sons are Ipai (emu).

Kubbi (opossum) is the son of Kumbo (bandicoot): therefore his sons are Kumbo (bandicoot).

Ipai (black snake) is the son of Murri (iguana): therefore his sons are Murri (iguana).

Kumbo (bandicoot) is the son of Kubbi (opossum): therefore his sons are Kubbi (opossum).

FOR FEMALES.

Matha (kangaroo) is the daughter of Kubbitha (kangaroo): therefore her daughters are Kubbitha (kangaroo).

Kubbitha (opossum) is the daughter of Matha (opossum): therefore her daughters are Matha (opossum).

Ipatha (emu) is the daughter of Butha (emu): therefore her daughters are Butha (emu).

Butha (black snake) is the daughter of Ipatha (black snake): therefore her daughters are Ipatha (black snake).

The lineal descent thus becomes :—

For Males.		For Females.	
Ipai	Kumbo	Kubbitha	Butha
Murri	Kubbi	Matha	Ipatha
Ipai	Kumbo	Kubbitha	Butha
Murri	Kubbi	Matha	Ipatha
and so on.	and so on.	and so on.	and so on.

It is also a curious arrangement in these tribes that every man in any one class is supposed to have marital rights over every woman in the class with which he can marry; thus every Ipai regards every Kubbitha woman as his wife *in posse*. Hence a young man of the Ipai class, as soon as by tribal ceremonies he has acquired the right to marry, may go to the abode of a family of Kubbitha girls and say to one of them, in the presence of her parents—

Ngaia	*coolaid*	*karramulla*	*yaralla*
I	wife	will take	by and by.

His demand thus made cannot be refused, and the parents must keep the girl until he comes to take her as his wife. When he does return, and his presence in the camp is recognized, the woman whom he has chosen retires to a little distance, constructs a *gunyah*, that is, a rude hut of branches and bark of trees, kindles a fire, and sits down within. The bridegroom is then led to the spot by his father or some old man of the tribe, occupies the hut with her, and without further ceremony they are husband and wife. But the marriage relation is not always formed in so peaceful a fashion as this; for there may be a blood feud between this *murri* (black man) and the family of the *gin* (woman), and although the parents cannot, according to tribal law, refuse the demand when made, yet they do not allow the woman to go and signify her consent to the marriage by preparing the *gunyah* and the fire. In this case the *murri* secures the assistance of some young fellows of his own class; watching their opportunity, they seize the woman and carry her off by force: thus the marriage seems to be by capture, but is really the assertion of a right which the law sanctions.* The man, however, is not likely to have quiet possession of his bride—the blood feud forbids; and so the male relations of the Kubbitha assemble and pursue the

* I think that the Rape of the Sabines is an instance of this, the blood feud probably arising from the slaying of Remus.

pair; the *murri* is challenged to meet their champion; if he is victorious in the single combat, he keeps his wife; if not, he loses his wife and perhaps his life; thus the blood is atoned. But, if he is a warrior and his superior prowess is known and acknowledged by his adversaries, they do not encounter him openly, but sneak about and watch until they can take him unawares, perhaps asleep or stooping to drink; then they pierce him through with their spears; thus again the blood is atoned.

Sometimes the men carry off the wives of others. This we may call aboriginal abduction. Where the husband has been oppressive or cruel, the wife probably expects to have greater comfort in her new relation. On one occasion two men carried off two *gins*. The one of the men, being afraid of the consequences of his act, gave back the woman he had. The other stood and defended himself with his *heelaman* (shield) against forty others armed with spears and boomerangs. He won the *gin*.

Sometimes they exchange wives, so as to assort ages better.

One strange social custom exists among them. A man must not speak to his wife's mother; they converse through a third person. In the Ooalaroi country, a friend of mine one day said suddenly to his black boy, "There's Mary; call her; I want to speak to her." The boy took no notice of the command, and when challenged for this, he replied, "You know I can't speak to that fellow." But there is no restriction on their converse with the wife's father.

A man's dignity and importance in the tribe are measured by the number of wives he has, as amongst us by the number of servants or retainers. Thus the chiefs have often three or four wives, while the commonalty have to content themselves with one only. A white man, who escaped from penal discipline here long ago and lived many years among the blacks, had four wives assigned to him by the head man of the tribe, to carry his baggage and to do all servile work for him.

(C.) *Condition and duties as a man.*

The *murri* is now subject to tribal government and tribal law. He has assumed the position of a man and a member of the tribe, and is henceforth under authority and answerable to an administrative and executive power which can punish him for wrongdoing. This power—this authority—is, by tribal custom, placed in the hands of the chiefs—the old and experienced men—an aboriginal senate and witenagemot. In the Kamilaroi tribe, at least, the rank of chief does not appear to have been hereditary; for a man who showed conspicuous valour as a warrior, or sagacity in counsel, or skill as an orator, might attain to a seat in the senate, while the sons of a chief might lose their father's place, if they were found unworthy of it. Nor are our blackfellows without precedent in this, for in more civilized communities elsewhere, in which hereditary right was fully acknowledged, the heir to a throne has been set aside because of his unfitness for the duties of the office; while, on the other hand, the mere force of worth and ability has raised a stranger even to the imperial purple. The general council of the tribe, then, consists of these chiefs, who have the sole control of all its affairs, the determination of peace and war, the power to summon assemblies, and the right to enforce the execution of tribal punishments. The tribe, if not too small, is divided into several sub-tribes, each one occupying its own *taurai* or hunting and food ground, within which it must strictly confine itself.* The head man of each of these sub-tribes is a chief and a member of the Council. When a matter occurs which demands deliberation, they assemble apart from the camp and discuss and resolve. "I once," writes a friend, "came suddenly upon a lot of the old men sitting in a circle in anxious consultation. As I passed on, one of them whispered to me not to tell anybody that I had seen them." In these meetings the oldest chief presides, and such is the respect shown to old age that he could carry a measure by his single voice. The chiefs sit as magistrates to decide on all complaints that are brought before them. The punishments they impose are various; for serious offences against tribal law, such as the divulging of sacred things, they decree death by the spear; if a man has spoken to his wife's mother, he is obliged to leave the camp and pitch his *gunyah* at some distance from it, and to remain there for some time; if a husband complains that his wife is *tarumu* ("wanton"), and the council finds her guilty, she is taken without the camp and exposed there to the insult of all who choose to come; but for smaller offences, the man is ordered by the chiefs to stand forth armed only with a *heelaman* or shield and defend himself against the spears and boomerangs thrown at him by a set number of men varying according to the nature of the fault he has committed; only one spear is thrown at him at a

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* To illustrate the cogency of the *taurai* regulation, I give this anecdote. Long ago, in the Ooalaroi country, one division of the tribe had increased so much in numbers that their hunting-ground was too strait for them, and a scarcity of food ensued. They therefore sent their messenger to the adjacent sub-tribe requesting them to surrender a portion of their ground. This was refused, on the ground that it was against tribal law, and that even as it was, their own *taurai* furnished them barely enough of food. The former then sent back an insolent message to say that they would come and take what they wanted and would leave the others only grass to eat. The latter replied, that, if so, they would appeal for justice and aid to the neighbouring sub-tribes. Notwithstanding, the two sections assembled their forces and met; as usual, numerous parleys ensued, much talk and angry oratory; at last it was agreed that next day an equal number from each side should fight it out, but when the time for action came, their courage, I suppose, began to fail them, for the dispute was settled by single combat. This is the common course and issue of a tribal quarrel.

time and he is warned each time of throwing; his relatives stand by in his interest. In some tribes if the offence is not of any magnitude, the offender's *gin* is allowed to stand beside her husband armed with a *conny* ("yamstick"); with this she strikes down the spears as they approach. Many grievances, however, are settled without the intervention of the magistrates, in the rough and ready way common among schoolboys. For instance, a man has been found stealing from his neighbour, or two men quarrel about women; a fight ensues, and with any weapons which may happen to be at hand; the one or the other gets his head broken and there the matter ends. In a set duel, the one man with his *nullah* pounds away at the other, who defends himself with his *heelaman;* he continues showering blows until he is tired; then his adversary sets to work with his *nullah* in the same manner, until the one or the other succumbs. Sometimes also, in more serious matters the chiefs are not required to intervene. If a man has by force married a woman in violation of tribal law, the woman's relatives complain to the man's class; they are bound to compel the man to give back the woman; if they do not, a party feud arises which can be appeased only by blood. The following description of such a party battle was written nearly fifty years ago, and is copied from a private journal. —"10th September, 1833.—I was to-day present for the first time at a battle of natives, ten men being engaged on each side. A clear spot had been selected as the place of combat. The two bands advanced to about thirty paces from each other; then a parley commenced in which words got higher and higher until in exasperation two or three *boomerangs* were thrown from the one side; presently the others returned the challenge in the same way, and then the parties gallantly closed and began belabouring one another's heads unmercifully with their *waddies*; three or four of the combatants were soon prostrate, and the blood on their backs showed that the blows had been forcibly applied. Threats dark and deep were now heard, spears were got ready for action, and the dreadful howl of defiance was raised; the combatants again opposed each other, but with more deadly weapons than before. But while the sight of blood arouses the valorous feelings of the men, it evidently excites the softer sensations of the other sex; for now all at once rushed between the parties a hag bearing the name of woman; her eloquence was great if we may judge from the noise she made; she 'suited the action to the word and the word to the action'; and as often as a man lifted a spear to throw, she interposed herself; her violence was becoming outrageous, when there came forward from the opposite side a woman also armed with a tomahawk, and seemed inclined to take summary means to quiet the first intruder; she, however, was not to be so daunted, for in reply she brandished her stick as though game to the backbone. The angry mood, however, of these two females suddenly changed, for they ceased to threaten, and agreed to endeavour to preserve peace between their friends. But the first, finding her efforts in this direction unavailing, abandoned herself to despair, and, seizing a tomahawk, cut her head with it in a most dreadful manner. Whether she intended also to cut short her existence or no remains an unsettled question, for the tomahawk was wrested from her hands.

"The female affray was to me by far the most amusing part of the business, and no London fisherwomen could have assailed one another with greater seeming virulence, or with more ready language.

"The one party had hawks' feathers stuck in their hair—a sure sign that their intentions were deadly."

In some tribes when a blood feud has to be atoned, the whole *totem* (say, black-snake) of the aggressor meets the *totem* (say, bandicoot) of the victim; champions are selected to represent each side as above, and the remainder of the men of these *totems* are spectators.

The council of chiefs also appoints the public officers of the tribe. The principal of these is the *marbull*, the "herald" or public messenger. He must be a man fluent of speech and a good traveller. He passes in safety between and through hostile tribes, for his person is inviolable, and he is known to be a herald by the red net which he wears round his forehead. Charged with a message from his tribe, he approaches the camp of the enemy, and makes his presence known by a peculiar *cooee*. This brings around him all who are within hearing of his call; he sits down and remains silent for a long time,* nor do they speak a word to him till at last his tongue is loosed and then his eloquence is like a rapid torrent; he is listened to with the greatest attention; the chiefs consult, and he waits there for the night or perhaps for several days to receive their reply.

A *murri* when carrying a white man's message is likewise allowed to pass safe even through a hostile territory. He carries in his hand a piece of stick with a notch at the end and fixed in this is a piece of white paper having the message written on it. To attack or injure this messenger is to raise a feud with the whole tribe of white men.

In some parts of Queensland, the tribes use "message sticks." These are pieces of bark or of thin split wood, oblong in shape, with nicks on the edges and marks on the flat side. In some way intelligible to them these nicks and dimpled marks indicate the number of men and women about whom information is wanted or sent.

* It is always a grievous violation of native etiquette to ask a man why he has come; he is allowed to choose his own time to speak.

Thus it is that the chiefs administer the affairs of the tribe and maintain the order of the community. Those whom they govern hold them in the highest estimation. But other classes of men of great influence in the tribe are the *koradjies* or "doctors," and the "wizards" who are supposed to deal in magical arts. These men have no share in the government, although a chief, if he is so inclined, may practice as a Koradjie.

The favourite mode of cure in disease is the sucking of the part affected. And here the Koradjie is both a mountebank and a successful practitioner, for there is no doubt that his method will often work a cure, for, like a sinapism or any counter-irritant, it draws the disease from its seat in the inner tissues and makes it depart through the pores of the skin. But, along with this, they endeavour to secure the curative influence of imagination and therefore work upon the credulity of their patients. A man has a pain in his arm or a lump in his side; he applies to the Koradjie, who sucks the part and in a little produces from his mouth a small piece of quartz, which he says is the pain or the magic cause of the pain, extracted from the arm; or he shows a round pebble from the man's side; the patient firmly believes that this stone was thrown at him and into him some days before by the malevolent spirit of some blackfellow, whose grave he passed; or again, a boy has his foot burned; the Koradjie sucks the wound and brings out of his mouth a large piece of charcoal, and now the wound must heal. The blacks firmly believe in the efficacy of these means of cure, and do not like to be told that it is all nonsense. The sucking however is really effective in the case of snake-bites; two or three Koradjies continue sucking the bitten spot, relieving each other, until the patient is out of danger. They have also some rational modes of cure; they gather herbs, the virtues of which it is part of their profession to know, and give them to the sick man, who prepares them according to their directions, and applies them externally. They also use the earth bath for a heavy cold which other remedies have failed to dislodge; for a bath, they dig a hole in any loose moist earth which they can find, and place the patient in it, filling in the earth around him until it is up to his neck; he continues in the bath four or five hours, and during this time he shouts for pain; drinks of water are supplied to him and a profuse sweat is induced. The strong recover, but sometimes the patient dies from exhaustion.

The wizards are a more dangerous and dreaded class of the community than the doctors. They are believed to cause sickness and death at will, to bring or drive away rain, and to do many other similar things. They pretend to have converse with the spirits of the departed; they can climb into the sky by ropes or by turning themselves into birds; there they talk with the ghosts and get knowledge and assistance from them. Sometimes the spirit of an animal, such as the native bear, would enter a wizard, who thenceforward could speak *corroboree* songs as one inspired.

In all these experiences of our initiated *murri*, now that he is a member of the tribe, there is nothing unique, nothing so peculiar that it may not be found, in essence at least, in other savage communities. Having therefore thus stated a few facts to show the conditions under which the *murri* continues to live, I pass on to

III.—The period of Old Age.

Here we meet with an amiable feature of the aboriginal character; they never desert their aged or treat them with inhumanity. Many a time have I seen blind old Boko led about by the hand, as carefully and patiently as a mother leads her child; if his guides were offered food, Boko received his due share; even the glass of rum was held to his lips that he too might have his mouthful of it. From their earliest years the young people of the tribe are taught to respect the old, and one of the duties laid upon the novice in his instruction at the Bora requires him when a successful hunter to bring the best of his prey and lay it at the door of the aged and infirm.

Some of our blacks are long-lived. I know of one or two who are supposed to be over eighty years of age; "another," says a friend, "must be nearly a hundred years of age from all accounts"; but wherever they are brought into contact with the vices of white men, as in our larger towns, they die off very rapidly. I am told that in the Maitland district fifty years ago there was a warrior known as Jimmie Jackass; he and his son and grandson all died within thirty years.

An old person, when no longer able to follow the camp as it moves about from place to place, and evidently near death, is left at a suitable spot in charge of one or two others; if a woman, she is tended by a woman and a girl; if a man, by a man and a boy. When death comes, they dig the grave and inter the body or otherwise bury it, and then rejoin the camp.

The blacks bury in any soft ground which may happen to be near, but some tribes, as those on the Paterson and the Upper Bogan, have regular burying grounds which have been used for generations, and are considered sacred. To these a corpse will be brought from the distance of many miles. "My black boy," says a correspondent, "wishes to be buried where he was reared." I need not compare with this similar practices and desires in all ages and countries.

Wherever a tribe does not inter the dead, the body is simply wrapped in two sheets of bark, which are secured with cords of kurrajong;* it is then placed in a hollow tree. If interment is the

* A native tree with very tough twigs.

practice, a grave is neatly dug, round but not very deep, and a friend goes down into it and tries if it is suitable. The body in the meantime has, while warm, been made into the form of a ball, knees to chin, and tied up in bark; it is brought to the grave, but before it is lowered into it, a wizard, standing by, questions the deceased and asks him who caused his death, and so on, to which answers are given by an old black on the other side. When the body is in the grave, weapons and articles of clothing are placed beside the dead man,* all present, and especially his relatives, contributing something; the women and men then utter pitiful yells and cut their heads till they stream with blood; then all is covered up, and the company departs. The mourning for the dead is continued for three or four months; the relatives, mostly the women, smear their heads with pipeclay, and at supper time and at night raise loud yells and cut their heads with tomahawks or knives; the streaming blood is left to dry there.

Elsewhere the grave is like ours in shape, and the body is laid in flat, on a sheet of bark; above the body is another sheet of bark and then grass, logs, and earth, the earth on the surface being left in a mound somewhat in shape like a half-moon; the trees also near the spot are decorated as in the Bora; the chiefs are sometimes buried in the Bora ground. In one part of Queensland two sticks are set up in the ground near the grave; each is about 2 feet long, shaped like a *nullah* and painted red; their tops are covered with the fine white down from the cockatoo. In the Kamilaroi country, not only is the bark of the adjacent trees marked with devices, but another grave is dug and no body placed in it; this they do, the blacks say, "to cheat the Krooben." The Krooben, as I have already explained, is a malevolent spirit that wanders about at night and carries off little children from the camp; and "cheating the Krooben" seems to imply that he also tears and devours the spirits of the dead. A correspondent tells me that "the Kūlin tribe (Victoria) believed that each man and animal had a *mūrŭp*, 'ghost or spirit,' which could pass into other bodies; the *mūrŭp* of a man could, during his life, leave his body in sleep and visit others in dreams; after his death it was supposed to wander about, revisit the grave, interview the *mūrŭps* of its living friends in dreams, eat up the remains of food left lying about, and warm itself at the night fires. Thus, when Buckley was seen sitting on a grave with a broken spear in his hand, he was naturally regarded as a *mūrŭp* come back to visit his body."

Something analogous to this is found among the blacks of Lower Guinea. When a man dies, they ascribe his decease to the enchantments of an enemy. At the grave they ask the corpse

* Thus they show their belief in a life after death, as many other nations do.

who bewitched him, who took away his life; why he departed, was it because he was dissatisfied, and so on. They believe that souls pass into other bodies, but that the deceased still lives in another state, and therefore they inter with him most of his effects and valuable presents from his friends. They believe also that the wizards by their incantations can raise the dead man, and make him hunt and fish and work as a slave for them; therefore, they erect at the burying ground a wooden image of the god who is the guardian of their dead; thus the wizards are foiled. Is this the meaning of the carvings on the trees and the red sticks at the graves of our aboriginals?

Our blackfellows desert their camp where one of them has died; so also do the Hottentots. An explanation may be found in a belief shared by many ancient nations, but most developed among the Hindus—that when the "gross body" is laid in the grave, or burned, the soul still lives in a material form, but that at first this is only a "subtile" not a real body, and therefore restless and miserable—a foul wandering ghost "unhouseled, disappointed, unaneled,"—so miserable as to have delight in doing malignant acts and taking revenge on all living creatures. Hence, also, of old, among various nations, savage and civilized, funeral rites were renewed at various intervals, for it was by these that the soul gradually attained to the possession of a real body capable of enjoying its new life.

To illustrate the funeral arrangements of the Gringai tribe, I again quote from the private journal to which I have already referred—King Jackey's funeral, August, 1833. "A long neck of land is here formed by the junction of a creek with the river, and the extremity of it, surrounded on three sides by the brush, was the place of interment, as pretty a spot for the purpose as I know of anywhere. When I approached I saw an old man digging the grave; this was a most laborious task, for the ground was very hard, and the only tool he used was a tomahawk. The form of the grave was oval, and the depth when finished short of 4 feet. There were about a dozen or more of blacks squatting or standing around, and amongst them the father, mother, and several brothers of the deceased. The parents were howling in company, the man's voice resembling the three sounds *a—— a—— ar*, long dwelt upon; the female's more treble, like *ei—— ou——*. This noise they kept up without intermission. The body itself, trussed up in as small compass as possible and wrapped in rugs, was on the ground about 4 yards from the grave, supported by two relatives, who, as they bent over it on their knees, gave full tokens of their grief and affection. The digging being finished, the sexton went to some of the youngest and freshest-looking trees, and, breaking off the small leafy branches, proceeded to line the grave with them. When this was done, the brother of the deceased descended to try whether the grave was comfortable, which he did by lying in it in the position the body was to occupy. Some slight alterations were required, and when these were made the younger members of the family came forward and, surrounding the corpse, lifted it from the ground. While doing this they gave a great shout and blew with their mouths* and waved with their hands over the body. These same observances were repeated while the body was being lowered into the grave, where the brother of the deceased had already placed himself ready to receive the body and to lay it carefully so that not a particle of earth should touch it. The shout then set up by all of them was awfully deafening. The old father, rushing by me, seized a tomahawk and cut his head in several places† until the blood gushed in quantities from the wounds. Another old man snatched the instrument from him and covered his own head with gashes; three or four did the same, some most viciously, while others seemed to think that a very little of that sort of thing was enough; the howling continued all the while. Bark was now placed carefully over the body, and the old men stretched themselves at full length on the ground and howled dreadfully. One of them at length got up and took a piece of bark which he placed across the grave and stretched himself on it, crying with all his might. I then left them, nothing of the ceremony remaining but the filling up of the grave."‡

An instance of the affection of the black—savage (can we call him so?) attended the burial of King Jackey. His mother could not be induced to leave the spot; she sat there refusing food until one morning she was found dead on the grave! She was buried beside her son, and not long after a little dog that had belonged to the old woman was also found dead on her grave. These are facts.

These, then, are the chief points of interest in connection with old age, death, and burial—the third and last head of my subject.

And now, as this essay has already swollen to unexpected dimensions, I will conclude with one or two specimens of aboriginal mythology which, I believe, are entirely new. Our native races are attentive observers of the stars; as they sit or lie around the camp fire after night-fall, their gaze naturally turns to the starry vault above, and there they see the likenesses of many things with which they are conversant in their daily life—young men dancing a corroboree (Orion), and a group of damsels looking at them (the Pleiades), making music to their dance—the

* The blacks do this also when they are driving away the rain-clouds. They rub their hands together, and looking up puff away the rain.

† Cf. 1 Kings xviii. 28; also Deut. xiv. 1.

‡ One mode of burial seems to be more honorable than another, for while King Jackey was buried trussed up, others have been buried at the same spot only wrapped up in bark at full length.

opossum, the emu, the crow, and so on. But the old men of the Gringai tribe say that the regions "above the sky" are the home of the spirits of the dead, and that there are fig-trees there and many other pleasant things; many men of their race are there, and that the head of them all is a great man, *Menee*; he is not visible, but they all agree that he is in the sky. A greater than he is the great *Garaboon*, or *Garaboong*, who, while on earth, was always attended by a small man; but now the two shine as comrades in the sky—the "Heavenly Twins." Both *Garaboong* and *Menee* are "skeletons." In his mortal state *Garaboong* was a man of great rank and power; he was so tall that his feet could touch the bottom of the deepest rivers; his only food was snakes and eels; one day, not being hungry, he buried a snake and an eel; when he came back to eat them he saw fire issuing from the ground where they were; he was warned by his companion, the little man, not to approach, but he declared he did not fear the fire and boldly came near; then a whirlwind seized him and carried him up "above the sky," where he and his companion still are and "can be seen any starlight night."

These two legends are interesting. *Menee* is to them the father and king of the black races, whom he now rules and will rule in spirit-land; he was once a mortal, but now he is a "skeleton"—a spiritualized being, without flesh and blood. I observe that his name, strange to say, is exactly the same as that given on the hieroglyphic inscriptions to the first king of Egypt, Menee—by Herodotus called Menes—the head of the First Dynasty of mortals. He was a public benefactor, for he executed several important works, and taught his people the worship of Phtah, the great artificer-god of Egypt (Herodotus II. 99). He must have some mythical relation to the human race, for in Greece he is Minos, king of Crete, "Minoia regna," author of many useful laws, and afterwards a judge of the shades of the dead; in Greece also, he is Minyas, the founder of a race of heroes; in India he is Menu, and in old Germany Mannus.

The story of *Garaboong* seems to correspond with that of the Dioscouroi—Castor and Pollux—who also were mighty heroes and benefactors of mankind. The ancient Germans (Tacitus, Germ. 43) worshipped them in a sacred grove and called them Alcis, which may mean the "mighty" ones, tall as the deepest rivers.

How have our blackfellows come to have the name Menee and such a myth about him. Are the name and myth invented by them, autochthonously? Are they not rather a survival—derived from a common origin—of traditions which belong to the once undivided human family.

In conclusion, let any one ask me how it is that our aborigines, if they are of such an origin as I assign to them, have sunk so low in the scale of humanity as to be regarded among the most degraded of the races of men. I deny that this estimate of them is well-founded; on the contrary, I assert that it was formed long ago by those who imperfectly understood the habits and the social organization of our native tribes, and has been ignorantly passed from mouth to mouth ever since; that, when these are thoroughly examined, our blackfellows are not the despicable savages that they are too often represented to be. They have or had virtues which we might profitably imitate; they are faithful and affectionate to those who treat them kindly; they have rules of family morality which are enforced by severe penalties; they show the greatest respect to age; they carefully tend and never desert the sick and infirm; their boys are compelled to content themselves with meagre fare, and to bring the best of the food which they have found and present it to the aged members of the tribe and to those who have large families. I am assured by one who had much intercourse with them for thirty years that he never knew them to tell a lie and that his property was always safe in their hands; another, who has been familiar with them since he was a child, says:—"Naturally they are an affectionate, peaceful people, and considering that they have never been taught to know right from wrong their behaviour is wonderful; I leave my house open, the camp close by, and feel the greatest confidence in them."

Then, again, although the material civilization of the world was commenced by the race of Ham, yet the task soon fell from their hands, for morally they were unfit for it; for the conservation and first dissemination of a pure and undefiled religion we are indebted to the race of Shem; while the sons of Japheth have gone forth to rule the earth and the sea—*audax Japeti genus*—and to spread the blessings of good government and the arts and inventions of an enlightened age to the remotest lands. The Hamites, on the other hand, have continued to sink in the social scale, have been persecuted and oppressed by the other races, and thus debased; and wherever, as in our island, the sky above and the earth beneath have conspired to render the means of life meagre and precarious, there the process of decay has been accelerated, and physically their condition has been very low, but still among their social institutions there are traces of better things. Would that we had a full record of what they really are before they pass away from among us!

On the Influence of the Australian Climate and Pastures upon the growth of Wool.

(IN ABSTRACT.)

By ANDREW ROSS, Esq., M.D., M.L.A., Molong.

I CONFESS that it is with the greatest diffidence that I approach the subject indicated by the title of this essay, knowing as I do that the question to be considered is one whose solution involves interests of vital importance to the progress and prosperity of the Colony—a Colony teeming with undeveloped natural resources, and awaiting only the expenditure of capital and industry to bring forth her inexhaustible treasures to the light of day. I must at the outset crave indulgence if I should advance ideas or hypotheses at variance with popular opinion or the expressions of recognized authorities.

It has been asserted that a change for the worse has been taking place of late in the character of Australian wool; and various causes have been assigned as having operated to produce this alleged deterioration. By some it is attributed to the want of proper care on the part of sheep-owners in the selection and crossing of breeds and in culling the flocks, while others put it down to an insane attempt to breed the same class of sheep in every part of this immense territory under widely varying climatic and other conditions. But it seems to me that a very obvious cause—one far more likely to produce the deterioration complained of than either of these—has been almost entirely overlooked.

One authority asserts that "the characteristics of our Australian Merinos have been ruined by the introduction of Rambouillet, Nigretti, Saxon, and other fine-woolled rams, undoing all that our fine climate had effected for generations past in establishing the qualities for which our wool was so renowned." Here, it will be seen, the high degree of perfection attained by Australian wool is ascribed to the influence of climate alone; and this view appears to have been generally accepted for many years past. Mr. Henry Hughes, wool-broker, London, before a Committee of the House of Lords, as far back as 1828, says:—"The Australian and Van Diemen's Land wools have been of varied qualities, but all possessing an extraordinary softness, which the manufacturers here so much admire that they are sought for far more than any other description of wools, from that peculiar quality which is supposed to arise from climate alone." But the climate, I am convinced, has undergone no material change since 1828, and why should not our wool present the same remarkable qualities now-a-days as then; for surely the influences which produced these effects fifty years ago are capable of producing the same effects at the present time, and the sheep now being imported ought to be benefited just in the same way as the early English merinos were. If these authorities are correct, the introduction of a few foreign sheep need cause us no alarm.

It appears to me, however, that these causes which have been suggested are quite inadequate to account for any great deterioration in the quality of our wool, or in the type and character of our sheep; and I am convinced that if any change has really taken place at all, the true source of the mischief is to be found in the operation of a very different set of causes, to which until lately the majority of our sheep-owners have paid little or no attention, and whose importance even now they seem very imperfectly to realize. I allude to the gradual but wholesale destruction of the native grasses and herbage all over the country, resulting from the practice which prevails in almost every part of the Colonies of grazing immense flocks of sheep year after year on the same pasturage, without giving any rest to the land to allow of the renewal of the herbage or the reproduction of seeds. Every blade of grass, as it appears above ground, is immediately eaten down; and thus those species which are best adapted to the constitution of the sheep are in time either entirely eradicated or become so altered in their growth and chemical composition as to be utterly unfitted to maintain the animal in the healthy thriving condition necessary for the production of a good sound staple of wool. If we carry our thoughts back for a moment to the profuse richness of the native grasses and succulent herbage abounding at the time when Mr. Macarthur first introduced Merinos into these Colonies, and then look at the scanty juiceless roots and grasses that are to be found on the majority of our runs now-a-days, a little consideration ought to make it clear even to the most sceptical that the suicidal policy so unremittingly pursued in our system of sheep-grazing is ruining our pastures, depriving our runs of their fertility, and must inevitably have the most disastrous effect upon the production of our wool. How can it be expected that sheep will thrive and produce good wool when they are badly or insufficiently fed? Under such conditions scurvy or a cachectic state of constitution is as readily produced in the lower animals as in man. Stinted feed gives imperfect stinted fleeces, with a brittle, harsh, irregular, yolkless staple; and breaks or flaws in the wool truly indicate irregularities in the quantity or quality of the pasture, just as the rings in the trunk of a tree denote variations in the seasons. It is absurd to think that sheep can ever be maintained in the same uniform condition unless proper attention is paid to the nature of the food on which they have to live and grow wool and mutton. I do not deny that some improvement may occasionally be effected in a flock by crossing with a fresh breed and paying careful attention to culling, but this is not enough; breed, import and cull as we may, if the supply of food be irregular or defective in quality, our labour, notwithstanding all our vigilance and industry, must prove abortive.

The increase in the number of our store sheep affords a too true index to the real poverty of many of our runs. If we improve our grass lands we take the most effective measures to transform crawlers into marketable wool-bearing sheep; and by increasing the grazing capabilities of the soil the Colony may be made to support a much larger number of sheep than 30 millions, as at present. If proper attention be paid to this subject, I feel assured that the time will come when instead of allowing 4 acres to one sheep, the land will be able to carry four sheep to the acre.

The ignorance of most of our sheep-owners with respect to the kinds of grass best suited for the sustenance of their flocks is a fruitful source of failure. I question whether many of our graziers are able to tell what species of grasses are to be found on their runs; a great number of them, I believe, are even incompetent to distinguish between one species and another. A flock-master riding over his run, and seeing abundance of grass in every direction, immediately concludes, perhaps, that there is no scarcity of food for his sheep, whereas this very abundance ought to make him suspect, if he were to think for a moment, that something was radically wrong; because, with his flocks continually grazing over the same ground, the grass should not be so plentiful. In almost every such instance, the cause of this supposed superabundance of forage lies in the fact that it is not the food congenial to the animal's constitution—that it does not contain those elements which the sheep require for their subsistence. The really valuable grasses are cropped down to the ground again and again, and eventually become very much deteriorated or entirely disappear, while the tall, worthless weeds are left to thrive and spread and become permanent fixtures on the soil. If more attention were paid to the study of the nature of our indigenous grasses, their suitability for sheep pasture, and their times of flowering and seeding, much of the annual loss of sheep which now takes place would be avoided, and stock-owners would not remain half so much at the mercy of the periodical droughts that tell so severely on the flocks and affect so injuriously the yield and quality of the wool. Sheep must be provided with those grasses which contain the elements best suited for their animal economy and the nourishment of the wool. It is as imposssible for wool to be sound, healthy, and elastic with an insufficiency of yolk as it is for trees to flourish without sap; and this yolk can only be derived from the grasses and vegetable matter consumed by the sheep. It contains a great quantity of potash, and if the food be deficient in that substance, the flocks cannot thrive and produce good wool.

The Government, I think, ought to adopt some means of acquiring and disseminating a more familiar acquaintance with the various native grasses, their characteristics of growth, and their nutritive qualities, in order that graziers might be enabled to discriminate between the wholesome species and those which are valueless or noxious, and distinguish the early from the late varieties, and the hardy from the too delicate. They could then take steps to propagate or conserve those only which are valuable for grazing purposes. A proper classification of our grasses would furnish far more satisfactory means of describing the character of a run, by stating the nature of the pasture, than the present method of merely stating that it is timbered with gum, pine, myall, box, or iron-bark, as the case may be. From a list made out by Linnæus, in Sweden, of the grasses of that country, it appears that there are 387 different varieties, not less than 141 of which sheep will not touch. A list of the grasses will be found in the second volume of the *Amœnitates Academiciæ.* There are scores of indigenous grasses in these Colonies that sheep refuse to eat. If not poisonous, they are at least instinctively avoided by the flocks as unsuited to their nature; and it would be a most advantageous thing if our graziers had some reliable guide to assist them in picking out these species, so that they might do their best to eradicate them. If a School of Agriculture should ever be established in the Colony, I hope a study of the grasses will form part of the curriculum. In a young country like this, practical information on matters of this kind is of the highest importance, and unless some effort is made to keep up the standard of our pastures, our reputation as wool-growers in the British markets will soon be gone for ever.

The reason that sheep prosper so well on box-timbered country is that this wood contains a large amount of potash, which, as I have before pointed out, is one of the chief ingredients in the yolk of wool. Of this fact any one may satisfy himself by watching a box-tree burning. However green it may be, it will be found to consume readily, leaving behind a large quantity of fine white ashes, which are to a great extent composed of potash. This alkali in solution is taken up by the vegetation which forms the food of the sheep; and it is found that the sheep in such districts are remarkably free from disease and produce excellent samples of wool, requiring very little washing. The amount of potash extracted from a run by a flock in the course of a year must, however, be something enormous—in some instances it forms a very large proportion of the entire weight of the fleece—and unless some measures are taken to supply the loss, the grazing capabilities of the land must be seriously impaired.

Oleaginous and saccharine plants furnish the chief source of animal heat, whereas salt (chloride of sodium) is principally expended in keeping the organs of digestion in an active state. Its action is as follows :—The chlorine unites with hydrogen (from water) and forms hydrochloric acid, an ingredient abundantly contained in the gastric juice, while the soda goes to the liver to aid in the formation of bile. The bile is to the animal economy what tannin is to the vegetable—it is that which prevents a too rapid decay taking place in animal or vegetable matter before it has undergone a thorough process of digestion and assimilation. Without bile or tannin, all things would have a tendency to decay and putrefy; they are the chief agents, in fact, in the preservation of vitality. It is the presence of tannin in wines, for instance, which causes them to keep so well. Who knows but that foot-rot, catarrh, and many of the other diseases which sheep are subject to, owe their origin to the absence of a sufficiency of saccharine, oleaginous, and saline matter in the food, reducing the vitality of the animal so that the various organs become incapable of performing their functions. It must be remembered, however, that an excess of salt has the effect of impoverishing the blood, and that if the nutritive elements are wanting in the food, it is likely to do more harm than good. The degeneration of the grass which I have alluded to has robbed the food of the sheep of its natural sweetness and nourishing properties, and yet as a rule nothing is supplied by the owners, with the exception of salt. I think that it would be far more beneficial if sugar, in some form or other, were furnished to the flocks, and I would suggest the cultivation for this purpose of saccharine plants, such as sugar-cane, turnips, sugar-beet, mangolds, &c. These plants would be very valuable in case of such ailments as catarrh, worms in lungs, &c.; oil-cake, too, might be used with advantage.

The practice of over-stocking, unfortunately almost universal in these Colonies, has had much to do with the falling off of our pastures, and the consequent depreciation of the wool. Quantity rather than quality seems to be the aim of almost all our squatters, and the result is that we find thousands of sheep on almost unlimited runs with but little wool, where, with reduced runs, and smaller but more select flocks, there would be abundance of grass and a good yield of wool. Good grass lands, in small divisions, will keep and fatten many more sheep than when in large blocks. A good plan to adopt is to subdivide runs into paddocks of convenient size, and allow them in rotation intervals of rest; the grass will then have an opportunity of arriving at maturity, and time will be given for the production of seeds and the growth of new herbage. It is especially necessary that some of the paddocks should have a spell, say for a few weeks or months, so as to have abundance of grass for the ewes during the beginning of the lambing season. They will then have no difficulty in filling their bellies, and will not have to be continually walking from place to place in search of food. The milk will be found to be richer and more plentiful, and the lambs as a consequence will be stronger and healthier. It is only natural that sheep should suffer materially if they have to be dogged and driven backwards and forwards all over the run to get enough grass to satisfy their hunger. A good percentage of healthy lambs, with a healthy constitution, cannot reasonably be expected when lambing takes place at some miserable barren station, with hardly a vestige of food, except, perhaps, a little trefoil. If proper care were taken at this season, a great deal of trouble later on would be saved; for culling is generally simply an attempt to remedy defects that have arisen from the ewes being starved or neglected at lambing-time. Rest to the ground is quite as necessary for the growth of grass as for that of cereals. No matter how good grain may be, it will never come to perfection in exhausted soil, and the same rules holds good with regard to pasture. From carelessness in this respect on the part of sheep-owners, many of the most valuable plants and grasses that grew so luxuriantly in the early days of the Colony are fast disappearing, and the carrying capabilities of our runs decreasing enormously. Take a ride over any of our squattages now-a-days, and the experienced eye cannot fail to detect the absence of numerous grasses, and those the species most noticeable for their fattening qualities, our annuals or summer grass especially.

A great deal of harm, in my opinion, is occasioned by the interference of wool-brokers in advising their clients to cross with this breed or that, to cure imaginary defects in the wool. If the sheep-farmer is unable to transact his own business without such assistance, it would be far safer for him to sell out at once. If he is anxious to obtain trustworthy advice as to the quality of his wool, he should seek it of the manufacturer, and not of the wool-broker, whose interest it is to be always fault-finding in order to be able to buy to advantage. He is almost certain to find some excuse to depreciate the clip, no matter how well the wool may have been got up, or how good the breeds from which it has been shorn. Suggestions are gratuitously made to correct this fault and remedy that imperfection; the breed is changed, perhaps year after year; and, shuttlecock-like, the unfortunate owner is tossed backwards and forwards from broker to stud-breeder until his purse becomes exhausted, his flocks are ruined, and the Insolvency Court stares him in the face.

The importation of new breeds is frequently resorted to for the purpose of curing evils arising from negligence and mismanagement in the system of grazing; but unless the root of the evil be attacked no improvement can be lasting. Any one who will devote serious attention to the nature and quality of pasture may save himself the expense of going beyond his own district or Colony for fresh blood. There seems to be an idea that if sheep only possess breed, no matter how they are fed, the owners must turn out successful graziers and wool-growers; and we find immense sums—30, 300, or even 1,000 guineas—paid for a single ram of some choice breed by persons who think that in this way they will improve their flocks and secure for themselves a reputation as thorough sheep-farmers. With the immense amount of money that has been expended in the importation of so much blood and pedigree, our flocks to-day ought to shear from 6 to 10 lbs. of wool per head, whereas the average barely exceeds $1\frac{1}{2}$ to 2 lbs. And there is a remarkable uniformity in the quality of the wools from all parts of the Colony, because the same system of grazing is followed by nearly all our wool-growers. Where an exceptional price has been obtained for a clip, it will in nearly every instance be found that the sheep have been paddock-fed and supplied with artificial grass, or that the customary old-fashioned methods of grazing have been departed from. It must be evident to every one that the same knowledge and experience as regards sheep and wool cannot have existed in 1828 as at the present day; and yet, notwithstanding all our boasted advance in every direction, the wool produced in the Colony then had a far higher reputation than, with a few isolated exceptions, any we send to the English market now. All our wools in those early days were alike remarkable for possessing a silky softness; and this quality, I feel confident, will be regained when the necessity for an improved rational system of management has become fully recognized.

The practice of wholesale ringbarking, I feel sure, exercises a very deleterious influence upon the growth of vegetation. Not only is the grass deprived of the protecting shade of the trees, scorched and withered by the unintercepted rays of the sun, but the radiation and reflection of the solar heat is far greater from the surface of uncovered mountains or treeless plains than from forests. The superincumbent air, therefore, becomes hotter, its capacity for sustaining vapour in suspension is increased, and thus the probability of rainfall is much lessened.

To sum up: the following are the principles which I should lay down as essential to successful wool-growing. In the first place, select an eligible breed of sheep suitable for the locality. Of course the same class of sheep will not thrive equally on hilly lands and on plains, on scrub and salt-bush country, or in the districts of Bourke and Mudgee and those of Kiandra and New England. It is necessary that the breed should be one adapted to the conditions of climate, &c., by which it will be surrounded; and when once chosen it should be adhered to. Secondly, the flocks should be provided with proper shelter, plenty of good water, and an abundant supply of suitable grass. In the next place, the land should be allowed periodical seasons of rest, so that the various grasses may have an opportunity of being renewed by the reproduction of seeds. With this end, large runs should be subdivided into smaller blocks, which might be given a spell in rotation. Where the choicer varieties of our indigenous herbage are wanting, roots and artificial grasses should be cultivated, and agriculture and grazing can thus be profitably combined. And finally, the ruinous practice of ringbarking should be discontinued, as being prejudicial to man and beast, and injurious in its effects upon climate. If these rules are closely adhered to, I feel confident that our wool will once more take the place which it so long occupied in the English and European markets.

I have been actuated by no other motive in taking up this all-important subject, in response to the interest displayed in our welfare by the Royal Society of New South Wales, than a sincere desire to make my humble services useful to the Colony; and should this paper be the means of inducing a few of our squatters to try the cultivation of artificial grasses or the conservation of the best of our indigenous ones, I shall feel well rewarded for the trouble I have taken in writing it.

PROCEEDINGS.

PROCEEDINGS

OF THE

ROYAL SOCIETY OF NEW SOUTH WALES.

WEDNESDAY, 3 MAY, 1882.

ANNUAL GENERAL MEETING.

H. C. Russell, B.A., F.R.A.S., President, in the Chair.

The minutes of the meeting held on December 7th, 1881, were read and confirmed.

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

"It affords the Council much pleasure to report that the affairs of the Society show increasing prosperity. The number of new members elected during the year was forty-six; one name was restored to roll. The Society lost by death three members, by resignation six, ten were struck off the roll for non-payment of the annual subscription, the election of five new members was cancelled on account of non-payment of the entrance fee and subscription. The actual increase is therefore twenty-four, and the total number of members on the 30th April, 1882, 475. The Society's Journal, Vol. XIV, for 1880, has been duly distributed to all the members entitled to it, and it is expected that Vol. XV. will be ready shortly.

"At the Council meeting held on 22nd March, 1882, it was unanimously resolved to award the Clarke medal for the year 1882 to James Dwight Dana, LL.D., Professor of Geology and Mineralogy, of Yale College, New Haven, United States of America, in recognition of his eminent work as a naturalist, and especially in reference to his geological and other labours in Australia, when with the United States Exploring Expedition round the world in 1839.

"During the past year the Society has received 645 volumes and pamphlets as donations; in return it has presented 531 volumes to various kindred Societies, as per accompanying list. The Council has subscribed to thirty-nine scientific journals and publications, and has made important additions to the Library, notably ninety volumes of 'The Philosophical Transactions of the Royal Society of London,' thus completing the series from the year 1801 to the present time. In all the sum of £206 19s. has been spent upon the Library during the past year.

"During the year the Society has held eight meetings, at which thirteen papers were read, and three of the Sections have held regular monthly meetings. A conversazione was held in the Great Hall of the University, on the 28th September last, which was attended by about 600 members and their friends.

"The Council reports that during the past year the mortgage upon the building has been reduced from £2,000 to £1,500, and during that period the sum of £25 4s. has been received towards the Building Fund, of which £10 10s. has been paid by those members who have kindly promised an annual subscription of one guinea; the amount now standing to the credit of this fund is £35 12s. 3d. The Council hopes that during the ensuing session the members will make an effort to greatly lessen, if not entirely clear off, the debt upon the Society's premises.

"During the past year the sum of £23 18s. was received by the Hon. Treasurer, from thirteen members of the Royal Society of New South Wales, towards the Biological Laboratory, Watson's Bay, which, together with a contribution of £25 from the Society's funds, making £48 18s., has been handed over to that institution.

"At a meeting held by the Council on the 26th October, it was resolved that the Society should offer prizes of £25 each for the best communication containing the results of original research or observation upon certain subjects to be set forth from time to time. A circular containing eight subjects, and the conditions to be observed in competing, &c., has been freely distributed throughout the Australian Colonies, Europe, and America.

"The Bill for incorporating the Society was approved by the Parliament of New South Wales on December 16, 1881. The thanks of the Society are due to Mr. G. H. Reid, Member for East Sydney, for introducing the Bill; the Hon. Professor Smith, C.M.G., for taking charge of it in the Legislative Council; and to Mr. Heron, the Society's Solicitor, for the preparation of the draft, and for his attention to all legal matters connected with its passage through both Houses."

The following Financial Statement for the year ending 30th April, 1882, was presented by the Honorary Treasurer:—

GENERAL ACCOUNT.

Receipts.	£ s. d.	£ s. d.
To Balance in Union Bank, 30th April, 1881 ...	....	8 15 7
„ Subscriptions and entrance fees, from 1st May, 1881, to 30th April, 1882	659 14 0	
„ Government Grant on subscriptions, from 1st January, 1881, to 31st December, 1881, £701 8s.	349 19 10	1,009 13 10
„ Government Grant to Building-fund	1 11 6	
„ hire of Rooms to sundry Societies	22 1 0	23 12 6
„ sale of Society's Journal	5 10 4	
„ „ ladder	0 8 0	5 18 4
		£1,048 0 3

Expenditure.	£ s. d.	£ s. d.
By Advertisements	15 3 0	
„ Assistant Secretary's salary to 30th April, 1882 (twelve months)	100 0 0	
„ Biological Laboratory, donation for 1881 ...	25 0 0	
„ books	230 10 8	
„ bookbinding	37 13 3	
„ busts	20 0 0	
„ Collector, commission on subscriptions	2 8 3	
„ Conversazione—refreshments	30 0 0	
„ „ temporary laying on gas......	15 4 0	
„ „ sundry expenses	14 8 5	
„ covering and packing exchanges and presentations to Foreign Societies	2 9 6	
„ delivering Society's Journal to members ...	4 16 0	
„ engraving illustrations for Journal	7 14 0	
„ freight, carriage, packing-cases, &c.	14 9 3	
„ furniture and effects	78 7 5	
„ Gas Account..........	9 14 4	
„ Housekeeper, to 30th April, 1882..........	10 0 0	
„ „ refreshments, monthly meetings	10 15 0	
„ interest on mortgage	97 10 0	
„ insurance on books and furniture	1 17 6	
„ paving footpath	20 14 1	
„ postage and petty cash	48 0 0	
„ printing..........	30 16 6	
„ Rates—City, water, and sewerage	20 14 2	
„ stationery	0 16 6	
„ sundry disbursements	14 13 6	863 15 4
„ transfer to Building-fund, in lieu of entrance fees	100 0 0	
„ „ „ hire of hall	22 1 0	
„ „ „ Government Grant...	1 11 6	123 12 6
„ Balance in Union Bank, 30th April, 1882...	...	60 12 5
		£1,048 0 3

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

Audited—
W. G. Murray.
A. S. Webster.
Sydney, 1st May, 1882.

BUILDING–FUND ACCOUNT.

Receipts.	£ s. d.	£ s. d.
To amount at fixed deposit in Union Bank ...	200 0 0	
,, Balance in Union Bank, 30th April, 1881...	118 15 7	318 15 7
,, amount withdrawn from fixed deposit, 1st May, 1881	100 0 0	
,, twelve months' interest on ditto	5 0 0	
,, amount withdrawn from fixed deposit, 30th September, 1881	100 0 0	
,, six months' interest on ditto	1 5 0	206 5 0
,, deposit withdrawn from Savings' Bank, New South Wales	100 0 0	
,, interest on ditto	1 13 4	101 13 4
,, hire of Hall	2 2 0	
,, ,, ,, transferred from General Account	22 1 0	24 3 0
,, Subscription to Building-fund	....	23 2 0
,, Government Grant	65 1 10	
,, Ditto transferred from General Account	1 11 6	66 13 4
,, amount transferred from General Account in lieu of entrance fees	....	100 0 0
		£840 12 3

Expenditure.	£ s. d.	£ s. d.
By insurance on building	....	5 0 0
,, amount deposited in Savings' Bank ...	....	100 0 0
,, amount withdrawn from fixed deposit ...	100 0 0	
,, ,, ,, ,, ,, ...	100 0 0	200 0 0
,, amount paid Savings' Bank of New South Wales, in reduction of mortgage ...	....	500 0 0
,, Balance in Union Bank, 30th April, 1882	....	35 12 3
		£840 12 3

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

Audited—
W. G. Murray.
A. S. Webster.

Sydney, 1st May, 1882.

STATEMENT OF ASSETS AND LIABILITIES ON THE 30TH APRIL, 1882.

ASSETS.	£	s.	d.
To Balance in Union Bank to credit of General Account ...	60	12	5
„ subscriptions and entrance fees due	70	7	0
„ furniture at cost	410	0	0
„ books at cost	623	0	0
„ hire of hall, University Musical Society	3	3	0
„ „ „ N.S.W. Branch British Medical Association	2	2	0
„ premises in Elizabeth-street—cost of purchase	3,525	0	0
„ Balance in Union Bank to credit of Building-fund account	35	12	3
	£4,729	16	8

LIABILITIES.	£	s.	d.
By *Sydney Daily Telegraph*, advertising	2	8	0
„ Savings' Bank, loan on mortgage	1,500	0	0
„ Balance of assets over liabilities	3,227	8	8
	£4,729	16	8

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

Audited—
W. G. MURRAY.
A. S. WEBSTER.

Sydney, 1st May, 1882.

CLARKE MEMORIAL FUND ACCOUNT.

1882. March 29—To amount at fixed deposit in Oriental Bank Corporation	£218	2	3

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

Audited—
W. G. MURRAY.
A. S. WEBSTER.

Sydney, 1st May, 1882.

The statement was adopted.

Messrs. A. S. Webster and F. Poolman 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:

CHRISTOPHER ROLLESTON, C.M.G.

VICE-PRESIDENTS:

ROBERT HUNT, F.G.S., &c.
F. N. MANNING, M.D.

HONORARY TREASURER:

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

HONORARY SECRETARIES:

PROFESSOR LIVERSIDGE, F.C.S., F.G.S., &c.
DR. ADOLPH LEIBIUS, F.C.S.

COUNCIL:

H. C. RUSSELL, B.A.	CHARLES MOORE, F.L.S.
W. A. DIXON, F.C.S.	G. D. HIRST.
C. S. WILKINSON, F.G.S.	W. G. MURRAY.

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

Cornwell, Samuel, jun., Sydney.
Dixon, Fletcher, Sydney.
Milson, Alfred G., North Shore.
Milson, James, North Shore.
O'Reilly, Rev, Alex. I., B.A., Five Dock.
Shewen, Dr. Alfred, Sydney.
Traill, Dr. Mark W., Sydney.
Want, Sydney A., Sydney.

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

One hundred and sixty-five donations were laid upon the table.

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

Microscopical Section.—Chairman: H. G. A. Wright, M.R.C.S.E., L.S.A., Lond. Secretary: P. R. Pedley. Committee: Dr. Ewan, F. B. Kyngdon, G. D. Hirst, and H. O. Walker.

Medical Section.—Chairman: Dr. P. Sydney Jones. Secretaries: Dr. H. N. MacLaurin, M.A., Thomas Evans, M.R.C.S.E. Committee: T. C. Morgan, L.R.C.S., Edin., A. Roberts, M.R.C.S.E., Dr. Mackellar, W. J. G. Bedford, M.R.C.S.E., Dr. Craig Dixson, Dr. Ewan.

Mr. H. C. Russell, B.A., F.R.A.S., President, then read his address.

A vote of thanks was passed to the retiring President, Hon. Treasurer, Hon. Secretaries, and other members of Council.

About seventy members were present.

The meeting was adjourned till the following Wednesday.

WEDNESDAY, 10 MAY, 1882.

Adjourned ordinary monthly meeting.

C. Rolleston, C.M.G., President, in the Chair.

The Rev. J. E. Tenison-Woods, F.G.S., F.L.S., read a paper on the "Geology of the Hawkesbury Sandstone."

About fifty members were present.

The meeting was adjourned till the following Wednesday, for the purpose of discussing the paper.

WEDNESDAY, 17 MAY, 1882.

Adjourned ordinary monthly meeting.

C. Rolleston, C.M.G., President, in the Chair.

The following gentlemen took part in the discussion upon the Rev. J. E. Tenison-Woods' paper on the "Geology of the Hawkesbury Sandstone":—C. S. Wilkinson, F.G.S., Professor W. J. Stephens, and Professor Liversidge.

Mr. Wilkinson exhibited maps, diagrams, and specimens in illustration of his remarks.

Professor Liversidge exhibited a series of slides of sands and sandstones.

The Rev. J. E. Tenison-Woods replied.

About forty members were present.

WEDNESDAY, 14 JUNE, 1882.

C. Rolleston, C.M.G., President, in the Chair.

The minutes of the monthly meeting held May 3, and of the adjourned meetings, May 10 and May 17, were read and signed.

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

Bullock, Chas. Cyrus, St. Leonards.
Copeland, H. P. R., Newtown.
Donkin, J. B., Sydney.
Gordon, Hon. Samuel Deane, M.L.C., Double Bay.
Smith, Bruce, Sydney.

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

Eighty-nine donations were laid upon the table.

Mr. H. C. Russell, B.A., F.R.A.S., read a paper on "Tropical Rains."

The Hon. G. H. Cox, M.L.C., and Mr. Charles Moore took part in the discussion.

About thirty members were present.

WEDNESDAY, 5 JULY, 1882.

H. C. Russell, B.A., F.R.A.S., in the Chair.

The minutes of the last meeting were read and confirmed.

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

Carruthers, Dr. Chas. Ulic, Balmain.
Dückershoff, Dr. August, Sydney.
Hurst, Dr. George, Sydney.
MacGillivray, Dr. P. H., M.A., Sandhurst, Victoria.
Moss, Sydney, Sydney.
Porter, Donald, Tamworth.
Rothe, W. H., Double Bay.
Russell, H. E., Sydney.
Sinclair, Dr. Eric.
Webster, Rev. Wm., Wilcannia.

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

Eighty-seven donations were laid upon the table.

Professor Liversidge announced that the Society's Journal for 1881 had been received from the Government Printer, and would be distributed to members without delay.

The Chairman exhibited and described an eye-piece which he had designed for facilitating transit observations.

Mr. G. Butterfield read a paper on "The Orbit of the late Comet," illustrated by a model constructed from the elements of Dr. Lamp, of Kiel.

Mr. W. MacDonnell exhibited Swan's, Maxim's, and Foxlane's Incandescent Electric Lamps, also De la Reve's experiment showing the rotation of the voltaic arc around an electro-magnet.

Dr. H. G. A. Wright exhibited one of Tolle's erecting stereoscopic binocular eye-pieces.

Mr. G. D. Hirst exhibited Abbe's defraction platte.

About forty members were present.

WEDNESDAY, 2 AUGUST, 1882.

C. ROLLESTON, C.M.G., 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:—

Curran, Rev. John Milne, Carcoar.
Lovell, Dr. Haynes, Sydney.
Hammond, Mark J., Ashfield.
Hankins, Dr. Geo. Thos., Sydney.
Palmer, Edward, Parramatta.

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

Sixty-three donations were laid upon the table.

The following letter from Professor Dana was read:—

My dear Sir, New Haven, Conn., June 23, 1882.

Your communication of the 17th ultimo, announcing the high honor conferred on me by the Royal Society of New South Wales, in the award of the Clarke Memorial Medal, has just been received, and with it the medal itself. The honor is especially grateful to me because of my long friendship for the Rev. Mr. Clarke, and delightful memories of geological excursions with him in Australia more than forty years since. The medal is a remarkably beautiful one, and will be greatly treasured.

Respectfully and truly yours,
JAMES D. DANA.

Professor Archibald Liversidge,
Honorary Secretary of the Royal Society of New South Wales.

Mr. J. S. CHARD read a paper on "A method of determining the True South."

The CHAIRMAN announced that Professor Liversidge had been elected a Fellow of the Royal Society of London.

Between thirty-five and forty members were present.

WEDNESDAY, 6 SEPTEMBER, 1882.

C. ROLLESTON, C.M.G., 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:—

Cameron, Alex. L., Booligal.
Conlan, Geo. Nugent, Grafton Club, London.
Renwick, Dr. Geo. Jas., B.A., Sydney.
Robertson, Rev. J. T., M.A., Tumut.
Twynam, Dr. Geo. Edwd., Petersham.

The certificate of one new candidate was read for the second time, and of two for the first time.

The following resolution was moved by the PRESIDENT, seconded by His Honor Judge WINDEYER, and carried unanimously, viz.—

"The members of the Royal Society of New South Wales having heard with deep regret of the death of Charles Robert Darwin, one of their most distinguished Honorary Members, desire to express their sense of the loss they with the whole scientific world have sustained, and they desire that the expression of their heartfelt sympathy shall be conveyed, through their President, to the widow and family of the late distinguished naturalist."

Dr. LEIBIUS stated that Dr. Darwin was elected an honorary member in 1879, and that he had expressed himself as highly gratified at the attention paid him by his election.

The CHAIRMAN drew attention to the following circular which would shortly be distributed to members, appealing for subscriptions to the Building-fund, in order to obtain the Government grant and clear off the mortgage upon the premises.

The Society's House, 37, Elizabeth-street,
Sydney, August, 1882.

Dear Sir,—We have the honor to inform you that the Parliament has been pleased to vote the sum of £500 towards the amount requisite to pay off the debt upon the Society's premises, on the condition that the members raise the sum of £1,000.

The original cost of the building	£3,525	0	0
Improvements and repairs	499	14	10
Total	£4,024	14	10

Of the above sum £2,524 14s. 10d. has been paid, leaving a debt upon the property of £1,500 now borrowed on mortgage.

The Council considers it most desirable that an earnest endeavour should now be made to clear off this debt, in order that the whole of the income from members' subscriptions may be devoted to the true objects of the Society and the advancement of science in New South Wales.

Trusting that you may be willing to contribute towards this fund,—

We are, dear Sir,
Your most obedient servants,
A. LIVERSIDGE, } HON. SECS.
A. LEIBIUS, }

The promise on the part of members would be made contingent on the full amount of £1,000 being thus obtained; therefore, if successful the whole of the debt on the building would be cleared off and all future revenue be devoted to the furtherance of the objects of the Society exclusively by increasing its Library and other work.

Sixty-one donations were laid upon the table.

Mr. C. ROLLESTON, C.M.G., President, read a paper—"Notes on the Progress of New South Wales during the years 1872 to 1881."

A discussion followed, in which the following gentlemen took part, viz. :—Messrs. G. A. Lloyd, C. S. Wilkinson, Charles Moore, Alex. Dean, and W. G. Murray.

Mr. H. C. Russell, B.A., F.R.A.S., exhibited a new driving clock for telescopes.

About thirty members were present.

WEDNESDAY, 4 OCTOBER, 1882.

C. Rolleston, C.M.G., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentleman was duly elected an ordinary member of the Society :—

Strickland, Sir Edward, K.C.B., &c., Manly Beach.

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

Thirty donations were laid upon the table.

Mr. Charles Moore, F.L.S., read a letter addressed to him from Melbourne, stating that a subscription had been set on foot there for the erection of a memorial over the grave of the late Mr. Daniel Bunce, a companion of Leichhardt in one of his expeditions. Mr. Moore expressed his willingness to receive and forward to Melbourne any subscriptions the members of the Royal Society might be disposed to make towards this object.

Mr. J. F. Mann also spoke upon the same subject.

The Chairman read a circular letter received from the President of the Linnean Society of N.S.W., in reference to the destruction of the Society's property and the possible inconvenience that might be caused thereby ; and proposed the following resolution, which was seconded by Mr. C. Moore, and carried unanimously, viz. :— "The members of the Royal Society desire to express their sympathy with the members of the Linnean Society on the loss they have sustained through the burning of the Garden Palace, and to offer the use of their rooms for the meetings of the Society pending the acquisition of suitable accommodation."

The Rev. J. E. Tenison-Woods, F.G.S., F.L.S., &c., read the following papers :—"On some Marine Fossils of the Coal Formation of New South Wales," and "On some Mesozoic Fossils from the Palmer River, Queensland."

Mr. E. M. de la Meslee brought before the Society some remarks on French Geographical Societies and the Colonies, the result of his recent visit to France.

Mr. G. Butterfield exhibited a paper model of the orbit of the Comet visible at present, and accompanied the same with explanatory remarks.

Between twenty and twenty-five members were present.

WEDNESDAY, 1 NOVEMBER, 1882.

C. Rolleston, C.M.G., 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 :—

Madsen, Hans F., Newtown.
Thornton, Hon. Geo., M.L.C., Sydney.

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

A letter from Herr R. Gessler, of Basle, Switzerland, received by Mr. Dixon, stated that, having seen an abstract of Mr. Dixon's paper on the Salt-bushes of New South Wales, he would esteem it a favour if a pound or so of the seeds of each could be forwarded to him.

The letter was laid before the Society, in the hope that some of the members might be able to assist in the matter.

Thirty-six donations were laid upon the table.

The Chairman read the following letter from the Linnean Society of New South Wales, viz. :—

Sir, Sydney, 21 October, 1882.

We are directed by the Council of the Linnean Society of New South Wales to convey their warmest acknowledgments for the sympathy expressed for their loss, and the kind offer of assistance contained in your letter of October 5th to our President. The Society is, fortunately, in a position to continue to hold its meetings in the same place in which they have hitherto been held, and has, therefore, no occasion to avail itself of your very generous and considerate offer of the use of your rooms. With sincere thanks for the offer,

We have the honor to remain,
Sir,
Your obedient servants,
WILLIAM MACLEAY,
W. J. STEPHENS,
Honorary Secretaries.

The President,
Royal Society of New South Wales.

The Chairman drew attention to the circular that had been distributed to the members relative to the £1,000 which (together with the Parliamentary grant) is required to enable the Society to clear off the entire debt upon its premises ; he announced that in response to this application about £220 had already been promised by forty-eight members, and pointed out that if each member contributed two guineas the requisite amount would at once be obtained.

Mr. JAMES MANNING read a paper,—"Notes on the Aborigines of New Holland."

A discussion followed, in which the following gentlemen took part, viz.:—Messrs. J. F. Mann, Hon. L. F. De Salis, Dr. R. L. Jenkins, P. N. Trebeck, Dr. Belgrave, E. Palmer, and the Chairman.

About twenty-four members were present.

WEDNESDAY, 6 DECEMBER, 1882.

C. ROLLESTON, C.M.G., 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:—

Atkinson, Jas. J. O., J.P., Oldbury, near Berrima.
Chambers, Dr. Thos., Sydney.
Fraser, Rev. John G., M.A., Glebe Point.
Norrie, Dr. Andrew, Sydney.
Steel, Dr. John, Sydney.

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

It was resolved that Messrs. J. Trevor Jones and F. Poolman be appointed Auditors for the current year.

The PRESIDENT, on behalf of the Council, announced that arrangements were being made for the delivery of a course of lectures on the Geology of Australia by the Rev. J. E. Tenison-Woods, F.G.S., F.L.S., in connection with the Clarke Memorial.

Mr. W. A. DIXON, F.C.S., read a paper "On the Ashes of some Epiphytic Orchids."

The Rev. J. E. TENISON-WOODS, F.G.S., F.L.S., &c., read a paper "On a Fossil Plant Formation in Central Queensland."

Mr. C. S. WILKINSON, Government Geologist, exhibited a number of corals which had been collected for him by Mr. Barling, of the Harbour and Rivers Department, on his visit to the Elizabeth Reef, Lord Howe Island, for the purpose of seeing that the provisioned lifeboat kept there in the event of shipwreck was secure. He had submitted them to the Rev. Mr. Tenison-Woods for his inspection, and that gentleman had made some notes on them.

The Rev. Mr. TENISON-WOODS said that the corals were all of reef-building formation, such as were never found out of tropical or very warm seas; and as Lord Howe Island was some 300 miles to the south of any place where such corals were known to be formed on the Australian coast, there must be some peculiar condition of temperature in that locality to account for their occurrence—probably a warm current from the north. The collection included several new species, among others that named the "brain coral," which would be subsequently described by him, and which were all found on the north-eastern Barrier Reef of Australia in warm seas. There was a coral reef off the coast of Western Australia named the Houtman's Abrolhos, in probably the same latitude as the Elizabeth Reef, Howe Island, and which was known to be in the midst of a warm current, flowing south from the Indian Ocean.

The President announced that it had been determined by the Council that the Library should next session be opened on week-days from 1.30 o'clock p.m. to 6 o'clock p.m., with the exception of Saturday, when it would be open from 9 o'clock a.m. to 1.30 o'clock p.m.

ADDITIONS

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The names of the Donors are in *Italics*.

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241. " * Königliches Mineralogisches Museum. Nos. 1, 2, 3.
242. **Frankfurt a/M.**—*Senckenbergische Naturforschende Gesellschaft in Frankfurt a/M. Nos. 1, 2, 3.
243. **Freiberg (Saxony).**—*Die Berg Akademie zu Freiberg. Nos. 1, 2, 3.
244. " Naturforschende Gesellschaft zu Freiberg. Nos. 1, 2, 3.
245. **Göttingen.**—*Königliche Gesellschaft der Wissenschaften in Göttingen. Nos. 1, 2, 3.
246. **Görlitz.**—*Naturforschende Gesellschaft in Görlitz. Nos. 1, 2, 3.
247. **Halle A.S.**—*Die Kaiserlich Deutsche Leopoldinisch—Carolinische Akademie der Naturforcher zu Halle A.S. (Prussia). Nos. 1, 2, 3.
248. **Hamburg.**—*Die Geographische Gesellschaft in Hamburg. Nos. 1, 2, 3.
249. " *Verein für Naturwissenschaftliche Unterhaltung in Hamburg. Nos. 1, 2, 3.
250. **Heidelberg.**—*Naturhistorisch Medicinische Gesellschaft zu Heidelberg. Nos. 1, 2, 3.
251. **Jena.**—*Medicinisch Naturwissenschaftliche Gesellschaft. Nos. 1, 2, 3.
252. **Konigsberg.**—*Die Physikalisch-ökonomische Gesellschaft. Nos. 1, 2, 3.
253. **Leipzig (Saxony).**—University Library. Nos. 1, 2, 3.
254. **Metz.**—*Verein für Erdkund zu Metz. Nos. 1, 2, 3.

255. **Marburg.**—*Gesellschaft zur Beförderung der Gesammten Naturwissenschaften in Marburg. Nos. 1, 2, 3.
256. „ *The University. Nos. 1, 2, 3.
257. **Mulhouse.**—*Industrial Society. Nos. 1, 2, 3.
258. **Munchen.**—*Königliche Akademie der Wissenschaften in München. Nos. 1, 2, 3.
259. **Stuttgart.**—*Königliches Statistisch. Topographisches Bureau zu Stuttgart. Nos. 1, 2.
260. „ *Der Verein fur Vaterländische Naturkunde in Würtemberg. Nos. 1, 2, 3.

HUNGARY.

261. **Bistritz (in Siebenburgen).**—*Direction der Gewerbeschule. Nos. 1, 2, 3.
262. **Zagreb (Agram).**—*Société Archéologique. Nos. 1, 2, 3.

ITALY.

263. **Bologna.**—Accademia delle Scienze dell' Istituto. Nos. 1, 2, 3.
264. „ Università. Nos. 1, 2, 3.
265. **Florence.**—*Società Italiana di Antropologia e di Etnologia. Nos. 1, 2, 3.
266. „ Società Entomologica Italiana. Nos. 1, 2.
267. **Genoa.**—Museo Civico di Storia Naturale. Nos. 1, 2, 3.
268. **Milan.**—Reale Istituto Lombardo di Scienze, Lettere ed Arti. Nos. 1, 2, 3.
269. „ Società Italiana di Scienze Naturali. Nos. 1, 2, 3.
270. **Modena.**—*Académie Royale des Sciences, Lettres et Arts de Modène. Nos. 1, 2, 3.
271. **Naples.**—Società Reale Accademica delle Scienze. Nos. 1, 2, 3.
272. „ *Società Africana d'Italia. Nos. 1, 2.
273. „ *Zoological Station (Dr. Dohrn). Nos. 1, 2.
274. **Palermo.**—*Accademia Palermitana di Scienze, Lettere ed Arti. Nos. 1, 2, 3.
275. „ Reale Istituto Tecnico. Nos. 1, 2, 3.
276. **Pisa.**—*Società Toscana di Scienze Naturali. Nos. 1, 2, 3.
277. **Rome.**—*Accademia Pontificia de' Nuovi Lincei. Nos. 1, 2, 3.
278. „ *Società Geografica. Nos. 1, 2, 3.
279. „ Circolo Geographico d'Italia. Nos. 1, 2, 3.
280. „ Osservatorio del Collegio Romano. Nos. 1, 2.
281. „ *R. Accademia dei Lincei. Nos. 1, 2, 3.
282. „ *R. Comitato Geologico Italiano. Nos. 1, 2, 3.
283. **Siena.**—R. Accademia de Fisiocritici. Nos. 1, 2.
284. **Turin.**—Reale Accademia delle Scienze. Nos. 1, 2, 3.
285. „ Regio Osservatorio della Regia Università. Nos. 1, 2.
286. **Venice.**—*Reale Istituto Veneto di Scienze, Lettere ed Arti. Nos. 1, 2, 3.

JAPAN.

287. **Yokohama.**—*Asiatic Society of Japan. Nos. 1, 2. 3.

JAVA.

288. **Batavia.**—Batavia Academy. Nos. 1, 2, 3.

NETHERLANDS.

289. **Amsterdam.**—*Académie Royale des Sciences. Nos. 1, 2, 3.
290. **Harlem.**—*Société Hollandaise des Sciences. Nos. 1, 2, 3.
291. „ *Bibliothèque de Musée Teyler. Nos. 1, 2, 3.

NORWAY.

292. **Bergen.**—*Museum. Nos. 1, 2, 3.
293. **Christiania.**—*Kongelige Norske Fredericks Universitet. Nos. 1, 2, 3.

RUSSIA.

294. **Moscow.**—*Société Impériale des Naturalistes. Nos. 1, 2, 3.
295. **St. Petersburgh.**—*Académie Impériale des Sciences. Nos. 1, 2, 3.

SPAIN.

296. **Madrid.**—Instituto Geografico y Estadistico. Nos. 1, 2, 3.

SWEDEN.

297. **Stockholm.**—*Kongliga Svenska Ventenskapo-Akademie. Nos. 1, 2, 3.
298. „ University. Nos. 1, 2, 3.

SWITZERLAND.

299. **Berne.**—*Institut Géographique International. Nos. 1, 2, 3.
300. **Geneva.**—*Institut National Genevois. Nos. 1, 2, 3.
301. **Lausanne.**—*Société Vaudoise des Sciences Naturelles. Nos. 1, 2, 3.
302. **Neuchatel.**—*Société des Sciences Naturelles. Nos. 1, 2, 3.

STRAITS SETTLEMENTS.

303. **Singapore.**—Royal Asiatic Society. Nos. 1, 2, 3.

Number of Publications sent to	Great Britain...	218
„ „	India and the Colonies... ...	108
„ „	America	147
„ „	Europe	332
„ „	Editors of Periodicals... ...	21
„ „	Asia, &c....	9
	Total	835

A. LIVERSIDGE, } Hon. Secretaries.
A. LEIBIUS, }

The Society's House, Sydney,
August 9th 1882.

PROCEEDINGS OF THE SECTIONS
(IN ABSTRACT).

PROCEEDINGS OF THE SECTIONS (IN ABSTRACT).

MICROSCOPICAL SECTION.

PRELIMINARY MEETING, HELD 25 APRIL, 1882.

Dr. WRIGHT was voted 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: Dr. WRIGHT. Secretary: Mr. P. R. PEDLEY. Committee: Mr. G. D. HIRST, Mr. F. B. KYNGDON, Mr. H. O. WALKER, and Dr. EWAN.

8 MAY, 1882.

Dr. WRIGHT in the Chair.

The CHAIRMAN exhibited a Tolles' 1-inch solid eye-piece, being the first eye-piece of that character constructed by Mr. Tolles, and also a pair of Tolles' 1-inch orthoscopic oculars. Dr. Wright stated that he had lately used the balsam of copaiba as an immersion fluid for very high-angled objectives, and had found that for central light illumination it was preferable to any other medium, but that for oblique light the sulpho-carbolate of zinc and glycerine yielded the better results. Dr. Wright also called the attention of the meeting to Dr. J. Anthony's researches on the value of the areolations of *Isthmia nervosa* as a test for high-power objectives. It would appear that the hexagonal areolations seen in the apparent openings in *Isthmia nervosa* are valuable for trying the qualities of objects $\frac{1}{8}$ of an inch in focus and upwards. The areolations are not small, but so delicate as not to be viewed at all by a poor object-glass. Dr. Wright was, however, of the opinion that for test purposes the areolation of *Isthmia enervis* were even better suited than those of *Isthmia nervosa*.

Mr. R. FRASER submitted a number of miscellaneous objects, and a very interesting slide of *Æcidium compositarium*.

Mr. PEDLEY exhibited a number of beautifully mounted histological preparations, mounted by Dr. L. M. Eastman, of Baltimore, U.S.A.

12 JUNE, 1882.

Owing to the inclemency of the weather, this meeting lapsed for want of a quorum.

10 JULY, 1882.

Dr. WRIGHT in the Chair.

The CHAIRMAN read the following paper by Mr. Henry Sharp, "On the mounting of objects in cells with Canada balsam medium"—

There are many objects, such as whole insects and parts of insects, which show better when mounted in Canada balsam than in any other medium; but when mounted in the usual way they are often so much squeezed and flattened by the pressure employed that they no longer present the appearance they did before the pressing process.

The only way to avoid this when the object is thick is by the use of a cell of some kind; but mounting in cells with balsam as the medium is, or at least I have always found it, a troublesome business, requiring also a long time for the balsam to set sufficiently to prevent the covering glass from being shifted.

Many of the difficulties attending balsam mounting in cells I have succeeded in avoiding by a method which I hit upon six or seven months ago, and which I will now describe.

I make the cells of rings of paper or cardboard of different thickness to suit the object I wish to mount. These rings I fasten to the slide with strong gum mucilage.

My practice in preparing a cell of this kind is to cement a piece of paper or card, of the requisite thickness, on the slide with gum, and, when sufficiently firm, I place the slide on the "turn-table," and with a sharp penknife make two cuts right through the card on to the glass, while the turn-table is revolving, so that when the central and outside portions are removed a truly-centred ring remains on the slide.

Other plans will of course suggest themselves; the rings, for instance, might be cut out by different sized gun-wad punches, and afterwards gummed to the slide.

Having the card-ring fixed and the slide nicely cleaned, I cut a small piece of the card away on opposite sides of the ring (as may be seen by inspecting the slides I have submitted for examination), the use of which I will describe further on.

In preparing an object for mounting I never allow it to become dry, but transfer it from the water, glycerine, or dilute spirit in which it may have been dissected or otherwise arranged into strong spirit, from the spirit into oil of cajeput, then into benzine for a few minutes, and finally into turpentine, where it may remain until required for the final putting up in balsam.

Having the object all ready for mounting, I proceed thus:—I place the object in the centre of the card cell, arrange its position to my liking, and place a single drop of turpentine on it to keep it moist, then with a small brush lay on some gum mucilage on the top of the card cell, not too much, and carefully put on the cover (previously cleaned, and which should be of the same diameter as the outside of cell), press it down into the gummed surface of cell, put on a light spring clip, and set aside for a short time for the gum to set.

If the cell is the right depth for the object the cover should only just press on the latter enough to retain it in position.

When the gum has hardened, and the cover is quite firm and secure, I take up with a small pipette a little benzine, and apply it to one of the openings cut in the card cell, when the benzine instantly runs in and fills up the cell, and in a few minutes the card is saturated with the benzine, which has not the slightest effect on the gum cement.

When the benzine has thoroughly soaked the card ring, I apply a bit of blotting-paper or linen rag to one of the openings and withdraw all the benzine; then apply some balsam, which should be soft enough to drop readily from a bit of wire at a temperature of about 60°, to one of said openings, warm the slide gently, and the balsam soon fills up the cell, and, if any bubbles appear, they vanish in a few hours.

When the cell is quite full and the balsam showing freely at both openings, I apply some more balsam with a bit of wire all round the cell, and put the slide away in a warm place for the balsam to harden. In summer if placed in a tin box and left in the sun the balsam will in a day be hard enough for finishing, which is done on the turn-table by "turning" away all the superfluous balsam with a sharp penknife and leaving a ring of balsam. The slide and cover can be cleaned with a bit of rag wet with spirit, care being taken not to allow the spirit to attack the ring of balsam.

When all this has been done it will be seen that the ring of balsam is dull and scratchy, and probably uneven, and with notches at its edge; the final finishing touch is done by holding the slide, cover side down, over the flame of a spirit lamp for a single instant, at the same time giving the slide a circular sweep so that the flame just touches the balsam ring all round, leaving it even and smooth as glass.

One great advantage of this method of mounting is that when once the cover is in its place and the gum mucilage has set, there is not the least danger of the cover shifting or the object being displaced when finishing and cleaning the slide.

The accompanying slides will show the result of this plan of mounting, which I hope may be taken up and improved upon by some of the micro-mounting men of our Section.

Should any one wish for any further information as to details of process, I shall be delighted to reply to any queries.

Some slides which Mr. Sharp had prepared were exhibited, and were much admired by the members present.

Dr. Wright exhibited one of Tolles' erecting stereoscopic binocular eye-pieces, intended to be used with either a microscope or telescope.

Mr. Pedley exhibited one of Seibert's $\frac{1}{12}$-inch homogeneous immersion objectives.

14 AUGUST, 1882.

Dr. Wright in the Chair.

Mr. Henry Sharp exhibited a Tolles' camera lucida in the form of a truncated prism, in place of the ordinary Wollaston prism. With this camera Mr. Sharp claims that it is far easier to delineate the internal structure of an object than with the ordinary prism, and exhibited a series of drawings of objects in which the detail was more perfectly depicted than is possible with the Wollaston's prism.

Mr. F. B. Kyngdon exhibited the following objectives, by Carl Zeiss, of Jena, viz.: A new variable low-power object-glass, magnifying from 6 to 20 diameters—a 1-inch, $\frac{3}{5}$ths, $\frac{2}{5}$ths, $\frac{1}{8}$th, dry, and a $\frac{1}{8}$th water immersion. These objectives were remarkable for the great beauty of their performance, and compared in a most favourable degree with the corresponding productions of the best English opticians.

Mr. G. D. Hirst exhibited a diatomaceous gathering from Bondi, and also a specimen of *Nitella translucens*, showing the fructification.

The Hon. W. McGregor exhibited drawings of the ringworm parasite, and Mr. Pedley some injected preparations of the tongue and spinal cord of a kitten.

11 SEPTEMBER, 1882.

Dr. Wright in the Chair.

Dr. Wright exhibited and presented to the Section a copy of "Adams on the Microscope." This work, which was published in 1787, possesses particular interest as being one of the very earliest comprehensive works on the subject in the English language. Dr. Wright also exhibited a Tolles' $\frac{2}{3}$ of an inch object-glass, having an angle of 65°, and fitted with an internal prism for the illumination of opaque objects.

Mr. H. O. Walker exhibited some interesting gatherings of marine diatomaceæ.

9 OCTOBER, 1882.

DR. WRIGHT in the Chair.

Dr. EWAN read some extracts from a letter by Dr. Morris, re the performance of Messrs. Powell and Leland's $\frac{1}{20}$ homogeneous objectives on tuberculous bacteria.

Dr. WRIGHT exhibited a freshly-opened sample of Koumiss, which was literally swarming with bacteria in a high state of development, and presented all the appearance of milk in an advanced state of decomposition.

Dr. EWAN exhibited and explained Browning's micro-spectroscope.

13 NOVEMBER, 1882.

Dr. WRIGHT in the Chair.

Dr. SINCLAIR exhibited *Oidium tuckeri*, the conidiiferous mycelium of an Erysiphe or Vine Fungus in an early stage (four days) of development.

Rev. G. MARTIN exhibited slides of diatomaceæ and marine gasteropoda, Dr. MACKELLAR a Swift's best challenge microscope stand, with all improvements, and Mr. PEDLEY a number of histological preparations.

MEDICAL SECTION.

The session of the Medical Section of the Royal Society for 1882 began with a special general meeting on April 19th, called in obedience to a requisition, for the purpose of considering the advisability of increasing the number of members of Committee.

It was decided that there should in future be six members of Committee instead of four, and that of these three should retire annually.

The meeting then resolved itself into the preliminary meeting for electing office-bearers.

The following were elected:—Chairman: Dr. P. SYDNEY JONES. Secretaries: Dr. MACLAURIN, Mr. THOS. EVANS. Committee: Dr. CECIL MORGAN, Mr. A. ROBERTS, Dr. MACKELLAR, Mr. BEDFORD, Dr. CRAIG DIXSON, Dr. EWAN.

Seven general meetings were held during the session, at which interesting papers were read.

H. N. MACLAURIN.
THOMAS EVANS.

6th December, 1882.

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, 1882.—GENERAL ABSTRACT.

Barometer Highest Reading... ... 30·102 inches on the 6th, at 7 & 8 a.m.
At 32° Faht., but not corrected to sea-level.
Lowest Reading ... ... 29·287 ,, on the 11th, at 1 a.m.
Mean Height ... ... 29·703
(Being 0·066 less than that in the same month on an average of the preceding 23 years.)

Wind ... ... Greatest Pressure ... 22·4 lbs. on the 5th.
Mean Pressure ... ... 0·9 lb.
Number of Days Calm ... 0
Prevailing Direction ... S.
(Prevailing direction during the same month for the preceding 23 years, E.N.E.)

Temperature Highest in the Shade ... 92·3 on the 23rd.
Lowest in the Shade ... 58·3 on the 3rd.
Greatest Range ... ... 28·1 on the 5th.
Highest in the Sun ... 147·5 on the 14th.
Lowest on the Grass ... 49·9 on the 3rd.
Mean Diurnal Range ... 12·9
Mean in the Shade ... 72·3
(Being 1·0 greater than that of the same month on an average of the preceding 23 years.)

Humidity ... Greatest Amount ... 93·0 on the 16th, at 9 p.m.
Least ... ... 47·0 on the 30th, at 9 a.m.
Mean 68.9
(Being 3·8 less than that of the same month on an average of the preceding 23 years.)

Rain ... ... Number of Days ... ... 11 rain and 1 dew.
Greatest Fall ... ... 0·176 inches on the 13th.
Total Fall... ... ... { 0·323 ,, 65 feet above ground. / 0.626 ,, 15 in. above ground. }
(Being 2·852 inches less than that of the same month on an average of the preceding 23 years.)

Evaporation Total Amount ... ... 4·831 inches.
Electricity ... Number of Days Lightning 4
Cloudy Sky ... Mean Amount ... ... 5·7
Number of Clear Days ... 3
Meteors ... Number observed ... 0

Remarks.

The weather has been very dry and hot, and but little rain has fallen on the coast. On the 11th at 1 a.m. the barometer was unusually low (29·287) at Sydney, but no severe gale followed. A few of the northern stations had a moderate supply of rain, but the greater number had little or none; in fact, 33 stations had none at all, and out of the 168 stations there are 111 that had less than half-an-inch of rain. At Maryland 4·78 inches fell, and at Glen Innes 4·47 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.

FEBRUARY, 1882.—GENERAL ABSTRACT.

Barometer ... Highest Reading ... ... 30·172 inches on the 23rd, at 10 p.m.
At 32° Faht., but not corrected to sea-level.
Lowest Reading ... ... 29·473 „ on the 17th, at 5 p.m.
Mean Height ... ... 29·899
(Being 0·093 greater than that in the same month on an average of the preceding 23 years.

Wind ... ... Greatest Pressure ... 21·8 lbs. on the 23rd.
Mean Pressure ... ... 0·9 lb.
Number of Days Calm ... 0
Prevailing Direction ... N.E.
(Prevailing direction during the same month for the preceding 23 years, S.)

Temperature Highest in the Shade ... 95·9 on the 16th.
Lowest in the Shade ... 57·4 on the 3rd.
Greatest Range ... ... 31·9 on the 16th.
Highest in the Sun ... 146·9 on the 4th.
Lowest on the Grass ... 50·7 on the 2nd.
Mean Diurnal Range ... 12·9
Mean in the Shade ... 71·2
(Being 0·4 greater than that of the same month on an average of the preceding 24 years.)

Humidity ... Greatest Amount ... 90·0 on the 17th.
Least ... ... 49·0 on the 1st.
Mean ... ... 67·7
(Being 7·3 less than that of the same month on an average of the preceding 23 years.)

Rain ... ... Number of Days ... ... 7 rain and 2 dew.
Greatest Fall ... ... 0·198 inches on the 6th.
Total Fall... ... { 0·124 „ 65 ft. above ground. / 0·401 „ 15 in. above ground. }
(Being 5·964 inches less than that of the same month on an average of the preceding 23 years.)

Evaporation Total Amount ... ... 3·610 inches.

Electricity ... Number of Days Lightning 0

Cloudy Sky ... Mean Amount ... ... 5·1
Number of Clear Days ... 3

Meteors ...Number observed ... 0

Remarks.

Abundant rains fell in the northern districts about the 5th and 6th of the month, the greatest fall being 10·64 at Terembone, close to Coonamble. The rain was the usual tropical downfall, extending down from Queensland; on the Paroo it was very heavy, and seems to have followed that river into this colony, and thence along the Darling and Macquarie to about Canonba, whence it turned to the east; the margin was well marked,—for instance, no rain fell at Mount Poole, and at the Nocoleche, 100 miles west of Bourke, 8·50 inches fell; the wind blew steadily from eastward N.E. to S.E. On the Paroo River the rain began January 30th, at Nocoleche on the 4th, Bourke on the 5th, Boolcarrol, near Narrabri, on the 9th. It did not extend to Cobar except the margin, and all the southern parts of the colony got little or none.

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.

MARCH, 1882.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·146 inches on the 25th, at 10 a.m.
At 32° Faht., but not corrected to sea-level.	Lowest Reading	29·396 „ on the 14th, at 4·30 p.m.
	Mean Height	29·802

(Being 0·089 less than that in the same month on an average of the preceding 23 years.)

Wind	Greatest Pressure ...	26·0 lbs. on the 14th.
	Mean Pressure	0·8 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 23 years, N.E.)

Temperature	Highest in the Shade ...	89·1 on the 29th.
	Lowest in the Shade ...	59·9 on the 19th.
	Greatest Range	21·7 on the 29th.
	Highest in the Sun ...	138·0 on the 29th.
	Lowest on the Grass ...	52·6 on the 22nd.
	Mean Diurnal Range ...	12·4
	Mean in the Shade ...	70·6

(Being 1·3 greater than that of the same month on an average of the preceding 23 years.)

Humidity ...	Greatest Amount ...	93·0 on the 8th.
	Least	49·0 on the 29th.
	Mean	72·9

(Being 3·8 greater than that of the same month on an average of the preceding 23 years.)

Rain	Number of Days	8 rain and 4 dew.
	Greatest Fall	2·645 inches on the 31st.
	Total Fall...	4·415 „ 65 feet above ground.
		5·295 „ 15 in. above ground.

(Being 0·175 inches greater than that of the same month on an average of the preceding 23 years.)

Evaporation	Total Amount	3·439 inches.
Electricity ...	Number of Days Lightning	4
Cloudy Sky ...	Mean Amount	4·3
	Number of Clear Days ...	3
Meteors ...	Number observed ...	0

Remarks.

The barometer this month has been low, and the average 0·089 below the averag for this month; but the temperature has been high—1·3 greater than the averag Generally the weather this month has been dry, with the exception of the coas districts, where heavy but rather partial rains have fallen. A good illustration o this may be seen in the records near Sydney. At the Observatory, 5·30 inches fell at Botany, 4·94 inches; at Moore Park, 6·87 inches; at Crown-street, 6·18 inches and at Croydon, 4 miles west from Sydney, only 3·35 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.

APRIL, 1882.—GENERAL ABSTRACT.

Barometer ... Highest Reading... ... 30·103 inches on the 9th, at 9 a.m.
At 32° Faht., but not corrected to sea-level.
Lowest Reading ... ... 29·368 „ on the 27th, at 3 p.m.
Mean Height ... ... 29·805.

(Being 0·128 less than that in the same month on an average of the preceding 23 years.)

Wind ... ... Greatest Pressure ... 32·8 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 23 years, W.)

Temperature Highest in the Shade ... 76·4 on the 24th.
Lowest in the Shade ... 49·2 on the 29th.
Greatest Range ... ... 19·7 on the 12th.
Highest in the Sun ... 129·0 on the 24th.
Lowest on the Grass ... 41·0 on the 29th.
Mean Diurnal Range ... 12·0
Mean in the Shade ... 64·2

(Being 0·7 less than that of the same month on an average of the preceding 23 years.)

Humidity ... Greatest Amount ... 97·0 on the 3rd, 4th, and 5th.
Least ... ... 41·0 on the 25th.
Mean ... ... 76·8

(Being 0·7 less than that of the same month on an average of the preceding 23 years.)

Rain ... ... Number of Days ... ... 8 rain and 5 dew.
Greatest Fall ... ... 6·482 inches on the 6th.
Total Fall ... ... 10·257 „ 65 feet above ground.
11·347 „ 15 in. above ground.

(Being 4·823 inches greater than that of the same month on an average of the preceding 23 years.)

Evaporation Total Amount ... ... 2·140 inches.
Electricity ... Number of Days Lightning 9
Cloudy Sky ... Mean Amount ... ... 5·0
Number of Clear Days ... 5
Meteors ... Number observed ... 0

Remarks.

The mean barometer has been 0·128 below the average at Sydney. On the 4th and 5th of April very heavy rain fell: the amount on the 5th was 6·482; nearly the whole of this fell between 3·30 p.m and 8 p.m. Generally the rainfall has been light or moderate, excepting the coast from Sydney southwards. Cape George reports 19·53, which was the greatest of all the stations for this month.

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.

MAY, 1882.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·205 inches on the 31st.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29·164 „ on the 30th.
	Mean Height	29·843.

(Being 0·066 less than that in the same month on an average of the preceding 23 years.)

Wind	Greatest Pressure ...	26·6 lbs. on the 7th.
	Mean Pressure	0·6 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 23 years, W.)

Temperature	Highest in the Shade ...	75·1 on the 7th.
	Lowest in the Shade ...	45·0 on the 8th.
	Greatest Range	22·8 on the 12th.
	Highest in the Sun ...	116·5 on the 4th.
	Lowest on the Grass ...	41·6 on the 14th.
	Mean Diurnal Range ...	13·6
	Mean in the Shade ...	58·6

(Being 0·1 greater than that of the same month on an average of the preceding 23 years.)

Humidity ...	Greatest Amount ...	96·0 on the 30th.
	Least	38·0 on the 16th.
	Mean	67·3

(Being 8·9 greater than that of the same month on an average of the preceding 23 years.)

Rain	Number of Days... ...	5 rain and 9 dew.
	Greatest Fall	1·580 inches on the 21st.
	Total Fall... ...	3·339 „ 65 ft. above ground.
		3·875 „ 15 in. above ground.

(Being 1·309 inches less than that of the same month on an average of the preceding 23 years.)

Evaporation	Total Amount	2·062 inches.
Electricity ...	Number of Days Lightning	1
Cloudy Sky ...	Mean Amount	4·3
	Number of Clear Days ...	7
Meteors ...	Number observed ...	0

Remarks.

At Sydney barometer and temperature have been close to the average this month; but the rainfall was 1·309 less than the average. Inland, most of the stations had from 1 to 2 inches; on the coast and high lands rather more, the maximum being 5·21 at Port Stephens.

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, 1882.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·181 inches on the 5th, at 9 a.m.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29·436 „ on the 15th, at 5 a.m.
	Mean Height	29·856

(Being 0·064 less than that in the same month on an average of the preceding 23 years.)

Wind	Greatest Pressure ...	18·6 lbs. on the 8th.
	Mean Pressure	0·9 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 23 years, W.)

Temperature	Highest in the Shade ...	63·4 on the 24th.
	Lowest in the Shade ...	40·2 on the 23rd.
	Greatest Range	21·5 on the 24th.
	Highest in the Sun ...	107·8 on the 18th.
	Lowest on the Grass ...	32·6 on the 23rd.
	Mean Diurnal Range ...	11·6
	Mean in the Shade ...	53·3

(Being 1·0 less than that of the same month on an average of the preceding 23 years.)

Humidity ...	Greatest Amount... ...	97·0 on the 6th.
	Least	47·0 on the 19th.
	Mean	74·9

(Being 1·7 less than that of the same month on an average of the preceding 23 years.)

Rain	Number of Days... ...	11 rain and 6 dew.
	Greatest Fall	3·802 inches on the 9th.
	Total Fall	3·605 „ 65 feet above ground. 5·141 „ 15 in. above ground.

(Being 0·185 inches less than that of the same month on an average of the preceding 23 years.)

Evaporation	Total Amount	1·284 inches.
Electricity ...	Number of Days Lightning	2
Cloudy Sky ...	Mean Amount	5·1
	Number of Clear Days ...	4
Meteors ...	Number observed ...	0

Remarks.

The weather has been colder than the average for this month, and the air dry, but the rainfall nearly equal to the average, the quantity being made up by the very heavy fall on the night of the 8th. On the high lands and coast districts the rainfall has been abundant, from 2 to 9 inches having fallen; but in the western, and especially south-western districts, the month has been dry. At Port Macquarie the rain of the month amounted to 9·39 inches.

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.

JULY, 1882.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading	30·325 inches on the 19th, at 10 a.m.
	Lowest Reading	29·366 „ on the 25th, at 6 a.m.
	Mean Height	29·892

(Being 0·052 less than that in the same month on an average of the preceding 23 years.)

Wind	Greatest Pressure ...	21·1 lbs. on the 25th.
	Mean Pressure	1·2 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 23 years, W.)

Temperature	Highest in the Shade ...	73·3 on the 7th.
	Lowest in the Shade ...	38·9 on the 15th and 30th.
	Greatest Range	27·1 on the 7th.
	Highest in the Sun ...	107·2 on the 7th.
	Lowest on the Grass ...	32·9 on the 15th.
	Mean Diurnal Range ...	13·8
	Mean in the Shade ...	52·0

(Being 0·3 less than that of the same month on an average of the preceding 23 years.)

Humidity ...	Greatest Amount ...	95·0 on the 18th.
	Least	43·0 on the 3rd, 24th, and 25th.
	Mean	68·5

(Being 6·7 less than that of the same month on an average of the preceding 23 years.)

Rain	Number of Days... ...	6 rain and 2 dew.
	Greatest Fall	0·350 inches on the 9th.
	Total Fall... ...	0·290 „ 65 ft. above ground.
		0·453 „ 15 in. above ground.

(Being 3·743 inches less than that of the same month on an average of the preceding 23 years.)

Evaporation	Total Amount	1·892 inches.
Electricity ...	Number of Days Lightning	1
Cloudy Sky ...	Mean Amount	3·2
	Number of Clear Days ...	7
Meteors ...	Number observed ...	0

Remarks.

The barometer this month has been rather below the average, and the weather very dry. At Sydney the rainfall was 3·743 inches less than the average, and generally over the colony (with the exception of the northern coast) the weather has been very dry.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, $10^h\ 4^m\ 50 \cdot 81^s$; MAGNETIC VARIATION, 9° 35′ 2
Height above Mean Sea-level, 146 feet.

AUGUST, 1882.—GENERAL ABSTRACT.

Barometer ... Highest Reading... ... 30·244 inches on the 24th at 9 a.m.
At 32° Faht., but not corrected to sea-level.
Lowest Reading ... ... 29·371 „ on the 5th, at 2 p.m.
Mean Height ... ... 29·879

(Being 0·057 less than that in the same month on an average of the preceding 24 years.)

Wind ... ... Greatest Pressure ... 2·4 lbs. on the 13th.
Mean Pressure ... ... 0·7 lb.
Number of Days Calm ... 0
Prevailing Direction ... W.

(Prevailing direction during the same month for the preceding 24 years, W.)

Temperature Highest in the Shade ... 74·0 on the 26th.
Lowest in the Shade ... 41·2 on the 7th.
Greatest Range ... ... 24·0 on the 16th.
Highest in the Sun ... 124·1 on the 24th.
Lowest on the Grass ... 32·7 on the 7th.
Mean Diurnal Range ... 13·9
Mean in the Shade ... 55·9

(Being 0·9 greater that of the same month on an average of the preceding 24 years.)

Humidity ... Greatest Amount ... 100·0 on the 24th.
Least ... ... 46·0 on the 2nd.
Mean ... ... 74·5

(Being 2·4 greater than that of the same month on an average of the preceding 24 years.)

Rain ... ... Number of Days ... ... 13 rain and 3 dew.
Greatest Fall ... ... 1·170 inches on the 23rd.
Total Fall... ... ... { 2·390 „ 65 ft. above ground. / 3·392 „ 15 in. above ground. }

(Being 0·259 inch greater than that of the same month on an average of the preceding 24 years.)

Evaporation Total Amount ... ... 2·100 inches.
Electricity ... Number of Days Lightning 3
Cloudy Sky ... Mean Amount ... ... 4·8
Number of Clear Days ... 5
Meteors ... Number observed ... 0

Remarks.

The barometer has been below the average, and the temperature 0·9 above; the rainfall has been slightly greater than usual in August.

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.

SEPTEMBER, 1882.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading	30·246 on the 14th, at 8 a.m.
	Lowest Reading	29·343 on the 29th, at 4 a.m.
	Mean Height	29·835

(Being 0·031 less than that in the same month on an average of the preceding 24 years.)

Wind	Greatest Pressure ...	25·2 lbs. on the 25th.
	Mean Pressure	0·9 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 24 years, W.)

Temperature	Highest in the Shade ...	89·1 on the 24th.
	Lowest in the Shade ...	43·9 on the 15th.
	Greatest Range	33·4 on the 24th.
	Highest in the Sun ...	130·5 on the 18th.
	Lowest on the Grass ...	34·4 on the 8th.
	Mean Diurnal Range ...	18·5
	Mean in the Shade ...	61·6

(Being 2·9 greater than that of the same month on an average of the preceding 24 years.)

Humidity ...	Greatest Amount ...	92·0 on the 27th.
	Least	26·0 on the 22nd.
	Mean	61·5

(Being 9·0 less than that of the same month on an average of the preceding 24 years.)

Rain	Number of Days	3 rain and 3 dew.
	Greatest Fall	0·042 inches on the 15th.
	Total Fall...	0·025 „ 65 ft. above ground.
		0·083 „ 15 in. above ground.

(Being 3·261 inches less than that of the same month on an average of the preceding 24 years.)

Evaporation	Total Amount	3·129 inches.
Electricity ...	Number of Days Lightning	1
Cloudy Sky ...	Mean Amount	3·7
	Number of Clear Days ...	5
Meteors ...	Number observed ...	0

Remarks.

The weather this month has been very warm. On the 24th the shade thermometer rose to 89·1, and the mean was 2·9 greater than the average; scarcely any rain fell.

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.

OCTOBER, 1882.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·131 on the 2nd, at 8 a.m.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29·283 on the 23rd, at 2 p.m.
	Mean Height	29·801

(Being 0·030 less than that in the same month on an average of the preceding 24 years.)

Wind	Greatest Pressure ...	17·4 lbs. on the 2nd and 10th.
	Mean Pressure	1·1 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 24 years, N.E.)

Temperature	Highest in the Shade ...	89·4 on the 17th.
	Lowest in the Shade ...	50·8 on the 3rd.
	Greatest Range	30·0 on the 17th.
	Highest in the Sun ...	135·8 on the 24th.
	Lowest on the Grass ...	37·8 on the 3rd.
	Mean Diurnal Range ...	12·9
	Mean in the Shade ...	63·6

(Being 0·4 greater than that of the same month on an average of the preceding 24 years.)

Humidity ...	Greatest Amount... ...	100·0 on the 28th and 29th.
	Least	36·0 on the 10th.
	Mean	74·1

(Being 5·0 greater than that of the same month on an average of the preceding 24 years.)

Rain	Number of Days	14
	Greatest Fall	4·235 inches on the 29th.
	Total Fall...	6·688 " 65 ft. above ground. 8·645 " 15 in. above ground.

(Being 5·690 inches greater than that of the same month on an average of the preceding 24 years.)

Evaporation	Total Amount	3·253 inches.
Electricity ...	Number of Days Lightning	1
Cloudy Sky ...	Mean Amount	5·1
	Number of Clear Days ...	4
Meteors ...	Number observed ...	0

Remarks.

Weather warm again, but with abundant rains, falling to the extent of 8·645 inches on fourteen days; the heaviest fall was 4·235 inches on the 29th.

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.

NOVEMBER, 1882.—GENERAL ABSTRACT.

Barometer ...	Highest Reading	30·241 on the 7th, at 8 a.m.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29·434 on the 22nd, at 12 noon.
	Mean Height	29·930

(Being 0·138 inch greater than that in the same month on an average of the preceding 24 years.)

Wind	Greatest Pressure ...	23·1 lbs. on the 27th.
	Mean Pressure	0·9 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	E.N.E.

(Prevailing direction during the same month for the preceding 24 years, S.)

Temperature	Highest in the Shade ...	83·7 on the 22nd.
	Lowest in the Shade ...	54·5 on the 8th.
	Greatest Range	17·8 on the 22nd.
	Highest in the Sun ...	147·5 on the 22nd.
	Lowest on the Grass ...	43·8 on the 23rd.
	Mean Diurnal Range ...	12·5
	Mean in the Shade ...	66·2

(Being 0·4 less than that of the same month on an average of the preceding 24 years.)

Humidity ...	Greatest Amount ...	92·0 on the 18th.
	Least	35·0 on the 22nd.
	Mean	70·6

(Being 0·8 greater than that of the same month on an average of the preceding 24 years.)

Rain	Number of Days... ...	10 rain and 2 dew.
	Greatest Fall	0·228 inches on the 29th.
	Total Fall...	0·526 „ 65 ft. above ground.
		0·879 „ 15 in. above ground.

(Being 2·450 less than that of the same month on an average of the preceding 24 years.)

Evaporation	Total Amount	3·575 inches
Electricity ...	Number of Days Lightning	2
Cloudy Sky ...	Mean Amount	6·0
	Number of Clear Days ...	4
Meteors ...	Number observed ...	0

Remarks.

This month the barometer has been higher than usual, the mean being 0·138 greater than the average. The humidity has been high, 0·8 above the usual amount, but very little rain fell, only 0·879 inch.

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, 1882.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading... ...	30·065 on the 26th, at 10 p.m.
	Lowest Reading	29·292 on the 31st, at 4 and 5 p.m.
	Mean Height	29·703

(Being 0·039 inch less than that in the same month on an average of the preceding 24 years.)

Wind	Greatest Pressure ...	11·5 lbs. on the 21st.
	Mean Pressure	1·0 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	S.

(Prevailing direction during the same month for the preceding 24 years, N.E.)

Temperature	Highest in the Shade ...	99·9 on the 19th.
	Lowest in the Shade ...	55·1 on the 4th.
	Greatest Range	39·1 on the 19th.
	Highest in the Sun ...	160·0 on the 19th.
	Lowest on the Grass ...	48·2 on the 3rd.
	Mean Diurnal Range ...	16·3
	Mean in the Shade ...	69·7

(Being 0·1 greater than that of the same month on an average of the preceding 24 years.)

Humidity ...	Greatest Amount ...	96·0 on the 6th.
	Least	30·0 on the 19th.
	Mean	66·0

(Being 3·9 less than that of the same month on an average of the preceding 24 years.)

Rain	Number of Days	18
	Greatest Fall	0·758 inches on the 7th.
	Total Fall...	1·365 „ 65 ft. above ground.
		2·245 „ 15 in. above ground.

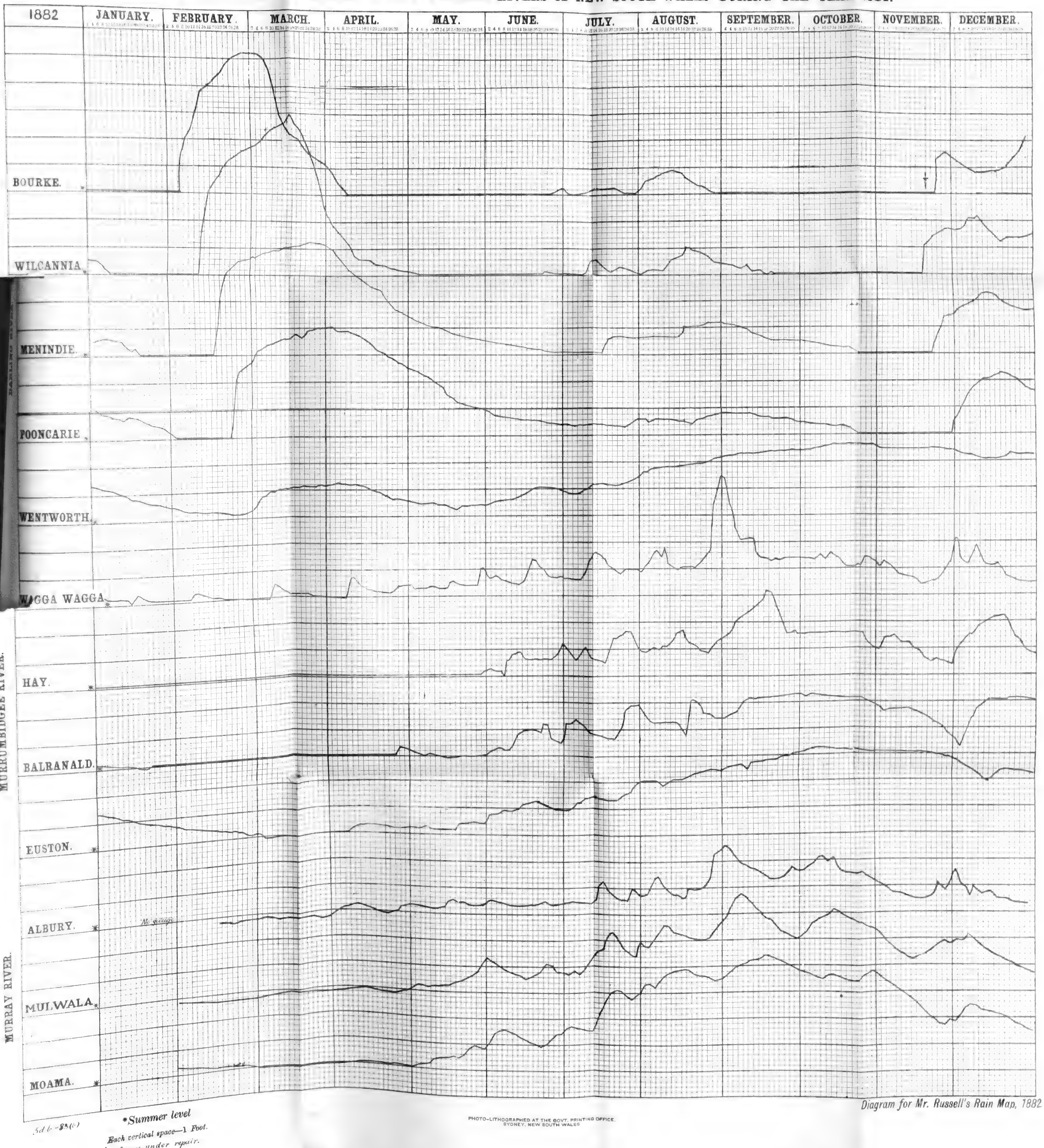
(Being 0·050 inch greater than that of the same month on an average of the preceding 24 years.)

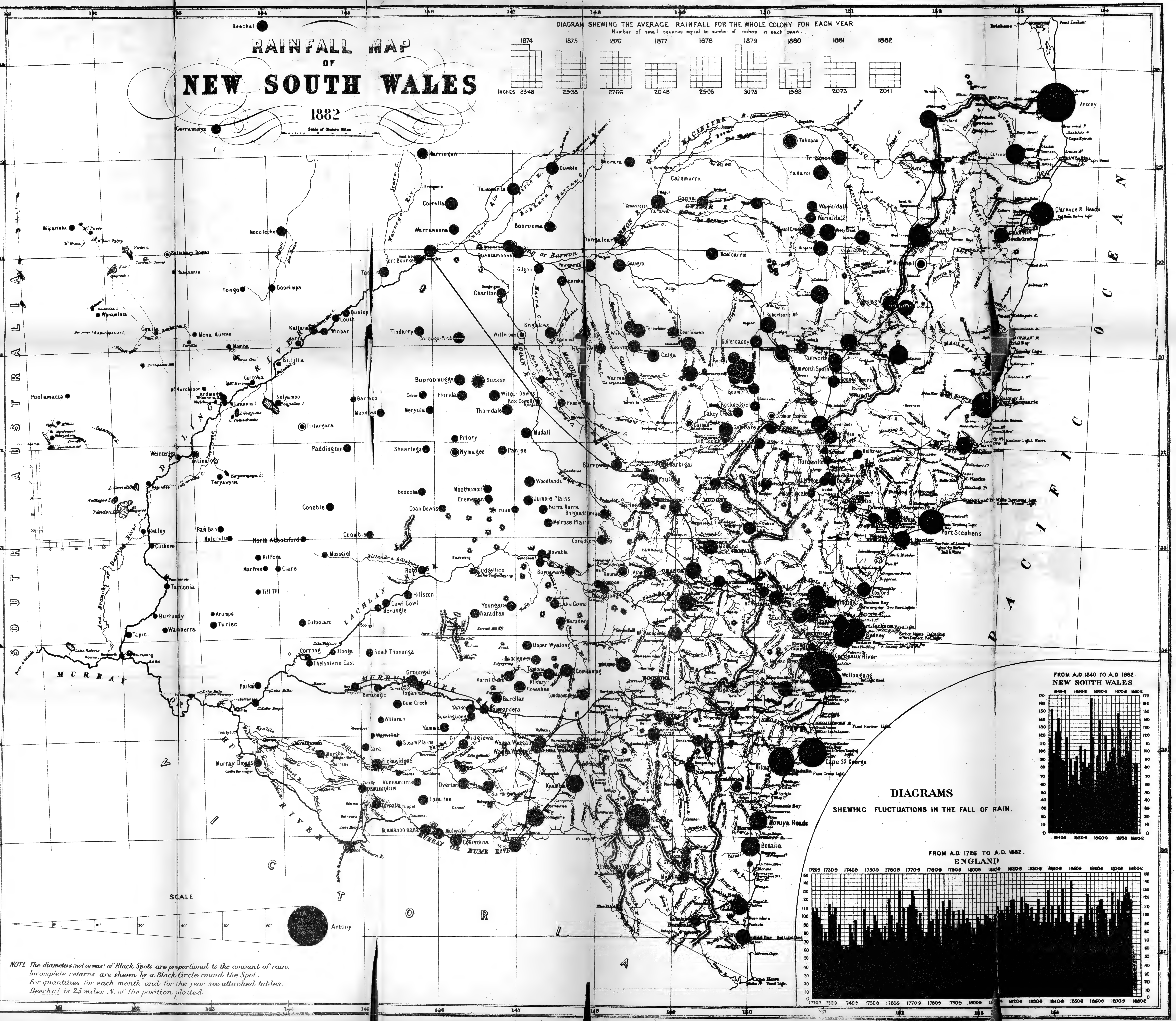
Evaporation	Total Amount	4·729 inches.
Electricity ...	Number of Days Lightning	3
Cloudy Sky ...	Mean Amount	5·4
	Number of Clear Days ...	0
Meteors ...	Number observed ...	1

Remarks.

This month's means are very close to the averages, both for barometer, temperature and rainfall.

CURVES SHOWING THE HEIGHT OF THE WESTERN RIVERS OF NEW SOUTH WALES DURING THE YEAR 1882.





Surveyor General's Office Sydney N.S.W. 1883

LIST OF PUBLICATIONS.

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„ VIII.—Statistical Review of the Progress of New South Wales in the last ten years, 1862–71	Chris. Rolleston, Esq.

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(Edited by Prof. Liversidge and Dr. Leibius.)

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(Edited by Prof. Liversidge).

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Sydney: Thomas Richards, Government Printer.—1883.

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